Drawing Technology Inc.

Operations and Instructions Manual



Model 63125.350TSH Wire Drawer

Serial No. 0823-5874

Includes RD56 Descaler, RF80 Flipper and Snag Assembly

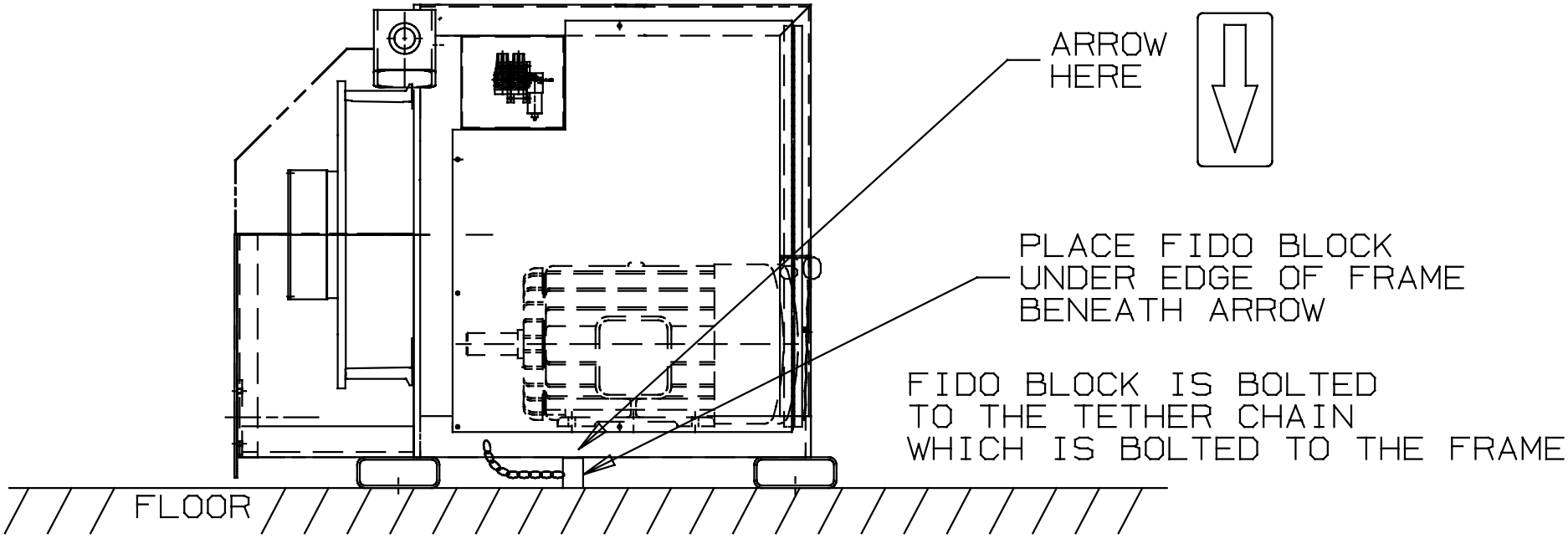
1550 Elmwood Road | Rockford, IL 61103 | Phone [815] 877.5133 | Fax [815] 877.3627
Email sales@drawingtechnology.com | Website www.drawingtechnology.com

Leading the Way in Wire Processing Equipment

FIDO

NOTE TO ELECTRICIAN AND MACHINE OPERATOR:

ON THE DRAWBOX END OF THE MACHINE, JUST ABOVE THE FLOOR IS A YELLOW AND BLACK ARROW POINTING DOWN. THE FIDO BLOCK MUST BE POSITIONED UNDER THIS ARROW FOR THE MACHINE TO RUN PROPERLY. THERE IS A PROXIMITY SWITCH IN THE BASE OF THE MACHINE WHICH LOOKS DOWN TOWARDS THE FLOOR AND "SEES" THE FIDO BLOCK. THIS IS THE "SNAG DETECTOR" CIRCUIT. IF A SEVERE TANGLE OCCURS THE MACHINE WILL MOVE TOWARDS THE TANGLE, WHILE THE FIDO BLOCK STAYS PUT, THE PROXIMITY SWITCH SENSES THAT THE FIDO BLOCK IS NO LONGER UNDER IT, AND SHUTS THE MACHINE DOWN.



REV	DESCRIPTION	BY	DATE

TOLERANCES

X.XXX +/- .005
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L:
STK SIZE:
FINISH:
H.T.
ASSEM:
MODEL:
BREAK ALL SHARP EDGES

BY: LSS
DATE: 7-6-04

DTi
DRAWING TECHNOLOGY INC.

FIDO INSTRUCTIONS

SHEET 1 OF 1
A SCALE

FIDO

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Specification Bulletin

Model 63125-350TSH

Capstan size	38 in. (954MM)
Maximum finished wire (alloy)	0.562 in. (14.3mm)
Maximum finished wire (medium carbon steel)	0.625 in. (16mm)
Maximum rated draw force	12,500 lbs. (5,660kg)
Weight	5,500 lbs. (2,491.50kg)
Main power	As required
Control voltage	24 VDC
Capstan guard	Full door
Capstan guards interlock	Included
Production slip interlock	Included
Production machine start interlock	Included
Drawer movement switch	Optional
Two hand jog system	Included
Two speed jog system	Included
Gripper assembly	Included
Pneumatic roller assembly	Included
Wire roller reverse interlock	Included
Lift off draw box	Included
Percent load and hour meter	Included

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General Safety Instructions

Caution!
Do not attempt to operate any equipment without reading and understanding all of the operating instructions listed in the machine manual.

- 3 Phase electrical power where required, must have conductors large enough to handle the amperage of the electric motor. This amperage is stamped on the machine identification plate located on the door of the electrical cabinet. It is recommended that a qualified electrician ensure your electrical supply to the machine meets all national and local electrical codes.

- DTI equipment is equipped with electrical safety interlocks and/or mechanical guards to provide the safest machine possible.
  - Two hand push button jog circuit during machine set up while guards are open.
  - Production machine start interlock will ensure other machines in the production line are ready for operation when the production machine starts to consume wire.
  - Production slip interlock will stop production machine when the wire drawer is unable to feed wire.
  - Full mechanical guards covering potential pinch points, and rotating parts that can cause injury.
  - Emergency stop button, interlocked to shut down the production line when an emergency occurs. This should not be used as a normal method of routinely stopping and starting the machinery. The emergency stop may cause a machine in the system to relax, and release clamping pressure on the wire.
  - Power supply disconnect is provided with every machine requiring electrical power. Customer should ensure proper **lock out / tag out** procedures are followed when doing any maintenance on the machinery.
  - Reversing interlock is provided on all wire drawing machinery, which will prevent the reverse operation of the wire drawer when the wire roller is engaging the wire to the capstan.
  - Wire tangle and wire snag detection is appropriately integrated into any wire processing line, minimizing any damage to equipment and injury to personnel in the case of a catastrophe.

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- Attempting to run any machine without guards closed, or attempting to defeat the interlocks could result in **SEVERE INJURY OR DEATH!!! DO NOT OPERATE THIS EQUIPMENT WITHOUT ALL SAFETY GUARDS IN PLACE!!!** Do not hesitate to contact the factory or your local representative if you have any questions.

- Routine machine maintenance is also an important part in keeping a machine safe. Periodic checks to various safety switches, and machine components should be incorporated into your preventative maintenance schedule. Refer to the service bulletin instructions listed in the machine manual table of contents for the PMS check list of your equipment.

- Eye protection and safety shoes should be worn when operating or performing maintenance all equipment.

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Operating and Installation Instructions

AC Variable Frequency In-line Wire Drawing Equipment

Services Required

- 3 Phase electrical power is required with conductors large enough to handle the amperage of the electric motor. This amperage is stamped on the machine identification plate located on the door of the electrical cabinet. Voltage unbalance between all 3 phases should not exceed 2%
- Air requirements are a minimum of 60 PSI at 1 CFM
- The machine is filled with oil at the factory and requires no additional lubrication at time of installation (see Fairfield gear reducer for lubrication instructions)

Installation

- The wire drawer should be located so the compensator lines up with the center of the production machine feed rolls.
- The distance between the production machine and the wire drawer varies. This distance should be wide enough to allow the loop of wire from the compensator to the feed rolls to be in a natural state without any sharp bends or twists.
- Phasing of the electrical power is automatic on a VF style drive
- The wire drawer is equipped with holes in the feet that can be used for bolting the machine to the floor. This is not required and is up to the customer's discretion.

Sequence of Operation

Caution: Do not attempt to operate this equipment without reading and understanding all of the operating instructions. All DTI drawers are equipped with a full capstan door that is electrically interlocked. Attempting to run the machine without this door closed or attempting to defeat the interlock could result in **SEVERE INJURY OR DEATH !!!**. **DO NOT OPERATE THIS EQUIPMENT WITHOUT ALL SAFETY GUARDS IN PLACE!!!!!!!** Do not hesitate to contact the factory or your local representative if you have any questions.

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Drawer without Feed Head String-Up Procedure

- Position gripper head to 3:00 o'clock position
- Remove bolt securing gripper head to capstan flange
- Insert pointed wire into drawbox
- Attach gripper head to wire point. Tighten set screws.
- Fill drawbox with lubricant (powder) or:
- Position lube trough under wire, 1 inch back from draw die. (liquid)
- Turn on lube tank pump (liquid)
- Make sure all clamp and wire rollers are disengaged.
- Jog machine 1 revolution until gripper head is at the 2:00 o'clock position
- Reverse capstan until wire is loose.
- Slide gripper head and chain to flange on outside of capstan.
- Continue wrapping capstan. More wraps are better than not enough. Actual number depends on capstan diameter, wire diameter, tensile, area reduction etc. If unsure, call DTI for an initial recommendation.
- When capstan is wrapped, stop gripper head at 3:00 o'clock position
- Reverse just enough to loosen last wrap of wire
- Set roller pressure. If near the upper limit of machine capacity, set roller pressure to maximum. Smaller diameter will use proportionally less pressure.
- Position last wrap under clamp roller(s) and engage.
- Jog machine forward just enough to tighten wire onto capstan.
- Remove gripper head. Loosen set screws, then tap on the end of the head with a hammer or similar object, keeping hands away from wire lead end.
- Attach gripper head back to capstan flange
- Jog forward, feeding wire around compensator arm.
- Continue jogging forward until wire is past drawer. Close capstan cover.
- Press "auto" button
- Jog forward or pull on wire. Feed wire into production machine
- Start production machine, adjust wire roller and compensator arm pressure to minimize wire slippage and wire marking. See troubleshooting guide for help.

Caution: never let go of the end of the wire without securing it somewhere else. For example, gripper head is not removed until wire rollers are tightly clamped. The wire end is dangerous and must always be contained.

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Wire Drawer Troubleshooting Guide

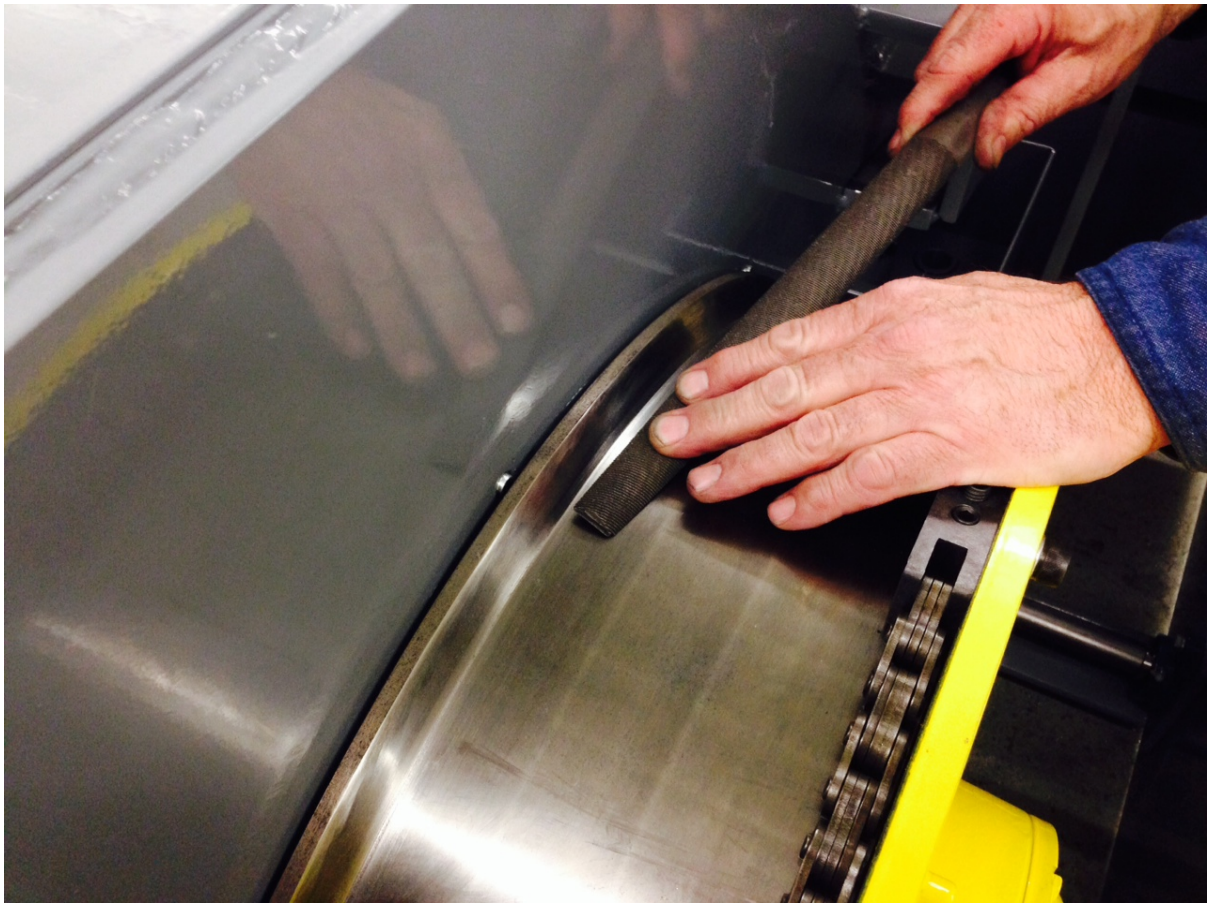
Problem	Cause	Remedy
Wire scratched before drum	Bad draw die	Replace die
	Bad Lubricant	Change-clean lube Try different lube
	Scratch before die	Inspect cause of scratch and remedy
Wire climbing capstan flange	Too much traction	Reduce number of wraps Lower wire roller pressure Lower compensator pressure
	Capstan dry	Add lubricant to drum and see if wire slides better.
	Pick-up on capstan surface	Clean capstan surface
	Damaged capstan surface	Repair-replace capstan
Wire slipping more than 6" per revolution	Not enough traction	Add wraps of wire Add wire roller pressure Add compensator pressure
	Too much lube on drum	Clean capstan Switch lubricant
Marks on top of wire	Wire roller pressure too high	Reduce wire roller pressure
	Wrong wire rollers	Change wire rollers
	Last wrap of wire dragging on floor	Increase comp arm pressure Engage and adjust 7 O'clock roller (mod 100)
Marks on bottom of wire	Pick-up on drum	Clean pick-up using file and scotchbrite, by hand only!!
	Damaged Capstan	Repair-replace capstan

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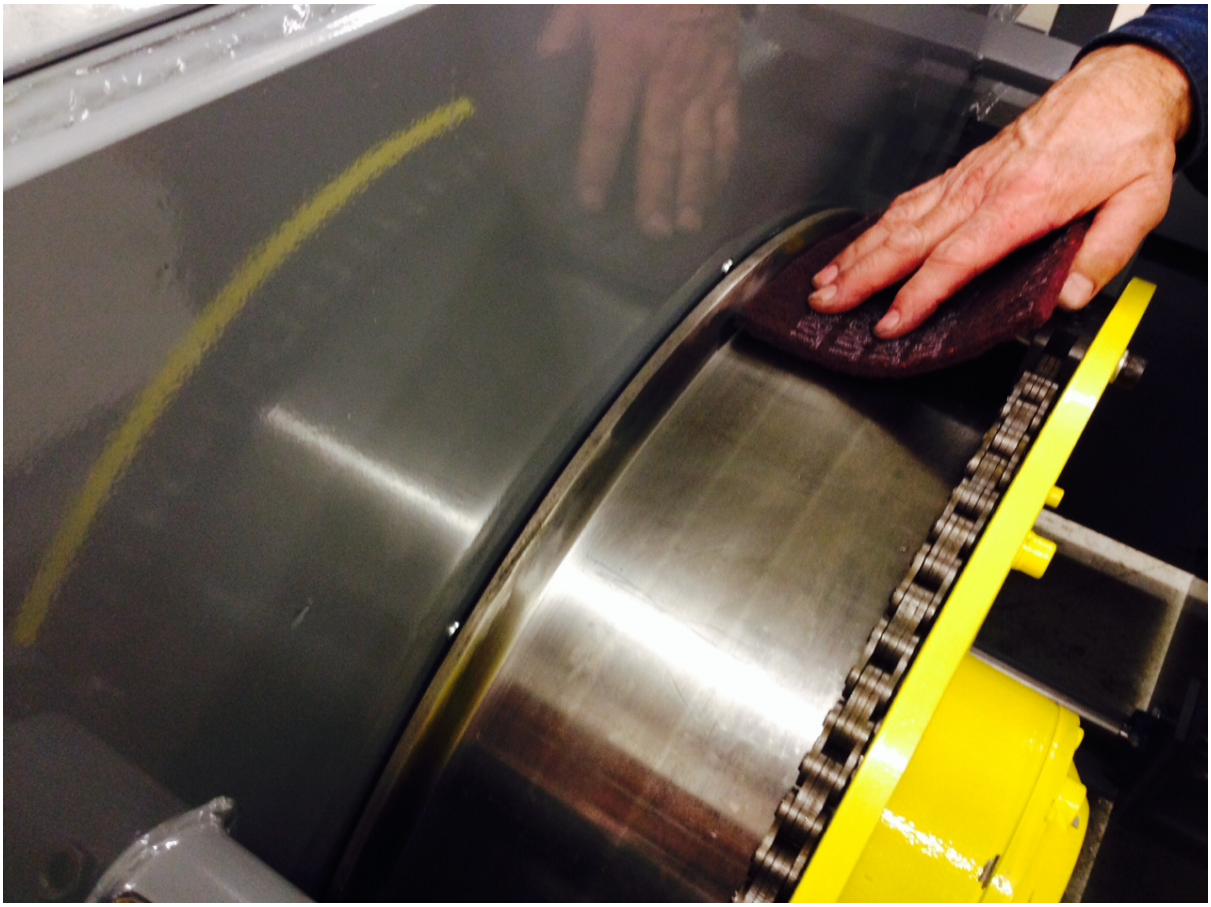
Capstan Pick-Up Removal Technique

Excessive wire slippage will cause a condition known as Pick-up. Little pieces of the drawn wire will actually weld themselves to the surface of the capstan. These will be little bumps that can be felt by hand. They usually are near the inside flange. They are very easy to remove but must be done using the proper technique. Use a sharp, single cut flat file. Work around the circumference of the capstan, not across front to back. Lay the file flat on the surface of the capstan, with your hand on top. The file will cut the pick-up material off and slide over the D2 capstan surface. You will feel noticeable resistance when you encounter the pick up being removed. Once you no longer feel this resistance, polish the area with crocus cloth or a scotch brite pad. Never use any type of power tool. Call DTI if you have any questions. Capstans damaged by power tools cannot be fixed in the field. They will need to be sent back to DTI. We have special machinery designed specifically for this task.



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Preventative Maintenance Schedule

To determine machine run time

For Toshiba S15 and AS1 drives

- Press the "MODE" key twice, then press the up arrow several times to display: t0.00
- Displays the cumulative run time in hours (.01=1 hour: 1.00=100 hrs)

Wire Drawers

- **Weekly or every 40 hours**
  - Check wire roller groove for wear and fit with the wire
  - Check wire roller bearing for slop
  - Check capstan for pick-up (bumps where wire first meets capstan)
  - Check compressed air filter and drain any water
- **Monthly or every 167 hours**
  - Check disk brake pads and disk for wear (if equipped)
  - Grease wire roller shaft
  - Check for air leaks
  - Check main drive belt tension
  - Check air cylinder movement, smooth and free
  - Remove, clean, and dry electrical box air filters. (if equipped) DO NOT BLOW OUT CABINET WITH COMPRESSED AIR. IF NECESSARY, VACUUM ONLY!!
  - Grease feed head bearings (models 73 and larger)
  - Check feed head shafts for slop (models 73 and larger)
  - Check feed head air cylinders for smooth operation (model 73 and larger)
- **After 3 months from new or 500 hours**
  - Drain and refill main gearbox oil. Use new oil specified in L&S table
- **Every 6 months or 1000 hours**
  - Check main gearbox oil level.
  - Grease electric motor bearings if equipped with fitting
  - Grease compensator shaft bearings
- **Yearly or every 2000 hours**
  - Drain and refill main gearbox oil
  - Check feed head gearbox oil level and add if necessary (models 73 and up)

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Descaler

- **Weekly or every 40 hours**
  - Check main rollers for wear. Particularly the coated faces and carbide inner ring.
  - Grease main descaler rollers.
  - Check main rollers for slop. Tighten Timken bearing nut to proper preload if necessary
  - Check alignment of air wipe
  - Check entrance rollers for wear

Recoiler

- **Weekly or every 40 hours**
  - Grease feed head shaft bearings. (3 grease fittings)
  - Oil chain inside housing using a spray chain lube
  - Check feed roll grooves for wear
  - Check feed roll mount to shafts for tightness
  - Check feed roll shafts for slop. Tighten Timken nut if necessary
  - Check casting rollers for wear in grooves
  - Check casting rollers for bearing tightness
- **Monthly or every 167 hours**
  - Check feed head drive chain tension. (check with feed rolls closed W/O wire)
  - Remove, clean, and dry electrical box air filters. (if equipped) DO NOT BLOW OUT CABINET WITH COMPRESSED AIR. IF NECESSARY, VACUUM ONLY!!
  - Check gearboxes for leaks. (feed head and turntable)
- **Yearly or every 2000 hours**
  - Replace oil in both gearboxes
  - Check tightness of turntable torque arm bolts and anchor

Spooler

- **Weekly or every 40 hours**
  - Check traversing unit shaft, clean with electrical contact cleaner
  - Check traversing unit movement, and reversing mechanism
  - Check traversing unit reversing springs
- **Monthly or every 167 hours**
  - Check gearbox for oil leaks
  - Check spool holder drive tang for wear
  - Check tensioning rollers for wear (Spooler without recoiler models)
- **Yearly or every 2000 hours**
  - Drain and replace oil in gearbox

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Power Turntable

- **Monthly or every 167 hours**
  - Check dancer arm roller(s) for wear
- **Yearly or every 2000 hours**
  - Replace oil in gearboxes
  - Check tightness of turntable torque arm bolts and anchor
  - Grease dancer arm bearings

LDF 112 Wire feeder

- **Monthly**
  - Grease shaft bearings
  - Check shafts for slop
  - Check hourglass rollers for slop
  - Grease feed head gears (fitting on side of head)
  - Check pocketed chain sheave for wear
  - Check air cylinders for smooth operation
- **Yearly**
  - Check oil levels in 2 gearboxes and add if necessary

Uncoiler 1296 and 890

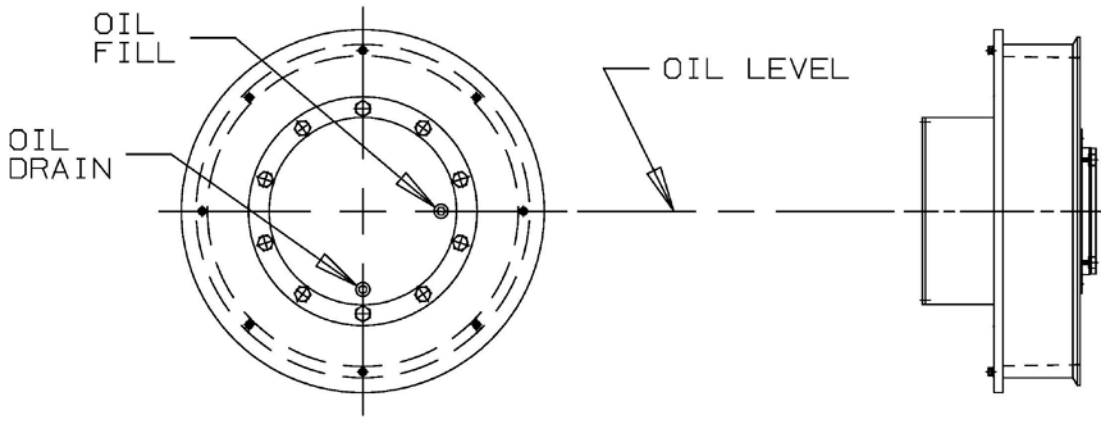
- **Monthly**
  - Check feed head shafts-bearings for radial play
  - Compressed air filter, drain water
  - Check air cylinder movement, free and smooth.
  - Lube main drive chain (motor cycle chain lube spray)
  - Check main drive chain tension
  - Straighten snag bar if bent
- **Yearly**
  - Check main gearbox oil level (90 wt)
  - Check feed head sump oil level add if necessary (90 wt)
  - Check one way clutch oil level (ATF)
  - Grease feed head bearings
  - Grease mandrel outboard bearing (1296 only)
  - Check jack screw gearbox oil levels (power straightener models)
  - Check couple straightener roller bearings
  - Check recoiling head roller bearings (if equipped)
  - Grease couple straightener main shaft
  - Grease recoiling head main shaft (if equipped)
  - Check saw gearbox oil level (if equipped)
  - Inspect all guide rollers for wear

DTI PLANETARY GEARBOX
INSTRUCTION SHEET

LUBRICATION:
ALL UNITS ARE FILLED WITH MOBILUBE HD PLUS 80W-90 GEAR OIL.
USE THIS OIL OR AN EQUIVALENT TYPE OF GEAR OIL WITH A VISCOSITY OF 80/90.

OIL CHANGES:
CHANGE THE OIL AFTER THE FIRST 60 DAYS (FOR A SINGLE SHIFT OPERATION).
CHANGE THE OIL AFTER THE FIRST 30 DAYS (FOR A 2 SHIFT OPERATION).
THEREAFTER, CHANGE THE OIL ON A YEARLY BASIS.
REFER TO FIG. 1 FOR OIL FILL, OIL DRAIN, AND OIL LEVELS.

FIG.1:



WHEN CHANGING THE OIL, USE CARE TO INSURE THAT CLEANLINESS IS OBSERVED WHEN OPENING ANY OF THE DRAIN PLUGS.
MAKE SURE TO CLEAN OFF ANY DIRT OR DEBRIS FROM THE AREA TO KEEP CONTAMINANTS FROM ENTERING THE GEARBOX.
USE ONLY CLEAN OIL FROM A CLEAN CONTAINER WHEN REFILLING THE GEARBOX.
USE CAUTION NOT TO OVERFILL THE BOX WITH OIL.
TOO MUCH OIL CAN LEAD TO CHURNING, EXCESSIVE HEAT BUILDUP, REDUCED OPERATING EFFICIENCY, AND REDUCED LIFE.

OPERATING TEMPERATURES:
IF USED UNDER HEAVY LOADS, THE GEARBOX MAY OPERATE AT A TEMPERATURE THAT EXCEEDS 100°F.
MAXIMUM OPERATING TEMPERATURES SHOULD BE KEPT AT OR LESS THAN A TEMPERATURE OF 140°F/60°C.
OIL BREAKDOWN AND SEAL BREAKDOWN ARE CONCERNS IF TEMPERATURES EXCEED THIS LEVEL.
TEMPERATURES ABOVE 140°F REQUIRE FULL SYNTHETIC LUBRICANT AND SLIGHTLY LOWER OIL LEVELS. CONTACT DTI FOR MORE INFORMATION.

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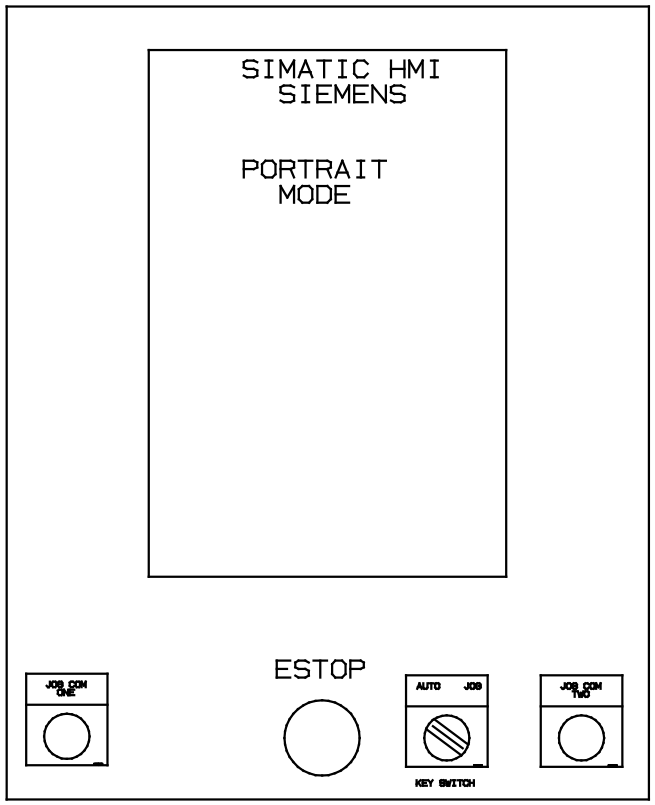
Gearbox Oil Capacity Information

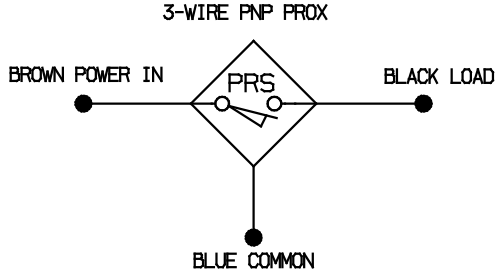
No.	Gearbox Model	DTI Part Number	Oil Capacity (L)
1	017T3088	502-017T3-88I	3
2	026T2026	502-026T2-26I	4
3	036T3100	502-036T3-100I	5
4	050T2040	502-050T2-40I	7
5	050T3116	502-050T3-116I	7
6	080T3127	502-080T3-126I	8
7	100T3193	502-100T3-193I	10
8	110T3128	502-110T3-128I	11
9	110T2024	502-110T2-24I	11
10	130T3115	502-130T3-115I	11
11	180T3111	502-180T3-112I	16
12	220T3		18
13	450T4		22

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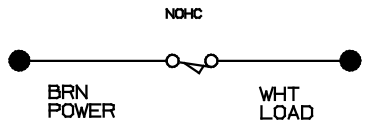
RELAY DESCRIPTIONS:
K1 ESTOP RELAY
K2 FINDER RELAY, VFD RESET
K3 FINDER RELAY, STARTGUARD
K4 FINDER RELAY, ESTOP RELAY RESET

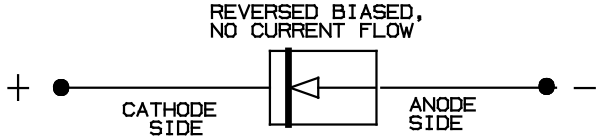
Y1 BRAKE SOLENOID
Y2 WIRE ROLLER SOLENOID
Y3 SNAG SOLENOID





CAPSTAN COVER





PENDANT WIRE NUMBER CODE

NUM	COLOR	TERMINAL	
1	RED	1003	24 VDC
2	BLACK	1001	0 VDC
3	BLUE		
4	ORANGE	I0.1	JOG COM 1
5	WHITE	I0.2	JOG COM 2
6	RED/BLACK	1002	24 VDC
7	ORA/BLACK	I0.0	KEYED SWITCH
8	WHT/BLACK	1014	ESTOP PB
9	GRN/BLACK	1015	ESTOP PB
10	RED/WHT	1016	ESTOP PB
11	BLACK/WHT	1017	ESTOP PB
12	BLUE/WHT	1012	ESTOP PB
13	GRN/WHT		
14	BLK/RED		
15	BLU/RED		
16	WHT/RED		
17	ORA/RED		
18	RED/BLK		

REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

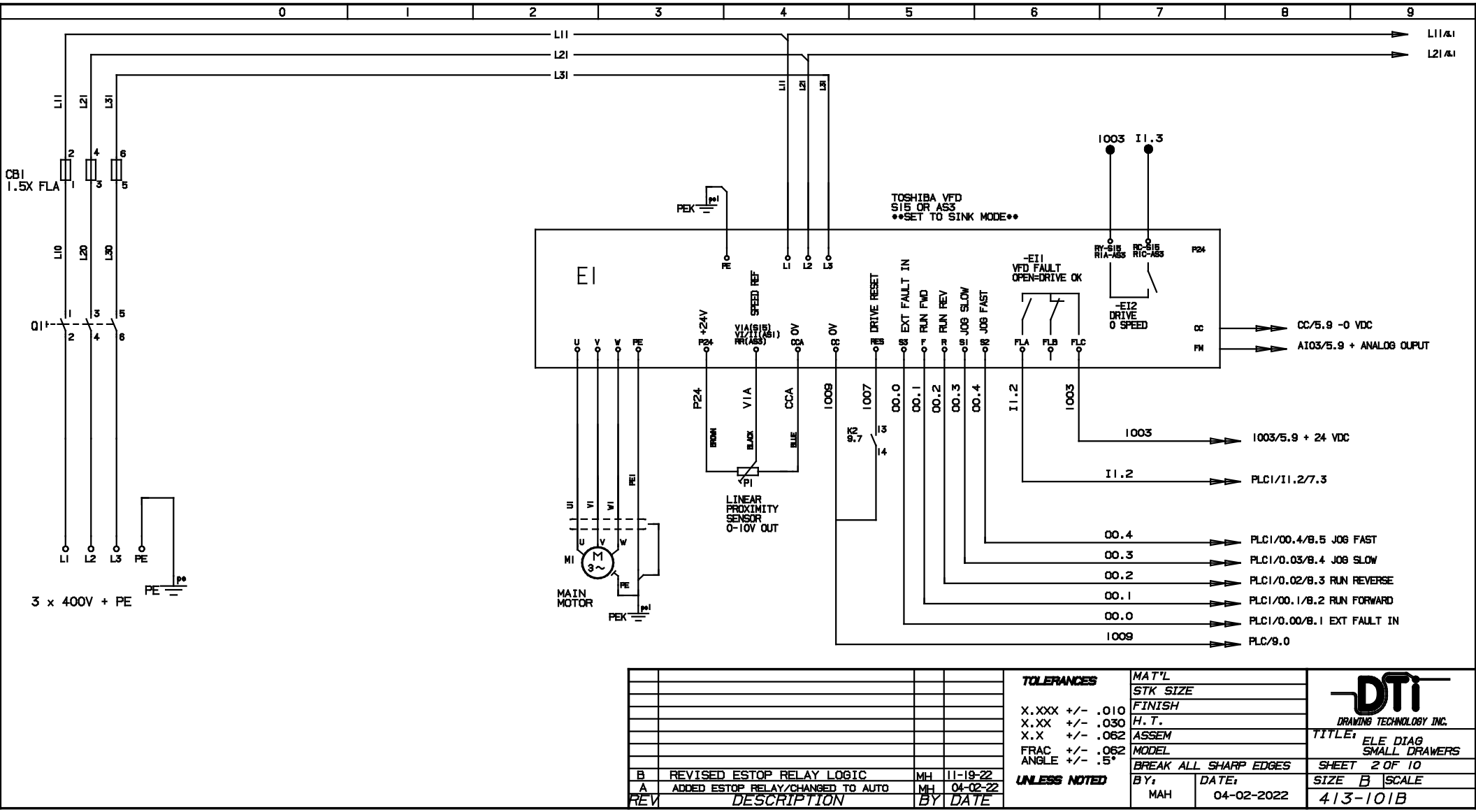
TOLERANCES UNLESS NOTED
X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES

BY: MAH
DATE: 04-02-2022

DTi DRAWING TECHNOLOGY INC.

TITLE: ELE DIAG SMALL DRAWERS
SHEET 1 OF 10
SIZE B SCALE
413-101B



REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

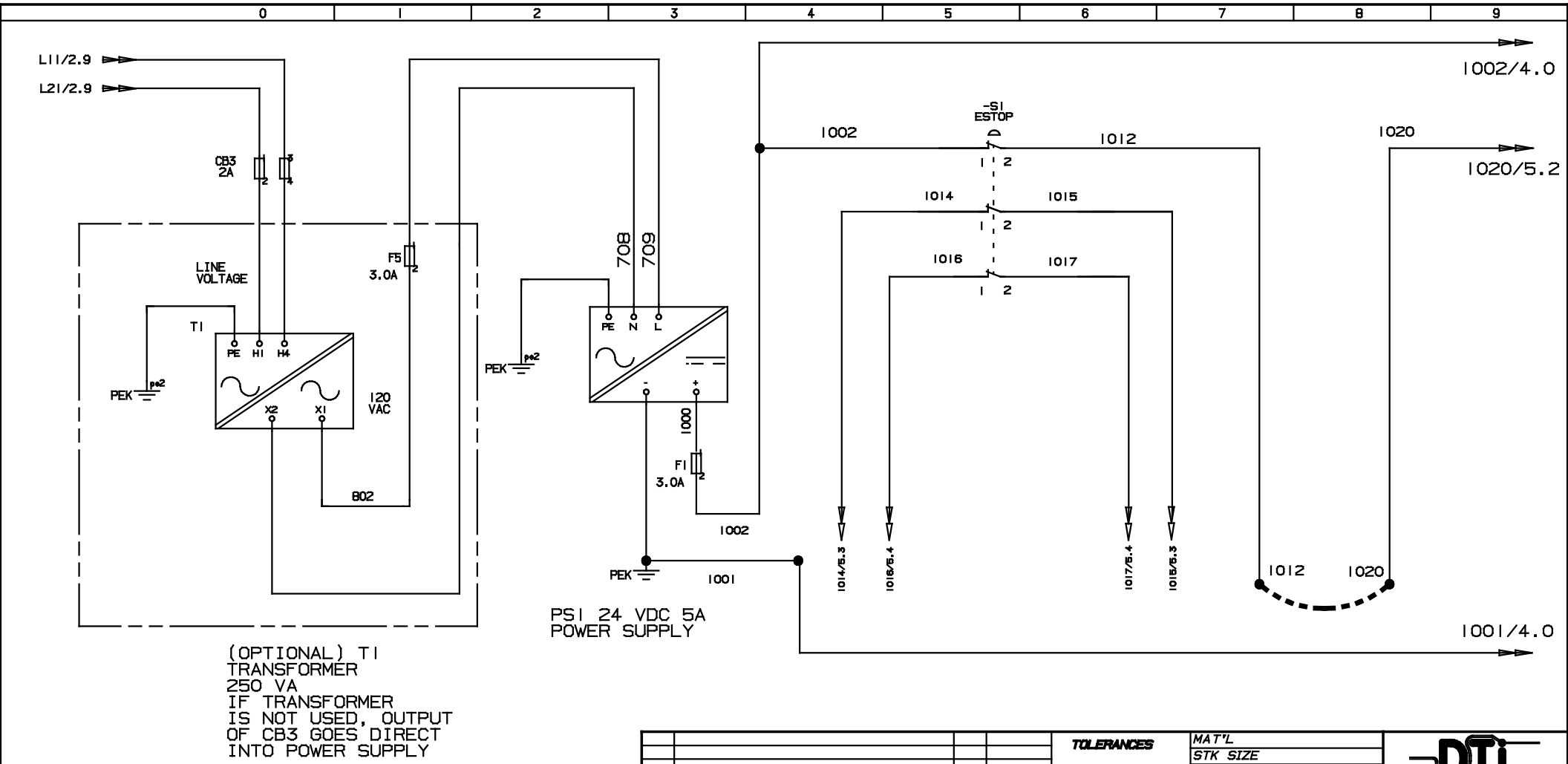
UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES

BY: MAH
DATE: 04-02-2022

DTi
DRAWING TECHNOLOGY INC.

TITLE: ELE DIAG SMALL DRAWERS
SHEET 2 OF 10
SIZE B SCALE
413-101B



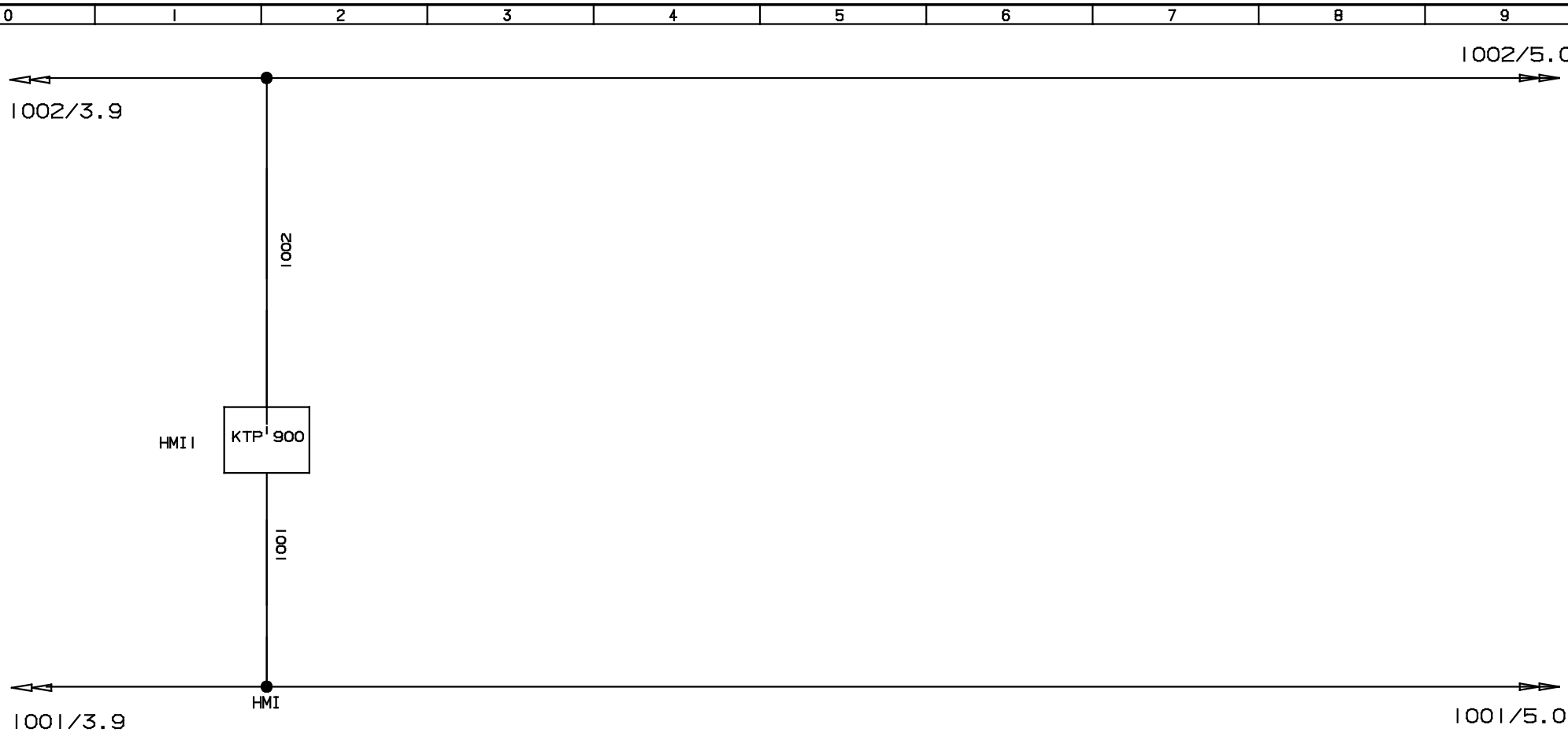
(OPTIONAL) T1
TRANSFORMER
250 VA
IF TRANSFORMER
IS NOT USED, OUTPUT
OF CB3 GOES DIRECT
INTO POWER SUPPLY

REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY	MH	4-2-22

TOLERANCES
X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°
UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES
BY: MAH
DATE: 04-02-2022

DRAWING TECHNOLOGY INC.
TITLE: SMALL DRAWER
SHEET 3 OF 10
SIZE B SCALE
413-101B



REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES

BY: MAH
DATE: 04-02-2022

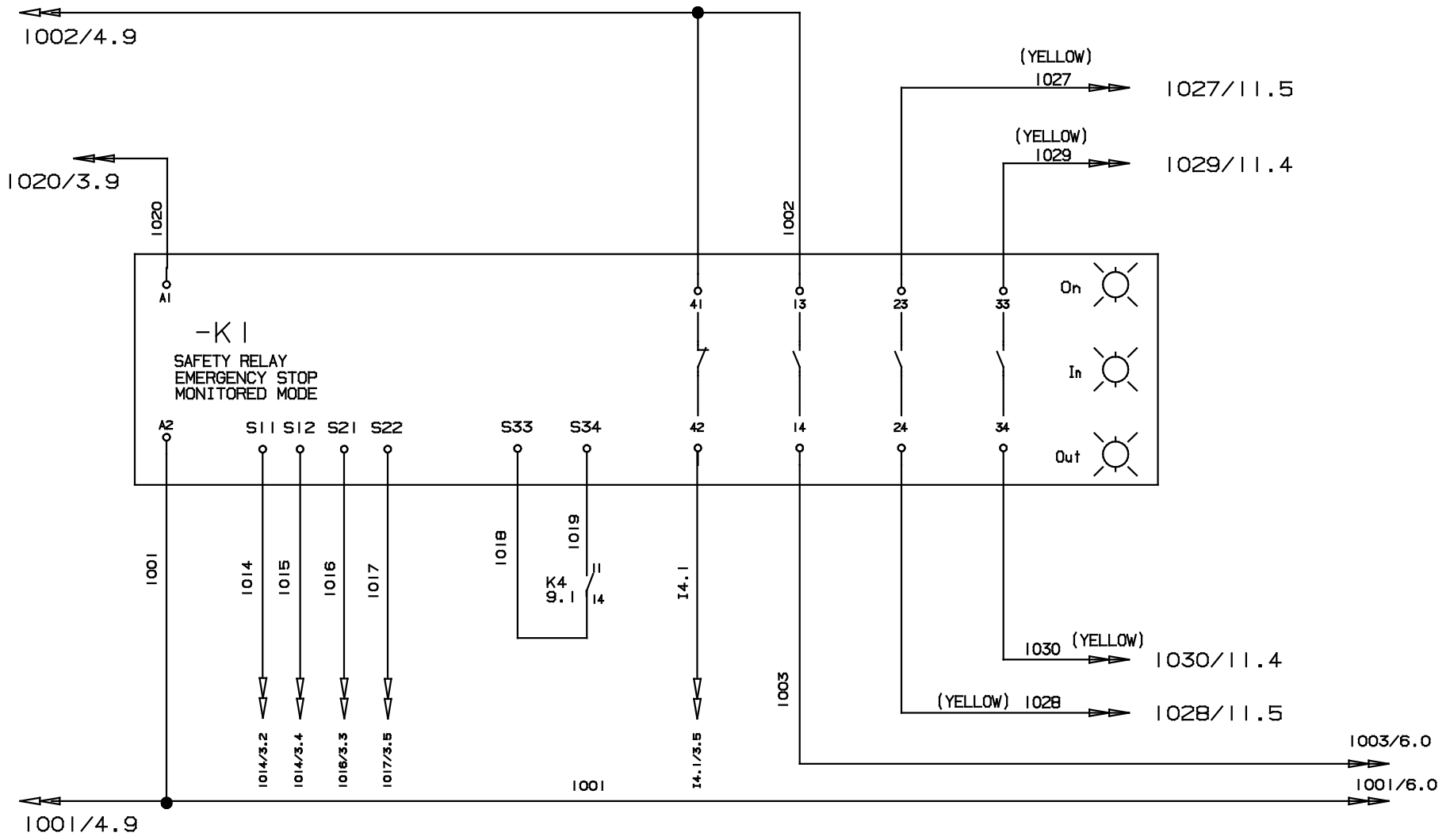
DTi
DRAWING TECHNOLOGY INC.

TITLE: ELE DIAG SMALL DRAWERS

SHEET 4 OF 10

SIZE B | SCALE

413-101B



REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES

BY: MAH
DATE: 04-02-2022

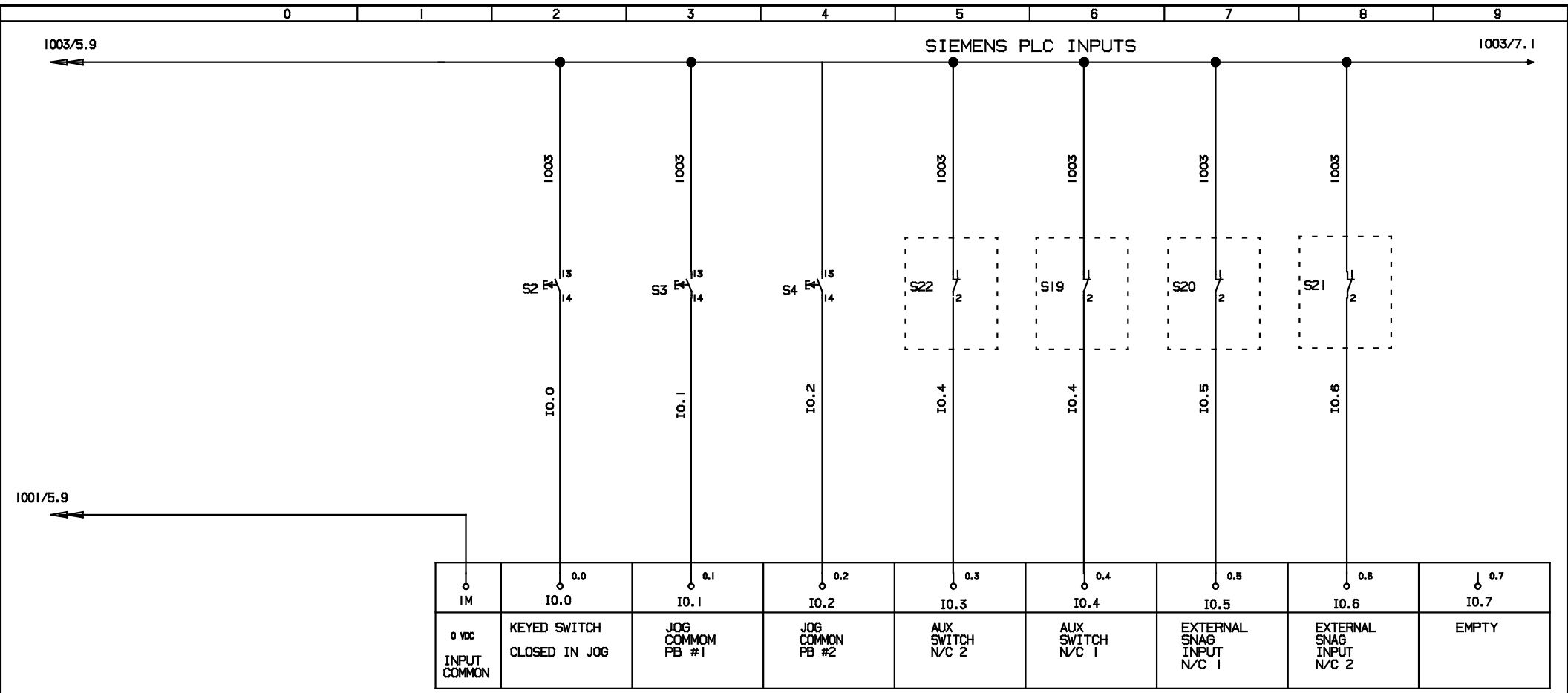
DTi
DRAWING TECHNOLOGY INC.

TITLE: UNCOILER

SHEET 5 OF 10

SIZE B | SCALE

413-101B



3-WIRE DC PROX
- BROWN + 24 VDC
- BLACK LOAD
- BLUE COMMON

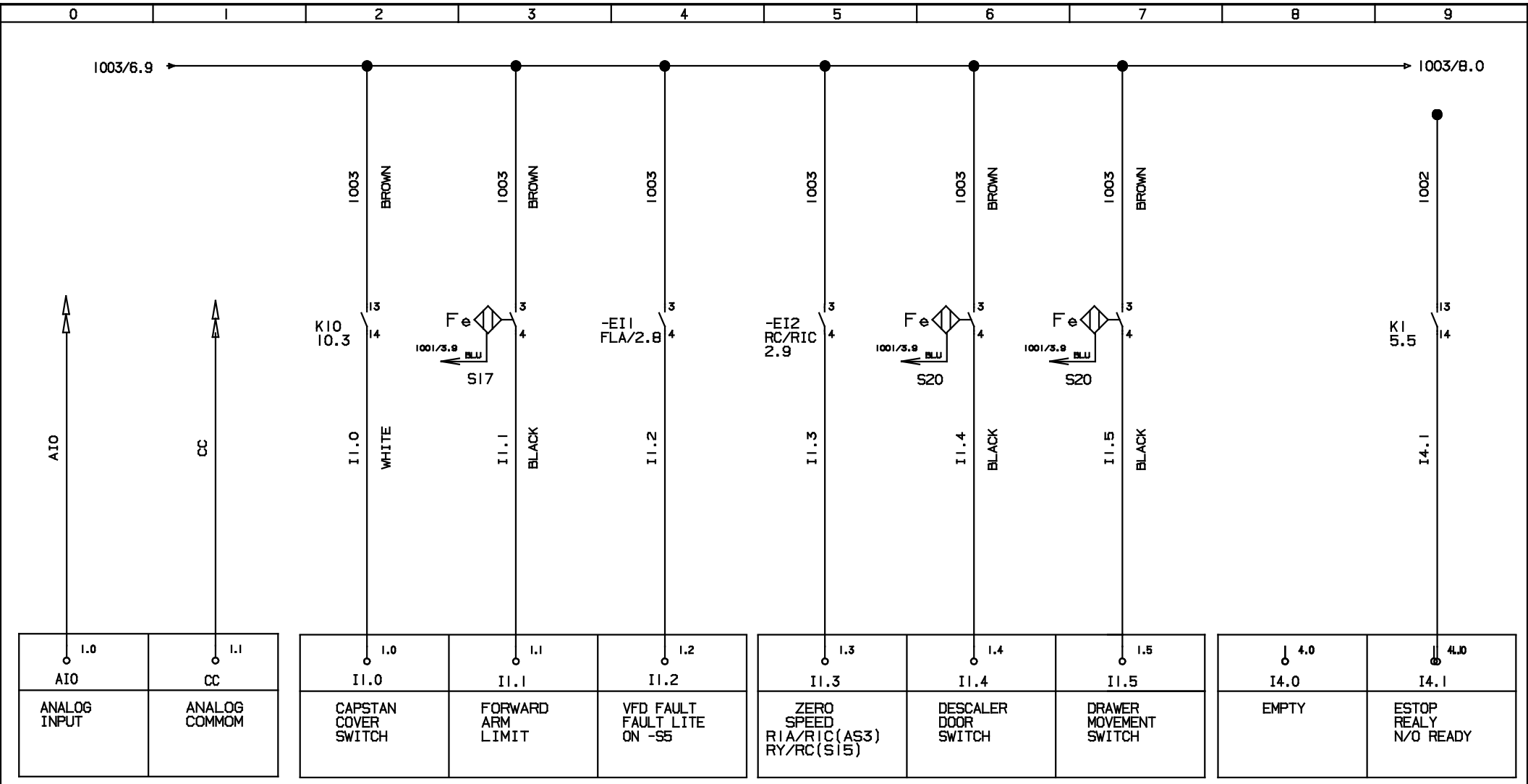
REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

TOLERANCES
X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°
UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES
BY: MAH
DATE: 04-22-2022

DTi DRAWING TECHNOLOGY INC.

TITLE: ELE DIAG SMALL DRAWERS
SHEET 6 OF 10
SIZE B SCALE
413-101B



SIEMENS
PLC INPUTS

3-WIRE DC PROX
- BROWN + 24 VDC
- BLACK LOAD
- BLUE COMMON

REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

TOLERANCES
X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°
UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES
BY: MAH
DATE: 04-02-2022

DTi DRAWING TECHNOLOGY INC.
TITLE: ELE DIAG SMALL DRAWERS
SHEET 7 OF 10
SIZE B SCALE
413-101B

SEIMENS PLC OUTPUTS

RELAY COMMON INOUT	VFD EXTERNAL FAULT INPUT	VFD FORWARD	VFD REVERSE	JOG SLOW	JOG FAST
1M	00.0	00.1	00.2	00.3	00.4
1009	00.0	00.1	00.2	00.3	00.4
EI/CC/2.8	EI/S3/2.8	EI/F/2.8	EI/R/2.8	EI/S1/2.8	EI/S2/2.8

GND	M	L+	SB+	SB-
PE	M	L+	SB+	SB-
PE	1001	1002	1002	1001

REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES

BY: MAH
DATE: 04-02-2022

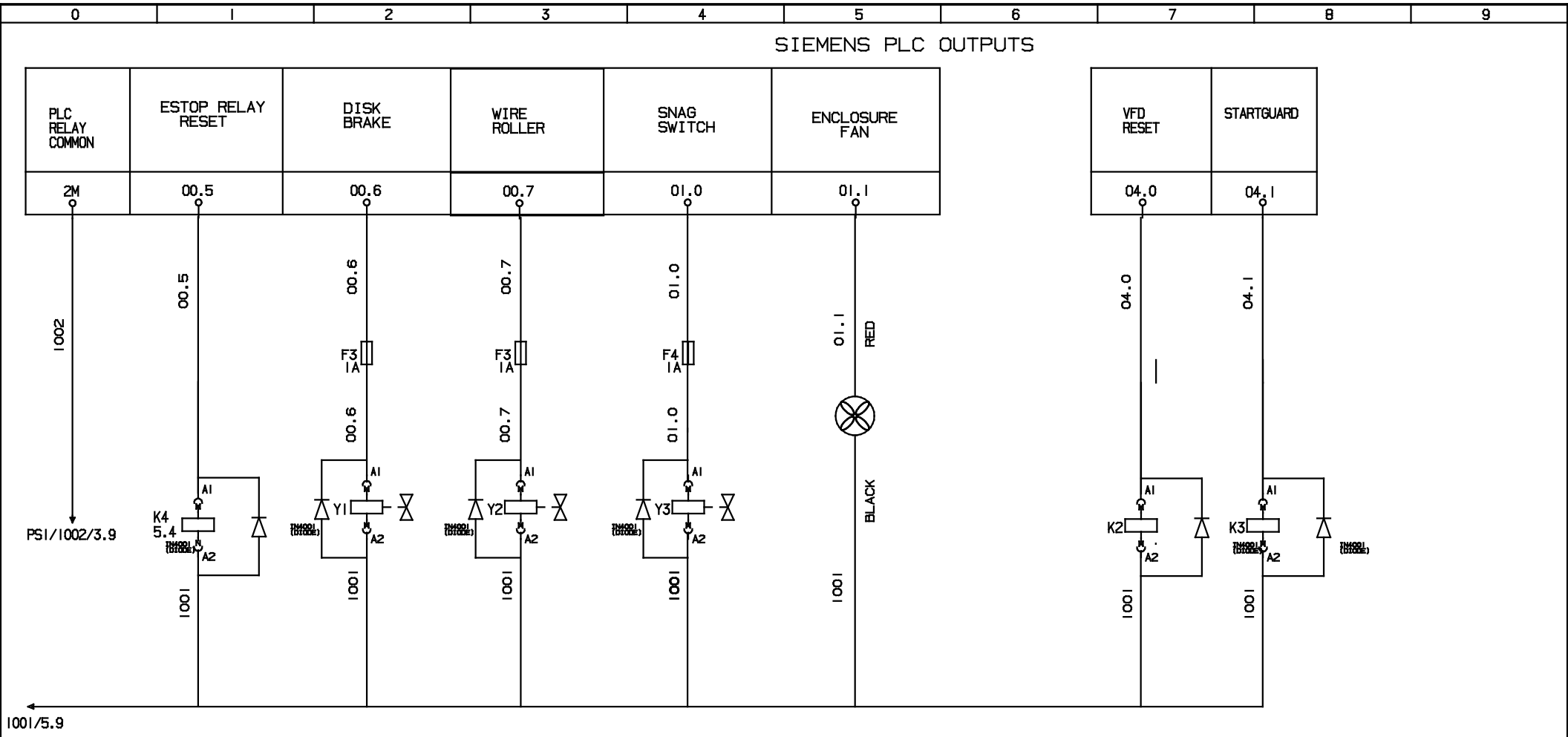
DTi DRAWING TECHNOLOGY INC.

TITLE: ELE DIAG SMALL DRAWERS

SHEET 8 OF 10

SIZE B SCALE

413-101B



REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY/CHANGED TO AUTO	MH	04-02-22

TOLERANCES
X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°
UNLESS NOTED

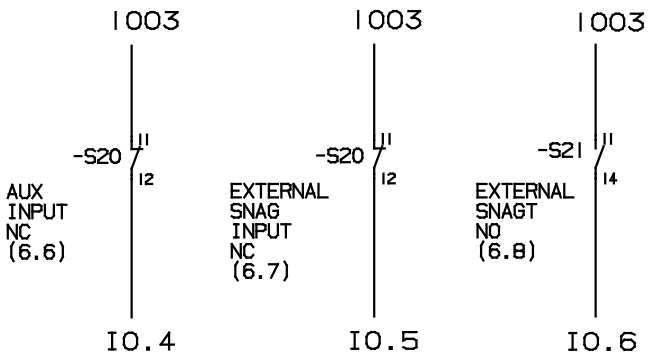
MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES

BY: MAH
DATE: 04-02-2022

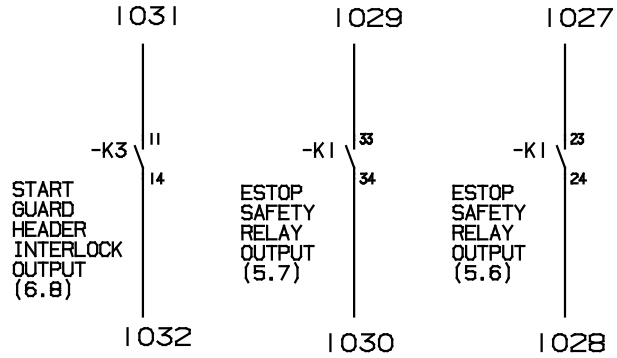
DTi DRAWING TECHNOLOGY INC.

TITLE: ELE DIAG SMALL DRAWERS
SHEET 9 OF 10
SIZE B
SCALE
413-101B

EXTERNAL MACHINE CONNECTIONS



USE YELLOW WIRE FOR 1027 THRU 1032



CLOSES WHEN DRAWER IS READY TO RUN IN AUTO MODE

K1 CLOSES WHEN ESTOP RELAY IS OK

REV	DESCRIPTION	BY	DATE
B	REVISED ESTOP RELAY LOGIC	MH	11-19-22
A	ADDED ESTOP RELAY	MH	4-2-22

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L
STK SIZE
FINISH
H.T.
ASSEM
MODEL
BREAK ALL SHARP EDGES

BY: MAH
DATE: 04-02-2022

DRAWING TECHNOLOGY INC.

TITLE: ELE DIAG SMALL DRAWER

SHEET 10 OF 10

SIZE B SCALE

413-101B

Drawing Technology Inc.

Toshiba 25-200 HP AS3
Parameter changes from default

Parameter #	Description	Default setting	DTI setting
FH	Maximum Frequency	80.0	90.0
UL	Upper limit frequency	60.0	90.0
ACC	Acceleration Time	30.0	3
DEC	Deceleration Time	30.0	3
Sr1	Preset speed #1	0.0	20.0 hz
Sr2	Preset speed #2	0.0	50.0 hz
(On machines faster than 250'/min, use Sr1=10 and Sr2=35)			
Pt	V/f Pattern	0	2
(high HP machines may need Pt set to 0, 3 or 9)			
OLM	Electronic overload char	0	4
F116	Terminal S3 function selection	14	20 (estop)
F203	RR point 2 value	100%	85%
F204	RR point 2 frequency	60.0	90.0
F241	Operation starting frequency	0.0	2.0
F242	Starting frequency hysteresis	0.0	1.0
F251	DC braking current	30	85
F300	Carrier frequency	12	4
F305	Overvoltage limit operation	2	3 (quick)
F603	External trip stop mode	0	2 (dc inject)
F604	E stop DC brake time	1.0	3
Typ	Drive default setting	0	7 (save user)
F700	Parameter lockout	0	1
Set the underlined parameters if dynamic brake resistor is used			
F304	**Dynamic braking**	**0**	**2**
F305	**Overvoltage limit operation**	**2**	**1**
F308	**Dynamic brake resistance**	**See brake resistor (ohms)**	
F309	**Dynamic brake capacity**	**See brake resistor (kW)**	

To display the drive monitor functions, press the "ESC" key twice, then scroll thru the values by using the touch wheel. % load and hour meter are found in this list. See section 8 in AS3 Manual for details.
GrU - Basic parameter will search all values changed from default

1550 Elmwood Road | Rockford, IL 61103 | Phone [815] 877.5133 | Fax [815] 877.3627
Email sales@drawingtechnology.com | Website www.drawingtechnology.com

413-101B / PLC_1 [CPU 1214C DC/DC/Rly] / Program blocks

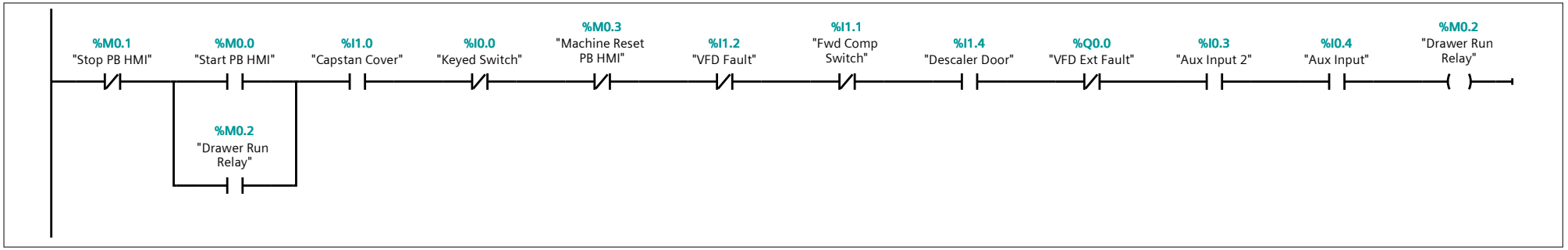
Main [OB1]

Main Properties							
General							
Name	Main	**Number**	1	**Type**	OB	**Language**	LAD
Numbering	Automatic						
Information							
Title	"Main Program Sweep (Cycle)"	**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Main		
Name	**Data type**	**Default value**
Input		
Initial_Call	Bool	
Remanence	Bool	
Temp		
Constant		

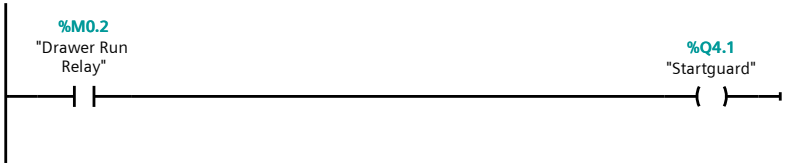
Network 1:

Auto Mode



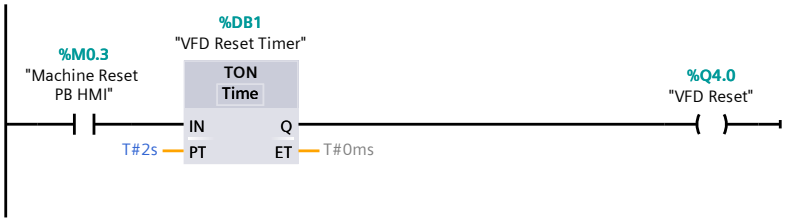
Network 2:

Startguard



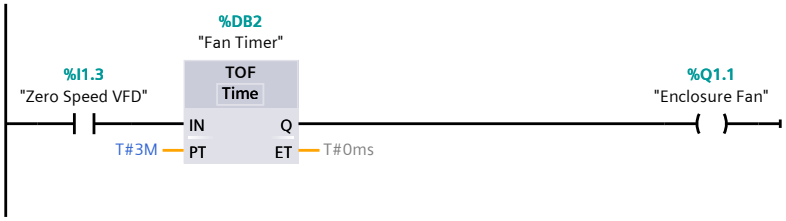
Network 3:

VFD Reset



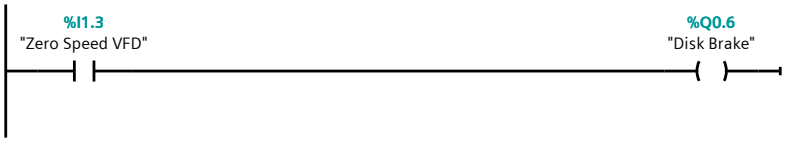
Network 4:

Enclosure Fan



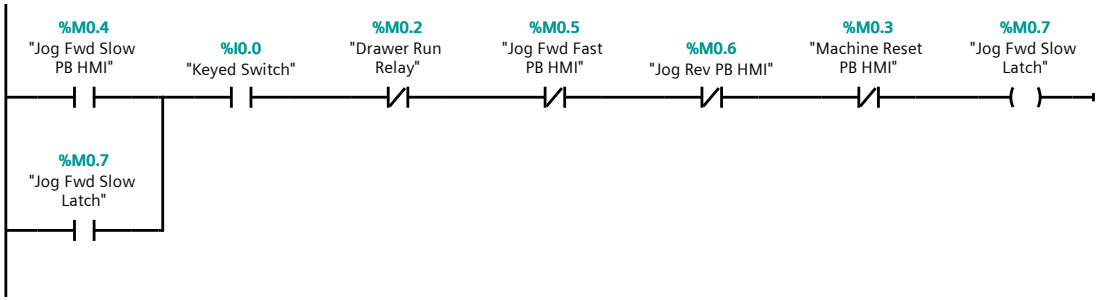
Network 5:

Disk Brake



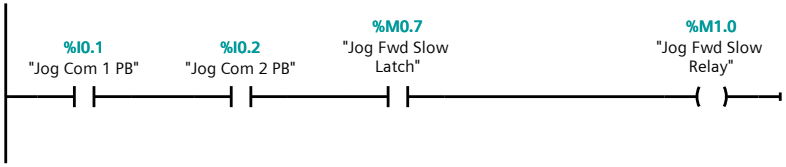
Network 6:

Jog Fwd Slow Latch



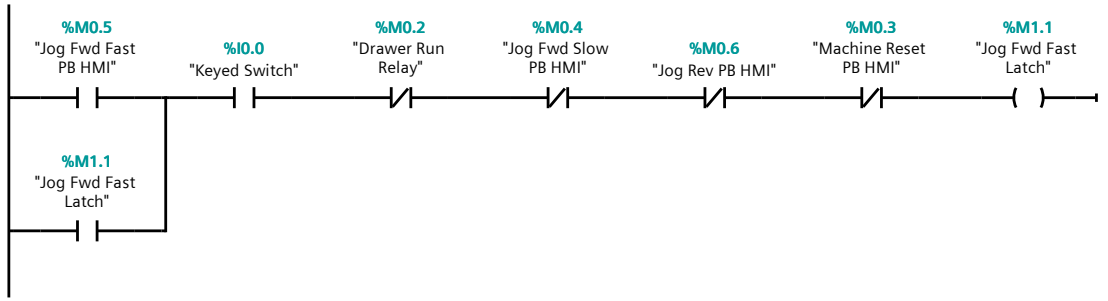
Network 7:

Jog Fwd Slow Relay



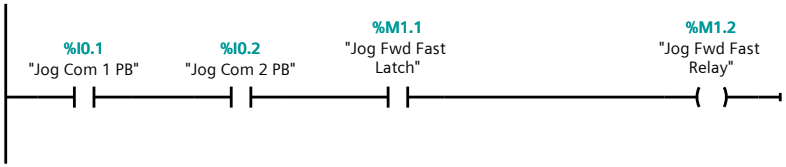
Network 8:

Jog Fwd Fast Latch



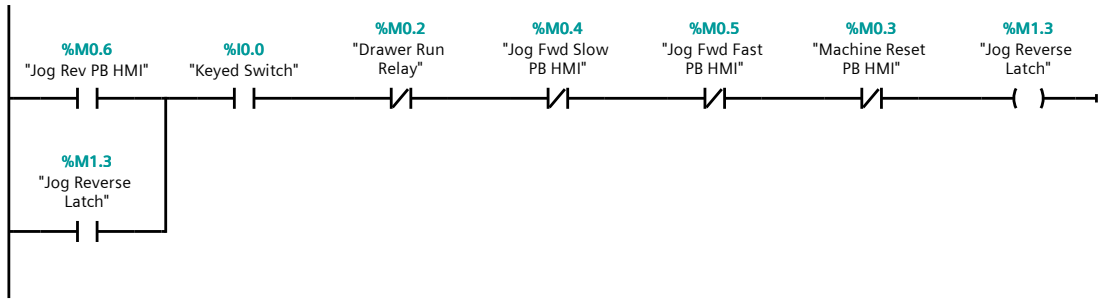
Network 9:

Jog Fwd Fast Relay



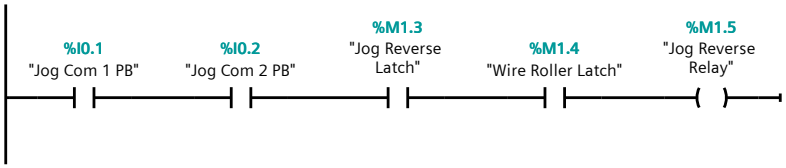
Network 10:

Jog Reverse Latch



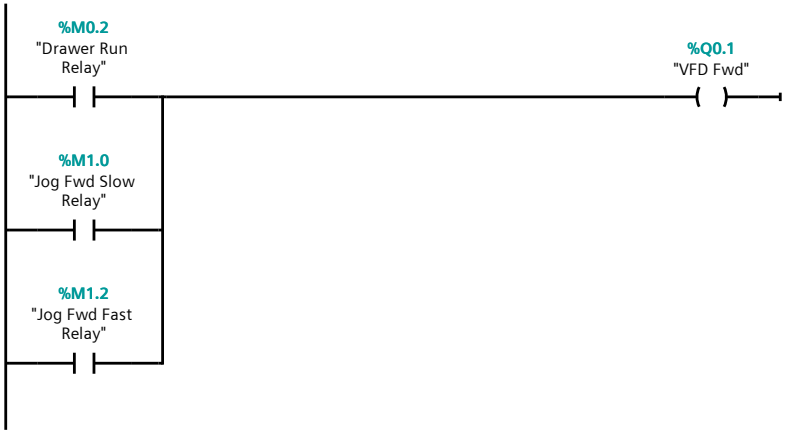
Network 11:

Jog Reverse Relay



Network 12:

VFD Forward



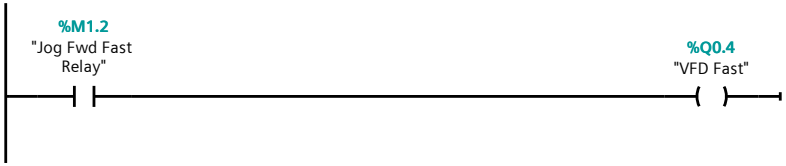
Network 13:

VFD Slow



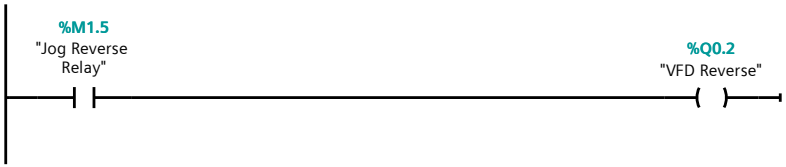
Network 14:

VFD Fast



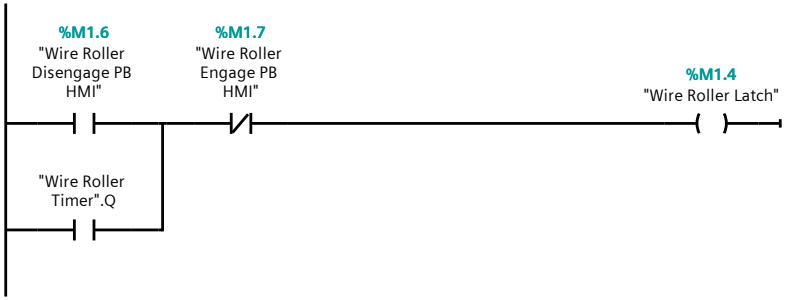
Network 15:

VFD Reverse



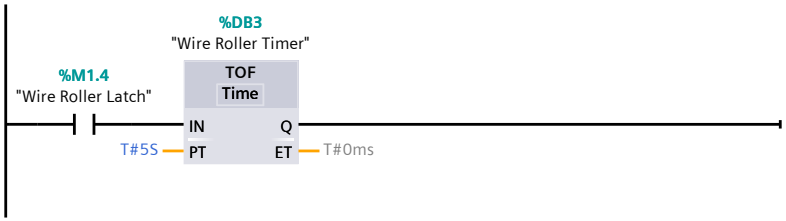
Network 16:

Wire Roller Latch



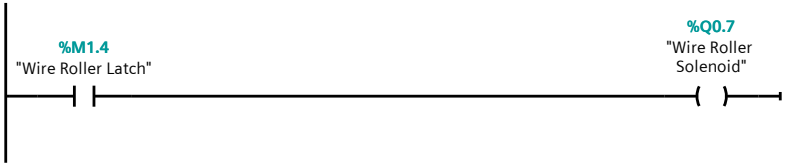
Network 17:

Wire Roller Timer



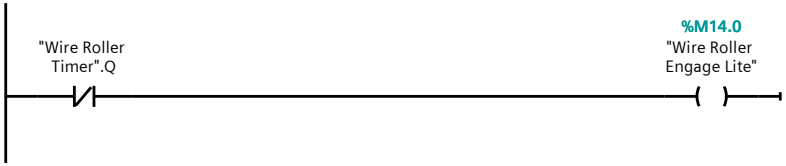
Network 18:

Wire Roller Solenoid



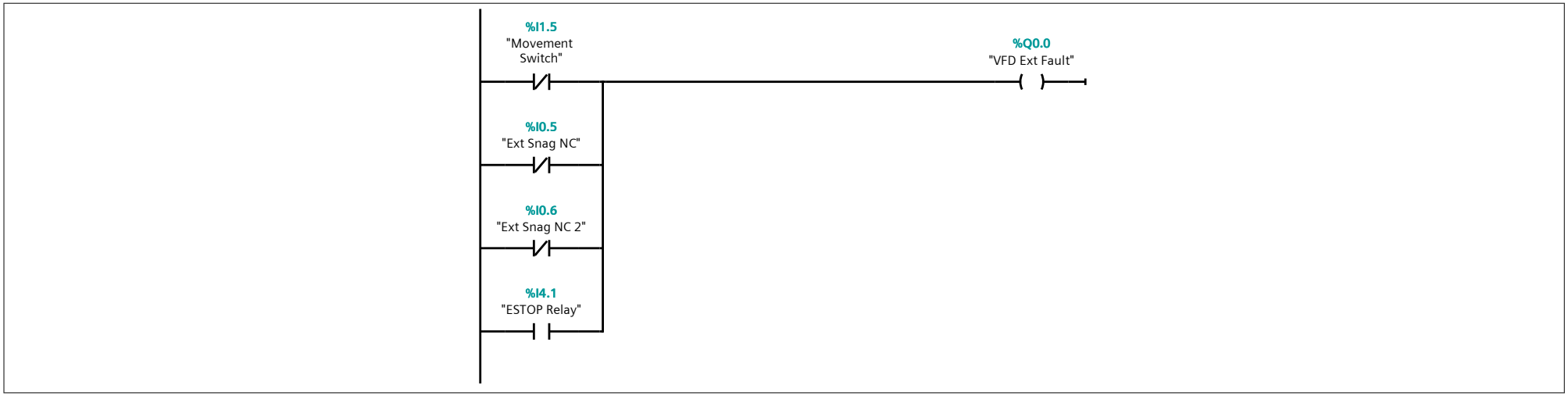
Network 19:

Wire Roller Engage Lite



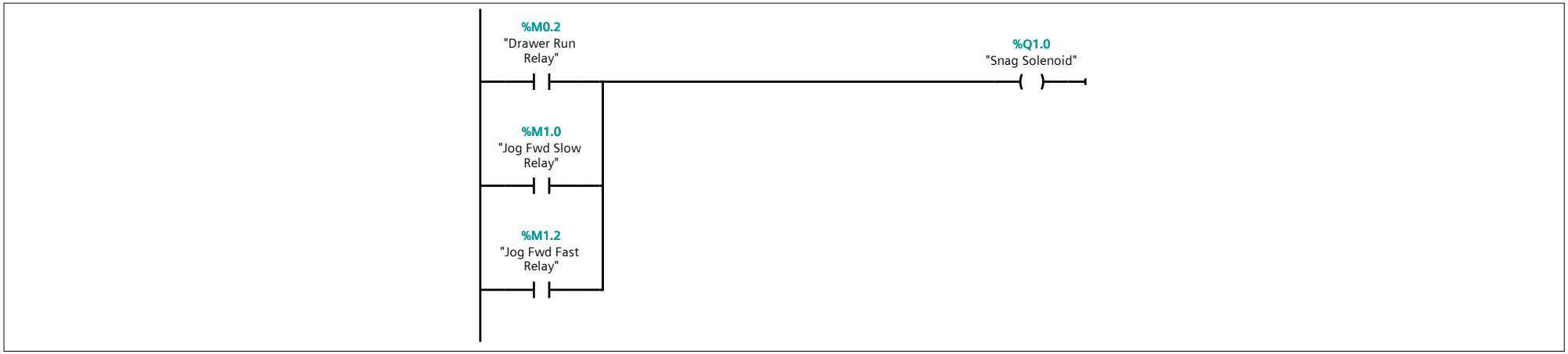
Network 20:

ESTOP to VFD



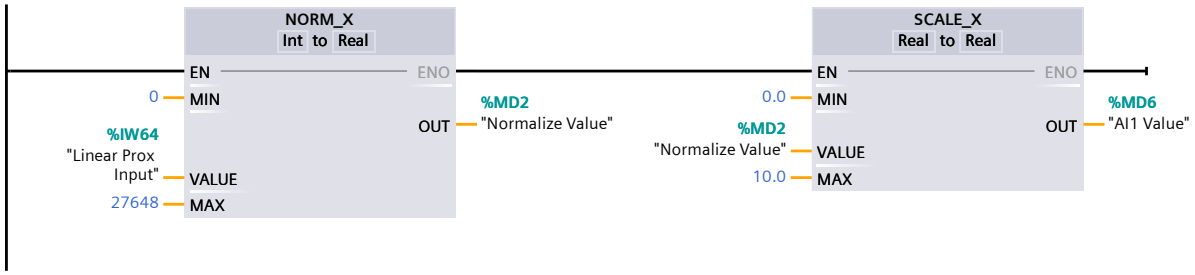
Network 21:

Snag Switch



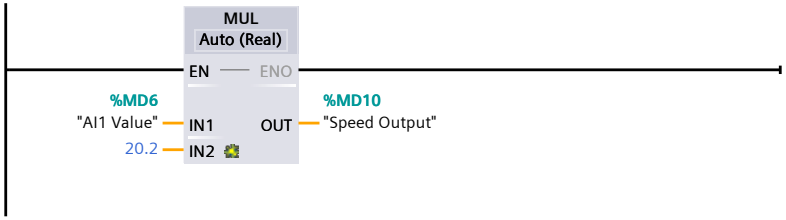
Network 22:

Monitor Speed Input

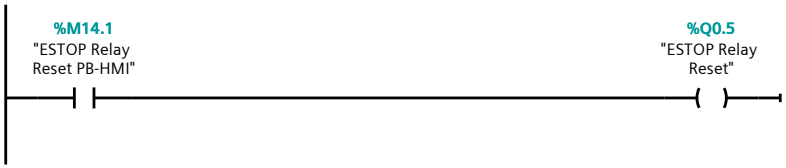


Network 23:

Monitor Speed Output



Network 24:



DRAWING TECHNOLOGY INC

BM0055-004209

Bill of Material

Level	Components	Rev	Description	UM	Quantity	Freq	Cat	Sc	Drawing	Tag	S	PL	Sort
Parent:	493-0823-5874		ELECTRICAL ASSY, 63125										
1*******	413-101B		ELEC DIAGRAM	EA	1.0000	0	Ref	MJ				PM	ELEC
1*******	413V-100L		VFD PARAMETER LIST, AS3	EA	1.0000	0	Ref	PS				PM	ELEC
1*******	413P-101B		SIEMINS PLC PROGRAM DC/DC/RLY	EA	1.0000	0	Ref	PS				PM	ELEC
1*******	603-092		ENCLOSURE, 48X36X16, RITTAL	EA	1.0000	0	Nor	PS	STA030			RM	ENCL
1*******	603-150		HOFFMAN 16X12 ENCLOSURE	EA	1.0000	0	Nor	PS	STA030			PP	ELEC
1*******	612-051-200		DISCONNECT, 200A	EA	1.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	612-052-200		DISCONNECT HNDL, 200A & A1/A2	EA	1.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	612-053-2430		DISCONNECT SHAFT FOR 200A X 4	EA	1.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	612-051-200TSC		TOUCH SAFE COVER FOR 200A DISC	EA	6.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	601-125-460-AS3		INVERTER VFAS3, 125HP 460V	EA	1.0000	0	Nor	PS	FOR020			PP	ELEC
1*******	609-043-2		2 AMP, 2 POLE CIRCUIT BREAKER	EA	1.0000	0	Nor	PS	FAC010			PP	ELEC
1*******	605-260-1		PWR SUPPLY, 5.0 AMP: 120-500V	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	603-102-44		ENCL. FAN,RITTAL,24VDC,10"X10"	EA	1.0000	0	Nor	PS	STA030			PP	ELEC
1*******	603-102-4		ENCL. FILTER, RITTAL, 10"X10"	EA	1.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	608-006		RELAY, DIN RAIL MTG, 24VDC	EA	3.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	608-151		SIEMENS PLC, DC/DC/RLY	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	608-151-SB		PLC SIGNAL BOARD-SIEMENS	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	608-158		SIEMENS HMI, 9" KTP900 BASIC	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	608-159		SIEMENS HMI SCRN PROTECTOR,9"	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	608-053-3		DOLD AUTOSTART SAFETY RELAY	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	611-003-1		TERMINAL BLOCK, FUSED	EA	3.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	611-005		END BRACKET, 35MM	EA	7.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	611-007-1		GROUND LUG; 8-14 AWG.	EA	1.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	611-009		SLOTTED DIN RAIL, 35MM	IN	47.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	604-004-2		WIRE DUCT & COVER 1 X 2.25	FT	10.0000	0	Ref	PS	FOR020			PP	ELEC
1*******	611-016		JUMPER BAR 2 POLES+SCREWS SCRE	EA	13.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	611-017		SCREWLESS TERMINAL BLOCK, 12-2	EA	50.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	611-018		SCREWLESS GRND TERM, 12 AWG MX	EA	2.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	611-019		BLANK MARKING TAGS	EA	50.0000	0	Ref	PS	AUT010			PP	ELEC
1*******	604-202		BRADY LABELS SIZE: 0.500" W XC	EA	8.0000	0	Ref	PS	STA030			PP	ELEC
1*******	604-204		BRADY LABEL -BLACK-SIZE: 1.200	EA	6.0000	0	Ref	PS	STA030			PP	ELEC
1*******	604-205		BRADY LABEL -RED-SIZE: 1.200"W	EA	2.0000	0	Ref	PS	STA030			PP	ELEC
1*******	610-1820		SO CABLE, 18 GA/20 COND.	FT	14.0000	0	Ref	PS	STE030			PP	WIRE
1*******	606-301		PUSH BUTTON, BLACK 22MM 1NO	EA	2.0000	0	Nor	PS	STE030			PP	ELEC
1*******	606-303		E-STOP PUSH BUTTON, 22MM, 1 N	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	606-302-4		SELECTOR SWITCH, KEYED	EA	1.0000	0	Nor	PS	STE030			PP	ELEC
1*******	606-306		CONTACT BLOCK, 1NO	EA	1.0000	0	Ref	PS	STE030			PP	ELEC
1*******	607-003-4		PROX. SW. 12MM PNP; NO	EA	2.0000	0	Nor	PS	HTM010			PP	ELEC
1*******	607-009-5		CABLE: STRAIGHT FOR 12MM PROX.	EA	2.0000	0	Nor	PS	HTM010			PP	ELEC
1*******	607-006		LINEAR PROXIMITY SWITCH	EA	1.0000	0	Nor	PS	WEI010			PP	ELEC
1*******	607-006-1		CABLE, LINEAR PROX	EA	1.0000	0	Nor	PS	WEI010			PP	ELEC
1*******	607-041		MAGNETIC SAFETY SWITCH HALF: 2	EA	1.0000	0	Nor	PS	FRO010			PP	ELEC

DRAWING TECHNOLOGY INC

BM0055-004209

Bill of Material

Level	Components	Rev	Description	UM	Quantity	Freq	Cat	Sc	Drawing	Tag	S	PL	Sort
1*******	607-042		MAGNETIC SAFETY SWITCH CODED M	EA	1.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	607-043-1		CABLE, 5 METER, SCHMERSAL #M8S	EA	1.0000	0	Nor	PS	FRO010			PP	ELEC
1*******	301-240		SWITCH MTG. ANGLE	EA	1.0000	0	Nor	MS	FRO010			PM	FWP
1*******	651-63125		NAMEPLATE	EA	1.0000	0	Ref	MS	ALL020			PM	MISC
1*******	649-005-323		ESTOP Legend, NO WRITING	EA	1.0000	0	Ref	PS	ALL020			PP	ELEC

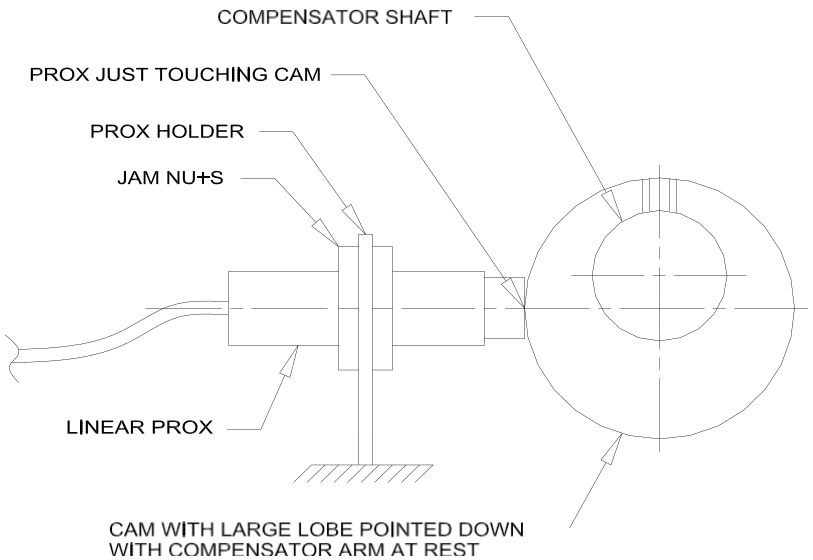
Drawing Technology Inc.

Linear Proximity Installation and Setup

To Set the Linear Prox, First:

1. Remove all wire from capstan
2. Secure gripper hook to capstan retainer ring
3. Retract wire roller
4. Remove access panel on drawbox end of machine
5. Close capstan cover
6. Make sure all tangle, E-stop, descaler covers, etc. interlocks are not tripped.
7. With compensator arm at rest in the full back position, rotate cam so large lobe is facing directly downward. Lightly tighten set screw. (see diagram below)
8. If linear prox is not installed, do so now. Install one nut onto prox and insert prox into holder. Locate prox so the plastic face is just barely touching cam. Tighten both nuts around prox being careful not to force the prox into the cam.
9. Make sure you are away from belts, pulleys or any potential moving part. Press the machine start button. The amber light on the control panel should light. If not, check for an open guard, pressed E-stop, or tripped tangle switch.
10. Rotate the cam away from the prox until the drive just barely begins to rotate. Turn backwards until drive stops. Tighten the cam set screw. The cam should be set so the drive just reaches 0 speed as the compensator arm comes to rest at its full back position.

Prox/Cam Initial Orientation



1550 Elmwood Road | Rockford, IL 61103 | Phone [815] 877.5133 | Fax [815] 877.3627
Email sales@drawingtechnology.com | Website www.drawingtechnology.com

411-063-3H

553-026 (1)
FILTER

AIR IN:
60-120 PSI

FILTER

552-020H REGULATOR(2)
0-60 PSI REGULATOR

COMPENSATOR, MODEL 63
REF 550-080H CYL.
80MM X 200MM STROKE
REF. 550-081H CLEVIS MOUNT
REF 550-082H ROD CLEVIS

W/R VALVE
#554-057H

"XL" DOUBLE WIRE ROLLER
REF 550-088H CYL.
100MM X 200MM STROKE
REF. 550-081H CLEVIS MOUNT
REF 550-082H ROD CLEVIS

REGULATOR
0-60 PSI

BRAKE VALVE
#554-057H

DISC BRAKE
ON MODEL
43 AND UP

REF. 552-019H
REGULATOR
0-60 PSI

REF.
SNAG ASSY.
VALVE
#554-057H

OPTIONAL
SNAG SWITCH
ASSEMBLY
W/3.25 X 12
CYLINDER

OPTIONAL AIR
WIPE ON DESCALER

REV	DESCRIPTION	BY	DATE

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

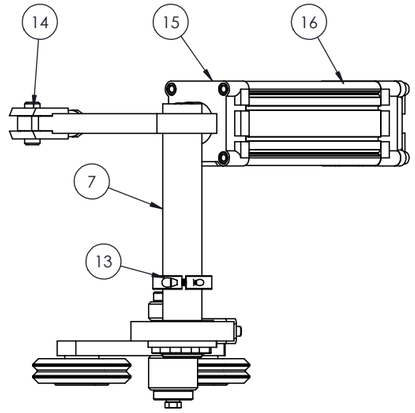
UNLESS NOTED

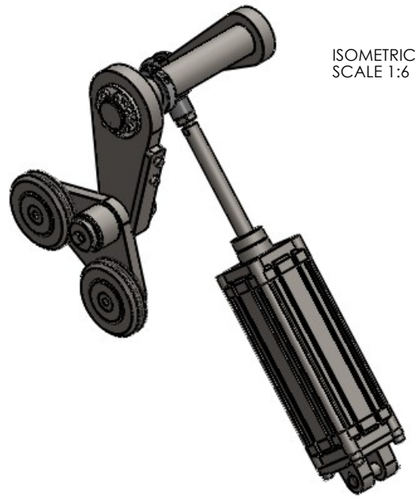
MAT'L NOTED
STK SIZE
FINISH
H.T.
MODEL 63 W/ SNAG OPTION
BREAK ALL SHARP EDGES
BY: MFB
DATE: 11/20/20

DTi
DRAWING TECHNOLOGY INC.

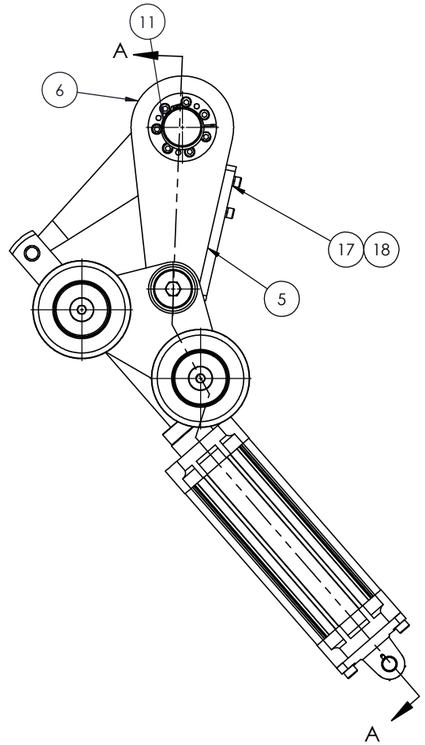
TITLE: PNEUMATIC ASSY.
SHEET 1 OF 1
SIZE B
SCALE: NONE
411-063-3H

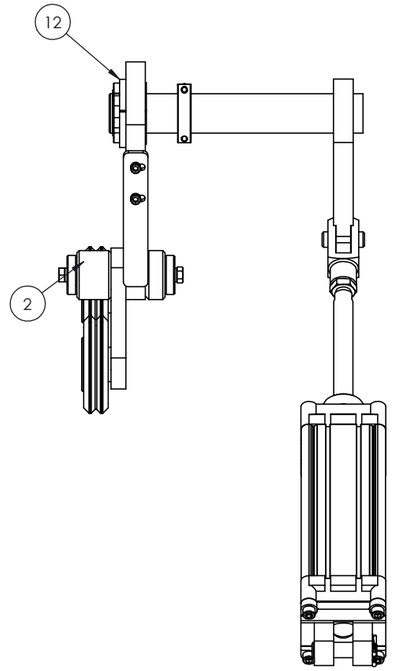
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	102-011-3	PIVOT PIN
2	2	104-XXX-5	5" WIRE ROLLER, GENERIC RANGE
3	2	107-013	RETAINER, DRIVE
4	2	107-035-1	RETAINER, 5" WIRE ROLLER
5	1	119-477	YOKE STOP
6	1	301-003-1R	W/R ARM WELDMENT
7	1	301-020-2	WIRE ROLLER SHAFT WLDMT
8	1	301-025-3	YOKE WELDMENT
9	2	503-027	BEARING, 6207 2RS1
10	4	504-008	SNAP RING, Ø2.813
11	1	504-026	SNAP RING, 2" SHAFT
12	1	509-007	B-LOC B-106 X 2" ID BUSHING
13	1	539-022-5	SHAFT CLAMP COLLAR 2.000" IDT
14	1	550-082H	CYL ROD CLEVIS : HYLAND
15	1	550-088H	AIR CYL., 100 X 200, HYLAND
16	1	550-089H	MTG FLANGE w/ 20 MM PIN
17	2	572-M08LW	M8 LOCK WASHER
18	2	572-M08SH-30	M8x1.25 x 30mm, SHCS
19	2	572-M12HH-30	M12 X 1.75 X 30MM HHCS
20	2	572-M12LW	M12 LOCK WASHER
21	2	572-M16FH-40	M16X2X40 MM LG FD SCREW

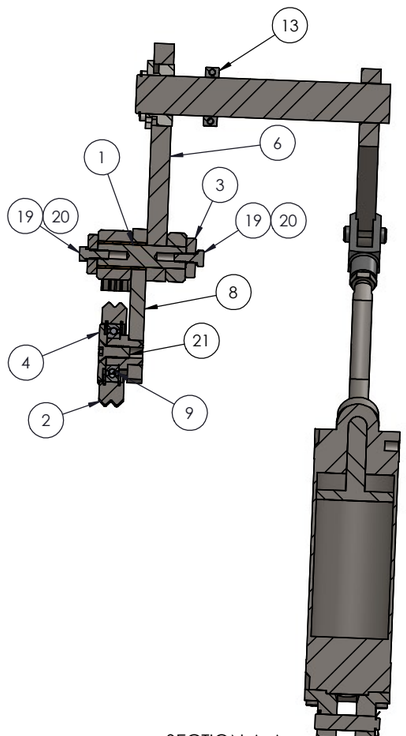




ISOMETRIC VIEW
SCALE 1:6







SECTION A-A

PART WEIGHS APPROXIMATELY 102.82 LBS.

FOR MACHINES WITH
HYLAND STD CYLINDERS

REV	DESCRIPTION	BY	DATE
X	X	X	X

TOLERANCES
X. XXX +/- . 010
X. XX +/- . 030
X. X +/- . 062
FRAC +/- . 062
ANGLE +/- . 5°
UNLESS NOTED

MAT'L SEE BOM
STK SIZE --
FINISH --
H. T. --
ASSEM --
MODEL 63
BREAK ALL SHARP EDGES
BY: DR
DATE: 04-12-2022

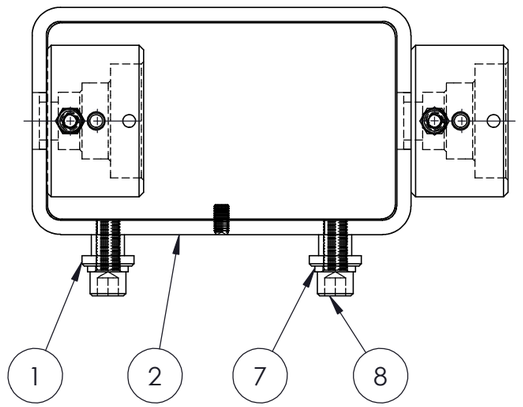
DTi DRAWING TECHNOLOGY INC.

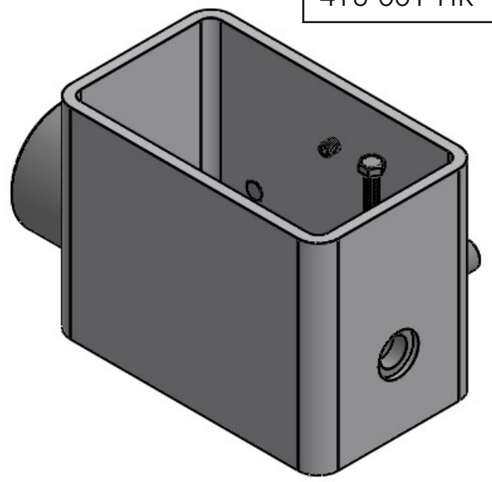
TITLE: WIRE ROLLER ASSEMBLY
SHEET 1 OF 1
SIZE C SCALE 1:4
415-063-3H-R

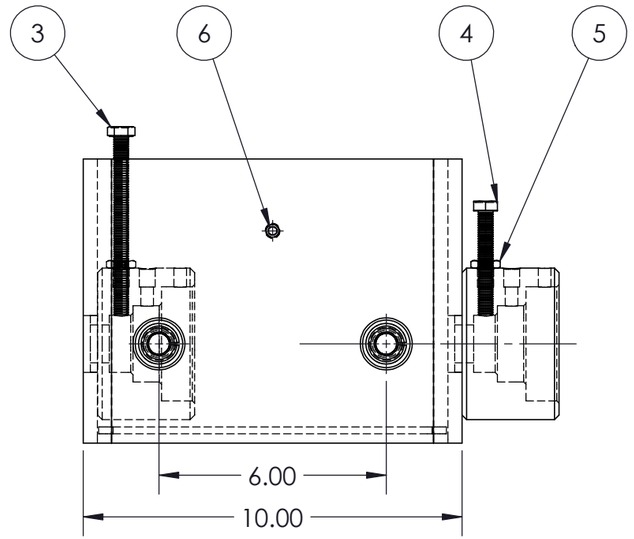
415-063-3H-R

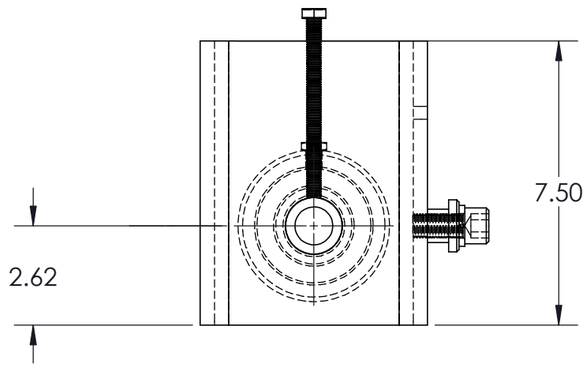
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	2	108-009	BOSS, D'BOX MTG
2	1	302-001-HR	STANDARD DRAWBOX WELDMENT
3	1	572-M10HH-120FT	M10 X 1.5 X 120MM HHCS FULLT
4	1	572-M10HH-70FT	M10 X 1.5 X 70MM HHCS FULLT
5	2	572-M10JN	M10 X 1.5 JAM NUT
6	1	572-M10SS-20	M10-1.5 X 20 MM SET SCREW
7	2	572-M16LW	M16 LOCK WASHER
8	2	572-M16SH-35	M16 X 2.0 X 35MM LG. SHCS

416-001-HR









NOTE:
SHOWN REVERSE HAND MACHINE (LEFT TO RIGHT)
SEE 416-001-H FOR STANDARD HAND MACHINE

REV	DESCRIPTION	BY	DATE

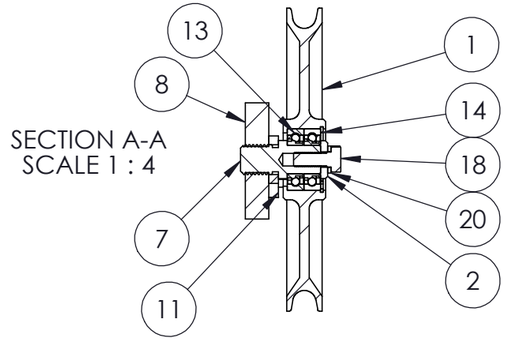
TOLERANCES
X. XXX +/- . 010
X. XX +/- . 030
X. X +/- . 062
FRAC +/- . 062
ANGLE +/- . 5°
UNLESS NOTED

MAT'L SEE BOM
STK SIZE --
FINISH --
H. T. --
ASSEM --
MODEL --
BREAK ALL SHARP EDGES
BY: DR
DATE: 02-03-2022

DTi DRAWING TECHNOLOGY INC.

TITLE: DRAWBOX ASSEMBLY
SHEET 1 OF 1
SIZE B SCALE A
416-001-HR

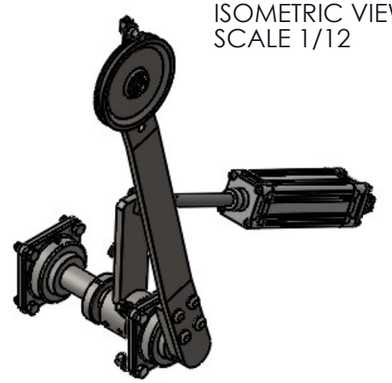
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	106-028-2	WHEEL, 8" STEEL COMP
2	1	107-051	RETAINER
3	1	108-042-1	BOSS, CYLINDER ARM 2"IDx3"LG
4	1	119-025	PROX MTG BRACKET
5	1	119-100-2	CYLINDER ARM
6	1	121-004-1	CAM, LINEAR PROX
7	1	123-047	STUD, 8" COMP WHEEL
8	1	125-058	COMP. ARM, 58
9	1	301-017-1	PROX MTG BRACKET
10	1	301-064-10	COMP SHAFT ARM WLD
11	1	417-080-8	RETAINER ASSY (8"COMP WHEEL)
12	2	503-062	FLANGE BEARING, UCF 211-32
13	2	503-091	BEARING, R12ZZ
14	1	504-024	ROTOR CLIP, Ø1-5/8" BORE
15	1	550-080H	AIR CYLINDER: 80MM BORE X 200M
16	1	550-081H	AIR CYLINDER MTGTANG: HYLAND
17	1	550-082H	CYL ROD CLEVIS : HYLAND
18	4	572-M10HH-25	M10 X 1.5 X 25MM HHCS
19	1	572-M10HN	M10 X 1.5 HEX NUT
20	4	572-M10LW	M10 LOCK WASHER
21	1	572-M10SS-15	M10-1.5 X 15 MM SET SCREW
22	2	572-M12SS-20	M12 X 1.75 X 20 MM SET SCREW
23	4	572-M16BH-40	M16X2.0, 40MM LG BHCS
24	4	572-M16FW	M16 FLAT WASHER
25	4	572-M16HH-40	M16x2 x 40mm, HHCS
26	4	572-M16HH-60	M16x2 x 60mm, HHCS
27	4	572-M16HN	NUT, M16 X 2 HEX
28	9	572-M16LW	M16 LOCK WASHER
29	1	SKS-050-027500	SQ, 1/2" CRS X 2.7500

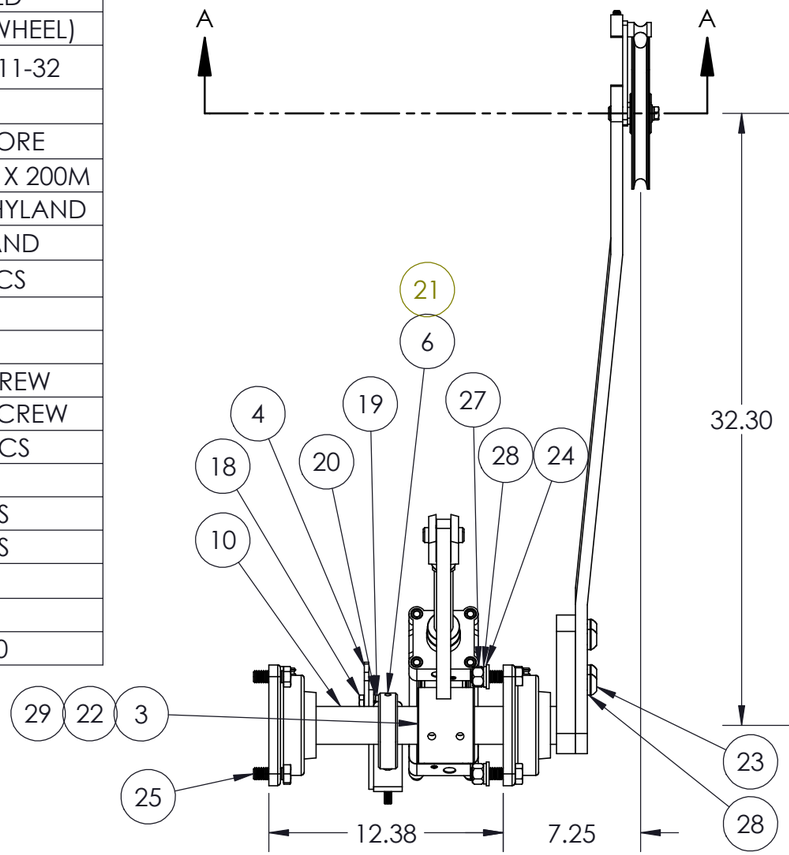


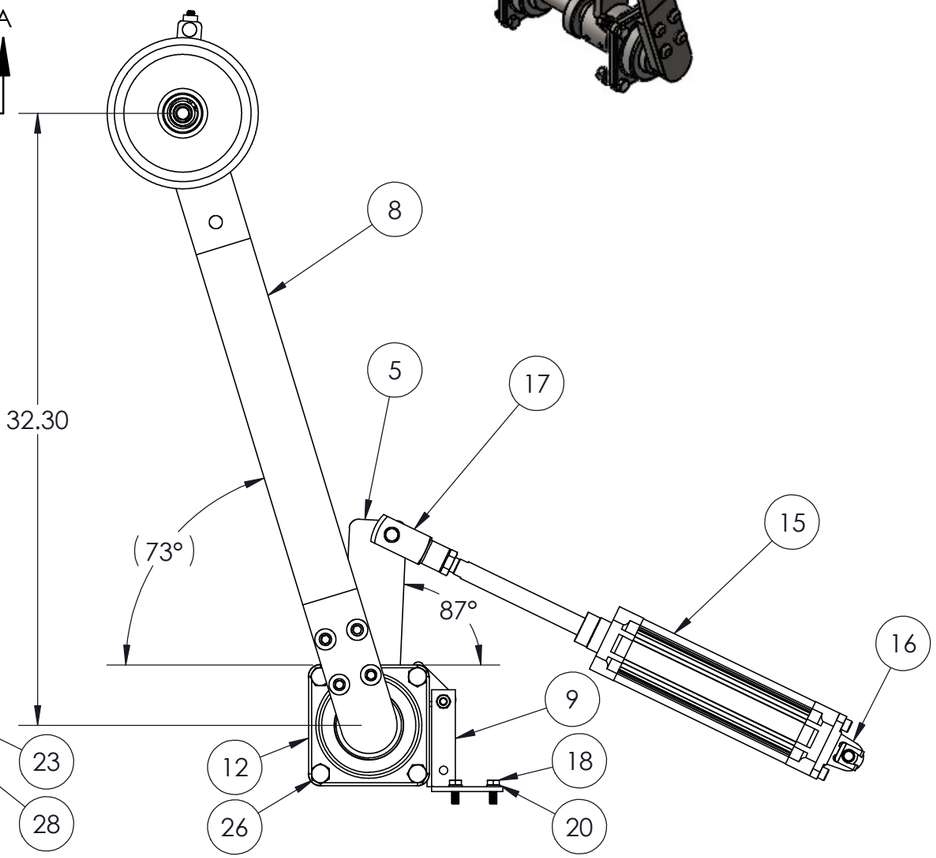
SECTION A-A
SCALE 1 : 4

417-063-8H-R

ISOMETRIC VIEW
SCALE 1/12







ASSEMBLY WEIGHS APPROXIMATELY 95 LBS.

REV	DESCRIPTION	BY	DATE

TOLERANCES
X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°
UNLESS NOTED

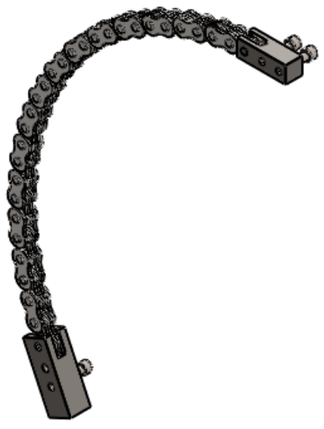
MAT'L SEE BOM
STK SIZE --
FINISH --
H. T. --
ASSEM --
MODEL 63 L-2-R
BREAK ALL SHARP EDGES
BY: MFB
DATE: 4/18/22

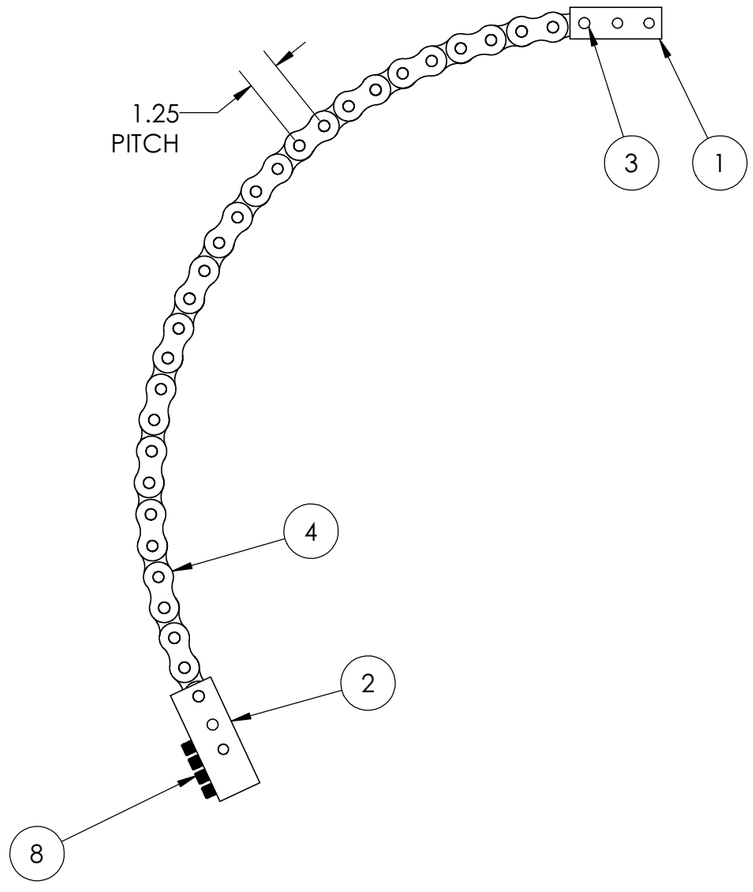
DTi
DRAWING TECHNOLOGY INC.

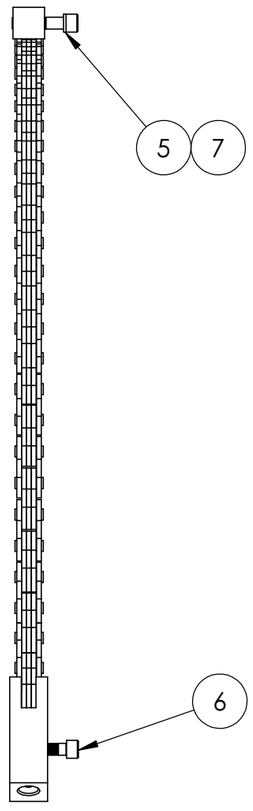
TITLE:
COMPENSATOR ASSY
SHEET 1 OF 1
SIZE B
SCALE 1/8
417-063-8H-R
REV

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	119-018-3	GRIPPER HOOK, MODEL 58
2	1	119-029-8	GRIPPER HEAD, 5/8
3	2	121-033-2	PIN
4	1	506-023	LEAF CHAIN,BL-1023 29 PITCHES
5	2	572-M12LW	M12 LOCK WASHER
6	1	572-M12SH-30	M12x1.75 x 30mm, SHCS
7	2	572-M12SH-50	M12x1.75 x 50mm, SHCS
8	4	572-M12SS-30	M12 X 1.75 X 30 MM SET SCREW

418-005







REV	DESCRIPTION	BY	DATE
X	X	X	X

TOLERANCES

X. XXX +/- . 010
X. XX +/- . 030
X. X +/- . 062
FRAC +/- . 062
ANGLE +/- . 5°

UNLESS NOTED

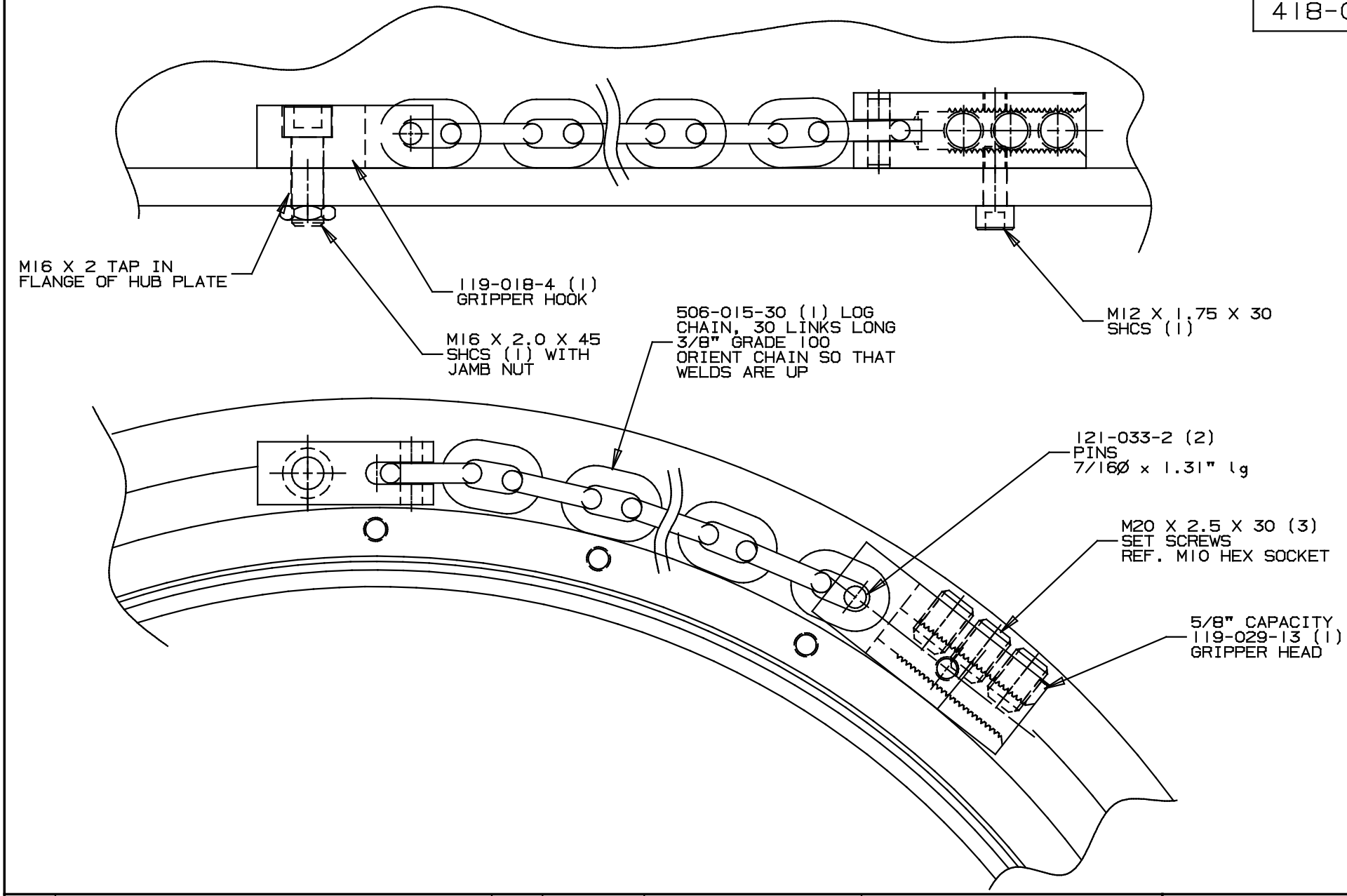
MAT'L	NOTED
STK SIZE	--
FINISH	--
H. T.	--
ASSEM	--
MODEL	63
BREAK ALL SHARP EDGES	
BY:	LSS
DATE:	1-5-2005

DTi
DRAWING TECHNOLOGY INC.

TITLE:
CHAIN ASSY, 5/8" GRIPPER

SHEET 1 OF 1
SIZE B SCALE 1:6
418-005

418-006



REV	DESCRIPTION	BY	DATE

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L	
STK SIZE	
FINISH	
H.T.	
FOR MODEL 63	
BREAK ALL SHARP EDGES	
BY: MJY	DATE: 2-2-15

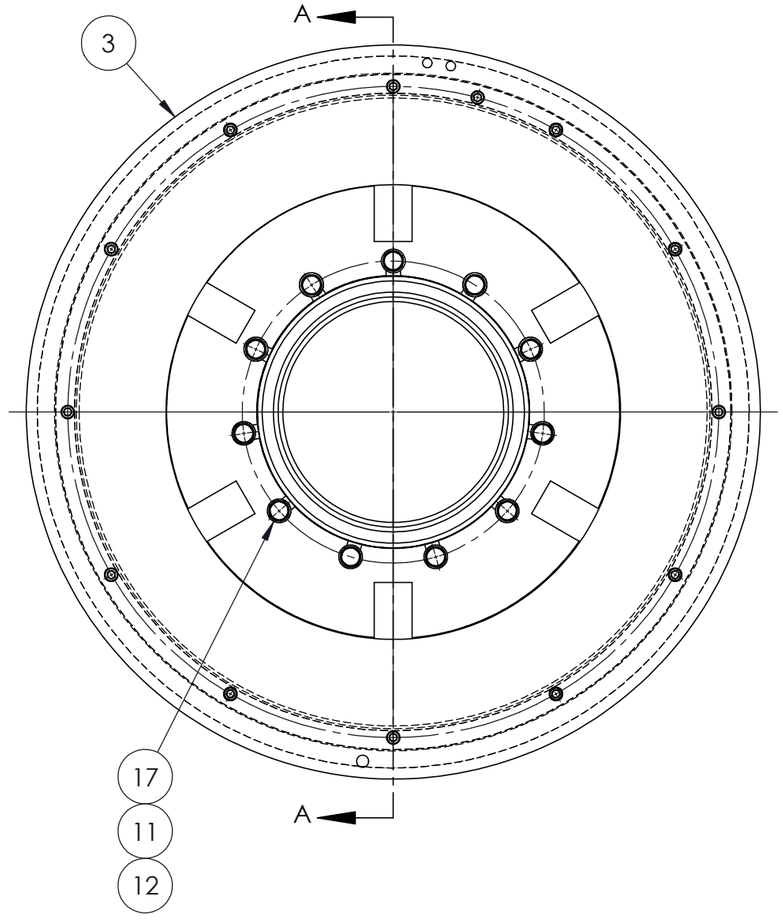
DTi
DRAWING TECHNOLOGY INC.

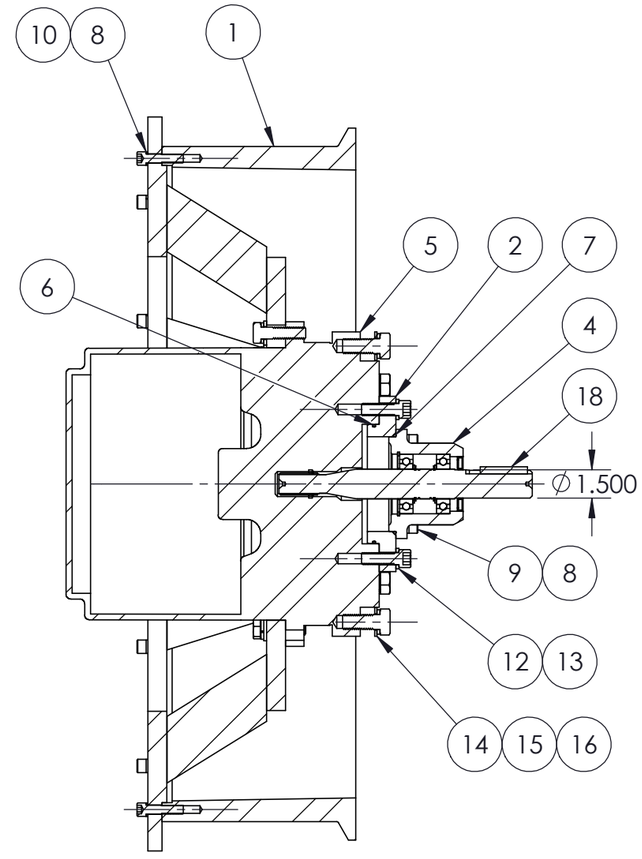
5/8 LOG CHAIN
GRIPPER ASSY

SHEET 1 OF 1
SIZE B SCALE .6

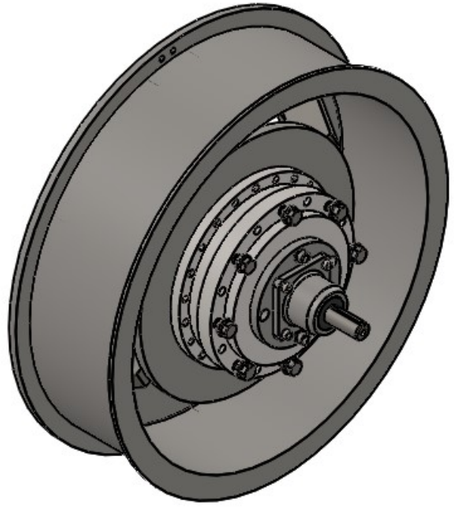
418-006

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	101-536	CAPSTAN, 36" MACHINED
2	1	202-053-4	INPUT ADAPTER PLATE
3	1	203-124	HUB PLATE WLDMT (63 X IFT-50T3)
4	1	409-311	SPECIAL DIN C
5	1	502-050T2-40I	GEARBOX, IFT50T2, 40:1
6	1	557-005	O-RING
7	1	557-007	O-RING; 4.984"ID X .139 SECTION
8	17	572-M12LW	M12 LOCK WASHER
9	4	572-M12SH-30	M12x1.75 x 30mm, SHCS
10	13	572-M12SH-50	M12x1.75 x 50mm, SHCS
11	11	572-M16HH-60	M16x2 x 60mm, HHCS
12	13	572-M16LW	M16 LOCK WASHER
13	2	572-M16SH-50	M16 X 2.0 X 50MM LG. SHCS
14	8	572-M20FW	M20 FLAT WASHER
15	8	572-M20HH-50	M20x2.5 x 50mm, HHCS
16	8	572-M20LW	M20 LOCK WASHER
17	11	573-625HFW	5/8" HEAVY FLAT WASHER
18	1	SKS-038-025000	KEYSTOCK, 3/8" SQ x 2.5000





SECTION A-A



REV	DESCRIPTION	BY	DATE

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L	SEE BOM
STK SIZE	--
FINISH	--
H. T.	--
ASSEM	--
MODEL	63
BREAK ALL SHARP EDGES	
BY: DR	DATE: 12-07-2021

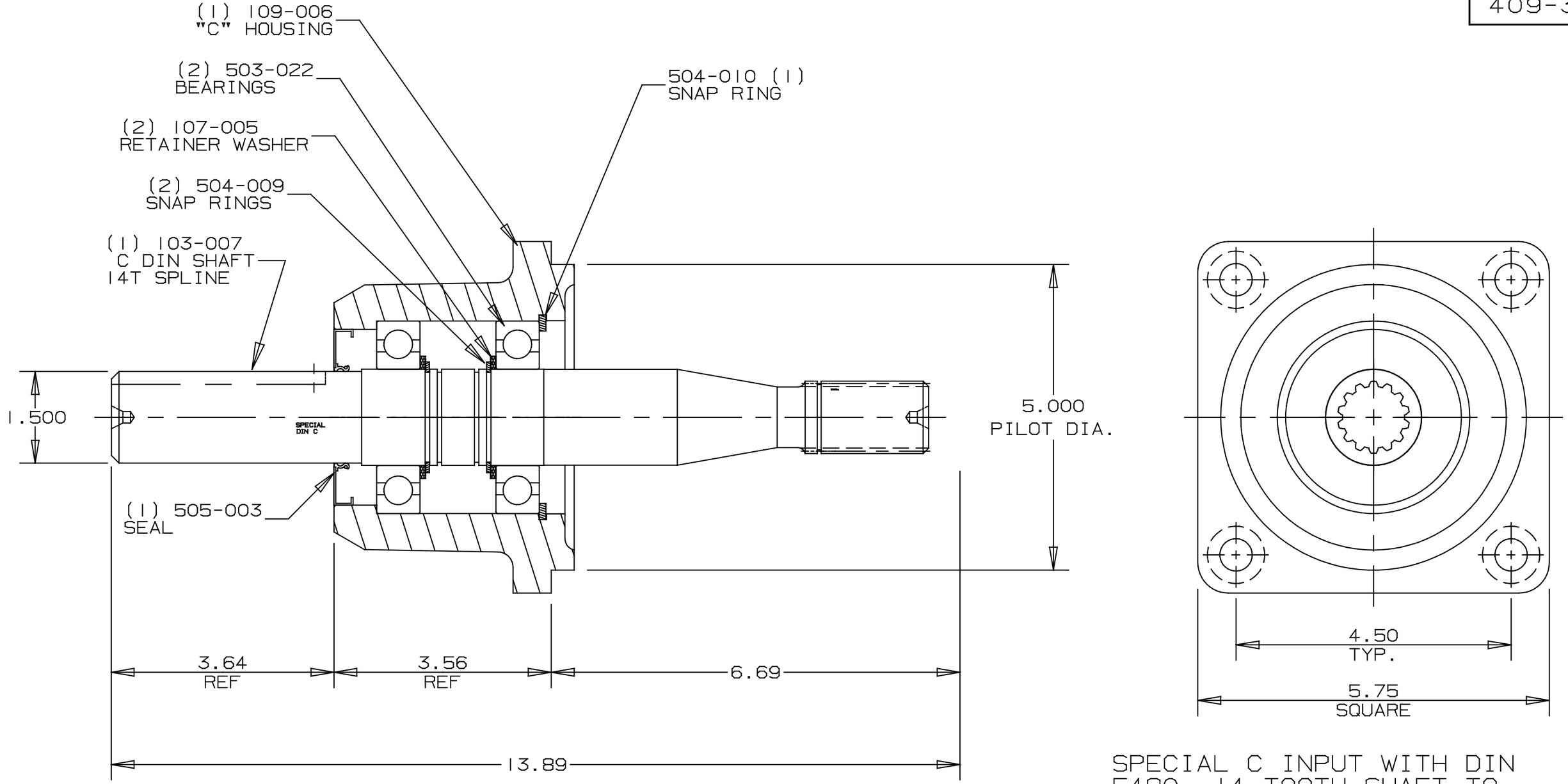
DTi
DRAWING TECHNOLOGY INC.

TITLE: CAPSTAN ASSY
63 X IFT-50T2

SHEET 1 OF 1
SIZE B SCALE 1:8
419-063-10

419-063-10

409-311



SPECIAL C INPUT WITH DIN 5480 14 TOOTH SHAFT TO FIT INTO A6VE80 CAVITY

(REF SEE 202-053-4 FOR ADAPTER PLATE)

REV	DESCRIPTION	BY	DATE
A	x	x	x

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062

FRAC +/- .062

ANGLE +/- .5°

UNLESS NOTED

MAT'L AS NOTED
STK SIZE
FINISH
H.T.
ASSEM
MODEL: USED ON GFT-36 W/ A6VE55 INPUT

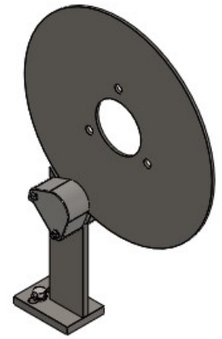
BY: LSS
DATE: 11-8-06

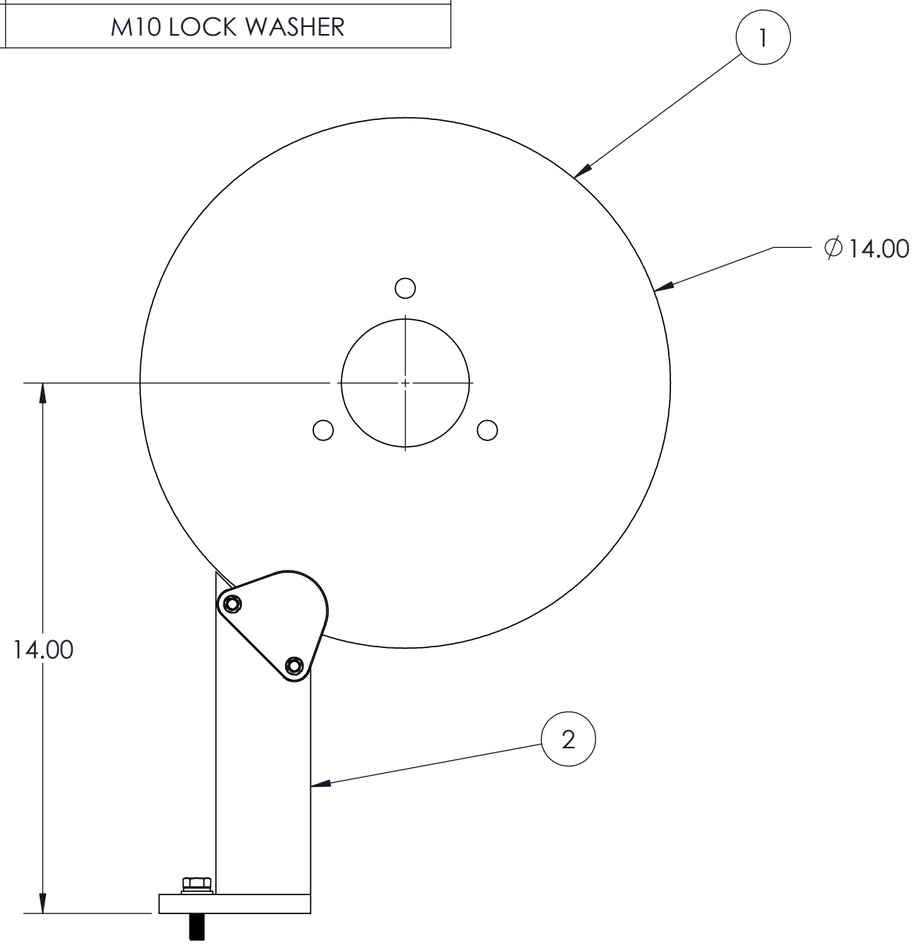
DTi
DRAWING TECHNOLOGY INC.

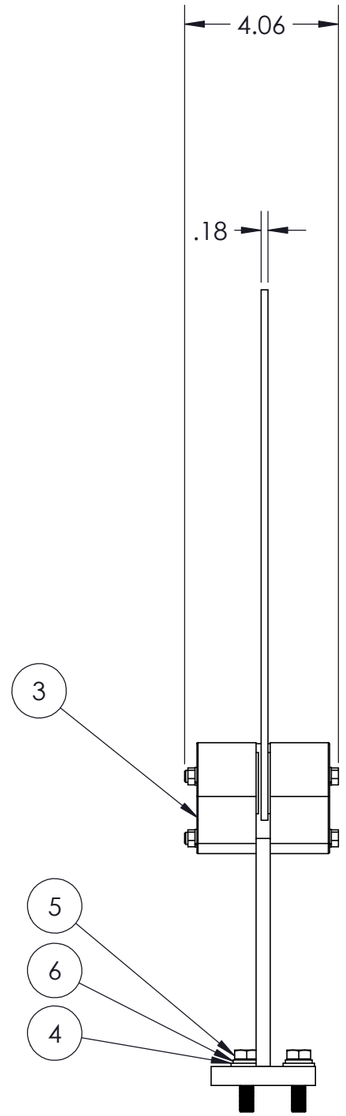
TITLE SPECIAL DIN C
SHEET 1 OF 1
SIZE B SCALE .75=1
409-311

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	202-044-914	BRAKE DISC, 14"OD "E"
2	1	301-042-6	BRAKE MOUNT WELDMENT
3	1	555-021	BRAKE CALIPER
4	2	572-M10FW	M10 FLAT WASHER
5	2	572-M10HH-35	M10 X 1.5 X 35MM HHCS
6	2	572-M10LW	M10 LOCK WASHER

422-019-7







ASSEMBLY WEIGHS APPROXIMATELY 14.99 LBS.

REV	DESCRIPTION	BY	DATE

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L	SEE BOM
STK SIZE	--
FINISH	--
H. T.	--
ASSEM	--
MODEL	63-125
BREAK ALL SHARP EDGES	
BY: DR	DATE: 03-15-2023

DRAWING TECHNOLOGY INC.

TITLE: BRAKE ASM: 14" OD, "E" 3.375"

SHEET 1 OF 1

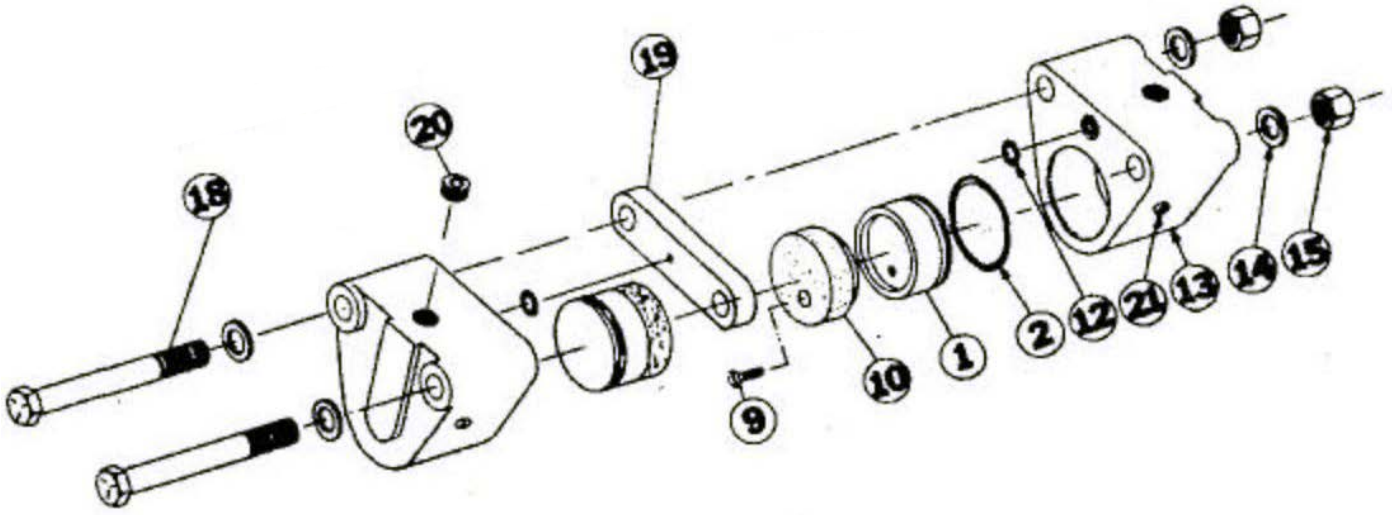
SIZE B | SCALE 1/4

422-019-7 REV

Drawing Technology Inc.

555-019 Disk Brake Assembly

Number	DTI Part Number	English
1	555-019-1	Piston
2	555-019-2	O-Ring, Piston
9	555-019-9	Screw, Flat Head
10	555-020	Brake puck
12	555-019-12	O-Ring
13	555-019-13	Housing, Retractable
14	555-019-14	Washer
15	555-019-15	Nut, nylock
18	555-019-18	Screw
20	555-019-20	Plug, ¼-27 npt
21	555-019-21	Screw, bleeder

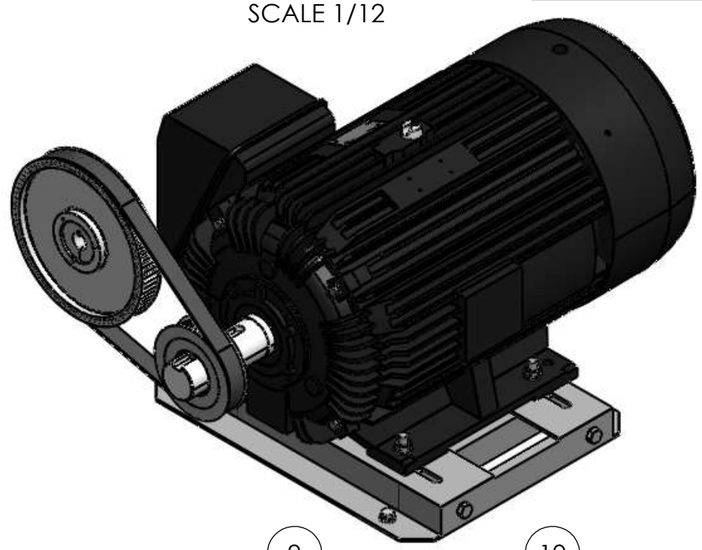


1550 Elmwood Road | Rockford, IL 61103 | Phone [815] 877.5133 | Fax [815] 877.3627
Email sales@drawingtechnology.com | Website www.drawingtechnology.com

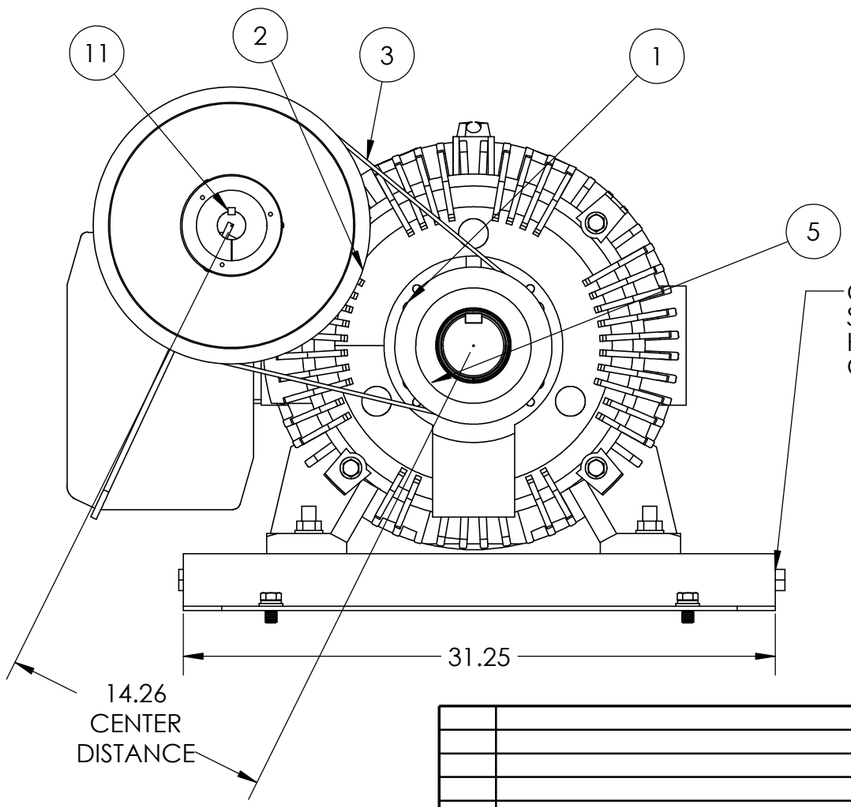
ITEM NO.		PART NUMBER	DESCRIPTION
1	1	500-0044-42	PULLEY, 44PTH14-42E
2	1	500-0080-42	80 PTH8M-12 (SDS) PULLEY
3	1	501-1610-42-I	1610-PTH-14M-42 BELT (14.26")
4	1	509-222	BUSHING, E X 1-1/2
5	1	509-237	BUSHING, E X 3.375
6	4	572-M16FW	M16 FLAT WASHER
7	4	572-M16HH-30	M16x2 x 30mm, HHCS
8	4	572-M16LW	M16 LOCK WASHER
9	1	602-125TGP	125 HP, 1750 RPM, 444B2 FRAME
10	1	604-029	SLIDE BASE, OVERLY-HAUTZ(444T)
11	1	SKS-038-027500	KEYSTOCK, 3/8" SQ x 2.7500

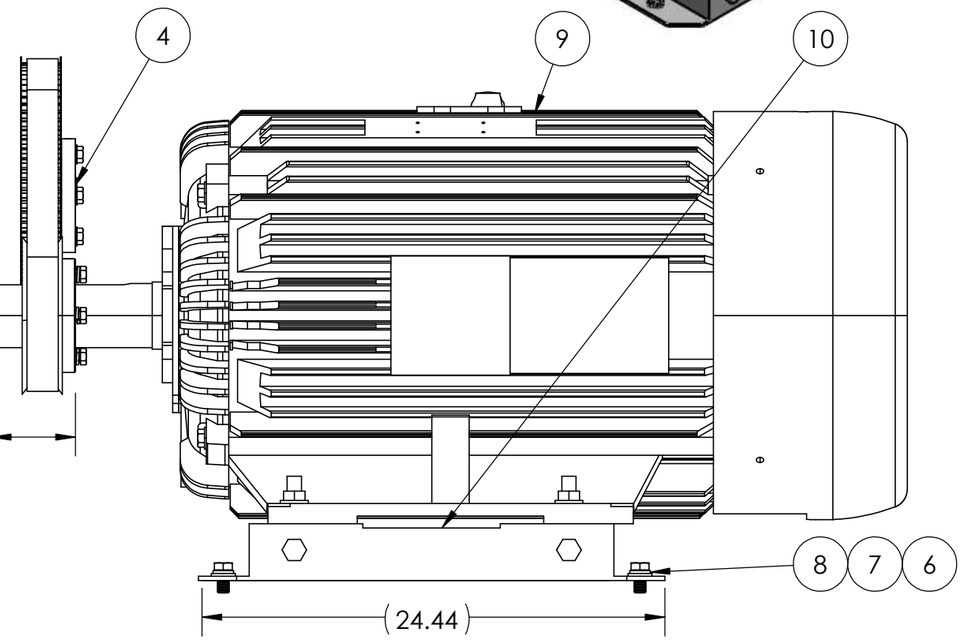
424-63125-330

ISOMETRIC VIEW
SCALE 1/12



BELT TENSION:
.204" BELT DEFLECTION @ 11#
LOAD AT BELT MIDPOINT





REF GEARBOX 502-050T2 40:I RATIO

$$\frac{1750 \text{ X } 90 \text{ X } 9.333' \text{ X } 44T}{40 \text{ X } 60 \text{ X } 80T} = 336.75 \text{ FPM}$$

REV	DESCRIPTION	BY	DATE

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L	SEE BOM
STK SIZE	--
FINISH	--
H. T.	--
ASSEM	463-125-330
MODEL	63125-330
BREAK ALL SHARP EDGES	
BY: DR	DATE: 11-18-2021

DTi
DRAWING TECHNOLOGY INC.

TITLE:
TRANSMISSION

SHEET 1 OF 1
SIZE B SCALE 1/8
424-63125-330 REV

DRAWING TECHNOLOGY INC

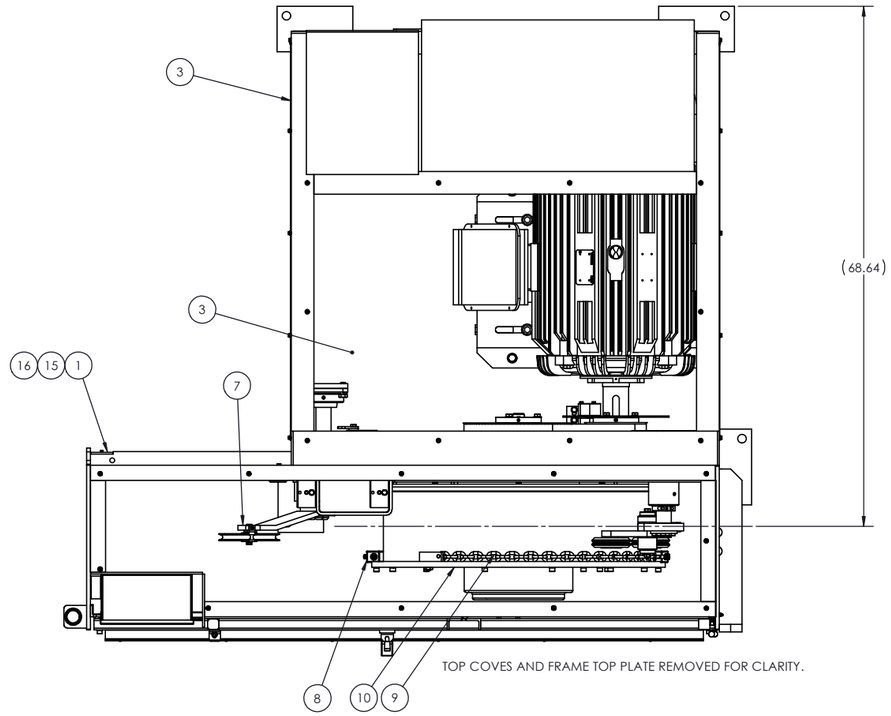
BM0055-004209

Bill of Material

Level	Components	Rev	Description	UM	Quantity	Freq	Cat	Sc	Drawing	Tag	S	PL	Sort
Parent:	463-125-350-8560		Model 63125.350TSH										
1*******	119-703		COVER PLATE FOR CHANNEL	EA	1.0000	0	Nor	MS				PM	FWP
1*******	301-361-5		OVERNIGHT BAR SOCKET WELDMENT	EA	1.0000	0	Nor	MS				PM	FWP
1*******	363-026-2R		FRAME WDMT 63125	EA	1.0000	0	Nor	MS				PM	FRAME
1*******	411-063-3H		PNEUMATIC DIAGRAM: 63 W/ SNAG	EA	1.0000	0	Pht	MJ				PM	PNEUM
1*******	415-063-3H-R		WIRE ROLLER ASSEMBLY 63	EA	1.0000	0	Pht	MJ				PM	RLRASSY
1*******	416-001-HR		DRAWBOX ASM HRZ. REVERSE	EA	1.0000	0	Pht	MJ				PM	DBOX
1*******	417-063-8H-R		COMPENSATOR ASSEMBLY 63125	EA	1.0000	0	Pht	MJ				PM	COMP
1*******	418-005		5/8 GRIPPER ASSY	EA	1.0000	0	Pht	MJ				PM	GRIP
1*******	418-006		GRIPPER ASSEMBLY 5/8 LOG CHN	EA	1.0000	0	Pht	MJ				PM	GRIP
1*******	419-063-10		CAPSTAN ASSY: 63 X I50T2	EA	1.0000	0	Pht	MJ				PM	CAPSTAN
1*******	422-019-7		BRAKE ASM: 14" OD, "E" 3.375"	EA	1.0000	0	Pht	MJ				PM	BRAKE
1*******	424-63125-330		TRANSMISSION ASSEMBLY	EA	1.0000	0	Pht	MJ				PM	TRANS
1*******	429-0823-5874		FA KIT 63125 L-2-R	EA	1.0000	0	Pht	MJ				PM	FAKIT
1*******	493-0823-5874		ELECTRICAL ASSY, 63125	EA	1.0000	0	Pht	MJ				PM	ELEC
1*******	572-M05LW		M5 LOCK WASHER	EA	2.0000	0	Ref	PS				PP	FASTNRS
1*******	572-M05SH-15		M5X.8X15MM LG. SOCKET HEAD CAP	EA	2.0000	0	Ref	PS				PP	FASTNRS
1*******	572-M08FW		M8 FLAT WASHER	EA	2.0000	0	Ref	PS				PP	FASTNRS
1*******	572-M08LW		M8 LOCKWASHERS	EA	2.0000	0	Ref	PS				PP	FASTNRS
1*******	572-M08SH-15		M8X1.25, 15MM LG, SHCS	EA	2.0000	0	Ref	PS				PP	FASTNRS
1*******	572-M16JN		M16 JAM NUT	EA	3.0000	0	Ref	PS				PP	FASTNRS
1*******	572-M16LW		M16 LOCK WASHER	EA	3.0000	0	Ref	PS				PP	FASTNRS
1*******	572-M16SH-45		M16 X 2.0 X 45MM LG. SHCS	EA	3.0000	0	Ref	PS				PP	FASTNRS

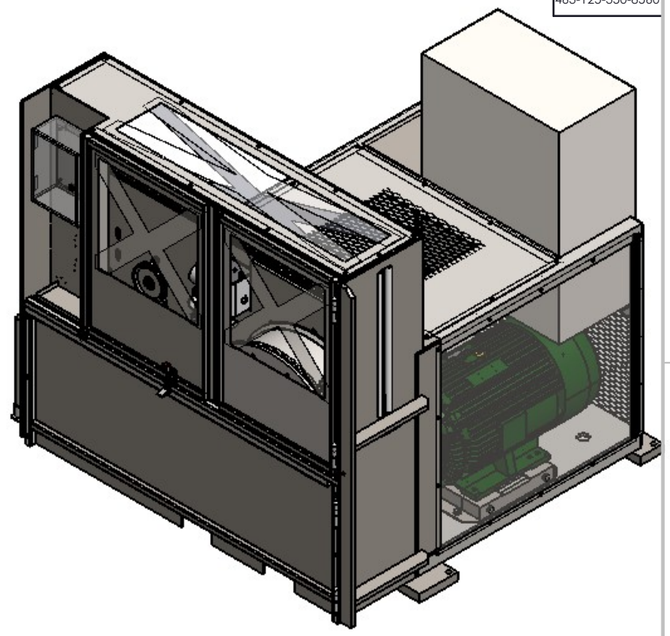
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	119-703	COVER PLATE	1
2	301-361-5	OVERNIGHT BAR SOCKET WLDMT	1
3	363-026-2R	FRAME WELDMENT, 63	1
4	411-063-3H	PNEUMATIC ASSEMBLY	1
5	415-063-3H-R	WIRE ROLLER ASSY, MODEL 63	1
6	416-001-HR	DRAWBOX ASSEMBLY	1
7	417-063-8H-R	COMPENSATOR ASSY, MODEL 63	1
8	418-005	CHAIN ASSY, 5/8" GRIPPER	1
9	418-006	5/8 GRIPPER ASSEMBLY WITH LOG CHAIN	1
10	419-063-10	CAPSTAN ASSY 36" MODEL 63	1
11	422-019-7	BRAKE ASSEMBLY	1
12	424-63125-330	TRANSMISSION ASSY, 63125-330	1
13	429-0823-5874	FA KIT	1
14	493-0823-5874	ELECTRICAL ASSY, 63125-330TSH	1
15	572-M05LW	M5 LOCK WASHER	2
16	572-M05SH-15	M5x.8 x 15mm, SHCS	2
17	572-M08FW	M8 FLAT WASHER	2
18	572-M08LW	M8 LOCK WASHER	2
19	572-M08SH-15	M8x1.25 x 15mm, SHCS	2
20	572-M16JN	NUT, M16 X 2 JAM HEX	3
21	572-M16LW	M16 LOCK WASHER	3
22	572-M16SH-45	M16 X 2.0 X 45MM LG. SHCS	3

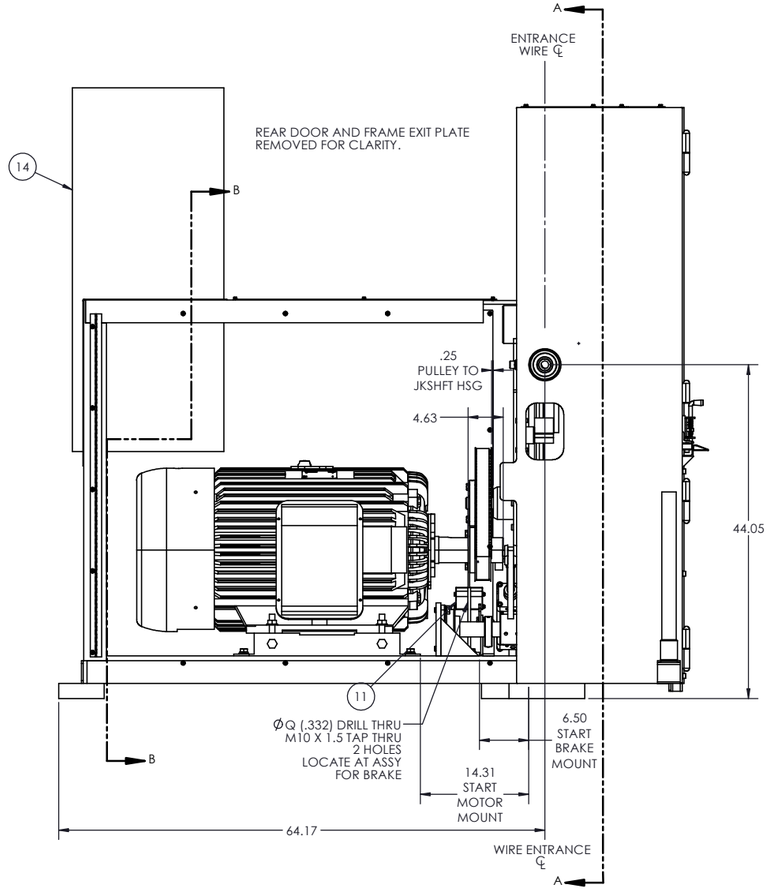
ITEM (2) NOT SHOWN

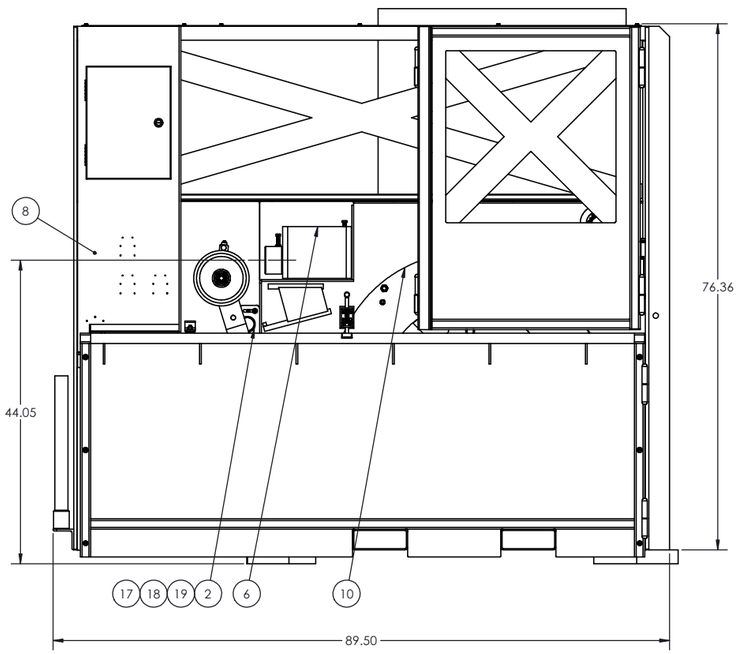


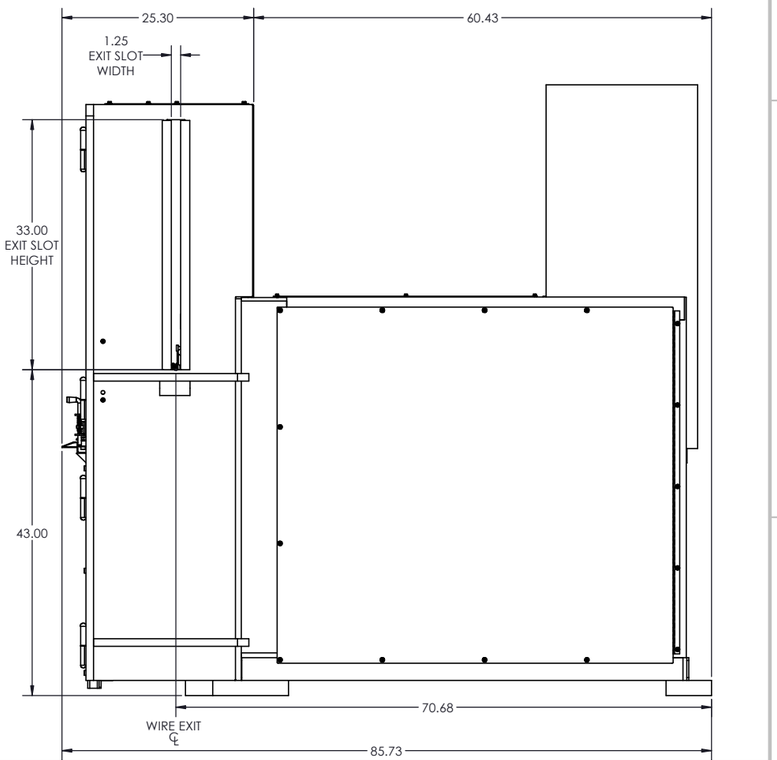
TOP COVES AND FRAME TOP PLATE REMOVED FOR CLARITY.

463-125-350-8560









REV	DESCRIPTION	BY	DATE	TOLERANCES	MAT'L SEE BOM	DTI DRAWING TECHNOLOGY INC.	
					STK SIZE --		
				X. XXX +/- .010	FINISH --		
				X. XX +/- .030	H. T. --		
				X. X +/- .062	ASSEM --	TITLE:	
				FRAC +/- .062	MODEL 63 DRAWER REVERSE	Model 63125-350TSH	
				ANGLE +/- 5°	BREAK ALL SHARP EDGES	SHEET 1 OF 2	
				UNLESS NOTED	BY: DR	DATE: 04-06-2023	SIZE D SCALE 1/10
						463-125-350-8560	REV

DRAWING TECHNOLOGY INC

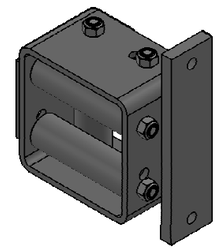
BM0055-004209

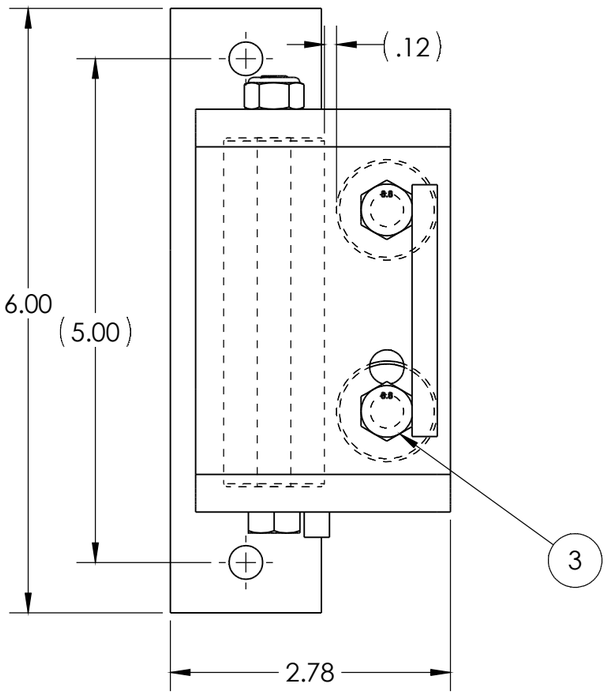
Bill of Material

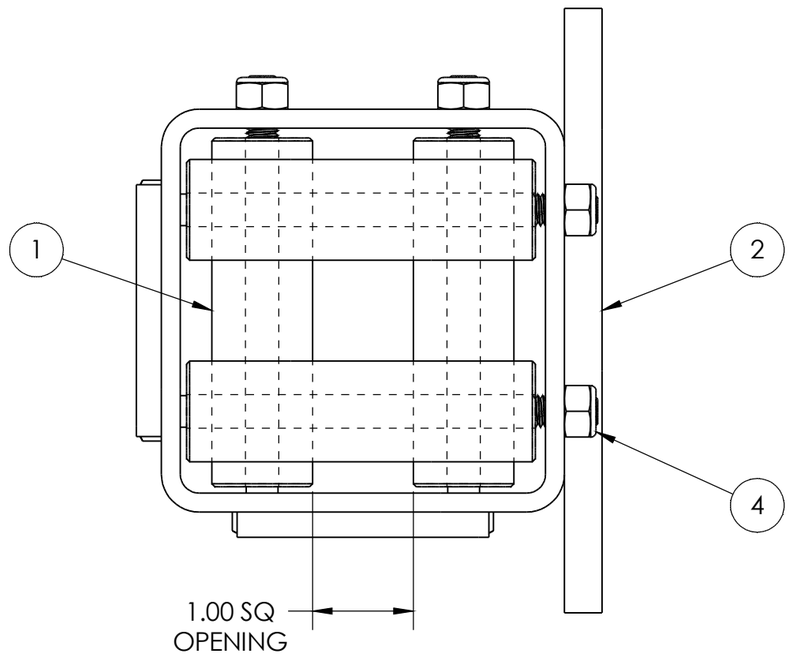
Level	Components	Rev	Description	UM	Quantity	Freq	Cat	Sc	Drawing	Tag	S	PL	Sort
Parent:	468-RD56-8560		Model RD56 descaler										
1*******	102-048-4		STOP PIN: RD56	EA	2.0000	0	Nor	MS				PM	SCALE
1*******	107-029		RETAINER WASHER	EA	8.0000	0	Nor	MS				PM	RETAIN
1*******	117-001-1		BACKUP PLATE, 1/2 X 6 X 10	EA	4.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	119-069-2		RETAINER CAP	EA	2.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	119-070-8		SPACER STRAP	EA	4.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	133-003		GUIDE RING, 6" ID	EA	1.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	301-058-3		JACK BOLT WLDMT: 1"-8 X 6" LG.	EA	4.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	301-935		BACK COVER WELDMENT: RD56	EA	1.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	320-056-1R		FRAME WELDMENT RD56 L-2-R	EA	1.0000	0	Nor	MS	Backup plate for 117			PM	FRAME
1*******	320-073-5		RETRACT CLEVIS/SPACER BAR WDMT	EA	2.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	320-074-2		DESCALER DOOR WELDMENT	EA	1.0000	0	Nor	MS	Backup plate for 117			PM	FWP
1*******	403-003		MED. ANNULAR ROLLER ASSY,	EA	1.0000	0	Pht	MJ	Backup plate for 117			PM	RLRASSY
1*******	411-075		PNEUMATIC DIAGRAM:	EA	1.0000	0	Pht	MJ	Backup plate for 117			PM	PNEUM
1*******	412-856		AIR WIPE ASM: RD56	EA	1.0000	0	Pht	MJ	Backup plate for 117			PM	WIPE
1*******	414-004-1		CYL ASM: 8" BR 9" ST NO SPRING	EA	2.0000	0	Pht	MJ	Backup plate for 117			PM	PNEUM
1*******	429-0823-5874-2		FA KIT	EA	1.0000	0	Pht	MJ				PM	FAKIT
1*******	450-056		ROLLER ASM: RD-56	EA	6.0000	0	Pht	MJ	Backup plate for 117			PM	ROLLER
1*******	550-014		CLEVIS, 3/4-16 THREAD	EA	2.0000	0	Nor	PS	CHI010			PP	PNEUM
1*******	550-019-2		AIR CYLINDER, 3.25 X 10	EA	2.0000	0	Nor	PS	HUB010			PP	PNEUM
1*******	554-029		QUICK EXHAUST VALVE, 1/4" NPT	EA	2.0000	0	Nor	PS	BAR050			PP	PNEUM
1*******	556-023		STRAIGHT FITTING: G1/4 X 6: FE	EA	2.0000	0	Nor	PS	AFF010			PP	PNEUM
1*******	558-411		1/4" BRASS HEX NIPPLES	EA	2.0000	0	Nor	PS	MCM010			PP	SUPPLYS
1*******	571-036		SPRING PLUNGER #KBP-144 M8 T	EA	2.0000	0	Nor	PS	MCM010			PP	MISC
1*******	571-037		DOOR HANDLE, USED ON RD-75	EA	2.0000	0	Nor	PS	ORR010			PP	MISC
1*******	571-038		CAM, DOOR HANDLE, USED ON RD-7	EA	2.0000	0	Nor	PS	ORR010			PP	MISC
1*******	571-514		1/4" NPT CONE MUFFLER	EA	2.0000	0	Ref	PS	MCM010			PP	PNEUM
1*******	572-M10HH-25		M10 X 1.5 X 25MM LG. HHCS	EA	2.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M10HLW		M10 HI-COLLAR LOCKWASHER	EA	2.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M12HH-35		M12X1.75, 35MM LG HHCS	EA	4.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M12LW		M12 LOCK WASHER	EA	4.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M16HH-60		M16 X 2.0 X 60 MM LG. HHCS	EA	8.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M16LW		M16 LOCK WASHER	EA	8.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M20HH-60		M20 X 2.5 X 60 HHCS GR. 8.8(ZI	EA	4.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M20LW		M20 LOCK WASHER	EA	28.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M20SH-45		M20 X2.5 X 45MM SHCS(12.9)	EA	16.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M20SH-70		M20 X 2.5 X 70 MM LG SHCS	EA	4.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M20SH-80		M20 X 2.5 X 80 MM LG SHCS	EA	4.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	573-100-8JN		1"-8 JAM NUT	EA	4.0000	0	Ref	PS	MCM010			PP	FASTNRS

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	4	106-009	ANNULAR ROLLER
2	1	301-037	ANNULAR ROLLER HOUSING WELDMENT
3	4	572-M08-HH-110	M8 X 1.25 X 110MM LG. HHCS
4	4	572-M08NN	M8 HEX NYLOCK NUT

403-003







NOTE: GREASE ID OF ROLLERS

REV	DESCRIPTION	BY	DATE
X	X	X	X

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L --
STK SIZE --
FINISH --
H. T. --
ASSEM --
MODEL RD-50 DESCALER
BREAK ALL SHARP EDGES

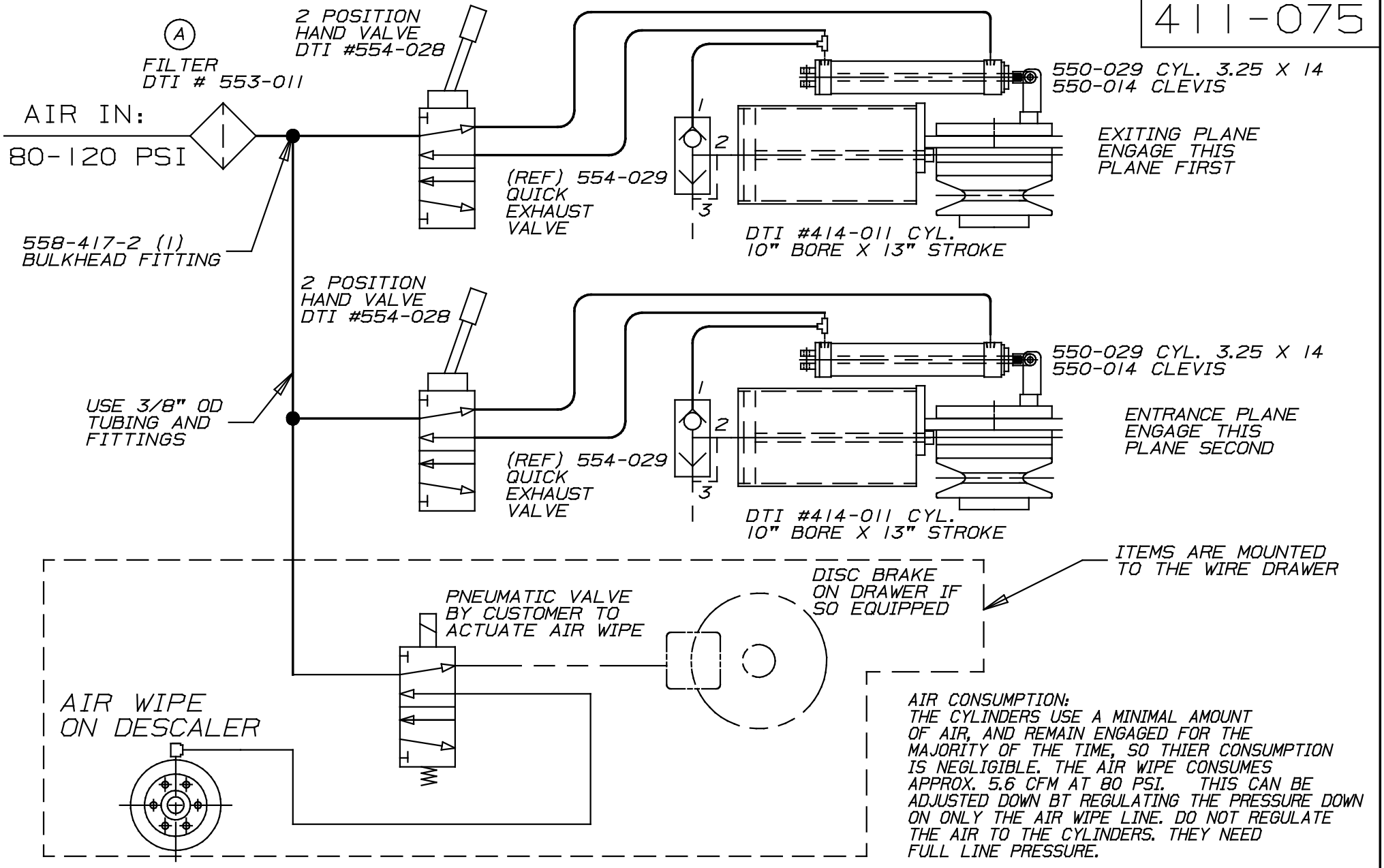
BY: TPB
DATE: 12-14-2000

DTi
DRAWING TECHNOLOGY INC.

TITLE:
ANNULAR ROLLER ASSY

SHEET 1 OF 1
SIZE B
SCALE 2:3
403-003

411-075



AIR CONSUMPTION:
THE CYLINDERS USE A MINIMAL AMOUNT OF AIR, AND REMAIN ENGAGED FOR THE MAJORITY OF THE TIME, SO THIER CONSUMPTION IS NEGLIGIBLE. THE AIR WIPE CONSUMES APPROX. 5.6 CFM AT 80 PSI. THIS CAN BE ADJUSTED DOWN BT REGULATING THE PRESSURE DOWN ON ONLY THE AIR WIPE LINE. DO NOT REGULATE THE AIR TO THE CYLINDERS. THEY NEED FULL LINE PRESSURE.

REV	DESCRIPTION	BY	DATE
A	553-011 WAS 553-006	LSS	1-9-06

TOLERANCES

X.XXX +/- .010
X.XX +/- .030
X.X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L	NOTED
STK SIZE	
FINISH	
H.T.	
ASSEM	
MODEL	RD-75 DESCALER
BREAK ALL SHARP EDGES	
BY: LSS	DATE: 3-21-03

DTi
DRAWING TECHNOLOGY INC.

TITLE: PNEUMATIC ASSY.

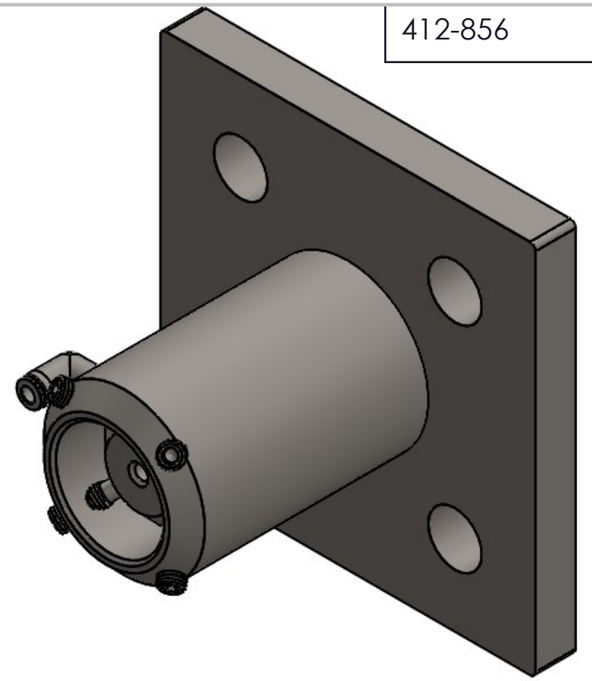
SHEET 1 OF 1

SIZE A | SCALE: NONE

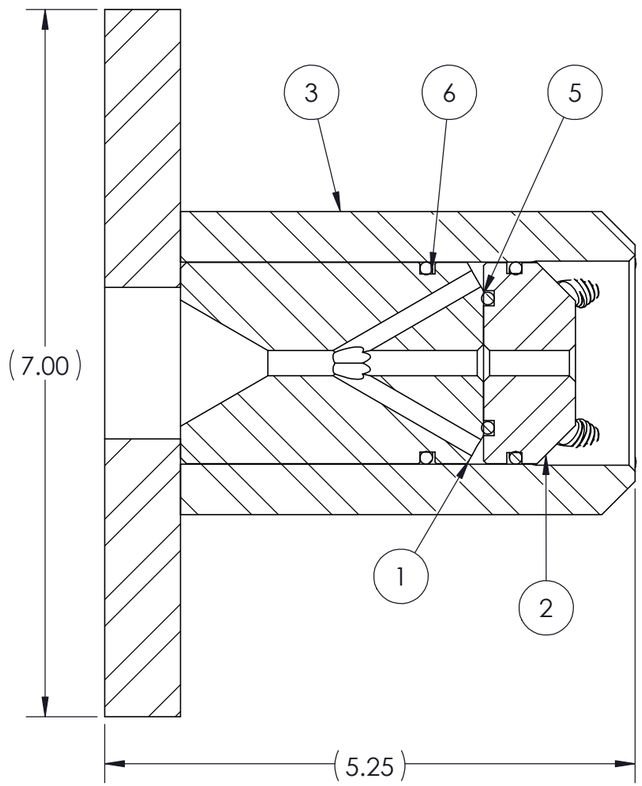
411-075

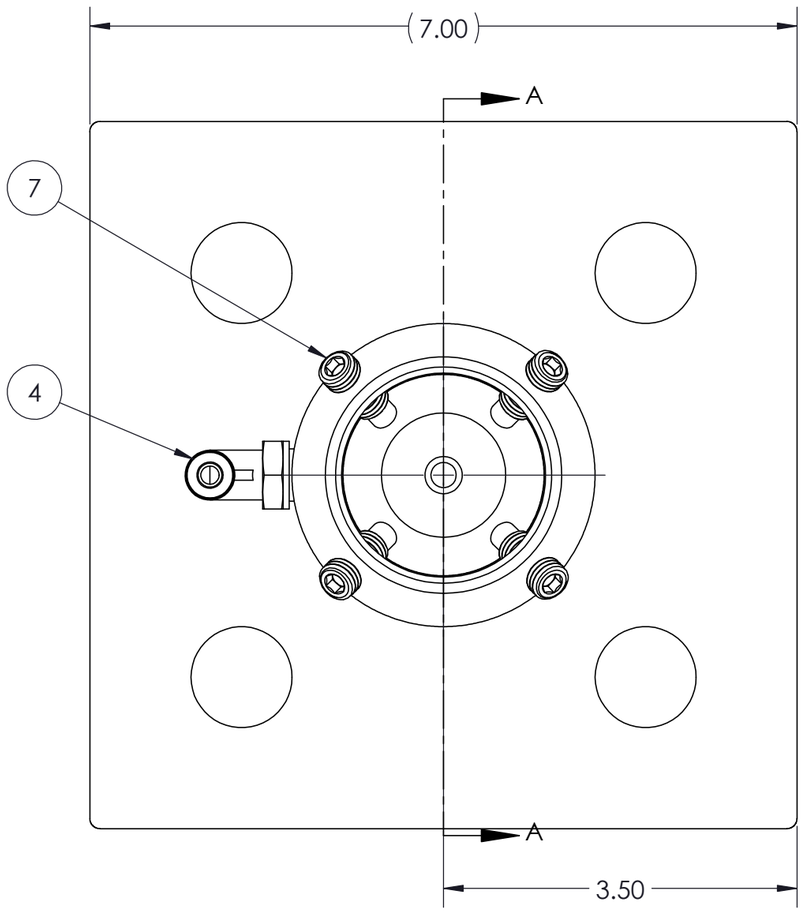
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	134-061-XXX	GUIDE TUBE
2	1	134-062-XXX	EXIT SEAL TUBE
3	1	301-130-4	AIR WIPE HSNG WDMT: RD56
4	1	556-021-1	ELBOW, FESTO #GSL-G1/4-61861
5	1	557-003	O-RING, 1.375 OD X Ø1/8"
6	2	557-004	O-RING, 2" OD X Ø1/8"
7	4	572-M10SS-25	M10x1.5 X 25mm LG SET SCREW DP

412-856



SECTION A-A





REV	DESCRIPTION	BY	DATE

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

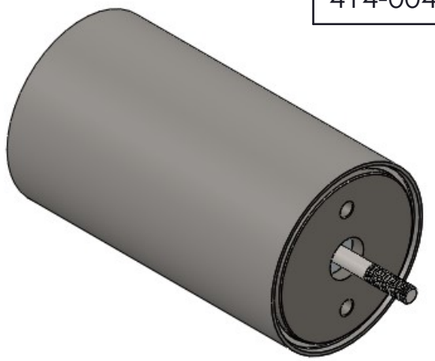
MAT'L	SEE BOM
STK SIZE	--
FINISH	--
H. T.	--
ASSEM	--
MODEL	RD56
BREAK ALL SHARP EDGES	
BY: DR	DATE: 10-12-2021

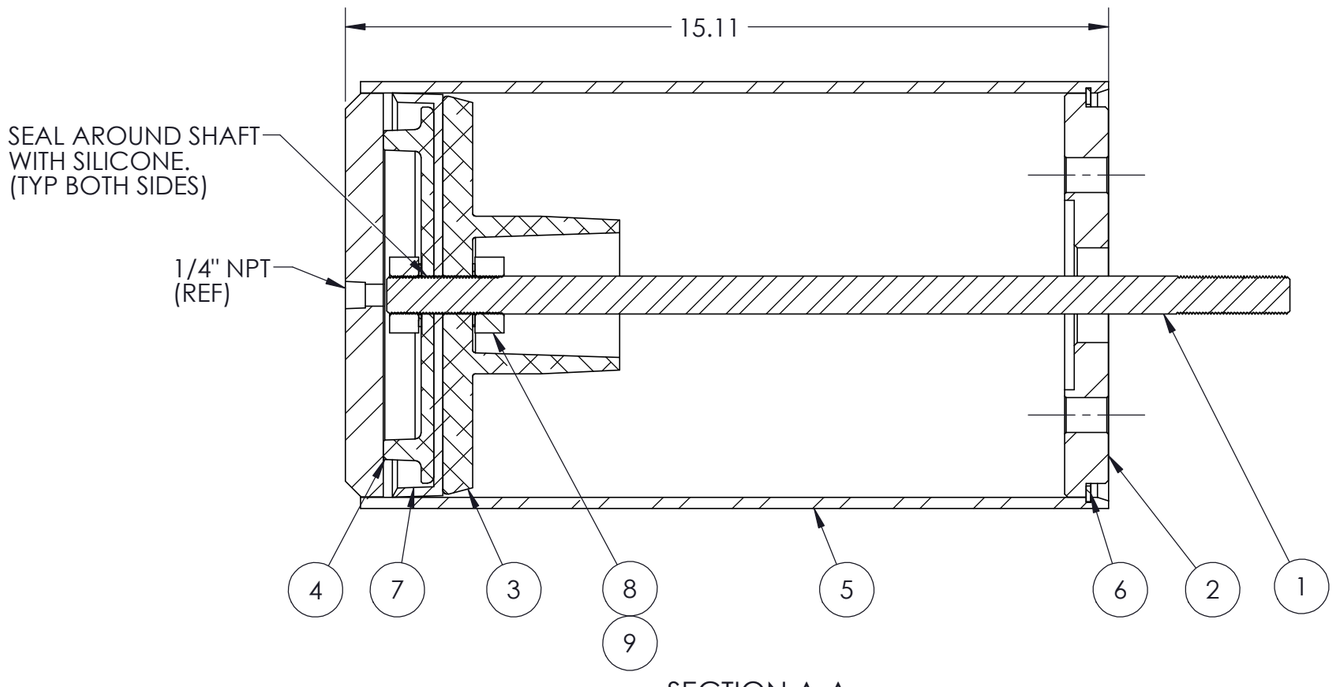
DTi
DRAWING TECHNOLOGY INC.

TITLE:	AIR WIPE ASSEMBLY: RD56
SHEET 1 OF 1	
SIZE B	SCALE A
412-856	

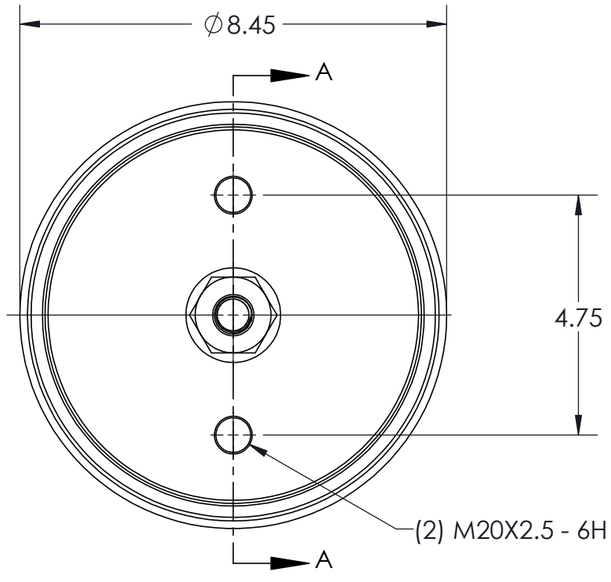
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	102-015-5	SHAFT, AIR BAG
2	1	121-005	CYLINDER CAP
3	1	133-001	PISTON, AIR BAG
4	1	133-002	BACKUP RING CASTING
5	1	301-013-8	CYL. WELDMENT: 8" BORE X9" STROKE
6	1	504-014	RERTAINING RING
7	1	550-005	SEAL, 8" ID CYLINDER
8	2	573-750FT-JAM	NUT, 3/4-16 JAM
9	2	573-750ILW	3/4" INTERNAL TOOTH LOCK WASHER

414-004-1





SECTION A-A



PART WEIGHS APPROXIMATELY 53.19 LBS.

REV	DESCRIPTION	BY	DATE

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L	SEE BOM
STK SIZE	--
FINISH	--
H. T.	--
ASSEM	--
MODEL	RD56
BREAK ALL SHARP EDGES	
BY: DR	DATE: 10-26-2021

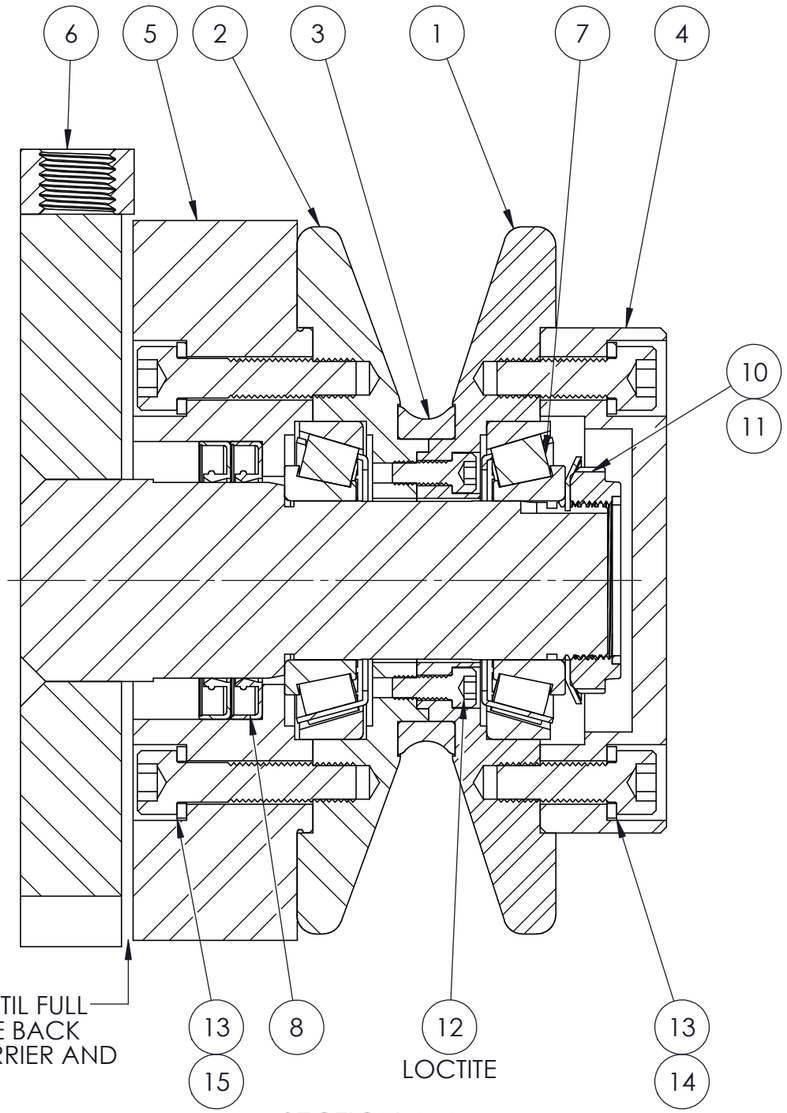
DTi
DRAWING TECHNOLOGY INC.

TITLE: CYLINDER ASSEMBLY: 8" BORE x 9" STROKE - NO SPRING

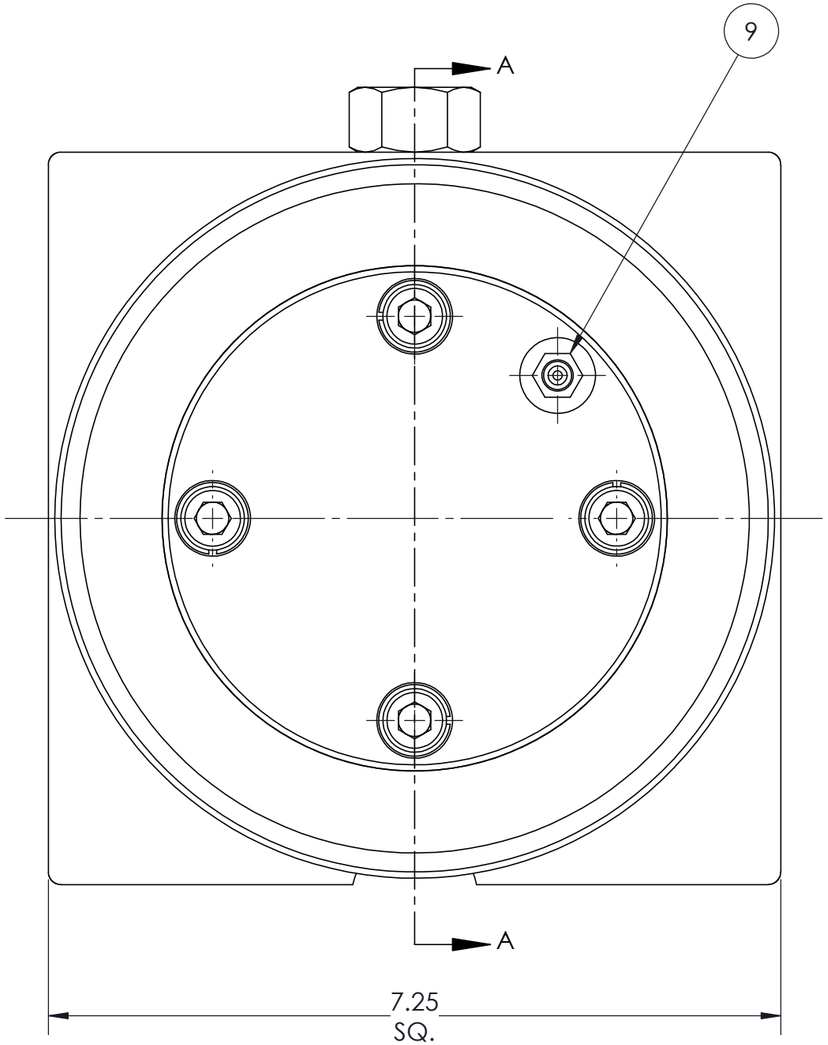
SHEET 1 OF 1
SIZE B SCALE A
414-004-1

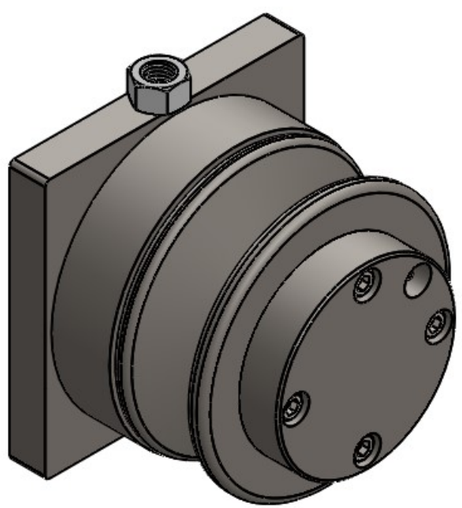
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	106-013-2	MALE ROLLER HALF
2	1	106-014-1	FEMALE ROLLER HALF
3	1	106-015-2	CENTER TIRE
4	1	107-010	COVER
5	1	107-011-4	RETAINER
6	1	320-020-11	SPINDLE BASE WELDMENT
7	2	503-083	TIMKEN BRG SET, 30208M
8	2	505-008	SEAL, 2.75"OD 1.94"ID
9	1	539-101-3	GREASE ZERK, 1/8" NPT
10	1	571-004	TIMKEN BEARING NUT #TN08
11	1	571-005	LOCK WASHER, TW-108
12	4	572-M06SH-15	M6x1 x 15mm, SHCS
13	8	572-M10HLW	M10 HI-COLLAR LOCK WASHER
14	4	572-M10SH-30	M10x1.5 x 30mm, SHCS
15	4	572-M10SH-45	M10x1.5 x 45mm, SHCS

450-056



SECTION A-A





REV	DESCRIPTION	BY	DATE

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

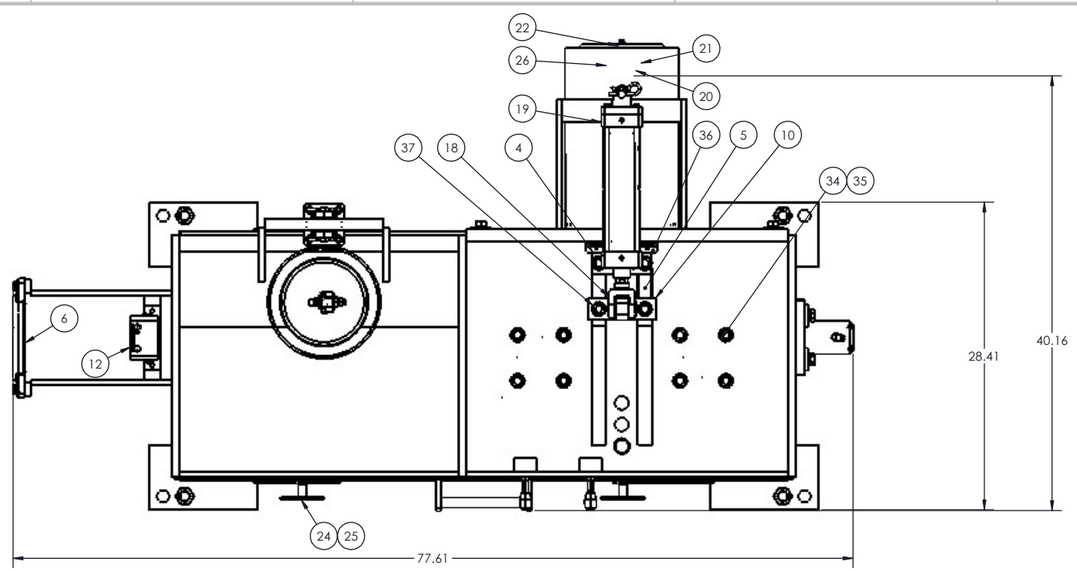
MAT'L SEE BOM
STK SIZE --
FINISH --
H. T. --
ASSEM --
MODEL RD-56
BREAK ALL SHARP EDGES
BY: DR
DATE: 09-30-2021

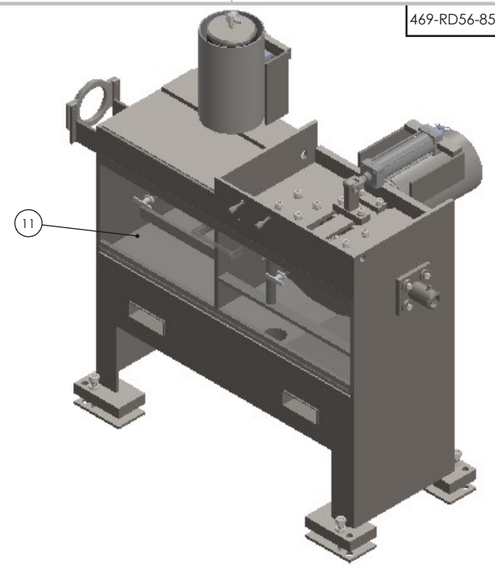
DTi DRAWING TECHNOLOGY INC.

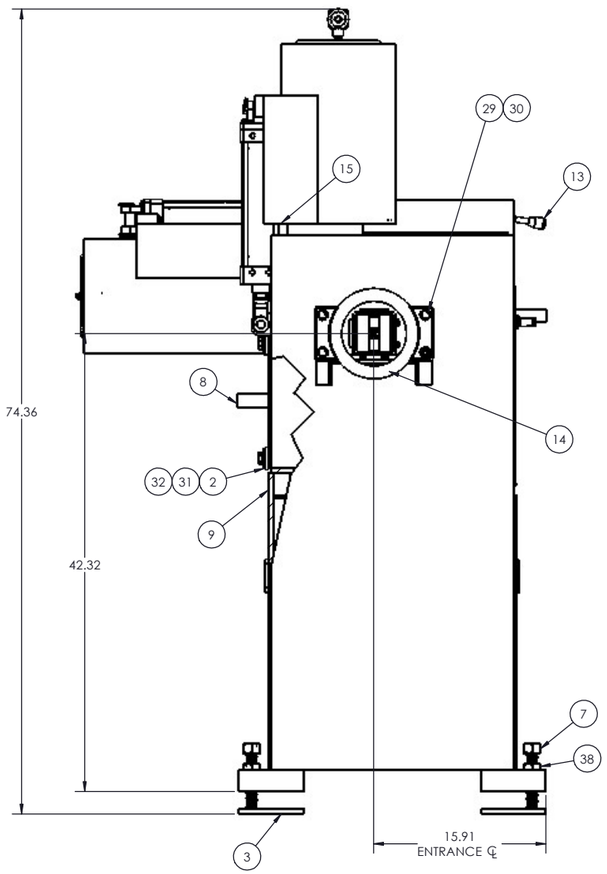
TITLE: ROLLER ASM: RD-56
SHEET 1 OF 1
SIZE B SCALE A
450-056

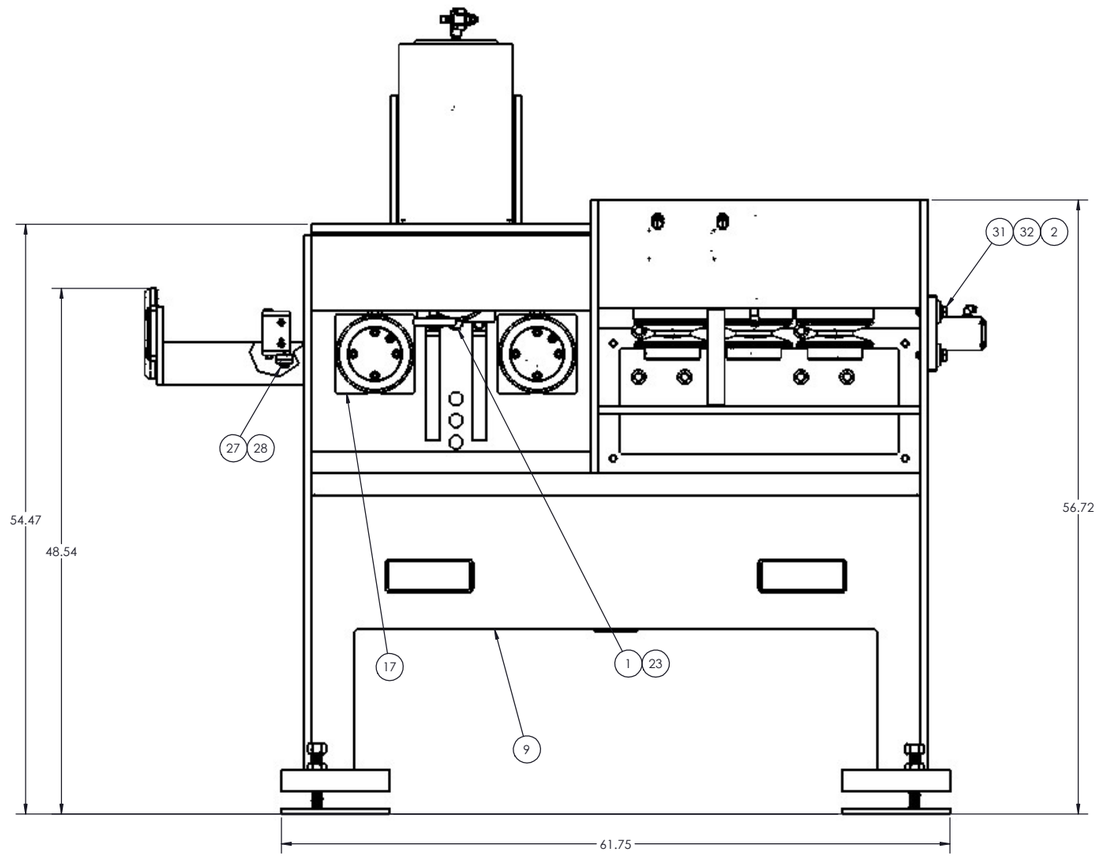
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	2	102-048-4	STOP PIN: RD56
2	8	107-029	RETAINING WASHER
3	4	117-001-1	BACKUP PLATE, 1/2 X 6 X 10
4	2	119-069-2	RETAINER CAP
5	4	119-070-8	SPACER STRAP
6	1	133-003	GUIDE RING
7	4	301-058-3	JACK BOLT WLDMT: 1"-8 X 6" LG.
8	1	301-935	BACK COVER WELDMENT: RD56
9	1	320-056-1R	FRAME WELDMENT
10	2	320-073-5	RETRACT CLEVIS/SPACER BAR WLD
11	1	320-074-2	DESCALER DOOR WELDMENT
12	1	403-003	ANNULAR ROLLER ASSY
13	1	411-075	PNEUMATIC ASSEMBLY
14	1	412-856	AIR WIPE ASSEMBLY: RD56
15	2	414-004-1	CYL., 8" BORE X 9" STROKE, NO SPRING
16	1	429-0823-5874-2	FA KIT RD56 DESCALER
17	6	450-056	ROLLER ASSEMBLY
18	2	550-014	CLEVIS, 3/4-16 THREAD
19	2	550-019-2	AIR CYLINDER: 3.25" x 10"
20	2	554-029	QUICK EXHAUST VALVE, 1/4" NPT

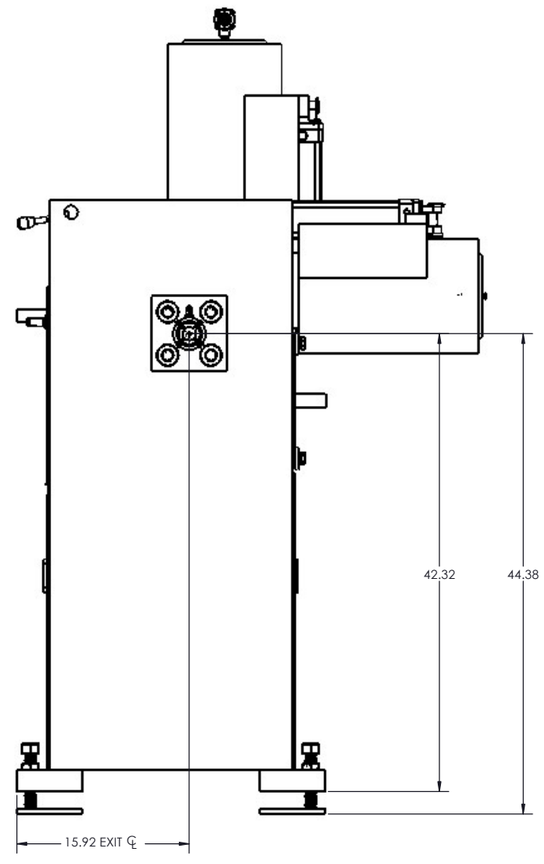
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
21	2	556-023	STRAIGHT FITTING: G1/4 X 6: FE
22	2	558-411	1/4" BRASS HEX NIPPLE
23	2	571-036	SPRING PLUNGER, #KBP-144; M8 T
24	2	571-037	DOOR HANDLE, RD-75
25	2	571-038	CAM, DOOR HANDLE
26	2	571-514	1/4" NPT CONE MUFFLER
27	2	572-M10HH-25	M10 X 1.5 X 25MM HHCS
28	2	572-M10HLW	M10 HI-COLLAR LOCK WASHER
29	4	572-M12HH-35	M12X1.75, 35MM LG HHCS
30	4	572-M12LW	M12 LOCK WASHER
31	8	572-M16HH-60	M16x2 x 60mm, HHCS
32	8	572-M16LW	M16 LOCK WASHER
33	5	572-M20HH-60	M20x2.5 x 60mm, HHCS
34	35	572-M20LW	M20 LOCK WASHER
35	22	572-M20SH-45	M20 X 2.5 X 45MM LG. SHCS
36	4	572-M20SH-70	M20 X 2.5 X 70MM LG. SHCS
37	4	572-M20SH-80	M20 X 2.5 X 80MM LG. SHCS
38	4	573-100-8JN	NUT, 1"-8 JAM











ASSEMBLY WEIGHS APPROXIMATELY 2358.84 LBS.

REV	DESCRIPTION	BY	DATE
X	X	X	X

TOLERANCES
X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°
UNLESS NOTED

MAT'L SEE BOM
STK SIZE --
FINISH --
H. T. --
ASSEM --
MODEL RD56 L2R
BREAK ALL SHARP EDGES
BY: DR
DATE: 04-06-2023

DTI DRAWING TECHNOLOGY INC.
TITLE: DESCALER ASSEMBLY RD56 L2R
SHEET 1 OF 1
SIZE D SCALE --
469-RD56-8560 REV

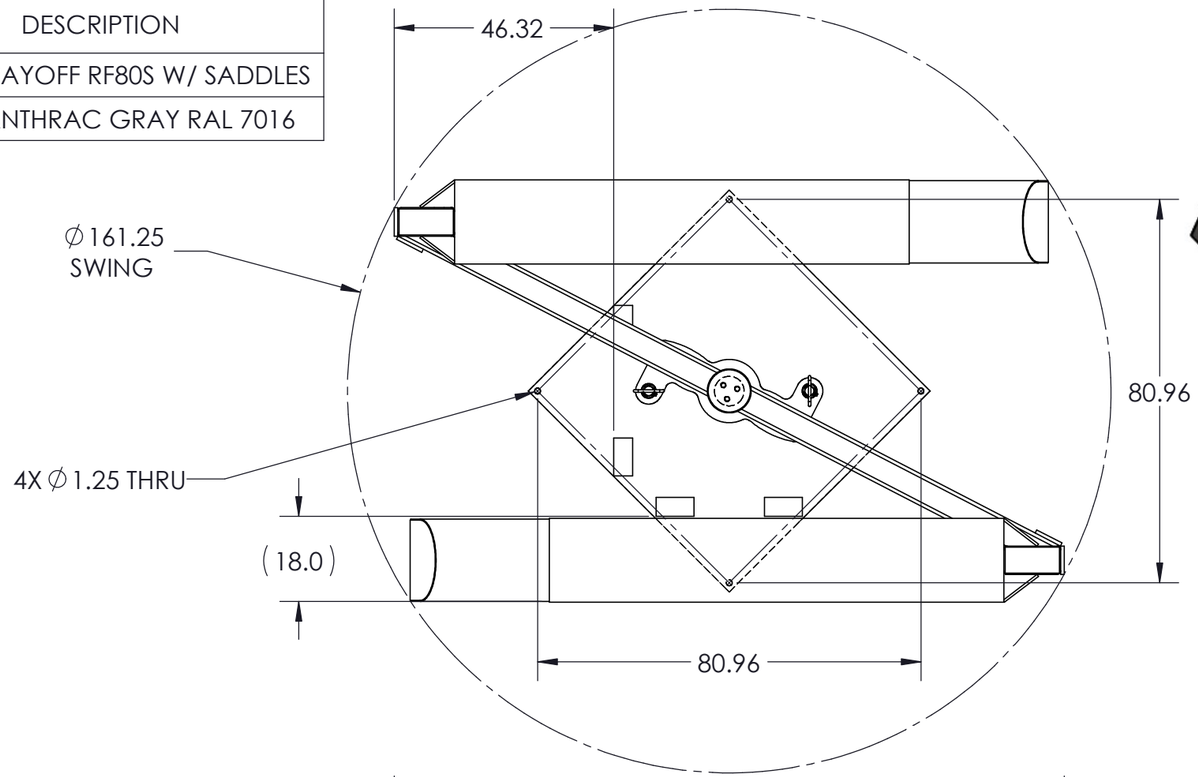
DRAWING TECHNOLOGY INC

BM0055-004209

Bill of Material

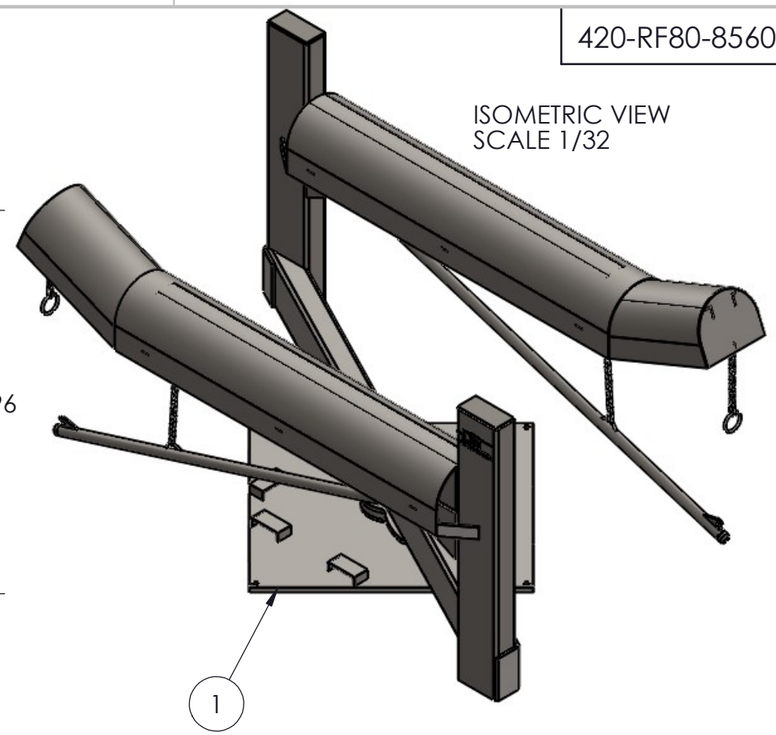
Level	Components	Rev	Description	UM	Quantity	Freq	Cat	Sc	Drawing	Tag	S	PL	Sort
Parent:	420-041		"S" FLIPPER, W/SADDLE (96")										
1*******	108-011		BOSS, ROTATION STOP	EA	2.0000	0	Nor	MS				PM	FWP
1*******	121-016		RETAINING PIN,	EA	2.0000	0	Nor	MS				PM	FWP
1*******	128-002FC		GUSSET F/C	EA	4.0000	0	Nor	PS	LIE010			PP	GUSSET
1*******	130-009-3		LOWER ARM, W/ANGLE CUT	EA	2.0000	0	Pht	MJ	(has drilled spring			PP	MISC
1*******	130-011-3		HORIZ BEAM, FLIPPER W/SADDLE	EA	2.0000	0	Pht	MJ	(has drilled spring			PM	FWP
1*******	201-022-5FC		SUPPORT PLATE	EA	1.0000	0	Nor	PS	LIE010			PP	FWP
1*******	304-004-7		BEARING TUBE/COLUMN	EA	1.0000	0	Pht	MJ	(has drilled spring			PM	FWP
1*******	304-005-3		BASE/SPINDLE WLDMT	EA	1.0000	0	Pht	MJ	(has drilled spring			PM	FWP
1*******	304-006		CAP, BEARING TUBE	EA	1.0000	0	Pht	MJ	Bearing Tube Cap Wel			PM	FWP
1*******	304-007-4		LOWER RESTRAINING ARM	EA	2.0000	0	Pht	MJ	Lower Restraining Ar			PM	FWP
1*******	304-008		PIN, STOP (ROTATION)	EA	2.0000	0	Pht	MJ	Pin, Rotation Stop			PM	FWP
1*******	304-041		SADDLE WLDMT (96") FLIPPER	EA	2.0000	0	Pht	MJ	Saddle Wldmt (96") N			PM	FWP
1*******	420-041CS		CUT STOCK	EA	1.0000	0	Pht	MJ	Saddle Wldmt (96") N			PM	STEEL
1*******	503-031		TIMKEN CUP 36920, (8.937"OD)	EA	1.0000	0	Nor	PS	WEI010			PP	BEARING
1*******	503-032		TIMKEN CONE 36990, (7.000 ID)	EA	1.0000	0	Nor	PS	WEI010			PP	BEARING
1*******	503-033		TIMKEN CUP 48220, (7.18 OD)	EA	1.0000	0	Nor	PS	WEI010			PP	BEARING
1*******	503-034		TIMKEN CONE 48286, (5.75 ID)	EA	1.0000	0	Nor	PS	WEI010			PP	BEARING
1*******	504-004		SNAP RING, 1.25 DIA SHAFT	EA	4.0000	0	Nor	PS	MOT010			PP	SNRING
1*******	506-003		CHAIN, PROOF COIL 8 LINKS/FT	FT	3.0000	0	Nor	PS	Lower Restraining Ar			PP	CHAIN
1*******	506-012		CONNECTING LINK, 3/8"THREADED	EA	4.0000	0	Nor	PS	Lower Restraining Ar			PP	CHAIN
1*******	507-007		DIE SPRING, 1.22 ODX.65IDX1.5(	EA	2.0000	0	Nor	PS	Lower Restraining Ar			PP	SPRING
1*******	538-007-1		DTI LOGO 4.25" X 11" (MEDIUM)	EA	2.0000	0	Nor	PS	DLU010			PP	LABEL
1*******	558-650		WELDED RING; 5" OD X 4" ID (FC	EA	2.0000	0	Nor	PS	MCM010			PP	SUPPLYS
1*******	571-031		EYE BOLT, 1/2-13 X 6" LG. SHAN	EA	2.0000	0	Nor	PS	Lower Restraining Ar			PP	MISC
1*******	571-032-1		COLD SHUT, 7/16 DIA.	EA	2.0000	0	Nor	PS	MCM010			PP	FWP
1*******	572-M12SS-20		M12 X 1.75 X 20 MM LG SET SCRE	EA	2.0000	0	Ref	PS	MCM010			PP	FASTNRS
1*******	572-M16HH-40		M16 X 2.0 X 40MM LG. HHCS	EA	3.0000	0	Ref	PS	Saddle Wldmt (96") N			PP	FASTNRS
1*******	572-M16LW		M16 LOCK WASHER	EA	3.0000	0	Ref	PS	Saddle Wldmt (96") N			PP	FASTNRS
1*******	573-500FW		1/2 FLAT WASHER	EA	2.0000	0	Ref	PS	FAS010			PP	FASTNRS
1*******	573-500LN		1/2-13 NYLOCK NUT	EA	2.0000	0	Ref	PS	Saddle Wldmt (96") N			PP	FASTNRS
1*******	STR-126-38		12" X 6" X 3/8" WALL	IN	140.0000	0	Nor	PS	Saddle Wldmt (96") N			RM	TUBE

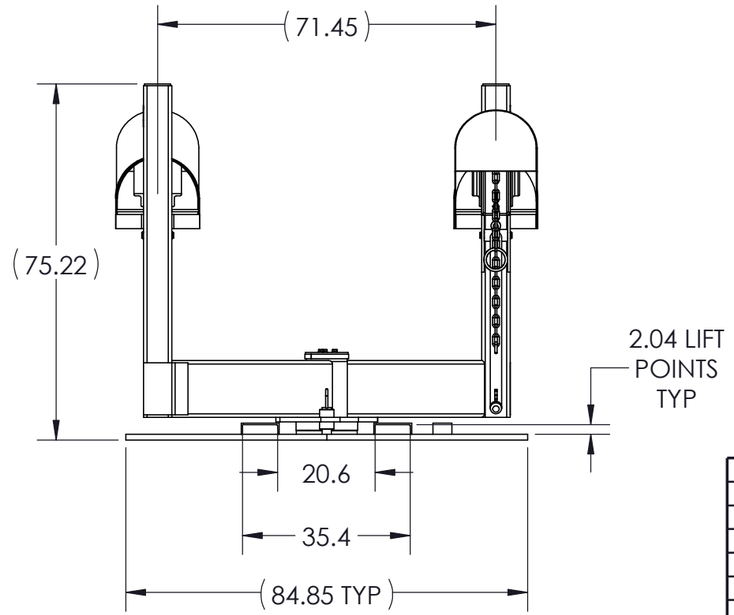
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	420-041	FLIPPER PAYOFF RF80S W/ SADDLES
2	1	558-032-63	PAINT ANTHRAC GRAY RAL 7016

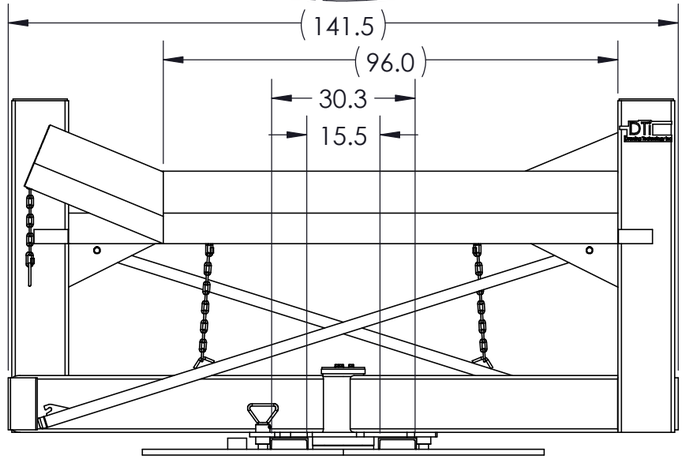


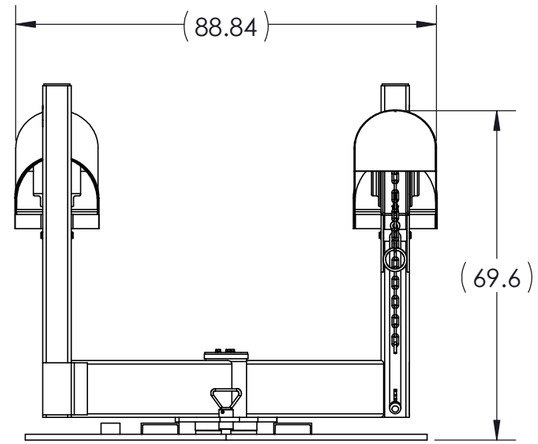
420-RF80-8560

ISOMETRIC VIEW
SCALE 1/32









ASSEMBLY WEIGHS APPROXIMATELY 4500 LBS.

REV	DESCRIPTION	BY	DATE

TOLERANCES

X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°

UNLESS NOTED

MAT'L SEE BOM
STK SIZE -
FINISH --
H. T. --
ASSEM --
MODEL RF80 S STYLE W/ SADDLES
BREAK ALL SHARP EDGES

BY: DR
DATE: 04-06-2023

DTi
DRAWING TECHNOLOGY INC.

TITLE: "S" FLIPPER PAYOFF W/ SADDLES
SHEET 1 OF 1
SIZE B SCALE A
420-RF80-8560 REV

DRAWING TECHNOLOGY INC

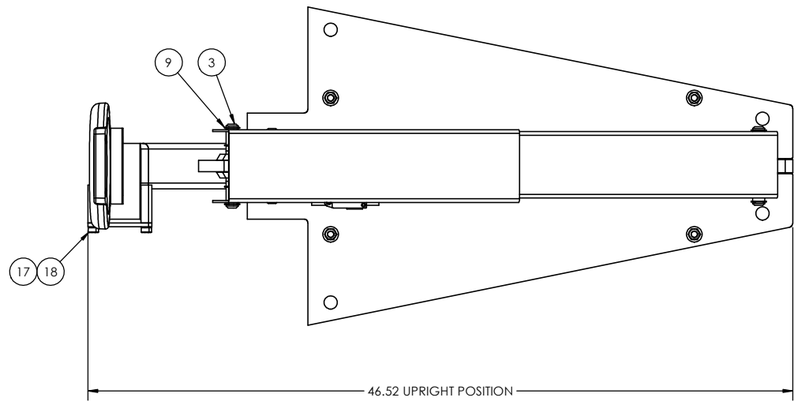
BM0055-004209

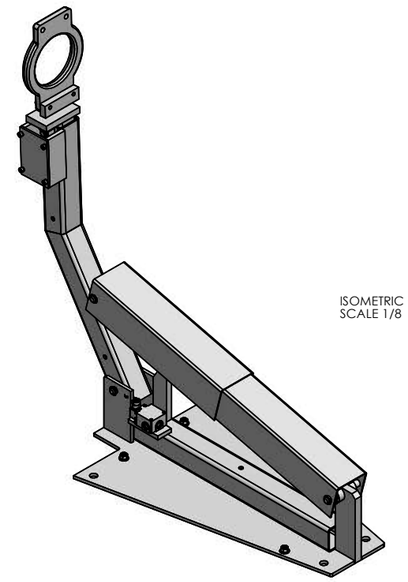
Bill of Material

Level	Components	Rev	Description	UM	Quantity	Freq	Cat	Sc	Drawing	Tag	S	PL	Sort
Parent:	435-503H		SNAG ASSEMBLY W/80X300 CYLINDE										
1*******	119-154		LIMIT SWITCH COVER PLATE,	EA	1.0000	0	Nor	MS				PM	MTG
1*******	121-032		RETAINING PIN,	EA	1.0000	0	Nor	MS				PM	MISC
1*******	121-032-4		RETAINING PIN, 20MM	EA	1.0000	0	Nor	MS				PM	MISC
1*******	121-032-5		PIN, RETAINING: 20MM	EA	1.0000	0	Nor	MS				PM	SNAG
1*******	133-003		GUIDE RING, 6" ID	EA	1.0000	0	Nor	MS				PM	FWP
1*******	335-503H		SNAG FRAME WELDMENT	EA	1.0000	0	Nor	MS				PM	WELDMT
1*******	335-522-1H		SNAG SWITCH PIVOT ARM,	EA	1.0000	0	Nor	MS				PM	WELDMT
1*******	335-523		ADJUSTING ARM, 2.50" SQ. TUBE	EA	1.0000	0	Nor	MS				PM	WELDMT
1*******	504-019		E-CLIP 3/4" DIA. SHAFT	EA	8.0000	0	Nor	PS	MOT010			PP	SNRING
1*******	542-024-1		SNAG CYL. OUTER COVER	EA	1.0000	0	Nor	PS	MOT010			PP	ENCL
1*******	542-025-1		SNAG CYL. INNER COVER	EA	1.0000	0	Nor	PS	MOT010			PP	ENCL
1*******	550-081H		CYLINDER MTG TANG:	EA	1.0000	0	Nor	PS	MOT010			PP	PNEUM
1*******	550-082H		CYL ROD CLEVIS :	EA	1.0000	0	Nor	PS	MOT010			PP	PNEUM
1*******	550-083H		AIR CYLINDER, 80MM X 300MM	EA	1.0000	0	Nor	PS	MOT010			PP	MISC
1*******	572-M04LW		M4 LOCK WASHER	EA	2.0000	0	Ref	PS	MOT010			PP	FASTNRS
1*******	572-M04SH-30		M4 X 0.7 X 30MM LG, SHCS	EA	2.0000	0	Ref	PS	MOT010			PP	FASTNRS
1*******	572-M08LW		M8 LOCKWASHERS	EA	4.0000	0	Ref	PS	MOT010			PP	FASTNRS
1*******	572-M08SH-25		M8X1.25, 25MM LG, SHCS	EA	4.0000	0	Ref	PS	MOT010			PP	FASTNRS
1*******	572-M12HH-40		M12X1.75, 40MM LG HHCS	EA	2.0000	0	Ref	PS	MOT010			PP	FASTNRS
1*******	572-M12LW		M12 LOCK WASHER	EA	2.0000	0	Ref	PS	MOT010			PP	FASTNRS
1*******	573-1032LW		10-32 LOCKWASHER	EA	2.0000	0	Ref	PS	MOT010			PP	FASTNRS
1*******	573-1032SH-750		10-32 X 3/4 LG SOCKET HEAD CAP	EA	2.0000	0	Ref	PS	FAS010			PP	FASTNRS
1*******	607-021		MINI LIMIT SWITCH, W/ADJ. LEVE	EA	1.0000	0	Nor	PS	AUT010			PP	ELEC
1*******	607-025		LIMIT SWITCH, H/D IEC STD ROLL	EA	1.0000	0	Nor	PS	AUT010			PP	ELEC

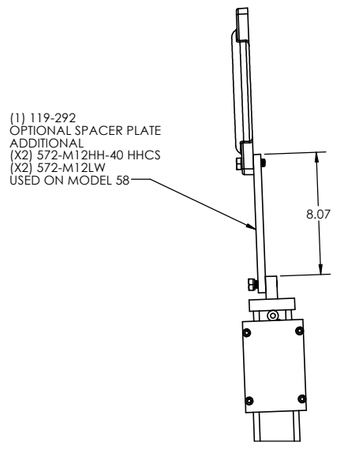
435-503H

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	119-154	COVER PLATE
2	1	121-032	PIVOT PIN
3	1	121-032-4	PIN, RETAINING (20 MM)
4	1	121-032-5	PIN, RETRAINING
5	1	133-003	GUIDE RING
6	1	335-503H	SNAG FRAME WELDMENT
7	1	335-522-1H	PIVOT ARM WELDMENT
8	1	335-523	SLIDER ARM WLDMT
9	8	504-019	E-CLIP 3/4" DIA. SHAFT
10	1	542-024-1	OUTER COVER
11	1	542-025-1	INNER COVER
12	1	550-081H	AIR CYLINDER MTGTANG: HYLAND
13	1	550-082H	CYL ROD CLEVIS : HYLAND
14	1	550-083H	CYLINDER 80 X 300 EXTENDED
15	2	572-M04LW	M4 LOCK WASHER
16	2	572-M04SH-30	M4x.7 x 30mm, SHCS
17	4	572-M08LW	M8 LOCK WASHER
18	4	572-M08SH-25	M8x1.25 x 25mm, SHCS
19	2	572-M12HH-40	M12X1.75, 40MM LG HHCS
20	2	572-M12LW	M12 LOCK WASHER
21	2	573-1032LW	10-32 LOCKWASHER
22	2	573-1032SH-750	10-32x3/4"LG SOCKET HEAD CAP
23	1	607-021	MINI LIM SW W/ADJ LEVER
24	1	607-025	LIMIT SWITCH, H/D IEC STD ROLL

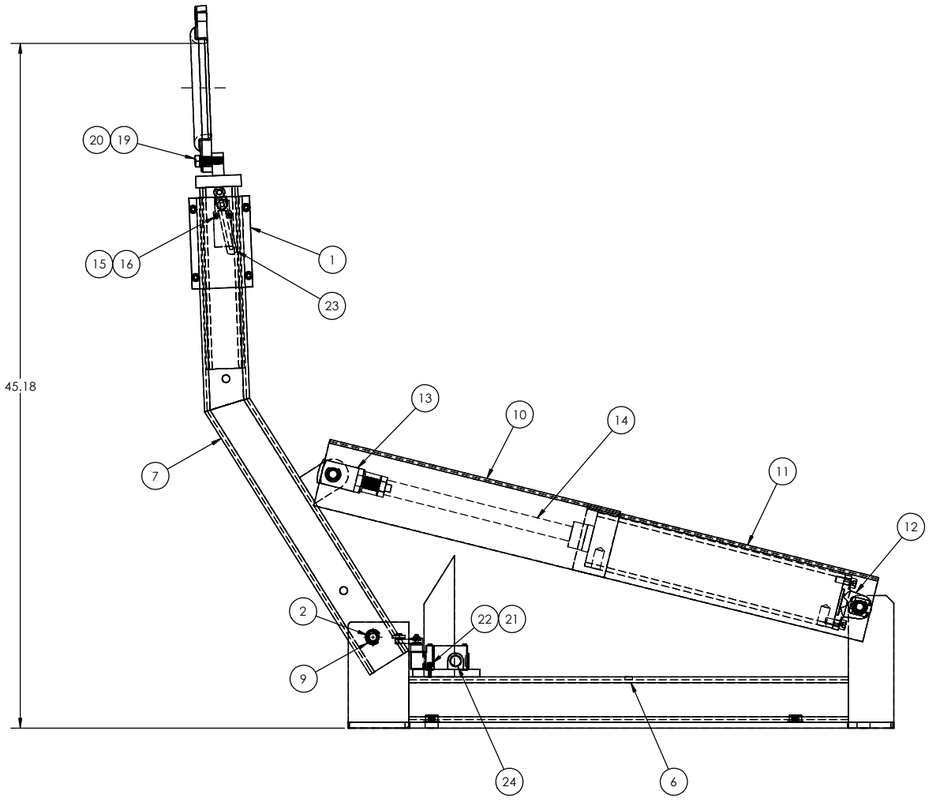


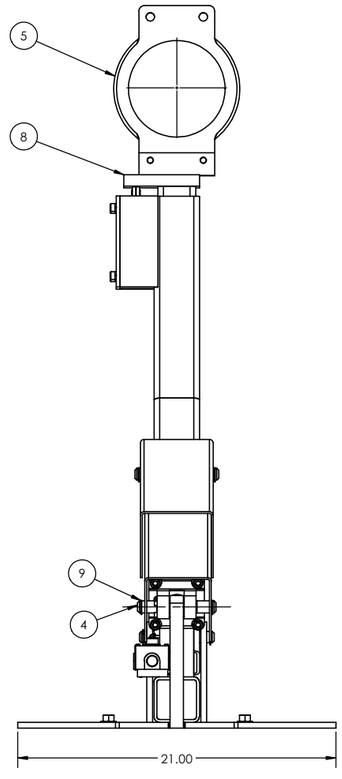


ISOMETRIC VIEW
SCALE 1/8



(1) 119-292
OPTIONAL SPACER PLATE
ADDITIONAL
(X2) 572-M12HH-40 HHCS
(X2) 572-M12LW
USED ON MODEL 58





CHOOSE ONE F/A KIT:
435-502-FA1H
INCLUDES:
554-057H 24VDC VALVE
552-020H REGULATOR
435-502-FA2
INCLUDES:
554-021M-110 110VAC VALVE
610-1KJ-3M CABLE
553-012-R60 REGULATOR
553-012-G60 GAGE

ASSEMBLY WEIGHS APPROXIMATELY 170 LBS.

REV	DESCRIPTION	BY	DATE

TOLERANCES
X. XXX +/- .010
X. XX +/- .030
X. X +/- .062
FRAC +/- .062
ANGLE +/- .5°
UNLESS NOTED

MAT'L	SEE BOM
STK SIZE	--
FINISH	--
H.T.	--
ASSEM	--
MODEL	SNAG SWITCH ASSY
BREAK ALL SHARP EDGES	
BY:	DATE:
MFB	2/9/22

DTI DRAWING TECHNOLOGY INC.

TITLE:	SNAG ASSY, w/80X300 CYL
SHEET 1	OF 1
SIZE D	SCALE 1:6
435-503H	

TOSHIBA

E6582062②

Industrial Inverter

(For 3-phase motors)

Instruction Manual

High-performance inverter

TOSVERT VF-AS3

3-phase 240V class 0.4 to 55kW
3-phase 480V class 0.4 to 280kW

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TOSHIBA INDUSTRIAL PRODUCTS AND SYSTEMS CORPORATION

Notice

1. Make sure that this instruction manual is delivered to the end user of the inverter unit.
2. Read this manual before installing or operating the inverter unit, and store it in a safe place for reference.

I Safety precautions

The items described in the instruction manual and on the inverter itself are very important so that you can use safely the inverter, prevent injury to yourself and other people around you as well as to prevent damage to property in the area. Thoroughly familiarize yourself with the symbols and indications shown below and then continue to read the manual. Make sure that you observe all warnings given.

Explanation of markings

Marking	Meaning of marking
 WARNING	Indicates that errors in operation will lead to death or serious injury.
 CAUTION	Indicates that errors in operation will lead to injury*1 to people or that these errors will cause damage to physical property*2.

*1 Such things as injury, burns or electric shock that will not require hospitalization or long periods of outpatient treatment.
*2 Physical property damage refers to wide-ranging damage to assets and materials.

Meanings of symbols

Marking	Meaning of marking
	Indicates an inhibition (Don't do it). Detailed information on the inhibition is described in illustration and text in or near the symbol.
	Indicates a mandatory action that must be followed. Detailed information on the mandatory action is described in illustration and text in or near the symbol.
	Indicates a warning or caution. Detailed information on the warning or caution is described in illustration and text in or near the symbol.

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■ Limits in purpose

This inverter is used for controlling speeds of three-phase motors in general industrial use.

⚠ Safety precautions

- This product is intended for general purpose uses in industrial application. It cannot be used for application which will cause big impact on public and require special quality control, such as power plant and railway, and equipment in which failure and operational errors of this product can endanger human life or harm a human body, such as equipment for nuclear power control, aviation, space flight control, traffic, medical, safety device, and amusement. However, it is possible to verify the application propriety under the condition that purpose is limited and special quality control is not required. Please contact your Toshiba distributor if you wish to use this product for a specific purpose.
- Please use our product for application which will not cause serious accident or damage even if the product has failure, or please use our product in environment where a backup circuit, device is provided as a system outside the product or a safety device functions.
- Please do not use our product for any load other than three-phase motors in general industrial use. Use in other than proper three-phase motors can cause an accident.

■ Handling

⚠ Warning

 Disassembly inhibited	• Never disassemble, modify or repair. This can result in electric shock, fire and other injury. Please call your Toshiba distributor for repairs.
 Prohibited	• Never remove the front cover when the power is on. The unit contains high voltage parts and contact with them will result in electric shock. • Do not stick your fingers into openings such as cable wiring holes and cooling fan covers. The unit contains high voltage parts and contact with them will result in electric shock. • Do not place or insert any kind of object (electrical wire cuttings, rods, wires etc.) inside the inverter. This will cause a short circuit and result in electric shock or fire. • Do not allow water or any other fluids to come in contact with the inverter. This will cause a short circuit and result in electric shock or fire.
 Mandatory action	• Turn the power on only after attaching the front cover. If you turn the power on without attaching the front cover, this will result in electric shock or other injury. • Immediately turn the power off if the inverter begins to emit smoke or an unusual odor, or unusual sounds. Continuous use of the inverter in such a state will cause fire. If the inverter is left to be turned on in that state, it can cause fire. Please call your Toshiba distributor for repairs. • Always turn the power off if the inverter is not used for long time. • The inverter will have failure due to leakage current caused by dust and other material. If the inverter's power is left to be turned on in that state, it can cause fire.

⚠ Caution

 Contact inhibited	• Do not touch heat radiating fins or discharge resistors. These devices get high temperature, and you will get burned if you touch them.

■ Transportation & installation

⚠ Warning

 Prohibited	• Do not install and operate the inverter if it is damaged or any of its components is missing. This will result in electric shock or fire. Please call your Toshiba distributor for repairs. • Do not place any inflammable object near the inverter. If flame is emitted due to failure in the inverter, this will lead to fire. • Do not install the inverter in any location where the inverter could come into contact with water or other fluids. • This will result in electric shock or fire.
 Mandatory action	• Operate under the environmental conditions prescribed in the instruction manual. Operations under any other conditions will result in failure. • Mount the inverter on a metal plate. The rear panel will get high temperature. Do not mount the inverter on an inflammable object, this will result in fire. • Do not operate the inverter with the front cover removed. The unit contains high voltage parts and contact with them will result in electric shock. • An emergency stop device must be installed that is configured in accordance with the system specifications. If such an emergency stop device that can activate mechanical brake by shutting off power supply is not installed, operation cannot be stopped immediately by the inverter alone, thus resulting in an accident or injury. • All options to be used must be those specified by Toshiba. The use of options other than those specified by Toshiba will result in an accident. • In using a power distribution device and options for the inverter, they must be installed in a cabinet. When they are not installed in the cabinet, this will result in electric shock.

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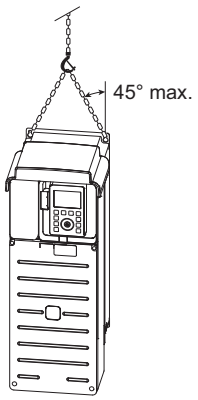
⚠ Caution

Prohibited

- For transporting or carrying the inverter, do not hold by the front cover.
  The cover will come off and the unit will drop, resulting in injury.
- Do not install the inverter in any place with large vibration.
  The unit will fall due to the vibration, resulting in injury.

Mandatory action

- Carry the inverter by two people or more when the inverter is the model mass 20kg or more (VFAS3-2110P - 2370P, VFAS3-4220PC - 4750PC).
  If you carry the inverter alone, this will result in injury.
- Transport a large-capacity inverter (VFAS3-2450P, 2550P, VFAS3-4900PC - 4280KPC) by a crane.
  If you transport a heavy load by hand, this will result in injury.
  Please take the utmost care for the operator's safety, and please handle the inverter carefully in order not to damage the product.
  For lifting the inverter, hang the inverter with wire ropes via hanging bolts (hanging holes) provided at upper part or lower part of the inverter as shown below.



- Please make sure that the inverter is hanged by two wire ropes in a balanced manner, and please be careful that the inverter does not receive excessive force during the hanging operation.
- Do not carry the inverter with the cover attached, hold nor put the hand in the wiring holes during the transportation.
  You can have your hands pinched and injured.
- Transport the operation panel in accordance with law.
  Please transport the operation panel by airplane or ship in accordance with law as a lithium battery is used in the operation panel.
- Install the inverter at a place which can support the unit's mass.
  If you install the inverter at a place which does not support the unit's mass, the unit will fall, resulting in injury.
- Install the mechanical brake when it is necessary to hold a motor shaft.
  A brake function of the inverter cannot perform mechanical hold, and it results in injury.
- When ambient temperature is above 50°C, use the operation panel by detaching it from the unit.
  There is a risk that heat can rise up and flame can be emitted in the lithium battery used in the operation panel. When ambient temperature is above 50°C, use the operation panel by detaching the panel from the unit and extending the panel.

■ Wiring

⚠ Warning

 Prohibited	• Do not connect power supply to the output (motor side) terminals [U/T1], [V/T2] and [W/T3]. Connecting power supply to the output will damage the inverter and result in fire. • Do not insert a braking resistor between DC terminals [PA/+] and [PC/-] or [PO] and[PC/-]. This will result in fire. Please connect the braking resistor in accordance with the instruction manual. • Do not touch wires of equipment (e.g. ELCB) that is connected to the inverter power side at least 15 minutes after turning off the power. If an electric charge remains in a capacitor in the inverter, touching the wires before the indicated time will result in electric shock. • Do not touch output terminals [U/T1], [V/T2] and [W/T3] on the PM motor side while the PM motor is rotating even after turning off the power. While the PM motor is rotating even after the power is turned off, as a high voltage is generated in the output terminals [U/T1], [V/T2] and [W/T3] on the PM motor side, touching the output terminals will result in electric shock. Please perform wiring after verifying that the PM motor is stopped. • When using this 480V class inverter with a power supply system that is grounded in other than the neutral point (e.g. when the power supply has delta connection with single phase grounding), the grounding capacitor should not be grounded (or the capacity of the grounding capacitor should not be increased). Otherwise, it will result in failure or fire.
 Mandatory action	• Electrical construction work must be done by a qualified expert. Erroneous connection of power supply by someone who does not have that expert knowledge will result in fire or electric shock. • Connect output terminals (motor side) correctly. If the phase sequence is incorrect, the motor will operate in reverse and that can result in injury. • Wiring must be done after installation. If you perform wiring prior to installation, this will result in electric shock or other injury. Verify that the power is turned off and the charge lamp is off before starting wiring. If you perform wiring without verification, this will result in electric shock. • Install an earth leakage circuit breaker (ELCB) between the power supply and the inverter (primary side) if protective device against earth leakage is not installed into your system. • Tighten the screws on the terminal block to specified torque. If the screws are not tightened sufficiently to the specified torque, this will result in fire. • Verify that the power supply voltage is within +10% and -15% (±10% when the load is 100% in continuous operation) of the applied power supply voltage written on the name plate. If you do not use the appropriate power supply voltage, this will result in failure or fire.
 Be grounded	• The grounding wire must be connected securely. If the grounding wire is not securely connected, when the inverter has failure or earth leakage, this will result in electric shock or fire.

I

⚠ Caution

Prohibited	• Do not attach devices with built-in capacitors (such as noise reduction filters or surge absorbers) to the output terminals (motor side). Heat rises up and this could cause a fire. • Do not switch only one of two grounding capacitor switch screws in the same form. The inverter will have failure due to insufficient switching. Please switch two grounding capacitor switch screws in the same form. • Do not detach the operation panel from the unit when the power is ON. This will result in failure. Please detach the operation panel after turning the power off. • When you connect a USB cable to the operation panel, do not perform the connection while the operation panel is attached to the unit. This will result in failure. Please connect the USB cable to the operation panel after detaching the operation panel from the unit. • Do not connect Ethernet to the RS485 communication connector. Erroneous connection will result in failure. • Do not connect RS485 communication to the Ethernet connector. Erroneous connection will result in failure.
Mandatory action	• Verify that the power is OFF before detaching the front cover. If you detach the front cover while the power is ON, this will result in electric shock or other injury. • Mount the front cover after wiring. If you turn the power on without attaching the front cover, this will result in electric shock or other injury. Please be careful that if you press too hard the front cover by a screwdriver for attachment, it will damage the inverter unit. • Mount the attached DC reactor (DCL) for VFAS3-4160KPC - 4280KPC. If you do not mount the attached DC reactor (DCL), it will result in failure. Mount the DC reactor (DCL) between [PA/+] and [PO]. • Supply AC power supply to cooling fans if you use VFAS3-4160KPC - 4280KPC with DC input. If you do not supply AC power supply, the cooling fans do not operate, and this will result in overheat trip.

■ Operations

⚠ Warning

Prohibited	• Do not touch terminals when the inverter's power is on even if the motor is stopped. Touching the terminals while voltage is applied will result in electric shock. • Do not touch switches when the hands are wet and do not try to clean the inverter with a damp cloth. This will result in electric shock. • Do not touch terminals or motor of the inverter while performing auto tuning. Touching the terminals or motor while voltage is applied to the terminals and motor may result in electric shock, even if the motor is stopped. After setting offline auto-tuning (F400 = "2"), execute the auto tuning at first start of the inverter. The auto tuning takes several seconds and the motor is stopped meanwhile, but voltage is applied to the terminals and motor. The motor may also generate a sound during the auto tuning, but this is not malfunction.
Mandatory action	• Turn the power on only after mounting the front cover. When you use the inverter housed in the cabinet with the front cover removed, always close the cabinet doors first and then turn the power on. If you turn the power on with the front cover or the cabinet doors open, this will result in electric shock. • Make sure to set the setup menu correctly. If you set the setup menu incorrectly, this will damage the inverter or cause the inverter to perform unexpected movement. • Make sure to set the parameter correctly. If you set the parameter incorrectly, this will damage the inverter or cause the inverter to perform unexpected movement. When you write the parameter in the inverter via a parameter writer or operation panel, please transmit correct data. • Make sure that operation instructions are off before resetting the inverter after malfunction. If the inverter is reset while the operation instructions are on, the motor will restart suddenly, resulting in injury. • Install circuit protection such as the mechanical brake in the crane. If there is no sufficient circuit protection installed in the crane, insufficient motor torque while auto tuning will cause the machine stalling/falling.

⚠ Caution

Prohibited	• Observe all allowable operating ranges of motors and machines in use. Not observing these ranges will result in damage to motors and machines and injury. Please use motors and machines within their respective allowable operating ranges by referring to their respective instruction manuals. • Do not set the stall prevention level parameters (F601 and F185) extremely low. If the stall prevention level parameters (F601 and F185) are set at or below the motor no-load current, the stall preventive function will be always enabled and increase the frequency when it judges that regenerative braking is taking place. Do not set the stall prevention level parameters (F601 and F185) at 30% or less under normal use conditions.

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 Mandatory action	• Use the inverter that conforms to specifications of the power supply and the three-phase motor to be operated. If you use the inappropriate inverter, not only will the three-phase motor not rotate correctly, but it will cause serious accidents such as overheating and burning out. • Take countermeasures against leakage current. The leakage current through the stray capacitance of the input/output power wires of inverter and motor can affect peripheral devices. In that case, please take countermeasures such as reducing the carrier frequency or shortening the length of input/output power wires. When the total wire length (total length between an inverter and motors) is more than 100m, if the trip occurs with the motor no-load current, make enough space between phase wires or insert the filter (MSF: motor-end surge voltage suppression filter).

■ When operation by communication or extension panel is selected

⚠ Warning

 Mandatory action	• Set the parameter Communication time-out. If the parameter is not properly set, the inverter cannot be stopped immediately and this will result in injury and accidents. • Install an emergency stop device and an interlock that are configured in accordance with the system specifications. If the inverter cannot be stopped immediately via communication or the extension panel, this will result in injury and accidents.

■ When auto-restart after momentary stop function is selected

⚠ Caution

 Mandatory action	• When the auto-restart after momentary stop function is selected, stand clear of motors and machines at momentary power failure. The motors and machines which have stopped due to momentary power failure will restart suddenly after power is restored, and this will result in injury. • Attach caution labels indicating functions programmed for Auto restart, on inverters, motors and machines. Please prevent accidents with the caution labels.

■ When retry function is selected

⚠ Caution

 Mandatory action	• When the retry function is selected, stand clear of motors and machines at tripping stop. The motors and machines which have stopped due to tripping stop will restart suddenly, and this will result in injury. Take measures for securing safety even if the motor restarts unexpectedly, such as attaching a cover to the motor. • Attach caution labels indicating functions programmed for Retry, on inverters, motors and machines. Please prevent accidents with the caution labels.

■ Maintenance and inspection

⚠ Warning	
Prohibited	• Do not replace parts. This will result in electric shock, fire and other injury. Please call your Toshiba distributor for repairs and replacement of expendable parts.
Mandatory action	• Perform daily inspection and periodic inspection on equipment. If the equipment is not inspected and maintained, faults and malfunctions cannot be discovered and that can result in accidents. • Before inspection, perform the following steps. (1) Turn off the power to the inverter. (2) Wait at least 15 minutes and verify that the charge lamp is no longer lit. (3) Use a tester that can measure DC voltages (800 VDC or more), and verify that the voltage to the DC main circuits between [PA/+] and [PC/-] is 45V or less, and verify that the residual voltage of AC main circuits cable is 45V or less. Performing inspection without carrying out these steps can lead to electric shock. When using the PM motor, please verify that the PM motor is stopped. While the PM motor is rotating even after the power is turned off, as a high voltage is generated in the output terminals [U/T1], [V/T2] and [W/T3] on the PM motor side, touching the output terminals will result in electric shock.

■ Disposal

⚠ Caution	
Mandatory action	• If you dispose of the inverter, have it done by a specialist in industry waste disposal[*1]. If you dispose of the inverter by yourself, this can result in explosion of capacitor or production of noxious gases, resulting in injury. • When you dispose of the operation panel, insulate the terminals of the lithium battery by wrapping the terminals with tapes. If the terminals contact with other metal or batteries, this will result in heat rising up, explosion, and fire.

*1 Persons who specialize in the processing of waste and known as “industrial waste product collectors and transporters” or “industrial waste disposal persons”. Please observe any applicable law, regulation, rule or ordinance for industrial waste disposal.

■ Sterilization, insect removal processing for wooden packaging material

⚠ Caution	
Mandatory action	• If wooden packaging materials require sterilization, insect removal processing, make sure to employ methods other than fumigation. The fumigation processing may damage electronic parts by generated gas and steam. Especially halogen disinfectants, such as fluorine, chlorine, bromine and iodine cause corrosion inside the capacitors.

■ Attach caution labels

Shown here are examples of caution labels for preventing accidents that are to be attached to inverters, motors and other equipment.

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Be sure to attach the caution labels where it is easily visible when selecting the auto-restart function or the retry function.

(Example of caution label)

⚠ Caution

(Functions programmed for Auto restart)

Do not go near motors and equipment.
Motors and machines that have stopped temporarily due to momentary power failure will restart suddenly after power is restored.

⚠ Caution

(Functions programmed for Retry)

Do not go near motors and equipment.
Motors and machines that have stopped temporarily due to tripping stop will restart suddenly after the specified time has elapsed and alarm condition has disappeared.

II Introduction

Thank you for purchasing Toshiba's industrial inverter.
To handle TOSVERT VF-AS3 correctly, this instruction manual explains how to install and wire the inverter, operation procedure, how to run the motor, measures for protective functions (when an alarm/trip occurs), etc.
It is for the "Ver. 100" and later CPU versions of the inverter.
Please be informed that the specifications described in the instruction manual and technical data, and the CPU version may be changed without notice.

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1 Read first

This chapter explains check items when you receive the inverter, names of parts of the inverter, and the flow of basic procedures before operation.

1. 1 Check product purchase

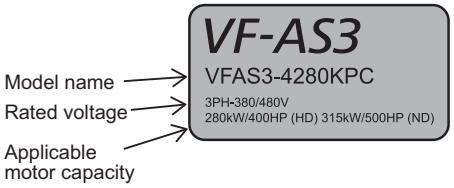
⚠ CAUTION

Mandatory action	• Use the inverter that conforms to specifications of the power supply and the three-phase motor to be operated. If you use the inappropriate inverter, not only will the three-phase motor not rotate correctly, but it will cause serious accidents such as overheating and burning out.

Before using the product you have purchased, check to make sure that it is exactly what you ordered. Check the contents of packing and accessories for damage.

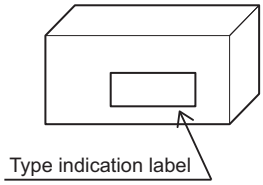
1

Rating label



* Refer to [1. 2] for (HD) and (ND).

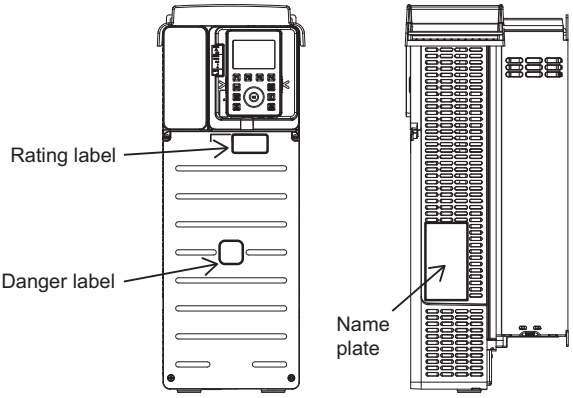
Carton box



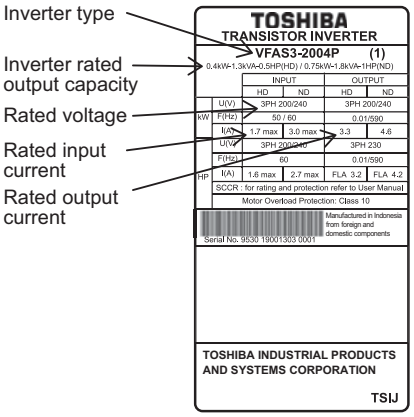
Danger label



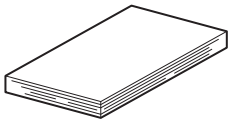
Inverter main unit



Name plate



Quick start



CD-ROM

Instruction manual is included as electronic data.



DC reactor

Only for frame size A7 and A8.

Danger label kit

Danger labels in 6 languages for sticking .



- French
- German
- Italian
- Spanish
- Chinese
- Japanese

- Labels for communication option

  Affix to lower side of communication indicator.

1

Important

- When you have purchased VFAS3-4160KPC to VFAS3-4280KPC (frame size A7 or A8), the DC reactor is packed together with the unit. Mount the DC reactor to the inverter by referring to [2. 3. 8].

1. 2 Multi-rating

This inverter has multi-rating.
Select rating with the parameter <AUL: Multi-rating select> according to the characteristics of the load to be applied.

1

<AUL>="2: ND rating (120%-60s) (0 after execution)"
- Select it to apply equipment with variable torque characteristic.
- Example) Fans, pumps, blowers, etc.

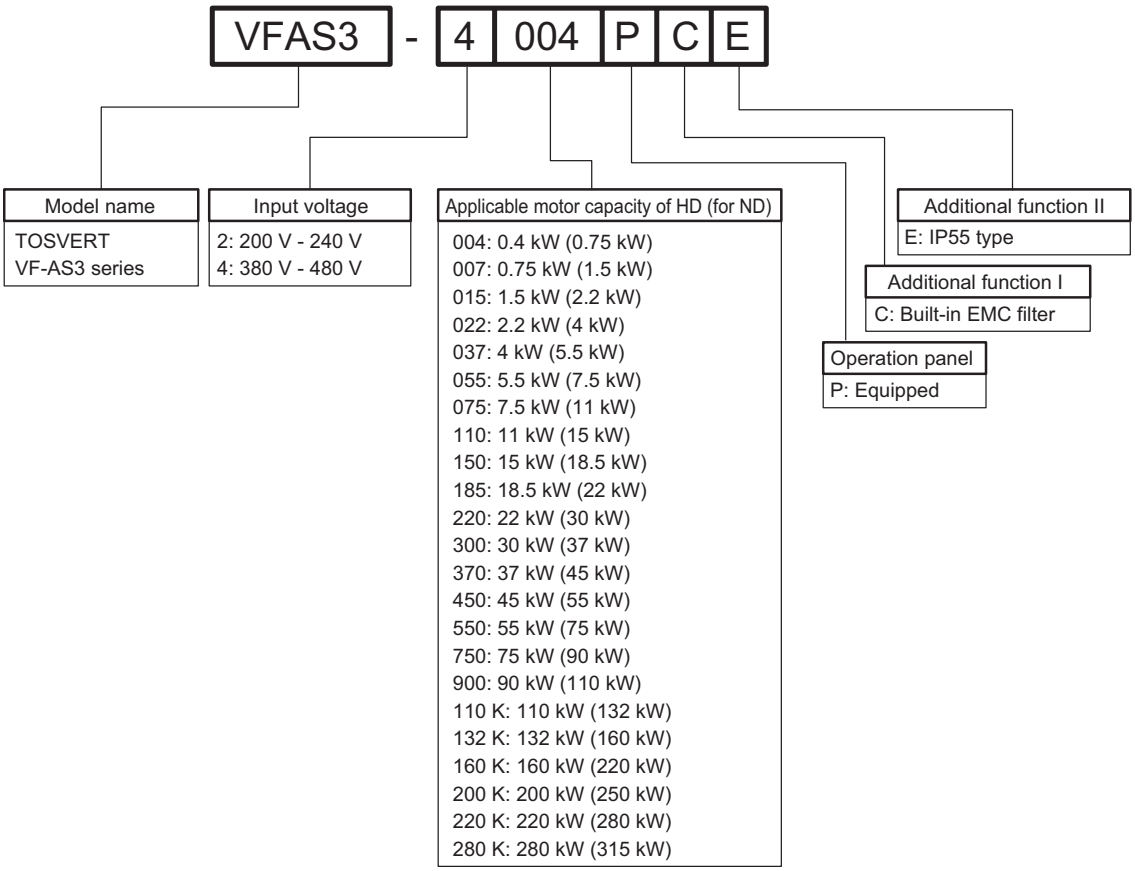
<AUL>="3: HD rating (150%-60s) (0 after execution)"
- Select it to apply equipment with constant torque characteristic.
- Example) Conveyors, load transporting machinery, cranes, mixers, compressors, making machines, machine tools, etc.

Both of them return to "0" after setting.
For details, refer to [5. 3. 2].

This instruction manual describes the motor capacity based on HD rating. In the case of ND rating, it is described with parentheses like (ND: **kW).

1. 3 Indication of product type

Explanation of the indication of the inverter type.



Important

- Always shut power off first then check the ratings label of inverter held in a cabinet.
- This inverter has multi-rating. The motor capacity is described based on HD rating. In the case of ND rating, it is described with parentheses like (ND: **kW).

■ Type and frame size

This inverter has eight types of units with frame size A1 to A8 according to the voltage class and the capacity. The following table shows the relationships between the types and the frame sizes.

Frame size	Type-Form	
	240V	480V
A1	VFAS3-2004P to 2022P	VFAS3-4004PC to 4037PC
A2	VFAS3-2037P	VFAS3-4055PC, 4075PC
A3	VFAS3-2055P, 2075P	VFAS3-4110PC to 4185PC
A4	VFAS3-2110P to 2185P	VFAS3-4220PC to 4370PC
A5	VFAS3-2220P to 2370P	VFAS3-4450PC to 4750PC

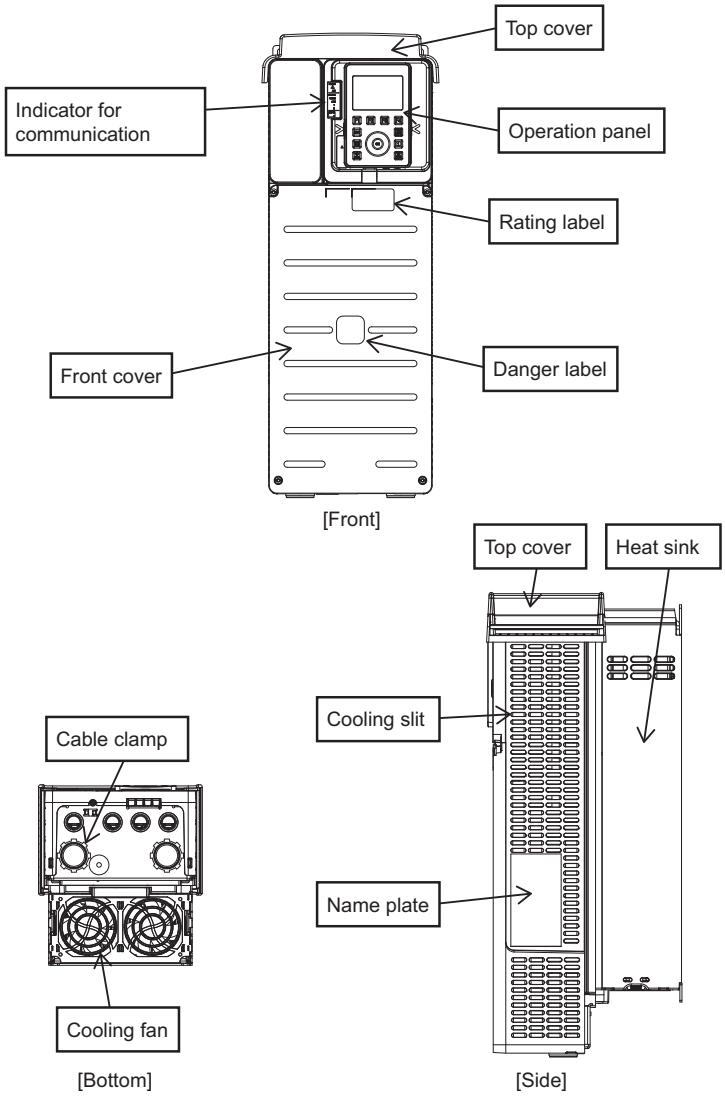
Frame size	Type-Form	
	240V	480V
A6	VFAS3-2450P, 2550P	VFAS3-4900PC to 4132KPC
A7	-	VFAS3-4160KPC
A8	-	VFAS3-4200KPC to 4280KPC

1. 4 Structure of equipment

The following is brief explanation of the names and functions of parts that compose the inverter.

1. 4. 1 Outside view

This inverter has eight types of units with frame size A1 to A8 (made of resin or metal) according to the voltage class and the capacity. For details of outside dimensions, refer to [12. 2].



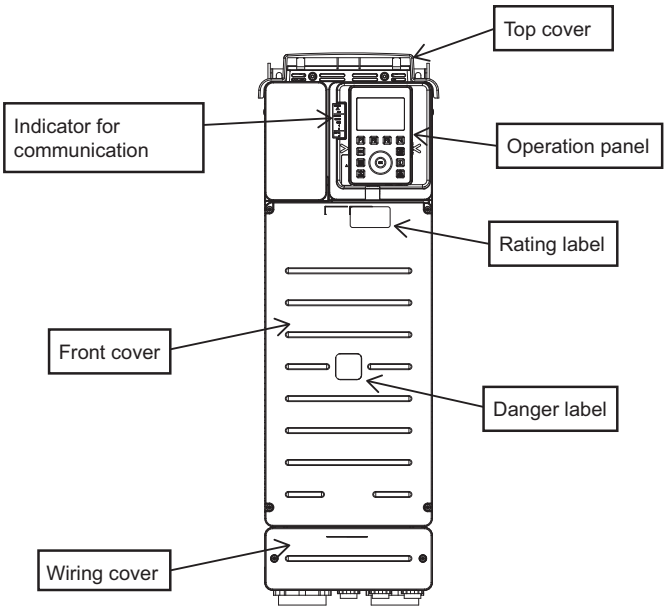
• Front cover

A cover for the terminal blocks (power circuit/control circuit). This cover should be removed for wiring to the power terminal block or the control terminal block, using the connector for communication and the option slot, switching the grounding capacitor, or checking the charge lamp. For how to remove, refer to [2. 2].

• **Top cover**

A cover to protect the top of the inverter, which is attached to models with frame size A1 to A5. Remove this cover to install inverters side by side or in a location with ambient temperature above 50°C for heat discharge. For how to remove, refer to [2. 2].

■ With frame size A4 or A5 VFAS3-2110P to 2370P, VFAS3-4220PC to 4750PC



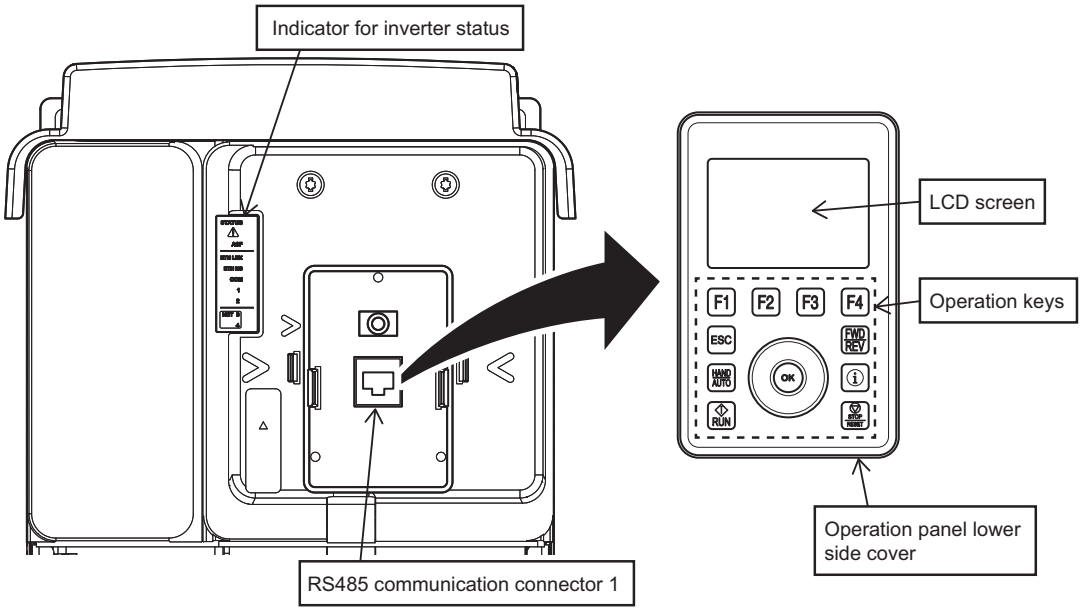
[Front]

• **Wiring cover**

The models with frame size A4 or A5 have a cover for wiring beneath the front cover. This cover should be removed to wire to the power terminal block or control terminal block. For how to remove, refer to [2. 2. 2] (frame size A4) or [2. 2. 3] (frame size A5).

1. 4. 2 Operation panel and peripherals

The operation panel of the inverter is directly connected to RS485 communication connector 1.
It is equipped with some indicators for inverter status on the left side of the operation panel.



■ Operation panel

The operation panel is equipped with a LCD screen and operation keys on the front side and two types of connectors (operation panel female connector and USB-miniB connector) on the bottom surface.
It is directly connected to the unit with the operation panel male connector on the back side but can be removed. It can be also used for remote control with Door mounting kit (SBP010Z) and an exclusive cable (optional), see [10. 3. 8] for detail.

• LCD screen

The operation panel is equipped with a multilingual (8 languages) LCD that displays the frequency, parameters and their set values and the operation status according to the display mode of the inverter. For details, refer to [3. 1. 1].

• Operation keys

There are an [ESC] key, [HAND/AUTO] key, [RUN] key, [FWD/REV] key, [i] key, [STOP/RESET] key, [F1] to [F4] keys, touch wheel, and [OK] key.
The [F1] to [F4] keys execute functions according to the indication on the lower side of the LCD screen.
With the touch wheel, you can change the menu items and values on the screen by touching it by your finger to rotate to the right or left or touching its upper side or lower side lightly.
For details of the operation keys, refer to [3. 1. 1].

• Operation panel lower side cover

This cover protects two connectors on the right of the lower side of the operation panel and the slot for battery on the left. The right side/left side of the cover can be opened respectively.

• **Operation panel female connector**
For handy use, connect the operation panel to this female connector with a cable. To mount the operation panel on the cabinet, use the Door mounting kit SBP010Z (optional).

• **USB-miniB connector**
Used only by manufacturer.

• **Slot for battery**
A lithium battery is inserted to this slot for internal real time clock of the operation panel (equipped as standard at the time of shipping). For how to replace the battery, refer to [14. 2. 2].

■ RS485 communication connector 1

Normally, this connector is used for connection of the operation panel.
For remote control, connect the operation panel with an exclusive extension cable (optional).

■ LED indicators

The upper three LEDs indicate the operation status, trip status, and STO (Safe Torque Off) respectively from the top.

STATUS (Green LED)
- On: Stopped
- Fast blinking: Run command ON, frequency command 0
- Slow blinking: During run
- Off: Power OFF

⚠ (Red LED)
- Blinking: A trip has occurred
- Off: In normal condition

ASF (Yellow LED)
- On: STO
- Off: In normal condition

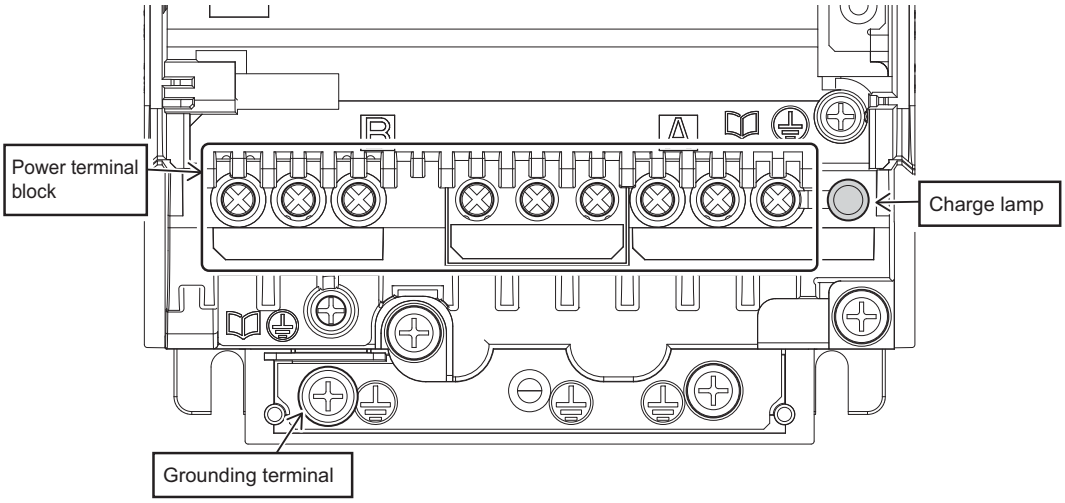
Other seven LEDs indicate the communication status. For details, please see function manual for each communication.

1. 4. 3 Terminal blocks

This inverter is equipped with a power terminal block and a control terminal block. To the power terminal block, connect the power supply and the motor. To the control terminal block, connect external control signals.
Both terminal blocks are equipped in the unit and wiring and the connection state cannot be checked during run.

■ Power terminal block

The power terminal block to which the power supply and the motor are connected has different shapes and arrangements depending on the type of the inverter.
The following figure shows an example of frame size A1.



• Power terminal block

A cage-type or screw-type terminal block to which the power supply and motor, braking resistor, etc. are connected.
For details of the terminal types and functions, refer to [2. 3. 3].

• Grounding terminal

Exclusive terminal to wire a grounding wire.

• Charge lamp

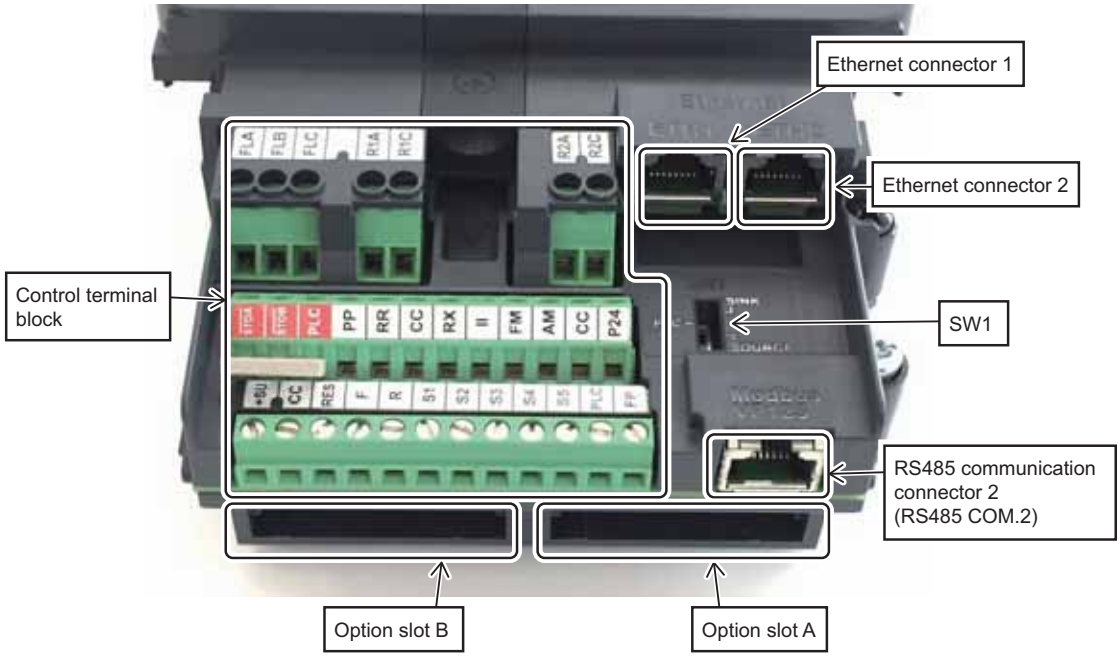
While the charge lamp is on, voltage is applied, or high voltage remains in the inverter.
The location of the charge lamp varies depending on the type (frame size).
For details, refer to [2. 2. 6].

Memo	• For the layout and shape of power terminal block of each type, refer to [2. 3. 3].

1

■ Control terminal block

The control terminal block is common to all the types and is located on the lower side of the operation panel.
It connects wiring between the inverter and an external control device.
Control terminal block is detachable.



• Control terminal block
A cage-type terminal block.
For details of the terminal types and functions, refer to [2. 3. 5].

• SW1
A switch to switch between the sink logic, source logic and external power supply sink logic of the input terminal.
The default setting is PLC (external power supply) side. For details, refer to [2. 3. 5].

• RS485 communication connector 2 (RS485 COM.2)
An RJ45 connector for RS485 communication.
For details, refer to [2. 3. 6].

• Ethernet connector 1, 2
Two RJ45 connectors for Ethernet are equipped.
For details, refer to [2. 3. 7].

• Option slot A, B
Two slots are equipped in the back of the control terminal block.
The right one is slot A and the left one is slot B.
Furthermore, an option adaptor can be added between the operation panel and the unit.
For details, refer to [10. 4. 3].

Important

• Connection of Ethernet to the RS485 communication connectors may result in a malfunction.

1. 4. 4 Features of inverter

This inverter has the following features.

(1) A detachable LCD operation panel is equipped as standard

- A touch wheel is adopted for excellent environment resistance.
- With the LCD display (240 x 160 dots), the operation panel has excellent visibility compared with an 7-segment LED display, allowing easy setting of parameters. Furthermore, it supports multiple languages.
- It is equipped with Real time clock that allows to calendar operation.
- Indication of QR Code® allows easy access from a smartphone to our website.
- An option to attach a door with IP65 water-proof and dust-proof performance is also provided.

(2) Built-in communication function for Ethernet to allow remote monitoring

- The inverter is equipped with RJ45 connectors for Ethernet and for RS485 communication, two for each of them.

(3) Full filling options can be installed to two slots (up to three slots)

- Cassette-type options for network (DeviceNet™, PROFIBUS, PROFINET, etc.), extended terminal block, encoder feedback, and safety function can be added easily.

(4) High environmental friendliness and enhanced environment resistance

- A DC reactor built in as standard suppresses generation of harmonics to comply with IEC61000-3-12.
- An EMC noise filter is built in as standard to comply with C2/C3 (480 V class) of IEC61800-3.
- Comply with the chemicals (3C3)/dust (3S3) standards of IEC60721-3-3. (Frame size A6 or smaller)
- Can be used at an altitude of up to 4800 m. (TN/TT system) (Frame size A6 or smaller)
- A built-in Nema type 1 kit. (Frame size A5 or smaller)
- The inverter is operable at an ambient temperature of -15 to +60°C. (Frame size A7 and A8:-10 to 60°C)
- The design expectancy life time of the cooling fan, smoothing aluminum electrolytic capacitor for power circuit, and aluminum electrolytic capacitor for control circuit are ten years. (Frame size A6 or smaller)

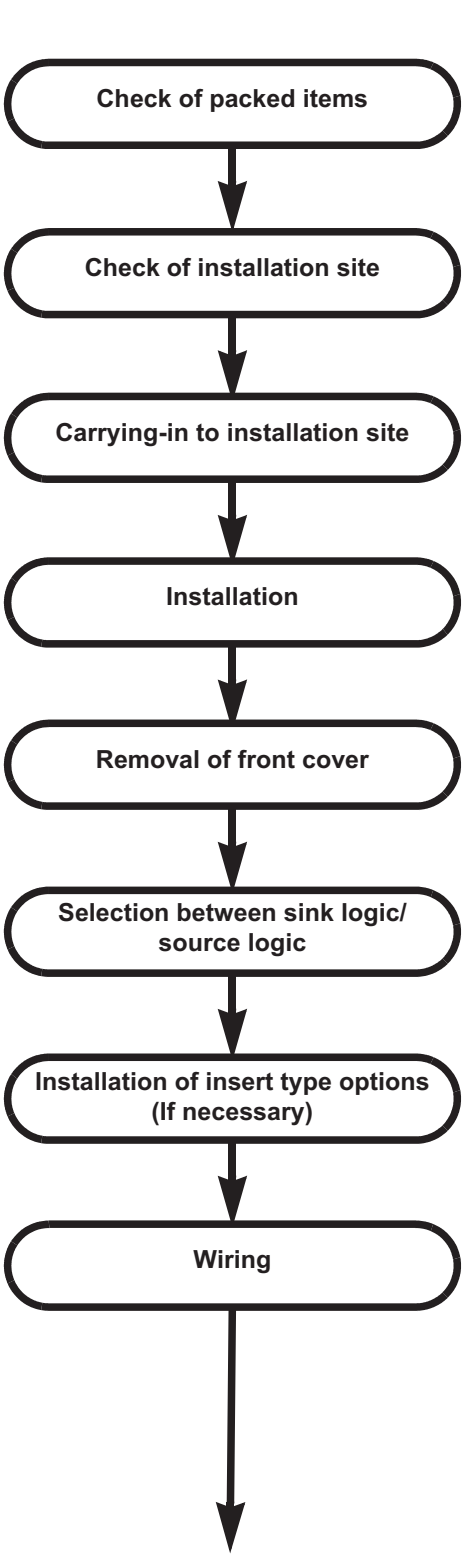
(5) High control performance is realized

- With its multi-rating, the inverter is usable for a wide range of applications with light load (120% for 1 min) and heavy load (150% for 1 min).
- It is also usable for a PM motor.
- Auto tuning is possible.
- High frequency operation up to 590 Hz is possible.
- High-accuracy motor control is possible.

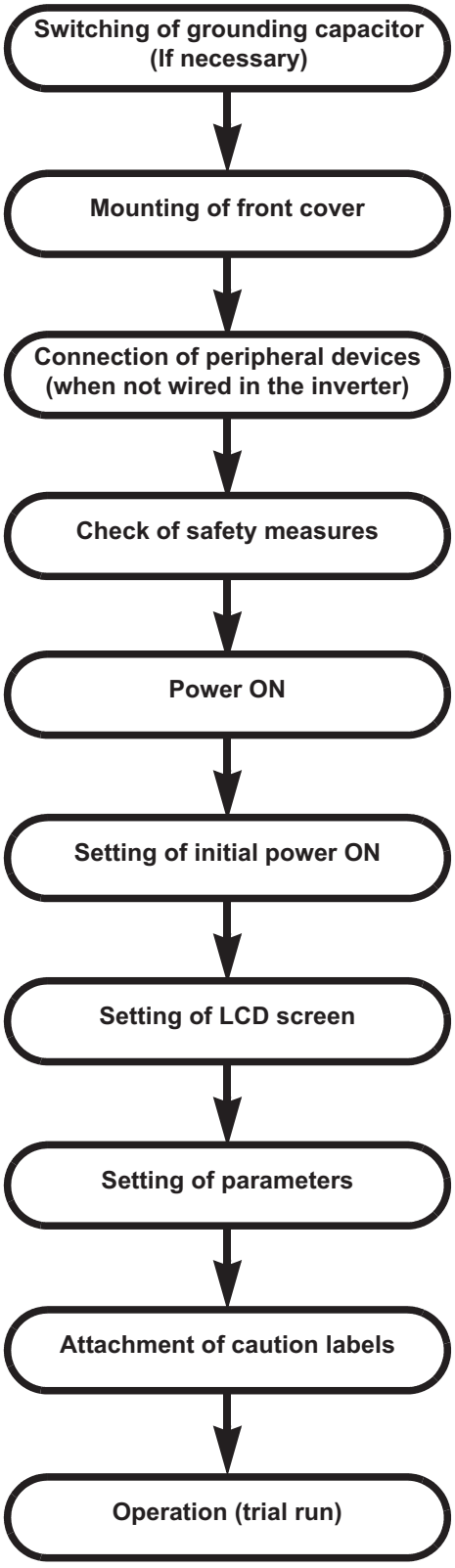
Note) QR Code is registered trademark of DENSO WAVE INCORPORATED.

1. 5 Operation procedure

The basic procedure to operate a motor with the inverter is as follows.



Reference
-> [1.1 Check product purchase]
-> [2.1.1 Installation environment]
-> [2.1.2 How to install] Removal of top cover -> [2.2 How to remove covers of inverter]
-> [2.2 How to remove covers of inverter]
-> [2.3.5 Control terminals]
->[10. 4 Selection of built-in options]
Power terminal block -> [2.3.2 Standard connection method, 2.3.3 Power terminal] Mounting of DC reactor -> [2.3.8 Mounting of DC reactor] Control terminal block -> [2.3.2 Standard connection method], [2.3.5 Control terminal] Connection of communication cables -> [2.3.6 RS485 RS485 communication connectors], [2.3.7 Ethernet connectors] Other wiring work in the inverter - Wiring of built-in options -> [10. 4 Selection of built-in options] - Connection change of cooling fan power supply (when a DC power supply is used) -> [10. 5 Using DC power supply] Connection of peripheral devices -> [Chapter 10]



-> [2.3.4 Switching of grounding capacitor]

-> [2.2 How to remove covers of inverter]

-> [2.4.1 Motor], [2.4.2 Inverters], [2.4.3 What to do about leakage current]

Only at the initial power-on, the following settings are required.
<SEt: Region setting check> -> Quick start, [5. 3. 10 Automatic setting of main parameters by region used]
<AUL: Multi-rating select> -> [1.2 Multi-rating], [5. 3. 2 Selecting an overload protection characteristic]

-> [3.1.3 Setting of LCD screen]

-> [Chapter 4], [Chapter 5], and [Chapter 6]

When "Auto-restart" or "Retry" is set, attach caution labels to the inverter, motor, and equipment.
->[I. Cautions for safety], Quick start

2 Installation and wiring

⚠ WARNING

 Disassembly prohibited	• Never disassemble, modify or repair. This can result in electric shock, fire and other injury. Please call your Toshiba distributor for repairs.
 Prohibited	• Do not stick your fingers into openings such as cable wiring holes and cooling fan covers. The unit contains high voltage parts and contact with them will result in electric shock. • Do not place or insert any kind of object (electrical wire cuttings, rods, wires etc.) inside the inverter. This will cause a short circuit and result in electric shock or fire. • Do not allow water or any other fluids to come in contact with the inverter. This will cause a short circuit and result in electric shock or fire.

⚠ CAUTION

 Prohibited	• For transporting or carrying the inverter, do not hold by the front cover. The cover will come off and the unit will drop, resulting in injury.
 Mandatory action	• Carry the inverter by two people or more when the inverter is the model mass 20kg or more (VFAS3-2110P - 2370P, VFAS3-4220PC - 4750PC). If you carry the inverter alone, this will result in injury.

This chapter explains installation of the inverter, how to remove the covers, how to wire to the power supply and the motor, connection of the control circuit, and functions of terminals and connectors for communication.

2. 1 Installation

Take special care with the installation environment of the inverter. Install the inverter in a location that secures space for ventilation and heat emitting (in the cabinet, etc.), considering heat generation and occurrence of noise.

2. 1. 1 Installation environment

⚠ WARNING

Prohibited	• Do not place any inflammable object near the inverter. If flame is emitted due to failure in the inverter, this will lead to fire. • Do not install the inverter in any location where the inverter could come into contact with water or other fluids. This will result in electric shock or fire.
Mandatory action	• Operate under the environmental conditions prescribed in the instruction manual. Operations under any other conditions will result in failure.

⚠ CAUTION

Prohibited	• Do not install the inverter in any place with large vibration. The unit will fall due to the vibration, resulting in injury.

This inverter is an electronic control instrument. Take full consideration to install it in the proper operating environment as follows.

(1) Do not install in any location of high temperature, high humidity, moisture condensation and freezing and avoid locations where there is exposure to water and/or where there may be large amounts of dust, metallic fragments and oil mist.



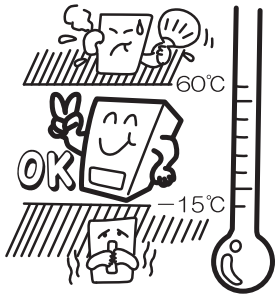
(2) Do not install in any location where corrosive gases or grinding fluids are present.

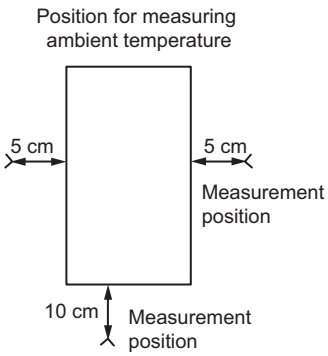
(3) Operate in areas where ambient temperature ranges from -15°C to +60°C.

- When using the inverter in locations with temperatures above 50°C, remove the top cover and operation panel of the inverter to use it.

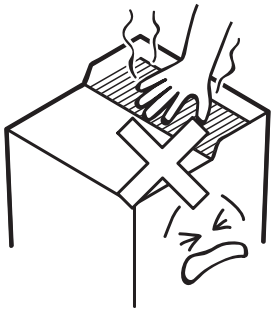
For details of how to remove the top cover, refer to [2. 2].

- -10 to 60°C for frame size A7 and A8.
- The inverter is a heat-emitting body. Make sure proper space and ventilation are provided when installing in the cabinet.
- Measure the ambient temperature in the positions shown in the figure on the right.





(4) Do not touch the heat sink as it may have a high temperature.



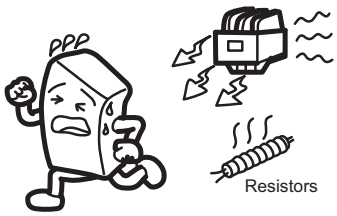
(5) Do not install in any location subject to large amounts of vibration.

- If the inverter is installed in a location that is subject to vibration, anti-vibration measures are required. Please consult with your Toshiba distributor about these measures.



(6) If the inverter is installed near any of the equipment listed below, provide measures to insure against errors in operation.

- Solenoids: Attach a surge suppressor on the coil.
- Brakes: Mount a surge absorber on the coil.
- Magnetic contactors: Mount a surge absorber on the coil.
- Resistors: Place far away from the inverter.



2. 1. 2 How to install

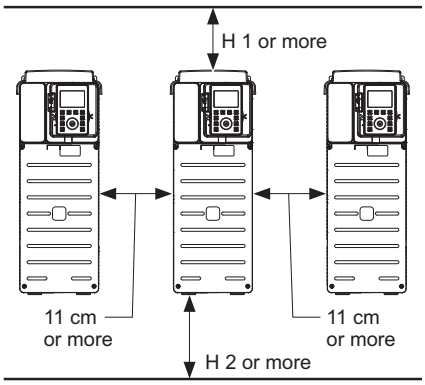
⚠ WARNING	
Prohibited	• Do not install and operate the inverter if it is damaged or any of its components is missing. This will result in electric shock or fire. Please call your Toshiba distributor for repairs.
Mandatory action	• Mount the inverter on a metal plate. The rear panel will get high temperature. Do not mount the inverter on an inflammable object, this will result in fire. • Do not operate the inverter with the front cover removed. The unit contains high voltage parts and contact with them will result in electric shock. • An emergency stop device must be installed that is configured in accordance with the system specifications. If such an emergency stop device that can activate mechanical brake by shutting off power supply is not installed, operation cannot be stopped immediately by the inverter alone, thus resulting in an accident or injury. • All options to be used must be those specified by Toshiba. The use of options other than those specified by Toshiba will result in an accident.

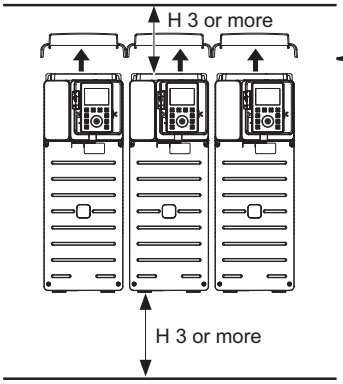
⚠ CAUTION	
Prohibited	• For transporting or carrying the inverter, do not hold by the front cover. The cover will come off and the unit will drop, resulting in injury.
Mandatory action	• Carry the inverter by two people or more when the inverter is the model mass 20kg or more (VFAS3-2110P - 2370P, VFAS3-4220PC - 4750PC). If you carry the inverter alone, this will result in injury. • Install the inverter at a place which can support the unit's mass. If you install the inverter at a place which does not support the unit's mass, the unit will fall, resulting in injury. • Install the mechanical brake when it is necessary to hold a motor shaft. A brake function of the inverter cannot perform mechanical hold, and it results in injury.

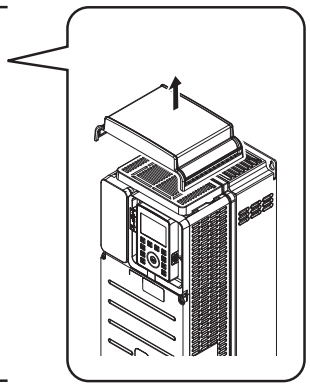
Select an indoor location with good ventilation, and then install the inverter upright on a flat metal plate. For the positions and sizes of the mounting holes, refer to [12. 2].

■ If multiple inverters are installed

To install multiple inverters in one location, either normal basic installation or side-by-side installation (to align inverters side-by-side horizontally with no space) can be adopted.







Type	H1(cm)	H2(cm)	H3(cm)
VFAS3-2004P - 2370P VFAS3-4004PC - 4750PC	10	10	10
VFAS3-2450P, 2550P VFAS3-4900PC - 4132KPC	25	25	25
VFAS3-4160KPC	15	15	25
VFAS3-4200KPC - 4280KPC	20	15	25

1) Basic installation

When installing multiple inverters, leave at least 11 cm or more of space between each inverter and install them aligned horizontally.

When using the inverter in locations with temperatures above 50°C, remove the top cover and operation panel of the inverter (refer to [2. 2]) and use the inverter with the output current reduced (refer to "Instruction manual for load reduction").

2) Side-by-side installation

To align the inverters side-by-side horizontally with no space, remove the top cover of the inverter before use (refer to [2. 2]). When using the inverter in locations with temperatures above 50°C, use the inverter with the operation panel removed and use the inverter with the output current reduced (refer to "Instruction manual for load reduction").

The space shown in the figure above is the minimum allowable space. Because the inverter has cooling fans built in on the top or bottom surfaces, make the space on top and bottom as large as possible to allow for air passage.

Important

- Do not install in any location with high humidity or high temperatures and where there are large amounts of dust, metallic fragments and oil mist.

Memo

- We also provide models with IP55 protective construction for adverse environments.

■ Current reduction curve

The current value of the inverter that can be output continuously varies depending on the installation method, ambient temperature, and the setting of carrier frequency.
For details, refer to "Instruction manual for load reduction" (E6582116).

■ Calorific values of inverter and required ventilation

The inverter will lose the power slightly as a result of conversion from AC to DC or from DC to AC. In order to suppress the rise in temperature inside the cabinet when this loss becomes heat loss, the interior of the cabinet must be ventilated and cooled.

The amount of forcible air-cooling ventilation required and the necessary heat discharge surface quantity when operating in a sealed cabinet depending on motor capacity are as follows.
<ND rating>

Input voltage Class	Applicable motor capacity (kW)	Inverter type-form		Frame size	Inverter calorific value (W) *1	Inner side calorific value (W) *1	Forced air-cooled Required ventilation amount (m^3/min)	Sealeded cabinet Necessary heat discharge surface quantity (m^2)
3-phase 240 V	0.75	VFAS3-	2004P	A1	65	27	0.37	1.30
	1.5		2007P		92	29	0.52	1.83
	2.2		2015P		115	32	0.65	2.31
	4.0		2022P		189	38	1.07	3.79
	5.5		2037P	A2	243	47	1.38	4.85
	7.5		2055P	A3	392	53	2.22	7.84
	11		2075P		544	62	3.09	10.87
	15		2110P	A4	625	90	3.55	12.51
	18.5		2150P		750	101	4.26	15.01
	22		2185P		874	112	4.96	17.49
	30		2220P	A5	1084	136	6.15	21.68
	37		2300P		1384	163	7.86	27.68
	45		2370P		1631	184	9.26	32.63
	55		2450P	A6	2466	278	14.00	49.33
	75		2550P		3432	359	19.48	68.64

*1 Case of 100% load ND continuous operation. The heat loss for the optional external devices (input reactor, radio noise reduction filters, etc.) is not included in the calorific values in the table.

Input voltage Class	Applicable motor capacity (kW)	Inverter type-form		Frame size	Inverter calorific value (W) *1	Inner side calorific value (W) *1	Forced air-cooled Required ventilation amount (m^3/min)	Sealeded cabinet Necessary heat discharge surface quantity (m^2)
3-phase 480 V	0.75	VFAS3-	4004PC	A1	56	26	0.32	1.13
	1.5		4007PC		79	28	0.45	1.58
	2.2		4015PC		100	30	0.57	2.00
	4.0		4022PC		140	33	0.79	2.80
	5.5		4037PC		192	37	1.09	3.83
	7.5		4055PC	A2	233	45	1.32	4.66
	11		4075PC		323	53	1.84	6.47
	15		4110PC	A3	455	62	2.58	9.10
	18.5		4150PC		557	70	3.16	11.14
	22		4185PC		603	71	3.42	12.06
	30		4220PC	A4	770	94	4.37	15.40
	37		4300PC		939	107	5.33	18.78
	45		4370PC		1101	123	6.25	22.02
	55		4450PC	A5	1094	132	6.21	21.88
	75		4550PC		1589	175	9.02	31.78
	90		4750PC		1827	199	10.37	36.54
	110		4900PC	A6	2920	309	16.58	58.40
	132		4110KPC		3457	358	19.62	69.13
	160		4132KPC		4013	405	22.78	80.26
	220		4160KPC	A7	5404	452	30.68	108.08
	250		4220KPC	A8	6279	606	35.64	125.58
	280		4250KPC		6743	769	38.28	134.86
	315		4280KPC		7749	769	43.99	154.98

*1 Case of 100% load ND continuous operation. The heat loss for the optional external devices (input reactor, radio noise reduction filters, etc.) is not included in the calorific values in the table.

■ Panel designing in consideration of effects of noise

The inverter generates high frequency noise. When designing the control panel, consideration must begiven to that noise.

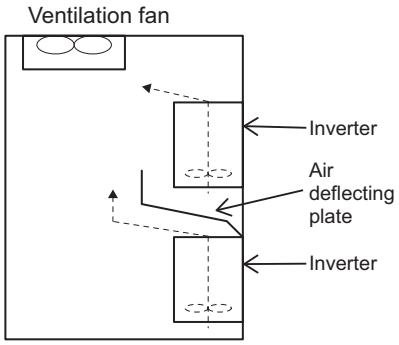
Examples of measures are given below.

- Wire so that the power connections and the control connections are separated. Do not place them in the same conduit, do not run them in parallel, and do not bundle them.
- Provide shielding and twisted wires for control connection.
- Separate the input (power) and output (motor) wires of the power circuit. Do not place them in the same conduit, do not run them in parallel, and do not bundle them.
- Be sure to ground the inverter grounding terminals.
- Install a surge absorber on any magnetic contactor and relay coils used around the inverter.
- Install radio noise reduction filters if necessary.

■ When more than one inverter are installed in one cabinet

When two or more inverters are installed in one cabinet, pay attention to the followings.

- Ensure a space of at least 20 cm or more on the top and bottom of the inverters.
  (Note: Depending on the inverter type.)
- Install an air deflecting plate so that the heat rising up from the inverter on the bottom does not affect the inverter on the top.
- Inverters may be installed side by side with each other with no space left between them.
  When installing inverters side by side, remove the top cover of the inverter. For how to remove, refer to [2. 2].
  When using the inverter in locations with temperatures above 50°C, use the inverter with the operation panel removed and the output current reduced.



2. 2 How to remove covers of inverter

⚠ WARNING

Prohibited

- Never remove the front cover when the power is on.
  The unit contains high voltage parts and contact with them will result in electric shock.

⚠ CAUTION

Mandatory action

- When removing and mounting the front cover, wiring cover or the power terminal block with a screwdriver, be sure not to scratch your hand as these results in injury.
- Turn the power off when removing the front cover and the wiring cover.
  If the power is on, it can result in electric shock or injury.
- Do not press too hard with the screwdriver.
  It can scratch the inverter unit.
- After wiring is complete, be sure to replace the front cover and the wiring cover.
  Otherwise, it can result in electric shock or fire.

In the following cases, covers of the inverter should be removed.

- **Wiring of the power circuit/control terminal block (refer to [2. 3. 2])**
- **Switching of the control terminal block (refer to [2. 3. 5])**
- **Switching of the grounding capacitor (refer to [2. 3. 4])**
- **Mounting of the DC reactor attached with frame size A7 and A8 (refer to [2. 3. 7])**
- **Mounting of insert type options (refer to [10. 4])**
- **Connection change of the cooling fan power supply when a DC power supply is used (refer to Application manual "DC power supply connect to inverter" (E6582156).**
- **Heat discharge measures in the case of high ambient temperature, side-by-side installation of multiple inverters, etc. (refer to [2. 1. 2])**
- **Removal of installed inverters with frame sizes A1 to A5**

Use the procedure and corresponding figure for each type, shown in following pages, to remove portions such as covers.

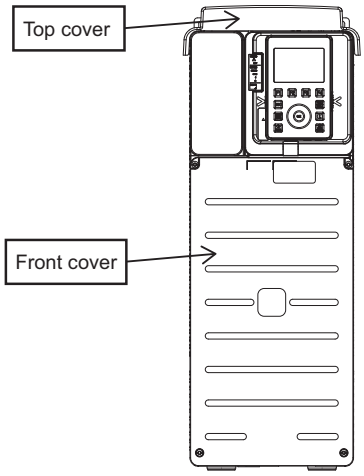
2. 2. 1 With frame size A1, A2, or A3

VFAS3-2004P to 2075P, VFAS3-4004PC to 4185PC

The parts to be removed are as follows.

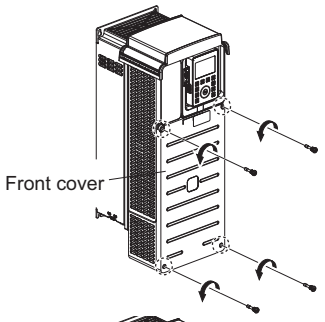
- **Front cover on the lower side of the front surface (resin)**
- **Top cover on the top surface (resin)**

Each cover can be removed separately.

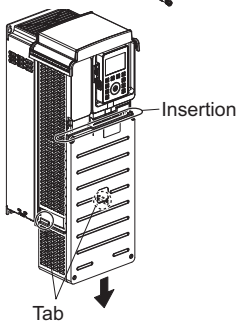


■ Front cover

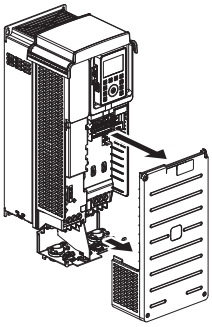
1 Loosen four screws of the front cover.
Since the screws are of falling prevention type, they do not come off the front cover even if loosened.



2 Hold the both side of the front cover and pull it slightly downward.
The inserted part of the upper side of the front cover comes off.
The tab shown in the figure on the right also come off.



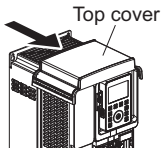
3 Pull the front cover toward you and remove it from the unit.



4 Mount the front cover in the reverse procedure.
Pay attention to engagement of the tab and insertion of the upper side of the cover.

■ **Top cover**

1 Put your fingers in the clearance in the back from the upper side of the top cover, and pull the cover toward you while lifting it upward.
The tab shown in the figure on the right comes off.

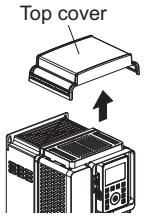


2

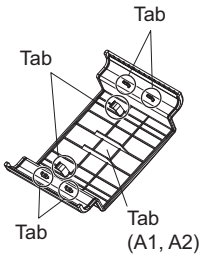
Important

- Since the tab is engaged stiffly, removing the top cover can result in injury. Pay enough attention.

2 Remove the top cover from the unit.



3 When mounting the top cover, put it on the top of the unit, adjust the position of the tab, push the cover to fit in.



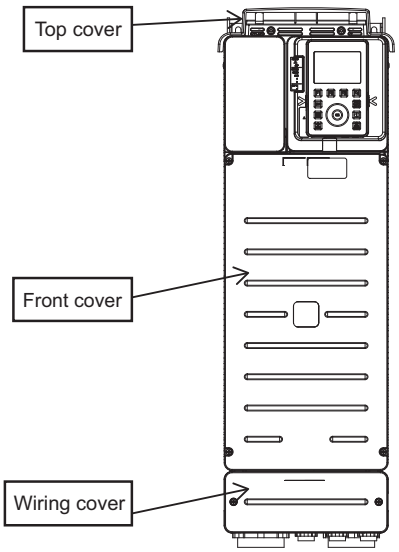
2. 2. 2 With frame size A4

VFAS3-2110P to 2185P, VFAS3-4220PC to 4370PC

The parts to be removed are as follows.

- **Front cover in the middle of the front surface (resin)**
- **Wiring cover on the lower side of the front surface (resin)**
- **Top cover on the top surface (resin)**

Each cover can be removed separately.

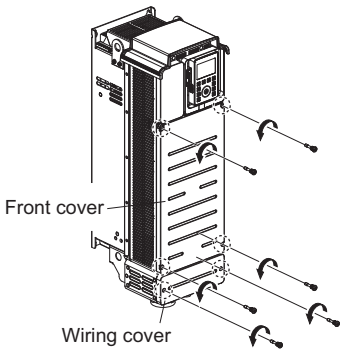


■ Front cover

1 Loosen four screws of the front cover.
Since the screws are of falling prevention type, they do not come off the front cover even if loosened.

2 Remove the front cover from the unit.
The upper part of the front cover has no inserted part.

3 Mount the front cover in the reverse procedure.

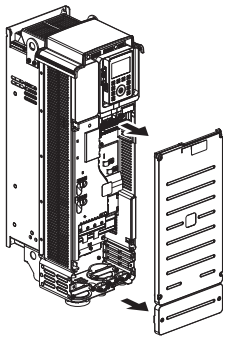


■ Wiring cover

1 Loosen two screws of the wiring cover.
Since the screws are of falling prevention type, they do not come off the wiring cover even if loosened.

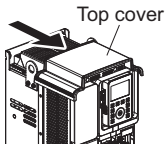
2 Remove the wiring cover from the unit.

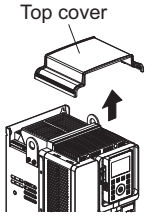
3 Mount the wiring cover in the reverse procedure.

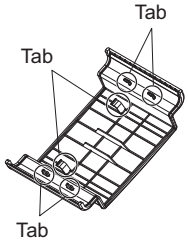


■ Top cover

1 Put your fingers in the clearance in the back from the upper side of the top cover, and pull the cover toward you to remove it.
The tab shown in the figure on the right comes off.







2 Mount the top cover in the reverse procedure.

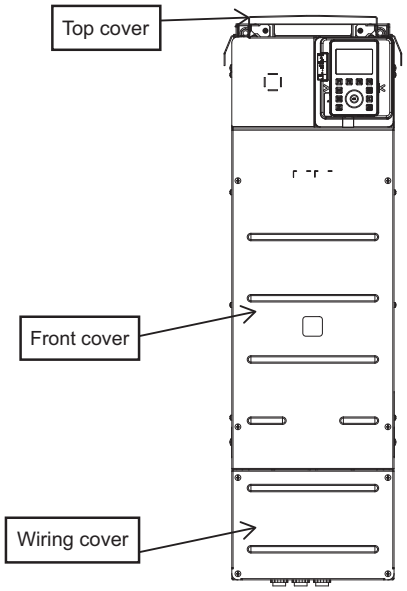
2. 2. 3 With frame size A5

VFAS3-2220P to 2370P, VFAS3-4450PC to 4750PC

The parts to be removed are as follows.

- **Front cover in the middle of the front surface (metal)**
- **Wiring cover on the lower side of the front surface (metal)**
- **Top cover on the top surface (metal)**

Each cover can be removed separately.

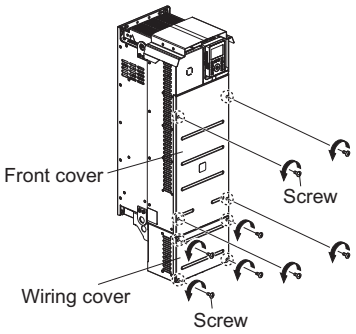


■ Front cover

1 Remove four screws of the front cover.
Store the removed screws so as not to be lost.

2 Remove the front cover from the unit.

3 Mount the front cover in the reverse procedure.

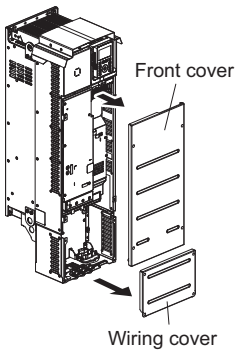


■ Wiring cover

1 Remove four screws of the wiring cover.
Store the removed screws so as not to be lost.

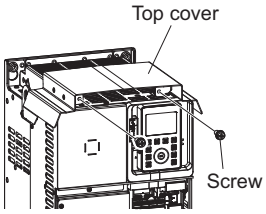
2 Remove the wiring cover from the unit.

3 Mount the wiring cover in the reverse procedure.

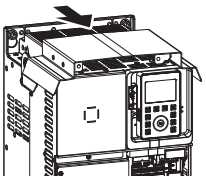


■ **Top cover**

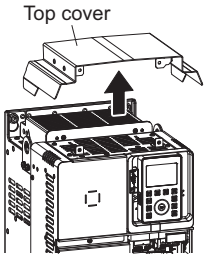
1 Remove two screws of the top cover.
Store the removed screws so as not to be lost.



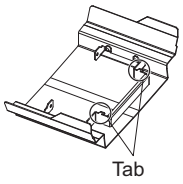
2 Pull the top cover slightly toward you.
The tab shown in the figure on the right comes off.



3 Lift the top cover upward and remove it from the unit.



4 Mount the top cover in the reverse procedure.



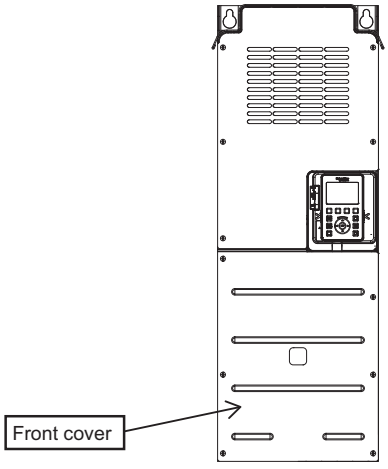
2. 2. 4 With frame size A6

VFAS3-2450P, 2550P,
VFAS3-4900PC to 4132KPC

The parts to be removed are as follows.

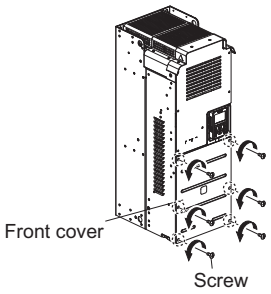
- **Front cover on the lower side of the front surface (metal)**
- **Transparent cover inside the front cover above (transparent resin)**
- **Wiring duct inside the front cover above (black resin)**

The top cover is never removed.

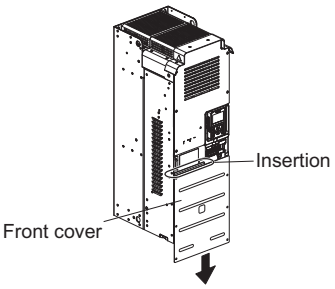


■ Front cover

1 Remove six screws of the front cover.
Store the removed screws so as not to be lost.



2 Lift the bottom end of the front cover, pull the entire cover downward and remove it from the unit.
Since the upper part of the front cover has an inserted part, the cover cannot be removed just by lifting it.

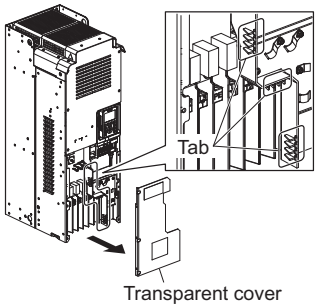


3 Mount the front cover in the reverse procedure.

■ Transparent cover

1 Remove the front cover.
Refer to the procedure above.

2 Remove the tab that holds down the transparent cover, lift the transparent cover and remove it from the unit.



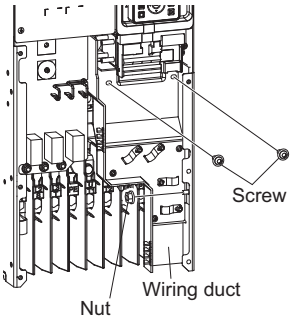
The transparent cover is just to be fitted in. It has no screw.

3 Mount the transparent cover in the reverse procedure.

■ Wiring duct

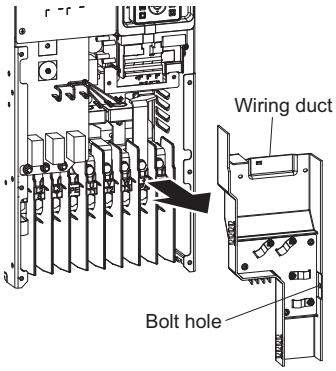
1 Remove the front cover and the transparent cover.
Refer to the procedure above.

2 Remove two screws of the wiring duct.
Store the removed screws so as not to be lost.



3 Remove one nut.
Store the removed nut so as not to be lost.

4 Lift the left side of the wiring duct first and remove it from the unit.
Be careful that the bolt from which the nut has been removed does not get caught in the bolt hole.



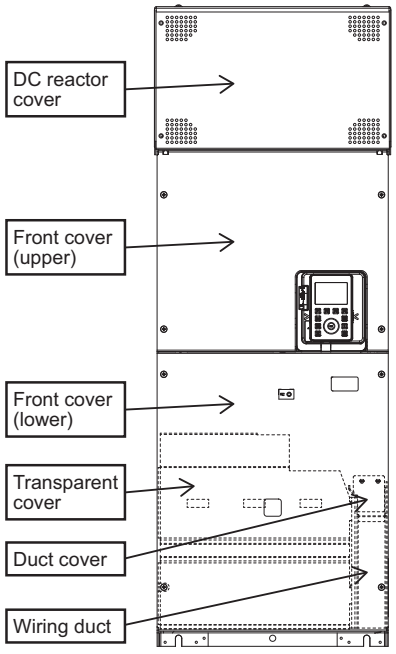
5 Mount the wiring duct in the reverse procedure.
First, adjust the bolt hole to the position of the bolt.
Be sure to mount the wiring duct before the transparent cover.

2. 2. 5 With frame size A7 and A8

VFAS3-4160KPC, VFAS3-4200KPC to 4280KPC

Here is a case of frame size A7.
Except for its wider unit, frame size A8 has the same enclosure and structure as frame size A7.
The parts to be removed are as follows.

- **Front cover (lower) on the lower side of the front surface (metal)**
- **Transparent cover inside the front cover above (transparent resin)**
- **Wiring duct inside the front cover above (white resin)**
- **DC reactor cover on the upper side of the front surface (metal mesh)**
- **Front cover (upper) in the middle of the front surface (metal)**

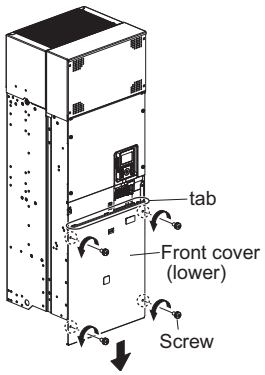


The DC reactor cover can be removed separately from the front cover.
The top cover is never removed.

■ Front cover (lower)

1 Remove four screws of the front cover (lower).
Store the removed screws so as not to be lost.

2 Lift the front cover (lower) and remove it from the unit.
The upper side of the front cover (lower) has three tabs. If you lift them perpendicular to the cover, the cover can be removed without getting caught in the tabs.

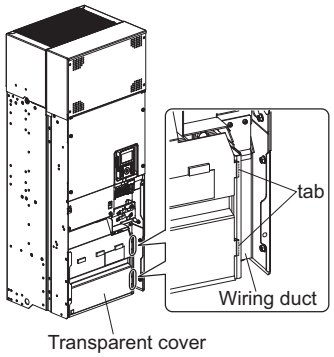


3 Mount the front cover in the reverse procedure.

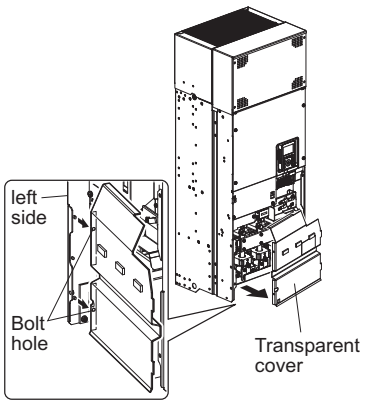
■ Transparent cover

1 Remove the front cover (lower).
Refer to the procedure above.

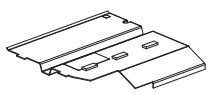
2 Press and bend the wiring duct lightly by hand and remove two tabs on the right of the transparent cover from the fitting holes of the wiring duct.
The tabs of the transparent cover are just fitted in.



3 Lift the right side of the transparent cover first and remove it from the unit.
The transparent cover is just fitted in and has no screw.
Be careful that two bolt holes on the left side of the transparent cover do not get caught.



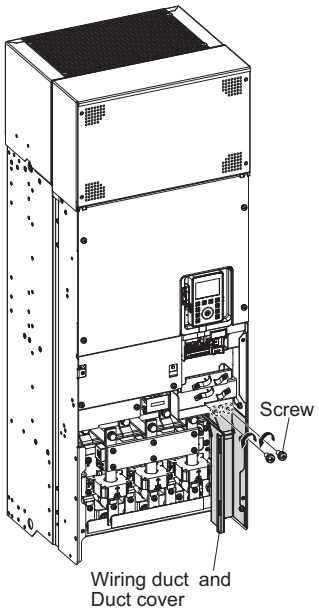
4 Mount the transparent cover in the reverse procedure.
First, adjust the positions of two bolt holes and fit the cover in, then, fit two tabs on the right in the wiring duct.



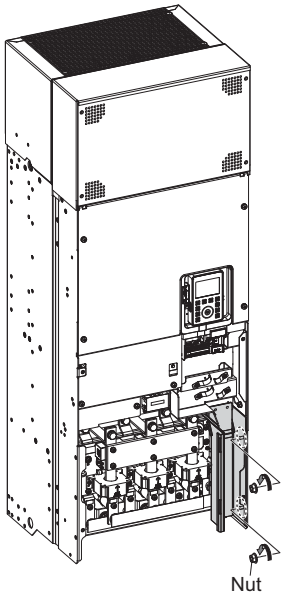
■ Wiring duct and Duct cover

1 Remove the front cover (lower) and the transparent cover.
Refer to the procedure above.

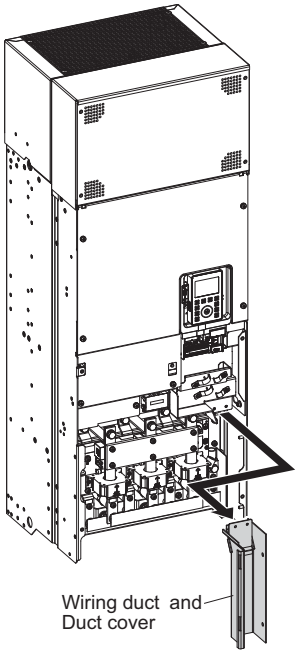
2 Remove two screws of Duct cover.
Store Duct cover and screws so as not to be lost.



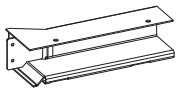
3 Remove two nuts of the wiring duct.
Store the removed nuts so as not to be lost.



4 Remove the wiring duct from the unit by pulling it down.

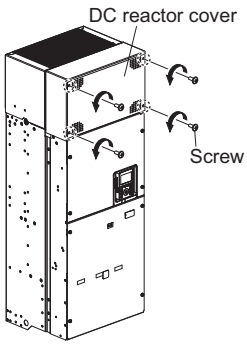


5 Mount Wiring duct and Duct cover in the reverse procedure.
First, insert the upper right part of the wiring duct to the unit. See the figure in step 4.
Be sure to mount the wiring duct before the transparent cover.



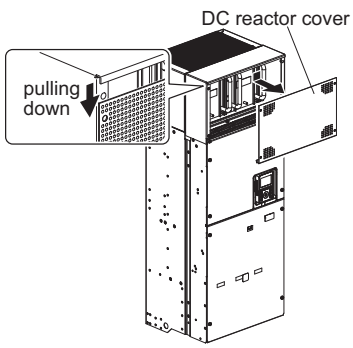
■ DC reactor cover

1 Remove four screws of the DC reactor cover.
Store the removed screws so as not to be lost.



2 Lift the lower end of the DC reactor cover slightly and remove it from the unit by pulling down.
The upper side of the DC reactor cover is to be inserted.

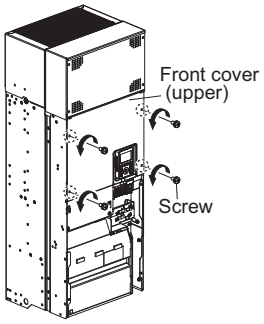
3 Mount the DC reactor cover in the reverse procedure.



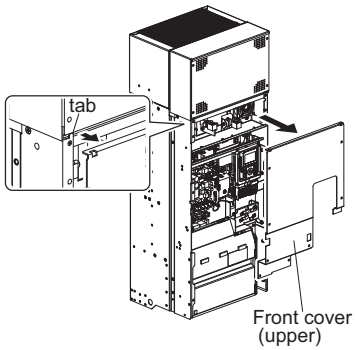
■ **Front cover (upper)**

1 Remove the front cover (lower) and the DC reactor cover.
Refer to the procedure above.

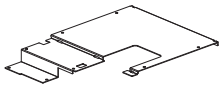
2 Remove eight screws of the front cover (upper).
Store the removed screws so as not to be lost.



3 Lift the lower end of the front cover (upper) slightly, move the front cover (upper) slightly upward and unfasten two tabs of the unit.
The upper end of the front cover (upper) is caught in two tabs of the unit.



4 Lift the front cover (upper) and remove it from the unit.



5 Mount the front cover (upper) in the reverse procedure.
First, fit the upper end of the front cover (upper) in two tabs of the unit.
Be sure to mount the front cover (upper) before the front cover (lower) and the DC reactor cover.

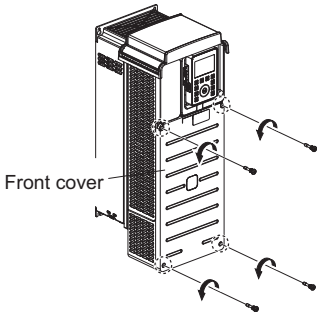
2. 2. 6 Charge lamp

While the charge lamp is on (red), voltage is applied, or high voltage remains in the inverter.
The location of the charge lamp varies depending on the type.

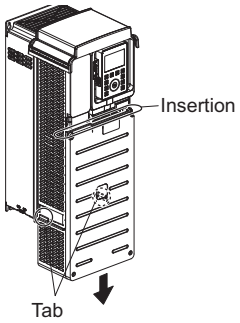
■ **With frame size A1 to A5**
VFAS3-2004P to 2370P, VFAS3-4004PC to 4750PC

The charge lamp is inside the front cover.
In the case of frame size A1, check the charge lamp in the following procedure. Also for other models, remove the front cover by referring to [2. 2] and check the charge lamp.

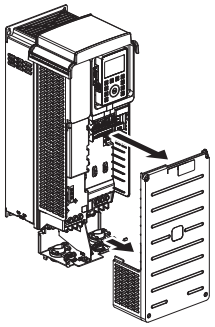
1 Loosen four screws of the front cover.
Since the screws are of falling prevention type, they do not come off the front cover even if loosened.



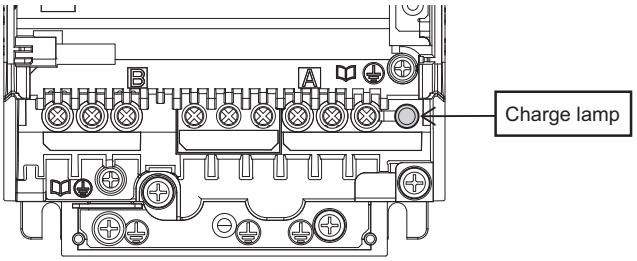
2 Hold the both side of the front cover and pull it slightly downward.
The inserted part of the upper side of the front cover comes off.
The tab shown in the figure on the right also come off.



3 Pull the front cover toward you and remove it from the unit.

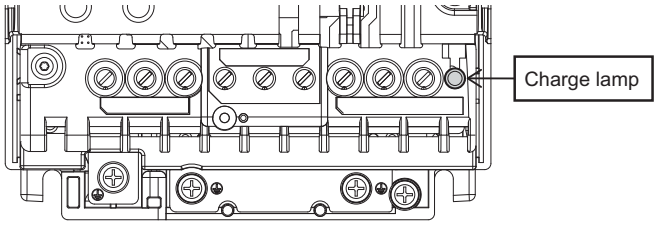


4 Check that the charge lamp is on/off.

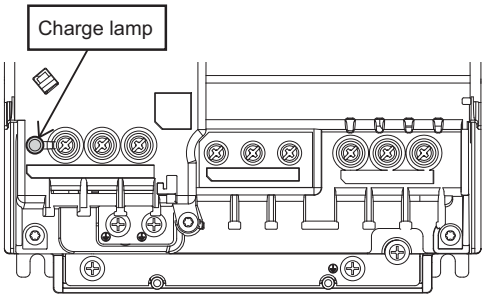


5 Mount the front cover in the reverse procedure.
Pay attention to engagement of the tab and insertion of the upper side of the cover.

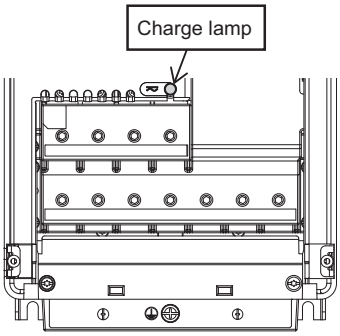
Frame size A2
VFAS3-2037P, VFAS3-4055PC, 4075PC



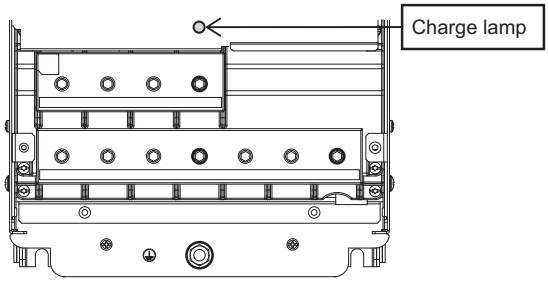
Frame size A3
VFAS3-2055P, 2075P, VFAS3-4110PC to 4185PC



Frame size A4
VFAS3-2110P to 2185P, VFAS3-4220PC to 4370PC

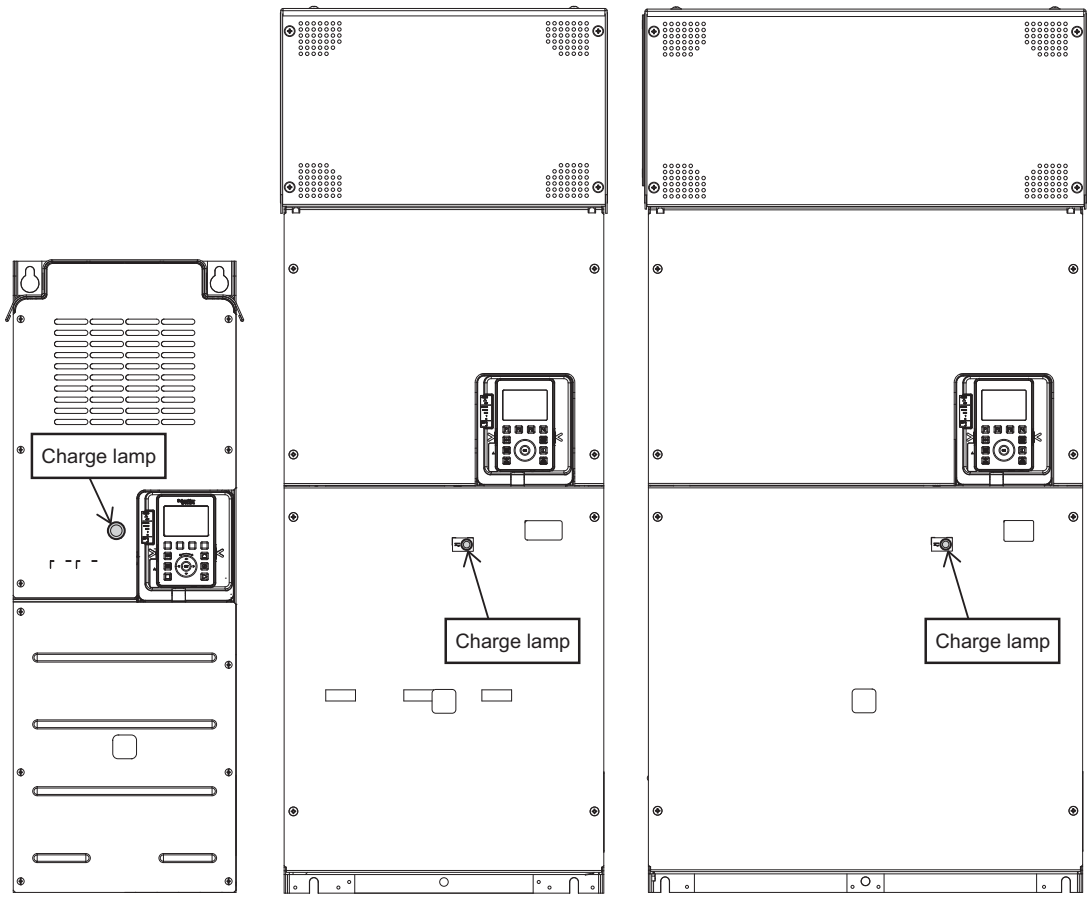


Frame size A5
VFAS3-2220P to 2370P, VFAS3-4450PC to 4750PC



■ **With frame size A6 to A8**
VFAS3-2450P, 2550P, VFAS3-4900PC to 4280KPC

You can check the charge lamp without opening the cover.When removing the front cover, be sure to check that the charge lamp is off.



2. 3 Wiring

⚠ WARNING	
 Disassembly prohibited	• Never disassemble, modify or repair. This can result in electric shock, fire and other injury. Please call your Toshiba distributor for repairs.
 Prohibited	• Do not stick your fingers into openings such as cable wiring holes and cooling fan covers. The unit contains high voltage parts and contact with them will result in electric shock. • Do not place or insert any kind of object (electrical wire cuttings, rods, wires etc.) inside the inverter. This will cause a short circuit and result in electric shock or fire. • Do not allow water or any other fluids to come in contact with the inverter. This will cause a short circuit and result in electric shock or fire.
 Mandatory action	• All options to be used must be those specified by Toshiba. The use of options other than those specified by Toshiba will result in an accident. • In using a power distribution device and options for the inverter, they must be installed in a cabinet. When they are not installed in the cabinet, this will result in electric shock.

This section explains cautions for wiring, how to connect to the power supply, motor, and control equipment, functions of the terminal blocks/connectors for communication, and how to switch the grounding capacitor, etc.

2. 3. 1 Cautions for wiring

⚠ WARNING	
 Prohibited	• Never remove the front cover when the power is on. The unit contains high voltage parts and contact with them will result in electric shock.
 Mandatory action	• Mount the front cover after wiring. If you turn the power on without attaching the front cover, this will result in electric shock or other injury. • Electrical construction work must be done by a qualified expert. Erroneous connection of power supply by someone who does not have that expert knowledge will result in fire or electric shock. • Connect output terminals (motor side) correctly. If the phase sequence is incorrect, the motor will operate in reverse and that can result in injury. • Wiring must be done after installation. If you perform wiring prior to installation, this will result in electric shock or other injury. • Verify that the power is turned off and the charge lamp is off before starting wiring. If you perform wiring without verification, this will result in electric shock. • Tighten the screws on the terminal block to specified torque. If the screws are not tightened sufficiently to the specified torque, this will result in fire. • Verify that the power supply voltage is within +10% and -15% (±10% when the load is 100% in continuous operation) of the applied power supply voltage written on the name plate. If you do not use the appropriate power supply voltage, this will result in failure or fire.

Be grounded	• The grounding wire must be connected securely. If the grounding wire is not securely connected, when the inverter has failure or earth leakage, this will result in electric shock or fire.

⚠ CAUTION

Prohibited	• Do not attach devices with built-in capacitors (such as noise reduction filters or surge absorbers) to the output terminals (motor side). Heat rises up and this could cause a fire.
Mandatory action	• Following type of screwdriver should be used; Frame size A1 : PH2 (phillips, bit type2), shaft diameter 5.0mm or less Frame size A2 : PH2 (phillips, bit type2), shaft diameter 5.8mm or less

Pay attention to the following when wiring.

■ Measures for noise

To prevent electrical interference due to high-frequency noise generated by the inverter, separately bundle wires to the power circuit's power side terminals ([R/L1], [S/L2], [T/L3]) and wires to the motor side terminals ([U/T1], [V/T2], [W/T3]).

■ Control power supply

The control power of this inverter is supplied inside from the power circuit power supply. Therefore, if a malfunction or trip causes the power circuit to be shut off, control power will also be shut off.

- To check the cause of the malfunction or trip, set <F602: Trip record retention> to "1: Retain at power off."
- To make the control circuit continuously operate even if the power circuit is shut off due to malfunction or tripping, use an optional control power supply unit and supply power to the control circuit.

■ Wiring

- For power terminals, use ferrules with insulation sleeve terminal and crimp-style terminal with insulation sleeve. Connect the terminals so that adjacent terminals do not touch each other.
- For the sizes of electric wires used in the power circuit, refer to the table in [10. 1].
- The length of each wire is assumed to be 30 m or less. If the wire length is over 30 m, the wire size (diameter) must be increased.
- For grounding terminal, use wires of the size that is equivalent to or larger than those given in table [10. 1] and always ground the inverter.
- Wire the grounding wire as close as possible to the inverter.
- To ground the inverter unit, connect it to an exclusive grounding terminal. Do not use screws of the case, chassis, etc.
- Tighten the screws of the power terminal block and the control terminal block to the recommended tightening torque shown in the table [2. 3. 3] and [2. 3. 5] respectively.

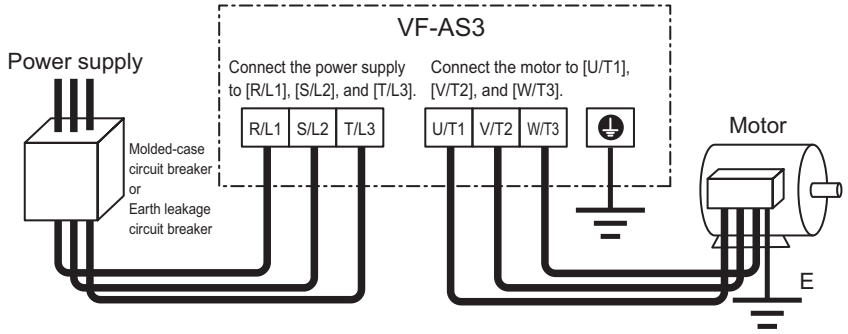
2. 3. 2 Standard connection method

⚠ WARNING	
Prohibited	• Do not connect power supply to the output (motor side) terminals [U/T1], [V/T2] and [W/T3]. Connecting power supply to the output will damage the inverter and result in fire. • Do not insert a braking resistor between DC terminals [PA/+] and [PC/-] or [PO] and[PC/-]. This will result in fire. Please connect the braking resistor in accordance with the instruction manual. • Do not touch wires of equipment (e.g. ELCB) that is connected to the inverter power side at least 15 minutes after turning off the power. If an electric charge remains in a capacitor in the inverter, touching the wires before the indicated time will result in electric shock.
Be grounded	• The grounding wire must be connected securely. If the grounding wire is not securely connected, when the inverter has failure or earth leakage, this will result in electric shock or fire.

The wiring of the power supply and motor is connected to the power terminal block and the wiring of external control equipment such as control signals to the control terminal block.

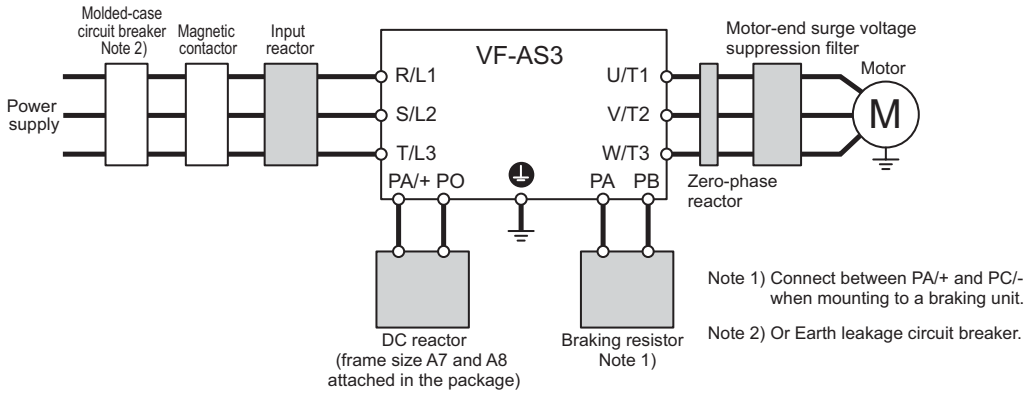
■ Connection to power supply and motor

This diagram shows a standard wiring of the power circuit.
Connection to the power supply and motor wiring is common to all the types.



■ Connection to peripheral devices

This diagram shows an example of connection to peripheral devices.



For details of the peripheral devices, refer to [Chapter 10].
- An noise filter is built in all the types as standard.
- A DC reactor is built in as standard or attached (frame size A7, A8).

Braking resistor
- To VFAS3-2004P to 2370P, VFAS3-4004PC to 4750PC, and VFAS3-4160KPC, connect only the braking resistor (optional) because a dynamic braking circuit is built in them as standard.
- When a braking resistor (optional) is installed for VFAS3-4900PC to 4132KPC and VFAS3-4200KPC to 4280KPC, a braking unit (optional) is also required.

For details, refer to [10. 3. 2].

DC input
- To input DC power, connect the inverter between terminals [PA/+] and [PC/-].
- When VFAS3-2110P to VFAS3-2550P or VFAS3-4220PC to VFAS3-4280KPC are used with a DC power supply, a circuit to suppress an inrush current should be required.
- When VFAS3-4160KPC to 4280KPC are used with a DC power supply, three-phase power input for cooling fan driving should be prepared separately.

For details, refer to application manual "DC power supply connect to inverter" (E6582156).

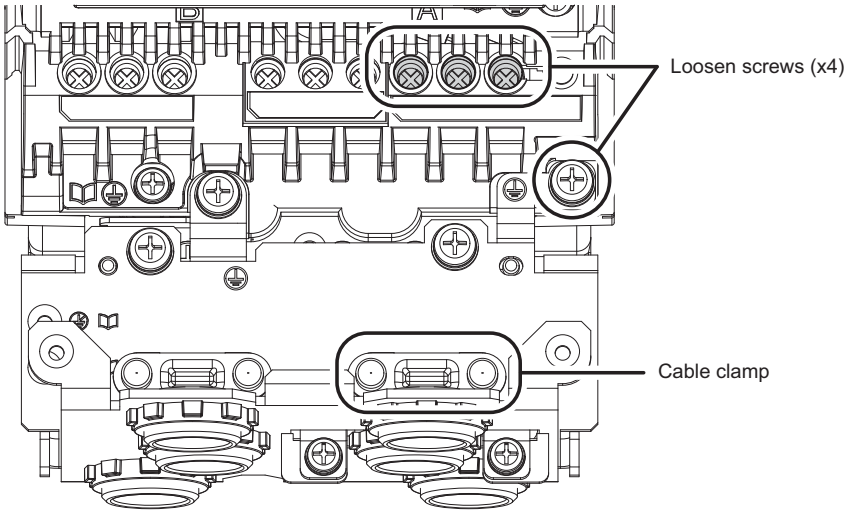
■ Connection procedure of power circuit wiring

The following is the connection procedure of the power connection, with frame size A1 as an example.
Connect other sizes in the same way.

1 Remove the front cover.
For how to remove, refer to [2. 2. 1].

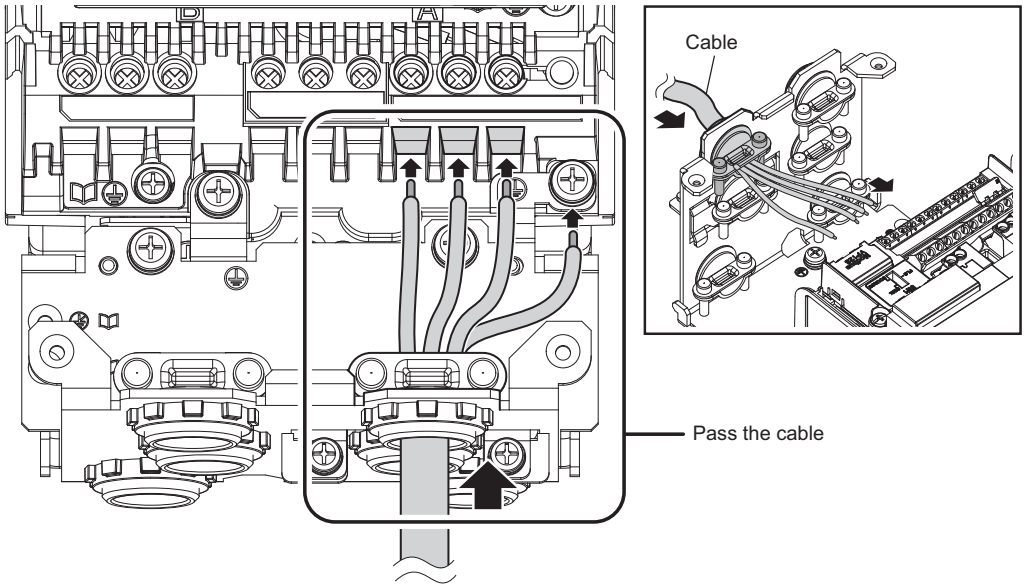
2 Loosen the screws of the grounding terminal for inverter case. Mount the grounding wire to the screws of grounding terminal. Switch the grounding capacitor when needed. For details of how to switch, refer to [2. 3. 4].

3 Loosen the screws of the terminals [U/T1], [V/T2], and [W/T3] and a terminal [PE] of the power terminal block.
The terminal [PE] exists only in frame size A4 to A6.

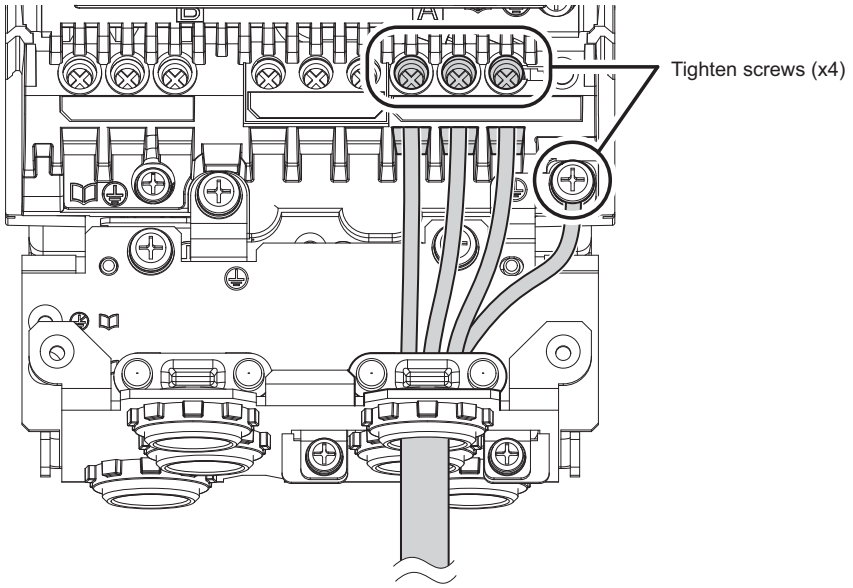


4 Pass the motor wiring through the cable clamp.
The cable clamp exists only in frame size A1 to A5.

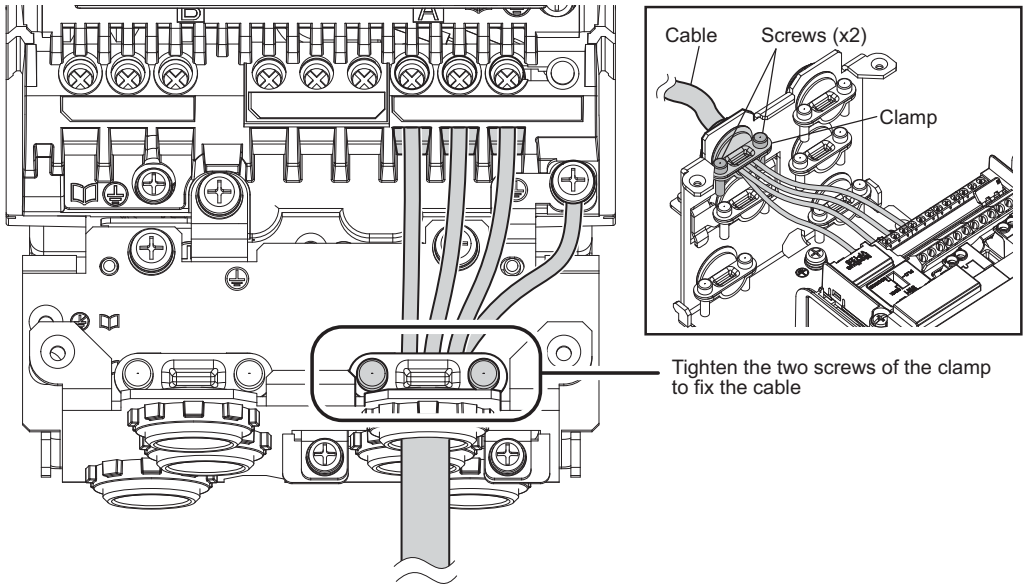
5 Mount the motor wiring to the screw of each corresponding terminal.
Mount ferrules with insulation sleeve terminal and crimp-style terminal with insulation sleeve to the end of each wire of the motor in advance. For cautions, refer to "■Wiring" of [2. 3. 1].



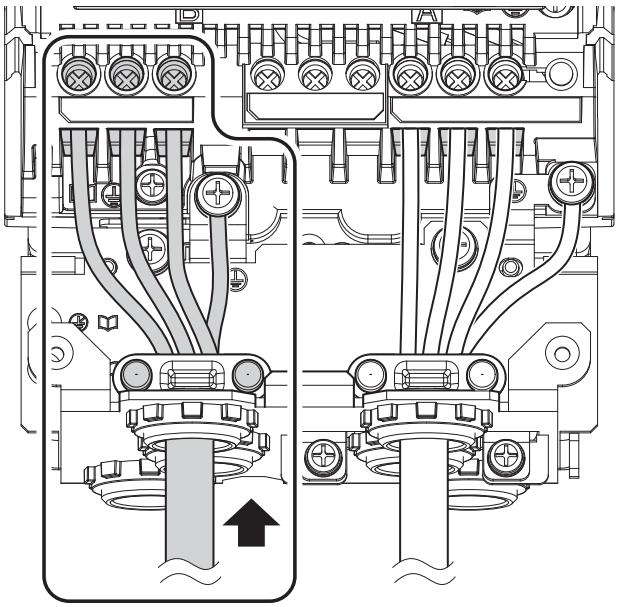
6 Tighten the screws of the terminals [U/T1], [V/T2], and [W/T3] and a terminal [PE].
For the recommended tightening torque, refer to "■Recommended tightening torque of power terminal screws" of [2. 3. 3].



7 Tighten two screws of the cable clamp and fix the motor wiring (four wires) with the cable clamp.
The cable clamp exists only in frame size A1 to A5.



8 Similarly, mount the power supply wiring to the terminals [R/L1], [S/L2], and [T/L3] and a terminal [PE] after passing it through other cable clamp.
For the recommended tightening torque of the screws, refer to "■Recommended tightening torque of power terminal screws" of [2. 3. 3].
Also fix the power supply wiring with the cable clamp.
The cable clamp exists only in frame size A1 to A5.



9 When connection is complete, mount the front cover.
For how to mount, refer to [2. 2. 1].

Memo	• For the layout and shape of power terminal block of each frame size, refer to [2. 3. 3]. • The cable clamp exists only in frame size A1 to A5. • Covers to be removed at the time of wiring vary depending on the frame size. For details, refer to [2. 2].

■ Connection of control circuit

- The input/output of the control circuit consist of digital input x 8 points, analog input x 3 points, analog output x 2 points, relay contact output x 3 points, etc. In many cases, the function of input/output can be switched with parameter setting.
- For the function and electrical specification of each terminal, refer to [2. 3. 5].
- For details of how to operate with terminal input, refer to [4. 4].

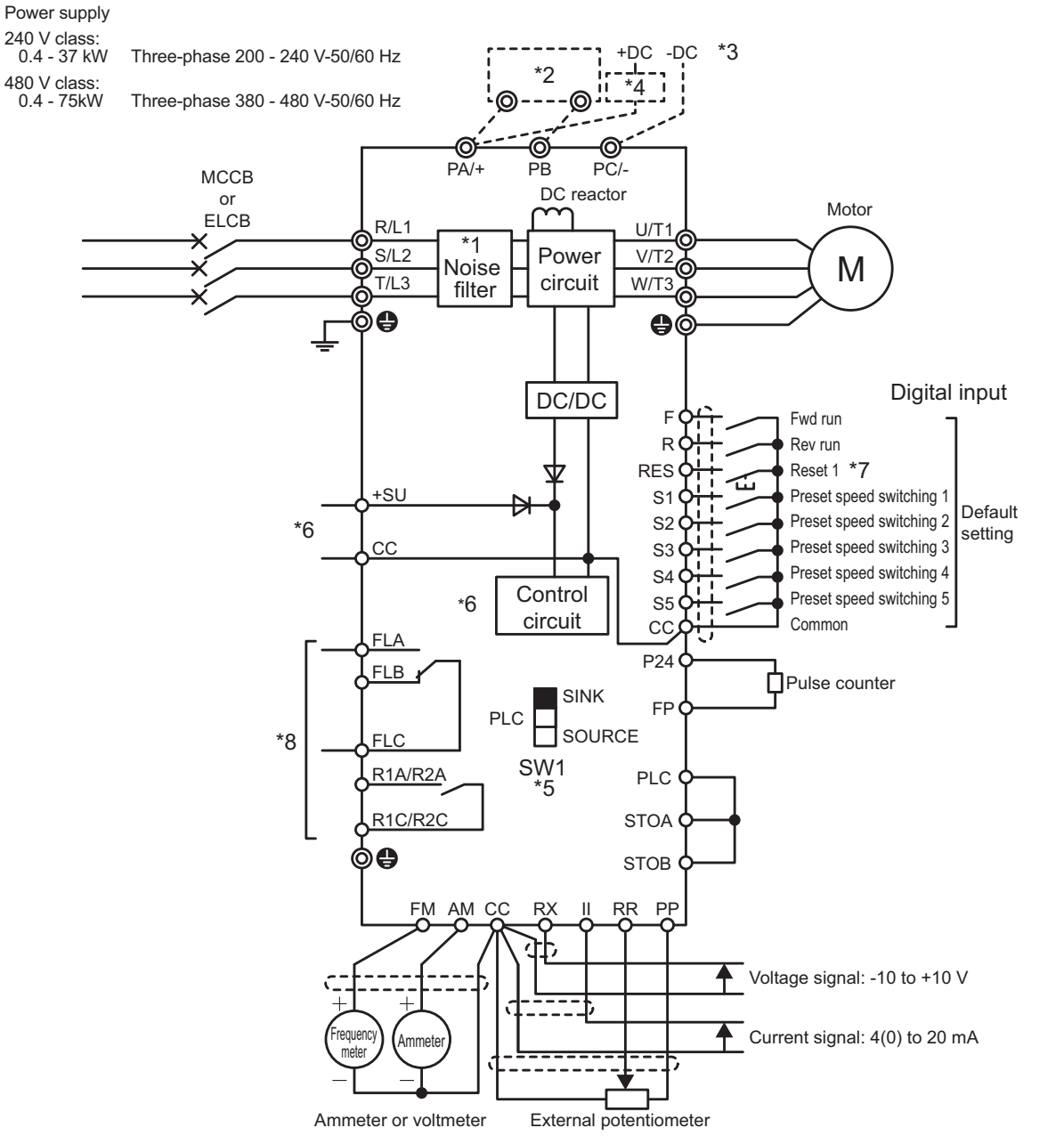
For an example of wiring of the control circuit, refer to the "■Standard connection diagram".

■ Standard connection diagram

This diagram shows a standard wiring of the power circuit and control circuit.

[Standard connection diagram - Sink]

This diagram shows an example of a standard connection for 240 V class, 0.4 to 37kW and 480 V class, 0.4 to 75kW (frame size A1 to A5).



*1 EMC filter is built in 480 V class.

*2 External braking resistor (option).

*3 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-].

*4 If your inverter is 240 V with 11kW or more, or 480 V with 22kW or more. when using it with a DC power supply, a circuit to suppress an inrush current is required. For detail, refer to application manual "DC power supply connect to inverter" (E6582156).

*5 For the switch function, refer to [2. 3. 5].

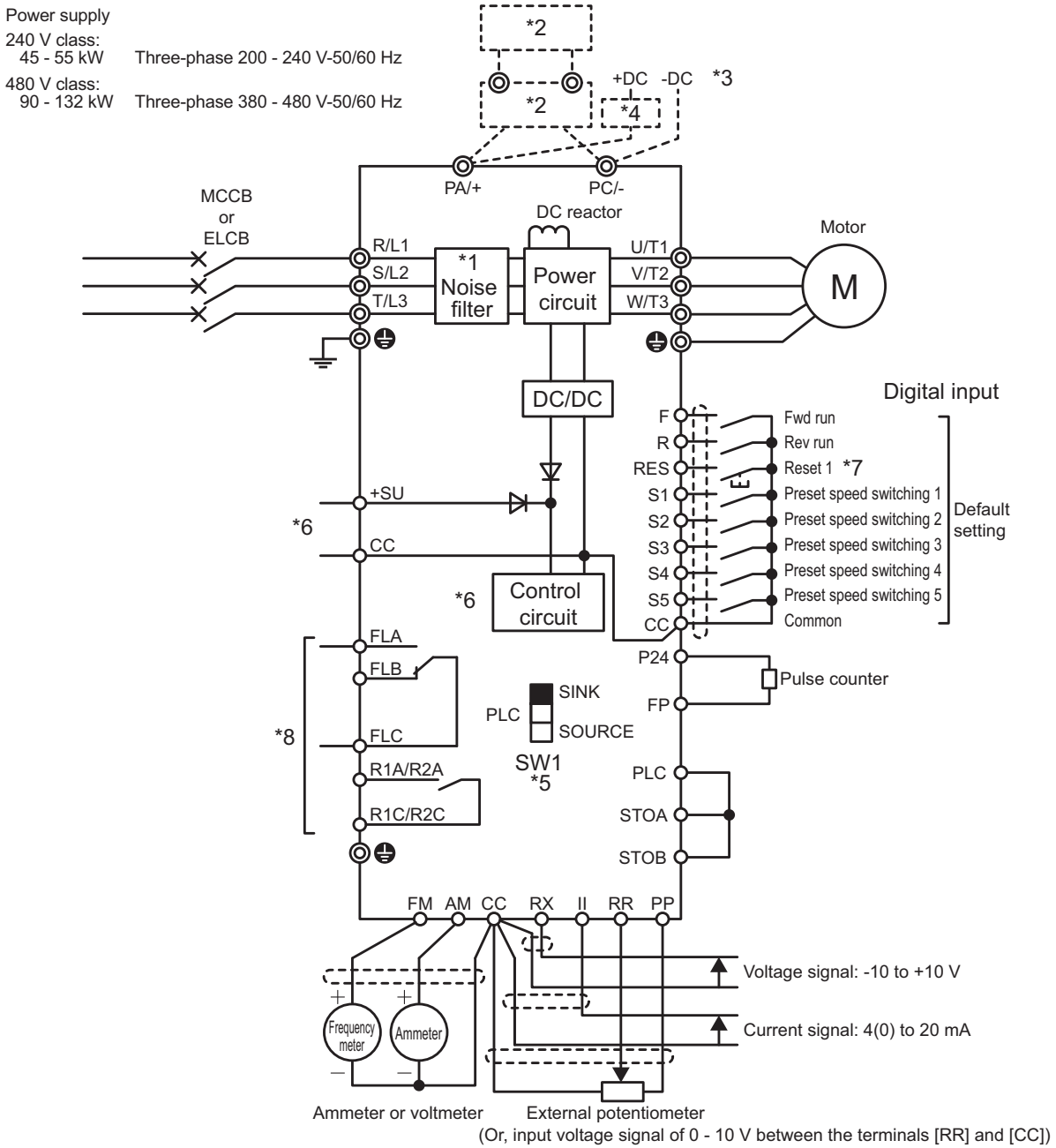
*6 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply.
Set <F647: Control power option failure detection> to back up the control power supply.
For details, refer to [6. 30. 20].

*7 The reset signal is activated by ON→OFF trigger input.

*8 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

[Standard connection diagram - Sink]

This diagram shows an example of a standard connection for 240 V class, 45 - 55 kW and 480 V class, 90 - 132 kW (frame size A6).



*1 EMC filter is built in 480 V class.

*2 When a braking resistor (optional) is mounted, a braking unit (optional) is also required.

*3 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-].

*4 When the inverter is used with a DC power supply, a circuit to suppress an inrush current should be required. For detail, refer to application manual "DC power supply connect to inverter" (E6582156).

*5 For the switch function, refer to [2. 3. 5].

*6 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply.
Set <F647: Control power option failure detection> to back up the control power supply.
For details, refer to [6. 30. 20].

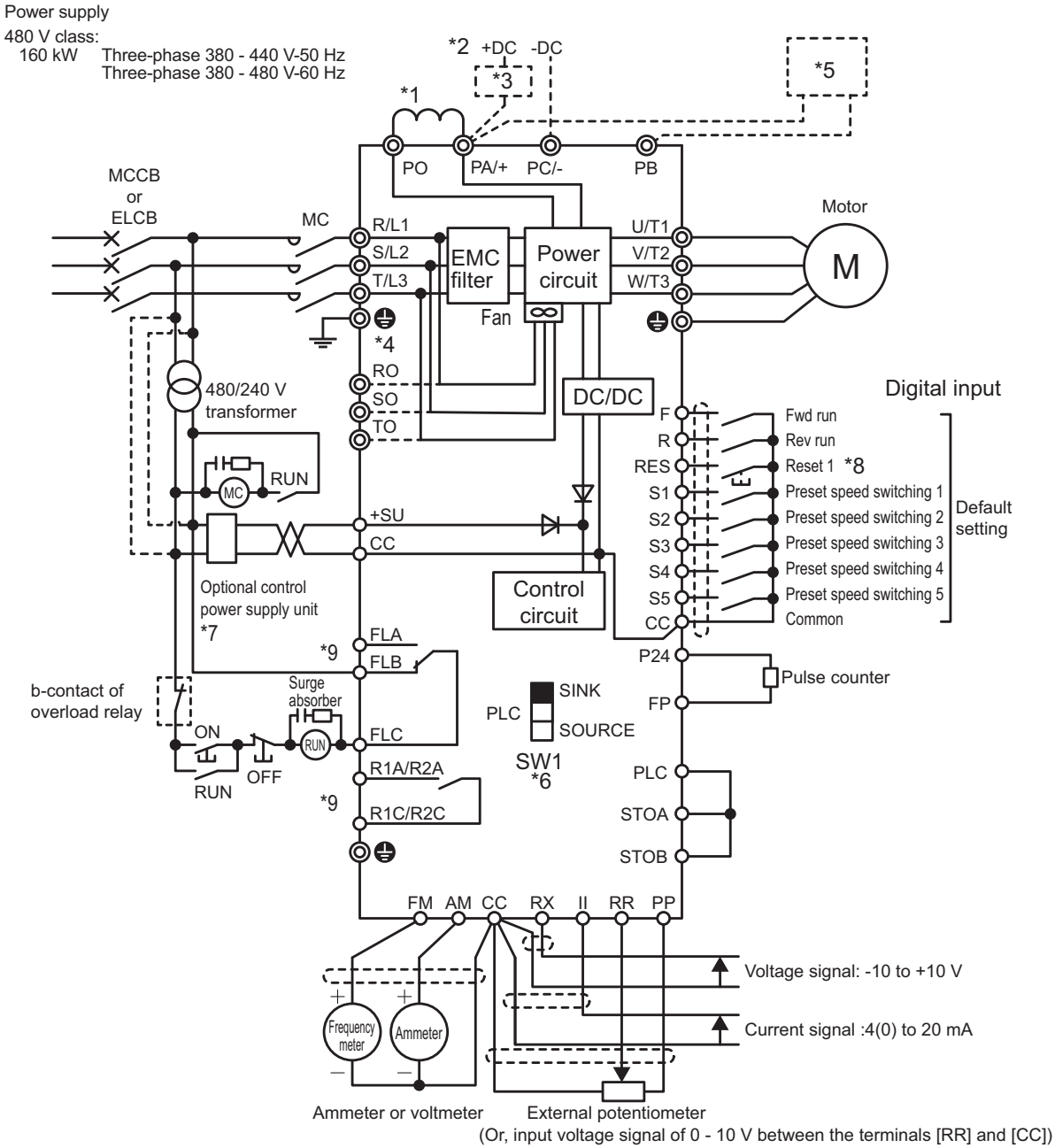
*7 The reset signal is activated by ON→OFF trigger input.

*8 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

2

[Standard connection diagram - Sink]

This diagram shows an example of a standard connection for 480 V class, 160 kW (frame size A7).



*1 Be sure to mount the DC reactor. A circuit between the terminals [PA/+] and [PO] is not short circuited (at the time of shipping).

*2 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-].

*3 When the inverter is used with a DC power, a circuit to suppress an inrush current should be required. For detail, refer to application manual "DC power supply connect to inverter" (E6582156).

*4 When the inverter is used with a DC power supply, three-phase power input for cooling fan driving is required separately. For details, refer to application manual "DC power supply connect to inverter" (E6582156).

*5 External braking resistor (option)

*6 For the switch function, refer to [2. 3. 5].

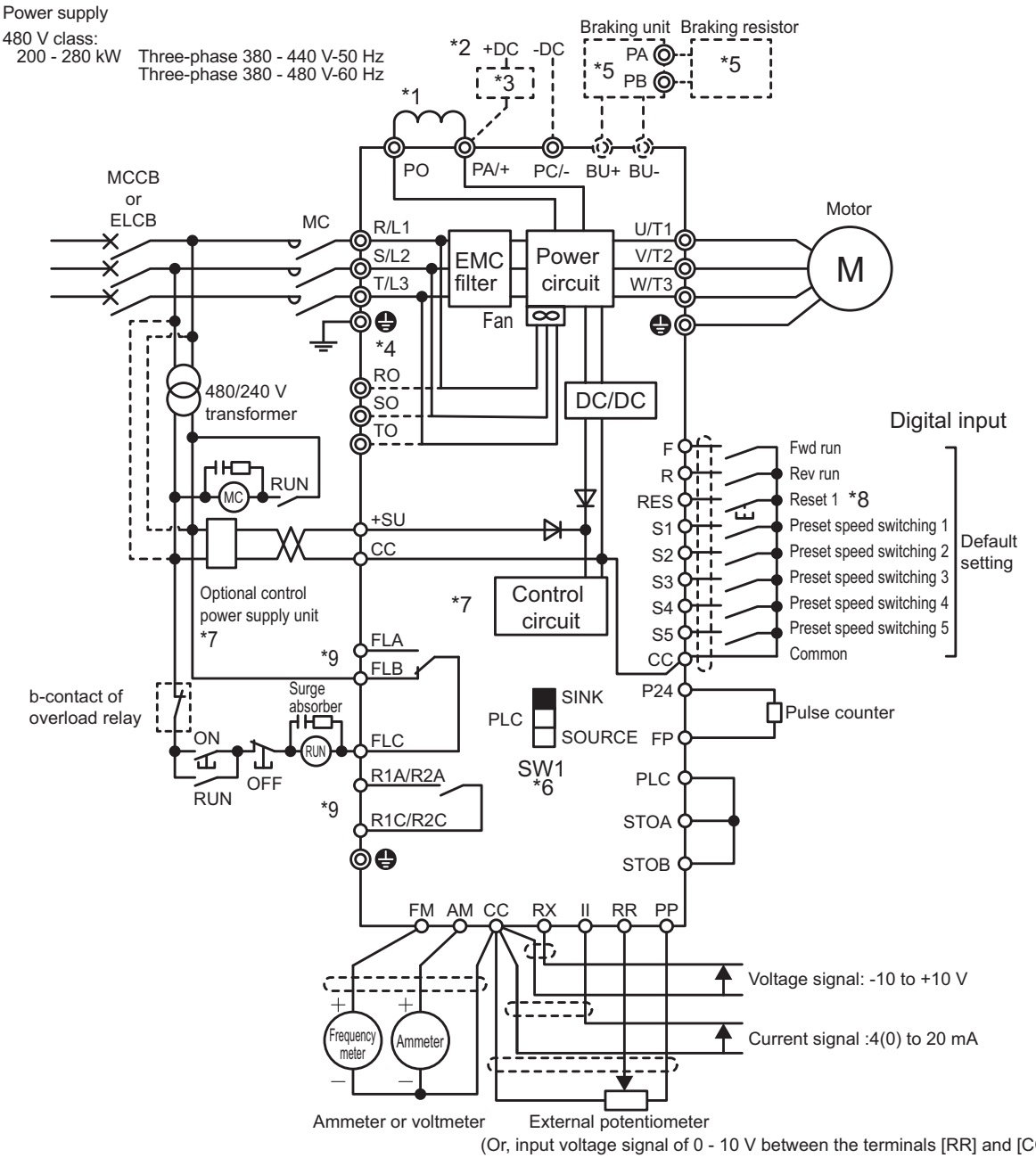
*7 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply.
Set <F647: Control power option failure detection> to back up the control power supply.
For details, refer to [6. 30. 20].

*8 The reset signal is activated by ON→OFF trigger input.

*9 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

[Standard connection diagram - Sink]

This diagram shows an example of a standard connection for 480 V class, 200 to 280 kW (frame size A8).



*1 Be sure to mount the DC reactor. It is not required for DC power input terminal. A circuit between the terminals [PA/+] and [PO] is not short circuited (at the time of shipping).

*2 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-]. It is not used in conjunction with the DC reactor option DCL1.

*3 When the inverter is used with a DC power supply, a circuit to suppress an inrush current is required. For detail, refer to application manual "DC power supply connect to inverter" (E6582156).

*4 When the inverter is used with a DC power supply, three-phase power input for cooling fan driving is required separately. For details, refer to application manual "DC power supply connect to inverter" (E6582156).

*5 When a braking resistor (optional) is mounted, a braking unit (optional) is also required.

*6 For the switch function, refer to [2. 3. 5].

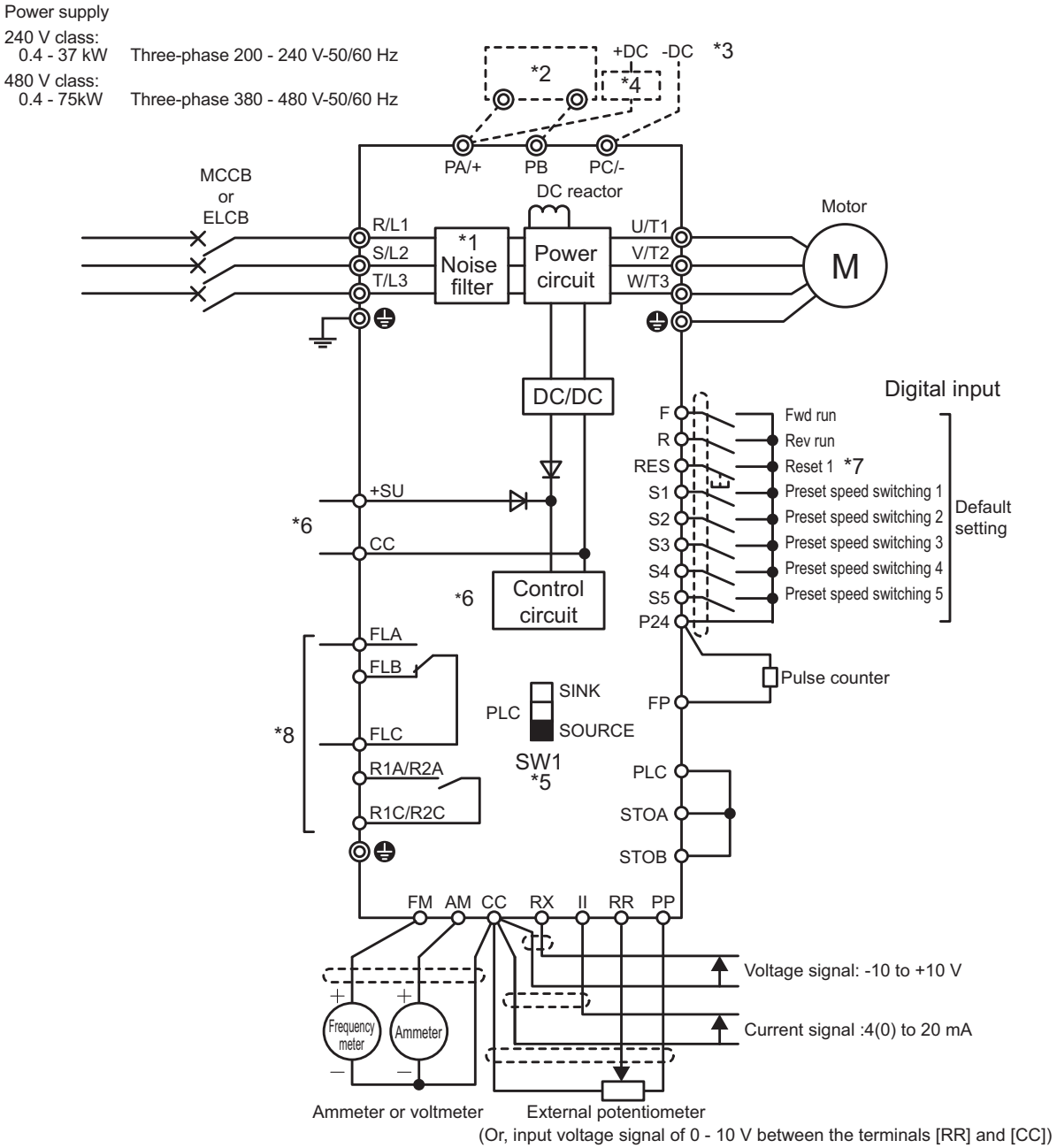
*7 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply.
Set <F647: Control power option failure detection> to back up the control power supply.
For details, refer to [6. 30. 20].

*8 The reset signal is activated by ON→OFF trigger input.

*9 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

[Standard connection diagram - Source]

This diagram shows an example of a standard connection for 240 V class, 0.4 to 37 kW and 480 V class, 0.4 to 75 kW (frame size A1 to A5).



*1 EMC filter is built in 480 V class.

*2 External braking resistor (option).

*3 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-].
When your inverter is VFAS3-2110P to VFAS3-2370P or VFAS3-4220PC to VFAS3-4750PC, a circuit to suppress an inrush current is required. For detail refer to application manual "DC power supply connect to inverter" (E6582156).

*5 For the switch function, refer to [2. 3. 5].

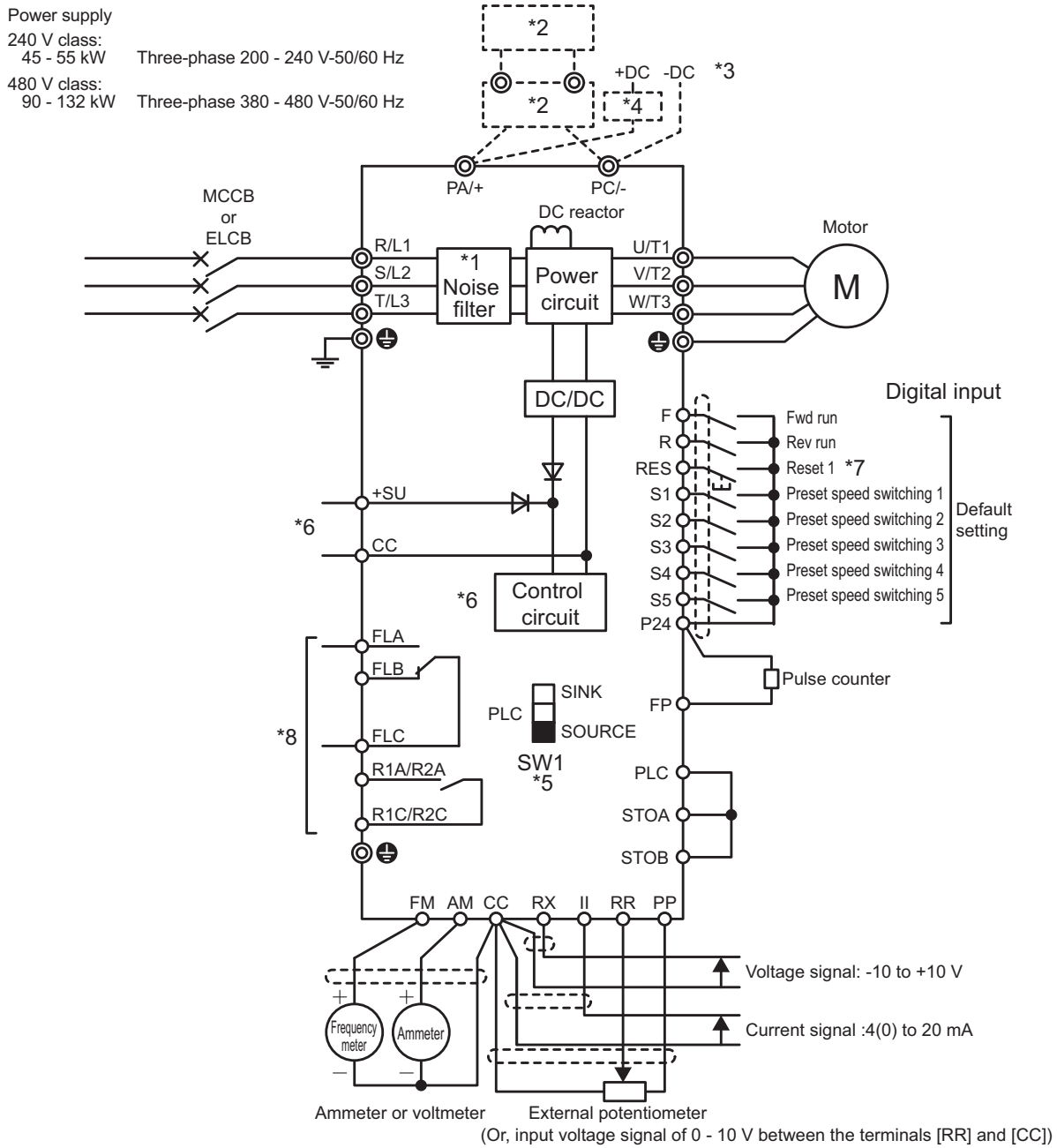
*6 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply.
Set <F647: Control power option failure detection> to back up the control power supply.
For details, refer to [6. 30. 20].

*7 The reset signal is activated by ON→OFF trigger input.

*8 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

[Standard connection diagram - Source]

This diagram shows an example of a standard connection for 240 V class, 45 to 55 kW and 480 V class, 90 to 132 kW (frame size A6).



*1 EMC filter is built in 480 V class.

*2 When a braking resistor (optional) is mounted, a braking unit (optional) is also required.

*3 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-].

*4 When the inverter is used with a DC power supply, a circuit to suppress an inrush current is required. For detail, refer to application manual "DC power supply connect to inverter" (E6582156).

*5 For the switch function, refer to [2. 3. 5].

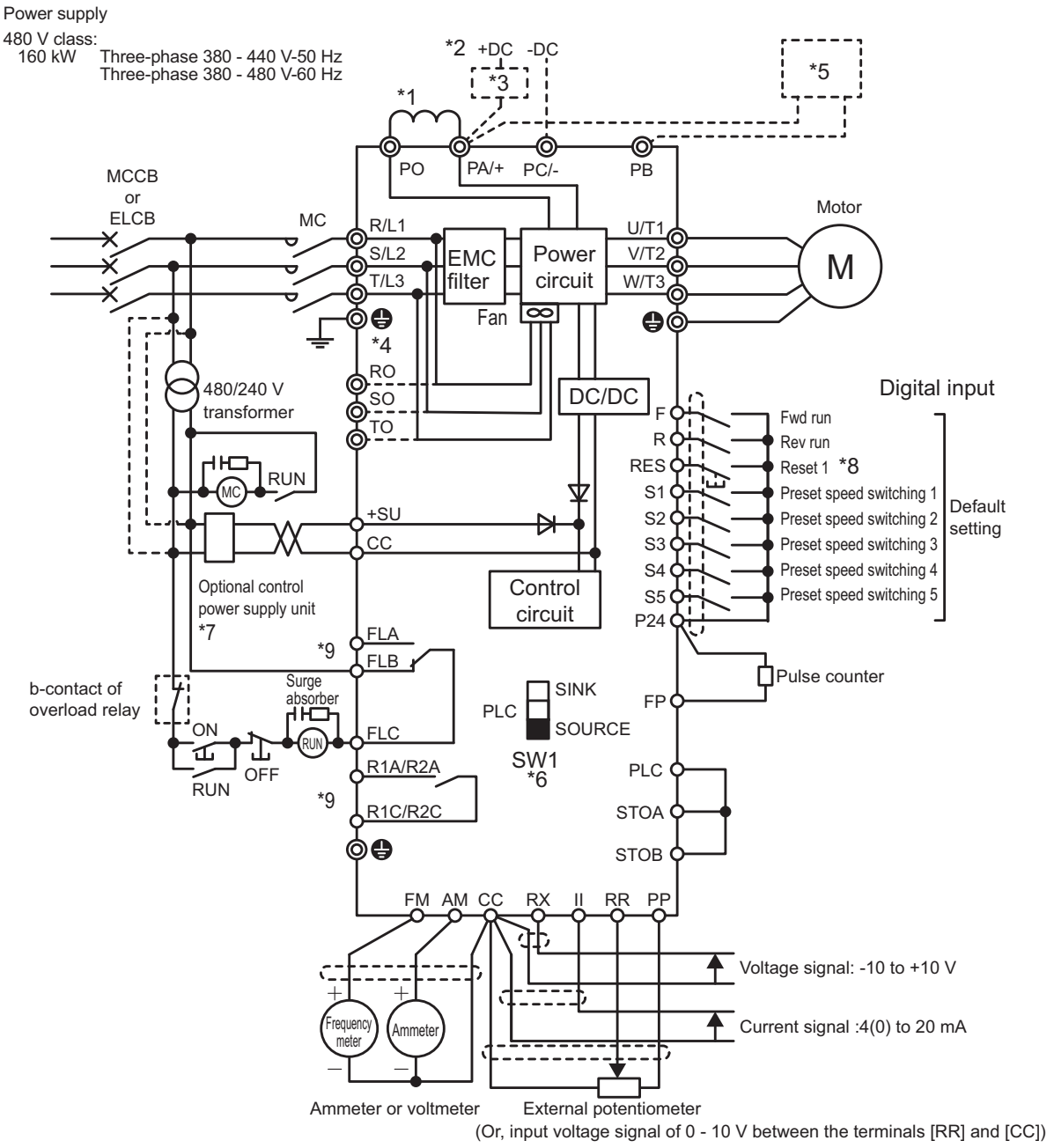
*6 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply.
Set <F647: Control power option failure detection> to back up the control power supply.
For details, refer to [6. 30. 20].

*7 The reset signal is activated by ON→OFF trigger input.

*8 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

[Standard connection diagram - Source]

This diagram shows an example of a standard connection for 480 V class, 160 kW (frame size A7).



*1 Be sure to mount the DC reactor. A circuit between the terminals [PA/+] and [PO] is not short circuited (at the time of shipping).

*2 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-].

*3 When the inverter is used with a DC power, a circuit to suppress an inrush current should be required. For detail, refer to application manual "DC power supply connect to inverter" (E6582156).

*4 When the inverter is used with a DC power supply, three-phase power input for cooling fan driving is required separately. For details, refer to application manual "DC power supply connect to inverter" (E6582156).

*5 External braking resistor (option)

*6 For the switch function, refer to [2. 3. 5].

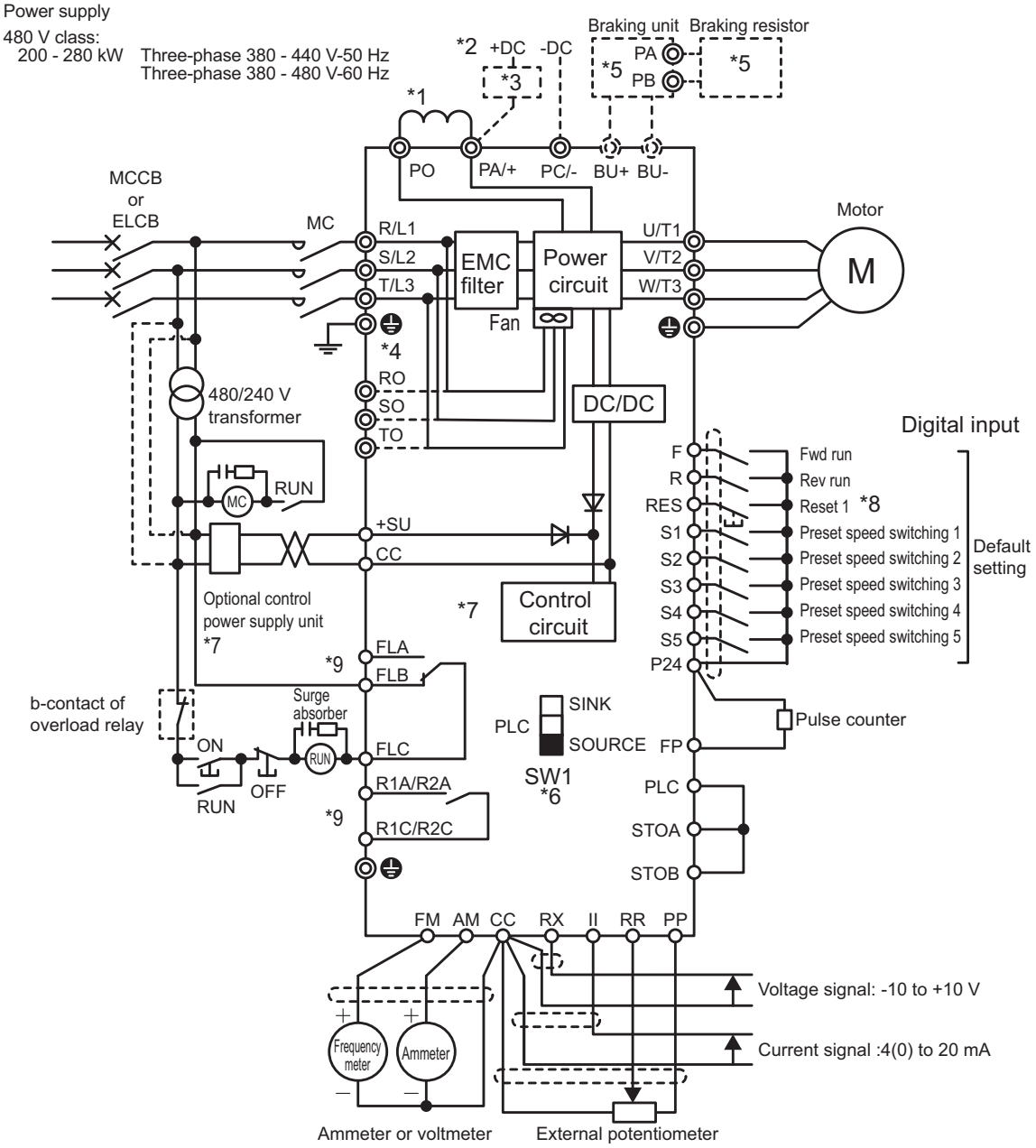
*7 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply. Set <F647: Control power option failure detection> to back up the control power supply. For details, refer to [6. 30. 20].

*8 The reset signal is activated by ON→OFF trigger input.

*9 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

[Standard connection diagram - Source]

This diagram shows an example of a standard connection for 480 V class, 200 to 280 kW (frame size A8).



*1 Be sure to mount the DC reactor. It is not required for DC power input terminal. A circuit between the terminals [PA/+] and [PO] is not short circuited (at the time of shipping).

*2 To input DC power, connect the inverter between the terminals [PA/+] and [PC/-]. It is not used in conjunction with the DC reactor option DCL1.

*3 When the inverter is used with a DC power supply, a circuit to suppress an inrush current is required. For detail, refer to application manual "DC power supply connect to inverter" (E6582156).

*4 When the inverter is used with a DC power supply, three-phase power input for cooling fan driving is required separately. For details, refer to application manual "DC power supply connect to inverter" (E6582156).

*5 If a braking resistor (optional) is mounted, a braking unit (optional) is also required.

*6 For the switch function, refer to [2. 3. 5].

*7 To supply control power from an external power supply for backing up the control power supplied from the inverter, an optional control power supply unit (CPS002Z) is required. In this case, it is used in conjunction with the inverter internal power supply.

*8 The reset signal is activated by ON→OFF trigger input.

*9 Connect to power to comply with OVC2 (Over Voltage Category 2). Isolation transformer is necessary when connecting to power supply (OVC3).

2. 3. 3 Power terminals

The power terminals are connected to the power supply (primary side) and the motor (secondary side).

■ Functions of power terminals

Terminal symbol	Function	Applicable frame size
⏚	Grounding terminal for inverter case. There are 3 terminals in cooling fin or mounting part of EMC plate.	All frame sizes
[PE]	Grounding terminal.	Frame size A4, A5, and A6
[R/L1] [S/L2] [T/L3]	Connected to an AC power supply. 240 V class: Three-phase 200 - 240 V-50/60 Hz 480 V class: VFAS3-4004PC to 4132KPC : Three-phase 380 - 480 V-50/60 Hz VFAS3-4160KPC to 4280KPC : Three-phase 380 - 440 V- 50 Hz Three-phase 380 - 480 V- 60 Hz	All frame sizes
[U/T1] [V/T2] [W/T3]	Connected to a three-phase motor.	All frame sizes
[PA/+] [PB]	Connected to a braking resistor. Change the parameters <F304: Dynamic braking, OLr trip>, <F308: Braking resistance>, and <F309: Braking resistor capacity> if necessary.	Frame size A1, A2, A3, A4, A5, and A7
[BU+] [BU-]	Inside the inverter. Connected to a braking unit (optional). Braking resistor (optional) is connected to a braking unit terminals [PA] and [PB].	Frame size A8
[PA/+] [PC/-]	A DC power can be input. For models of VFAS3-2110P to 2550P and VFAS3-4220PC to 4280KPC, a rush current suppression circuit (optional) is required. Connected to a braking unit (Optional) for frame size A6. Supply AC power supply to cooling fans if you use VFAS3-4160KPC - 4280KPC with DC input.	All frame sizes
[PA/+] [P0]	Be sure to connect the attached DC reactor.	Frame sizes A7 and A8
[R0] [S0] [T0]	Supply AC power supply for cooling fans if you use VFAS3-4160KPC - 4280KPC with DC input.	Frame sizes A7 and A8

Memo

- The arrangement of the terminals varies depending on the type. See the figures on the next page and after.

■ Recommended tightening torque of power terminal screws

Power terminal torque and wire strip length

Screw size	Frame size	Torque		Strip length (mm)	Cable size
		(N・m)	(lb・in)		
M4	A1	1.3	11.5	10	-
	A2	1.5	13.3	10	-
M5	A3	2.6	23	18	-
M8	A4	5.0	44.3	28	AWG2 or smaller
		10	88.5	28	AWG1 or bigger
M10	A6	27	239	-	-
M12	A5	10	88.5	35	AWG1/0 or smaller
		18	159	35	AWG2/0 or bigger
M12	A7/A8	41	360	-	-
M10	A7	24	212	-	-
M4	A7/A8	1.4	12.4	-	-

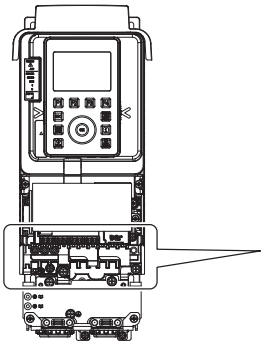
Grounding terminal torque

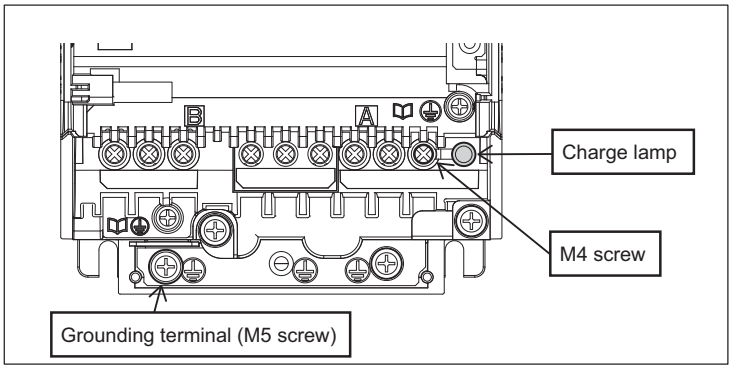
Screw size	Frame size	Torque		Strip length (mm)	Cable size
		(N・m)	(lb・in)		
M5	A1,A2,A3	2.6	23	-	-
M6	A4	4.4	38.9	-	-
M8	A4	5.0	44.3	28	AWG2 or smaller
		10	88.5	28	AWG1 or bigger
M8	A5,A6	11.8	104	-	-
M10	A6	27	239	-	-
M12	A5	10	88.5	35	AWG1/0 or smaller
		18	159	35	AWG2/0 or bigger
M12	A7/A8	41	360	-	-
M10	A7	24	212	-	-

Note) 1(N・m) = 8.850(lb・in)

■ **Arrangement of power terminals**

1) Frame size A1
VFAS3-2004P to 2022P, VFAS3-4004PC to 4037PC



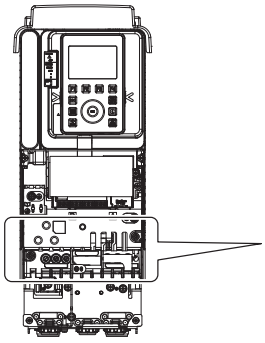


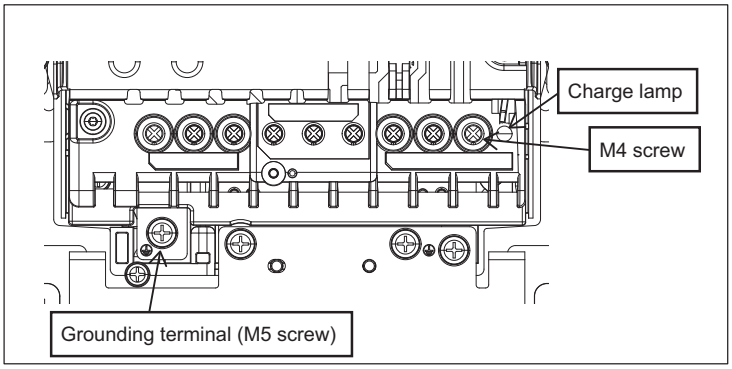
⚠ CAUTION

Mandatory action

- Following type of screwdriver should be used for M4 screw;
  PH2 (phillips, bit type2), shaft diameter 5.0 mm or less.

2) Frame size A2
VFAS3-2037P,VFAS3-4055PC, 4075PC



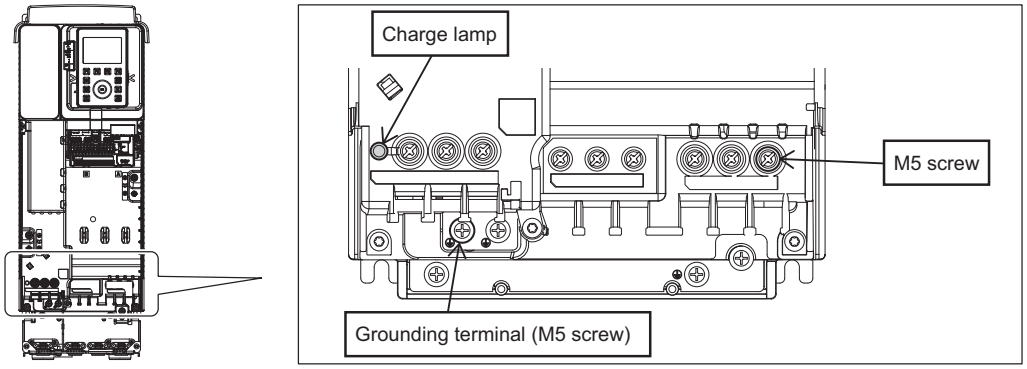


⚠ CAUTION

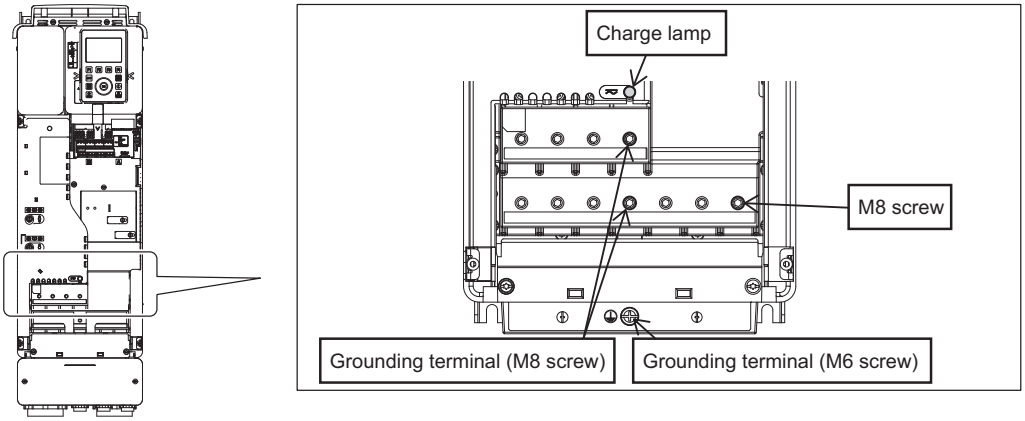
Mandatory action

- Following type of screwdriver should be used for M4 screw;
  PH2 (phillips, bit type2), shaft diameter 5.8 mm or less

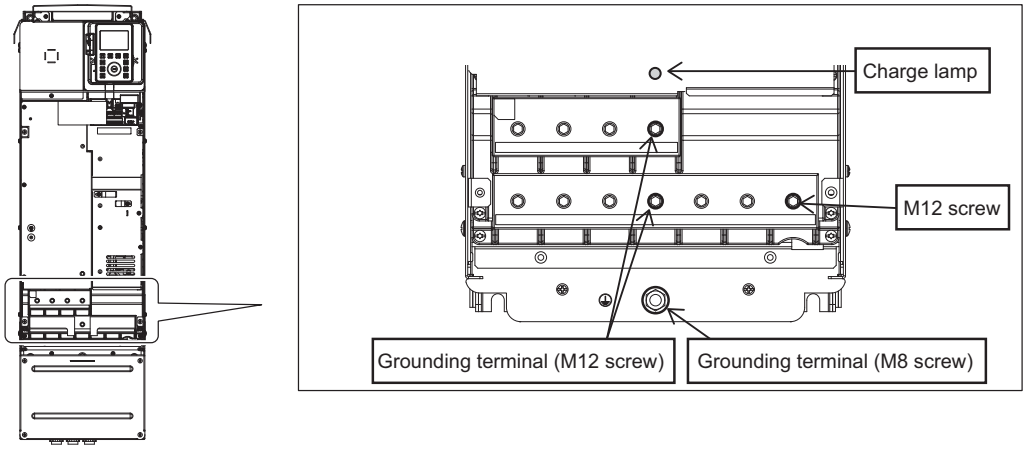
3) Frame size A3
VFAS3-2055P, 2075P, VFAS3-4110PC to 4185PC



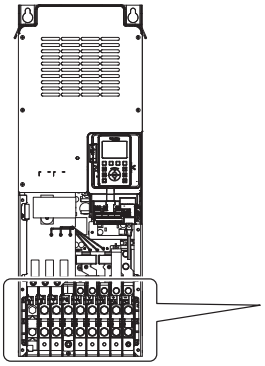
4) Frame size A4
VFAS3-2110P to 2185P, VFAS3-4220PC to 4370PC

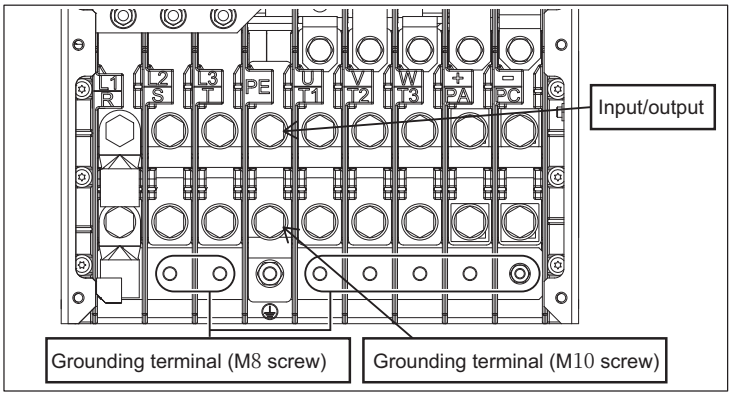


5) Frame size A5
VFAS3-2220P to 2370P, VFAS3-4450PC to 4750PC

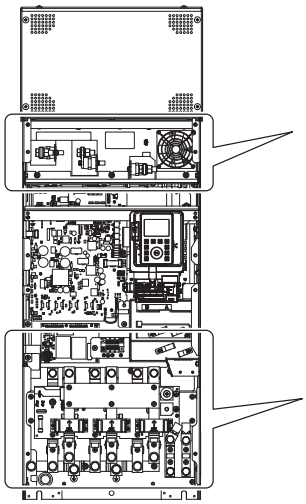


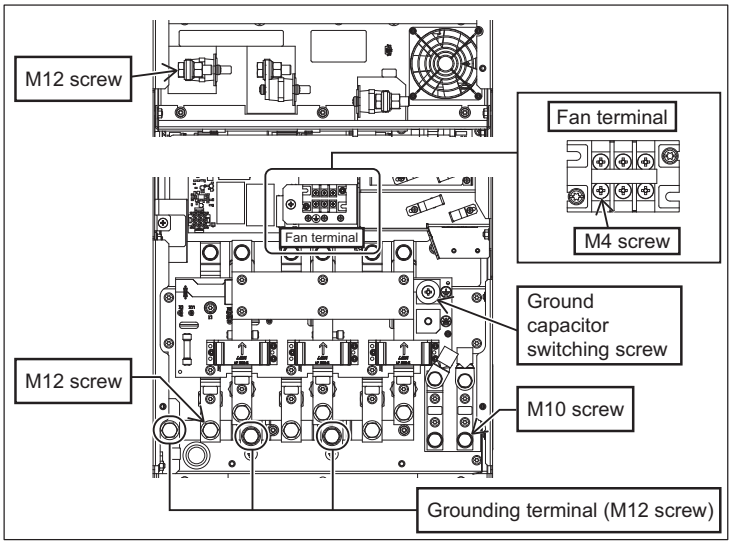
6) Frame size A6
VFAS3-2450P, 2550P, VFAS3-4900PC to 4132KPC



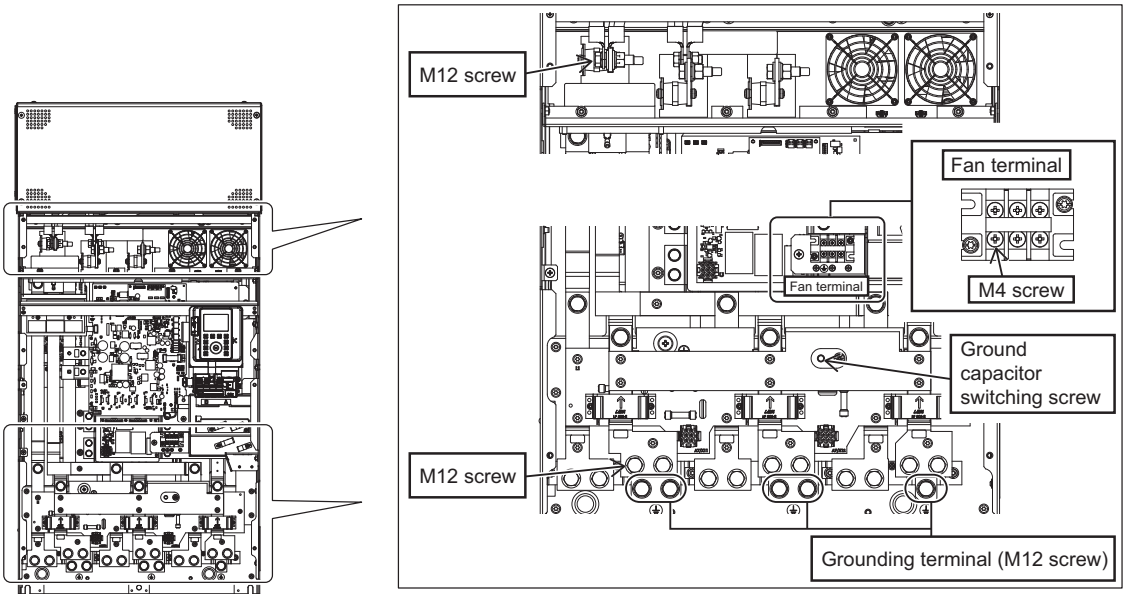


7) Frame size A7
VFAS3-4160KPC





8) Frame size A8
VFAS3-4200KPC to 4280KPC



2. 3. 4 Switching of grounding capacitor

⚠ WARNING

Prohibited

- When using this 480V class inverter with a power supply system that is grounded in other than the neutral point (e.g. when the power supply has delta connection with single phase grounding), the grounding capacitor should not be grounded (or the capacity of the grounding capacitor should not be increased).
  Otherwise, it will result in failure or fire.

This inverter has a built-in noise filter (EMC noise filter for 480V class) and the inverter input power supply is grounded via the capacitor. By switching this grounding capacitor, the leakage current from the inverter can be reduced.
It is switched by changing the position of the exclusive switching screw(s) that varies depending on the type. For some types, the grounding capacitor is completely disconnected (frame size A1 to A5). For others, the capacitor capacity is reduced (frame size A6 to A8).
For the details of the influence of the leakage current and measures, refer to [2. 4. 3].

Important

- Note that when the grounding capacitor is reduced or not grounded, the inverter unit no longer comply with the EMC directive.
- Be sure to switch with the power off.
- For models with two switching screws, be sure to set both screws to the same side.

Switch the grounding capacitor in the following procedure given for each type. At the time of shipping, the grounding capacitor is grounded or its capacity is small.

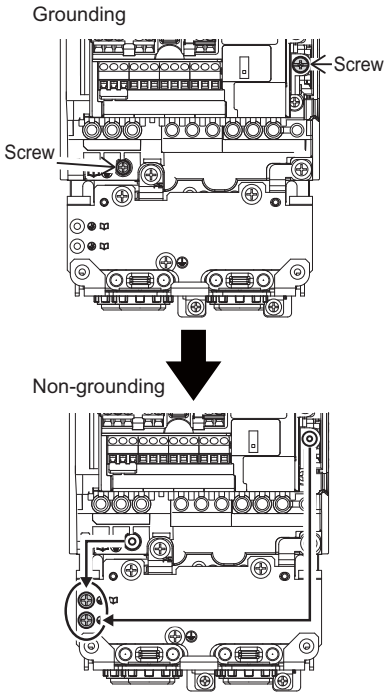
■ **With frame size A1**
VFAS3-2004P to 2022P, VFAS3-4004PC to 4037PC

1 Remove the front cover.
For how to remove, refer to [2. 2. 1].

2 Remove two screws for switching of grounding capacitor.
The grounding capacitor is disconnected.
Mount the removed screws to the positions shown in the figure on the right and tighten them.

3 To recover the shipping state, mount the two screws for switching of grounding capacitor and tighten them.
The grounding capacitor is connected and grounded.

4 After switching, mount the front cover.
For how to mount, refer to [2. 2. 1].



Important

• For models with two switching screws, be sure to set both screws to the same side.

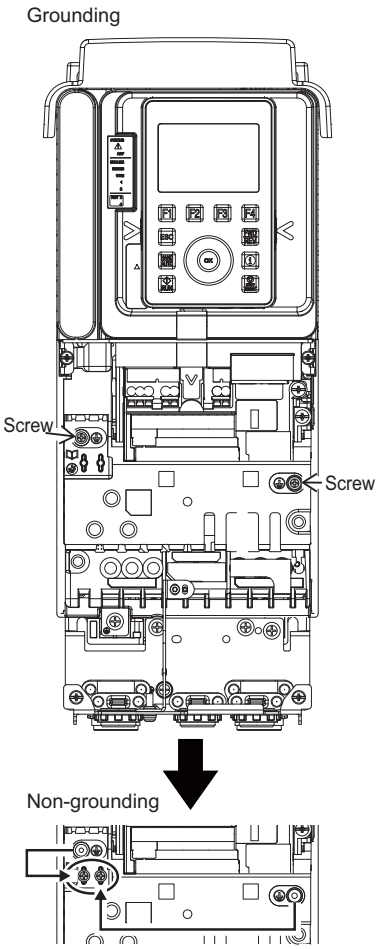
■ **With frame size A2**
VFAS3-2037P, VFAS3-4055PC, 4075PC

1 Remove the front cover.
For how to remove, refer to [2. 2. 1].

2 Remove two screws for switching of grounding capacitor.
The grounding capacitor is disconnected.
Insert the removed screws to the positions shown in the figure on the right.

3 To recover the shipping state, mount the two screws for switching of grounding capacitor and tighten them.
The grounding capacitor is connected and grounded.

4 After switching, mount the front cover.
For how to mount, refer to [2. 2. 1].



Important

• For models with two switching screws, be sure to set both screws to the same side.

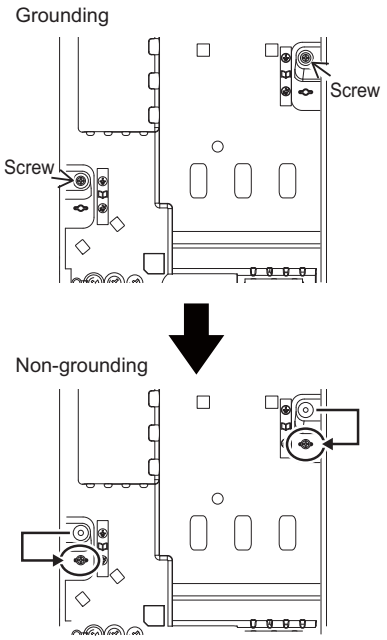
■ **With frame size A3**
VFAS3-2055P, 2075P, VFAS3-4110PC to 4185PC

1 Remove the front cover.
For how to remove, refer to [2. 2. 1].

2 Remove two screws for switching of grounding capacitor.
The grounding capacitor is disconnected.
Insert the removed screws to the positions shown in the figure on the right.

3 To recover the shipping state, mount the two screws for switching of grounding capacitor and tighten them.
The grounding capacitor is connected and grounded.

4 After switching, mount the front cover.
For how to mount, refer to [2. 2. 1].



Important

- For models with two switching screws, be sure to set both screws to the same side.

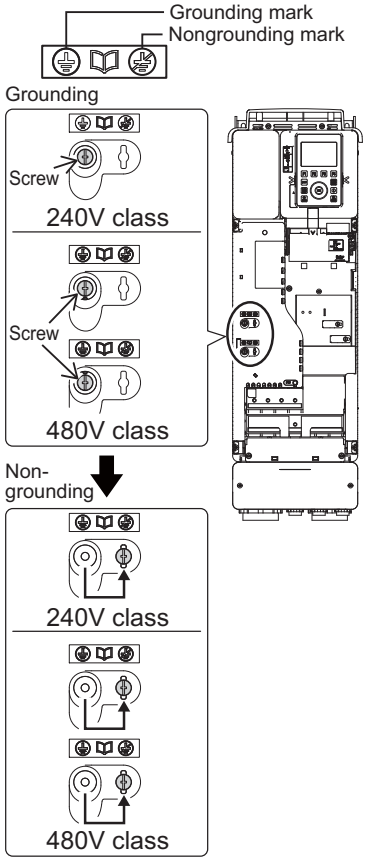
■ **With frame size A4**
VFAS3-2110P to 2185P, VFAS3-4220PC to 4370PC

1 Remove the front cover.
For how to remove, refer to [2. 2. 2].

2 Remove the screw(s) for switching of grounding capacitor from the position of the grounding mark and insert it/them into the position of the non-grounding mark.
The 240 V class has one screw.
The 480 V class has two screws. Remove both of two screws.
The grounding capacitor is disconnected.

3 To recover the shipping state, remove the screw(s) for switching of grounding capacitor and tighten it/them to the screw hole in the position of the grounding mark.
The grounding capacitor is connected and grounded.

4 After switching, mount the front cover.
For how to mount, refer to [2. 2. 2].



Important

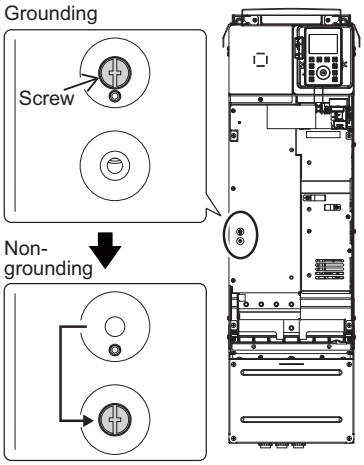
• For models with two switching screws, be sure to set both screws to the same side.

■ **With frame size A5**
VFAS3-2220P to 2370P, VFAS3-4450PC to 4750PC

1 Remove the front cover.
For how to remove, refer to [2. 2. 3].

2 Remove the screw for switching of grounding capacitor from the position of the grounding mark and tighten it to the position of the non-grounding mark.
The grounding capacitor is disconnected.

3 To recover the shipping state, remove the screw(s) for switching of grounding capacitor and tighten it/them to the screw hole in the position of the grounding mark.
The grounding capacitor is connected and grounded.



4 After switching, mount the front cover.
For how to mount, refer to [2. 2. 3].

For frame size A6, A7 and A8, grounding capacitor is set to small (non-grounding mark side). To comply with EMC directive, switch the capacitance into large (grounding mark side) according to the procedure below.

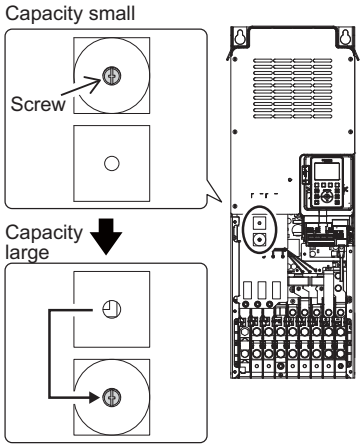
■ **With frame size A6**
VFAS3-2450P, 2550P, VFAS3-4900PC to 4132KPC

Gounding capacitor is set to small (non-grounding mark side). To comply with EMC directive, switch the capacitance into large (grounding mark side) according to the procedure below.

1 Remove the front cover and the transparent cover inside (transparent resin).
For how to remove, refer to [2. 2. 4].

2 Remove the screw for switching of grounding capacitor from the position of the non-grounding mark and tighten it to the position of the grounding mark.
The grounding capacitor's capacity is increased.

3 To recover the shipping state, remove the screw(s) for switching of grounding capacitor and tighten it to the screw hole in the position of the non-grounding mark.
The grounding capacitor's capacity is recovered.



4 After switching, mount the transparent cover and the front cover in this order.
For how to mount, refer to [2. 2. 4].

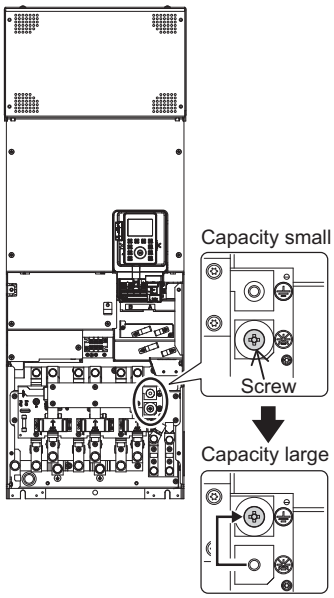
■ **With frame size A7**
VFAS3-4160KPC

1 Remove the front cover and the transparent cover inside (transparent resin).
For how to remove, refer to [2. 2. 5].

2 Remove the screw for switching of grounding capacitor from the position of the grounding mark and tighten it to the position of the grounding mark.
The grounding capacitor's capacity is increased.

3 To recover the shipping state, remove the screw(s) for switching of grounding capacitor and tighten it/them to the screw hole in the position of the non-grounding mark.
The grounding capacitor's capacity is reduced.

4 After switching, mount the transparent cover and the front cover in this order.
For how to mount, refer to [2. 2. 5].



2

⚠ CAUTION

Prohibited

- In case of one phase grounding system (A three-phase supply power is connected in delta), do not change the connection of grounding capacitor before factory setting. If connection changed (this means the capacitance is increased), the capacitor may become damaged.

Note) If a neutral grounding system is used, changing the connection of the grounding capacitor as shown in the figure at the top (changing the capacitance from Small to Large) makes the inverter compliant with the EMC directive.

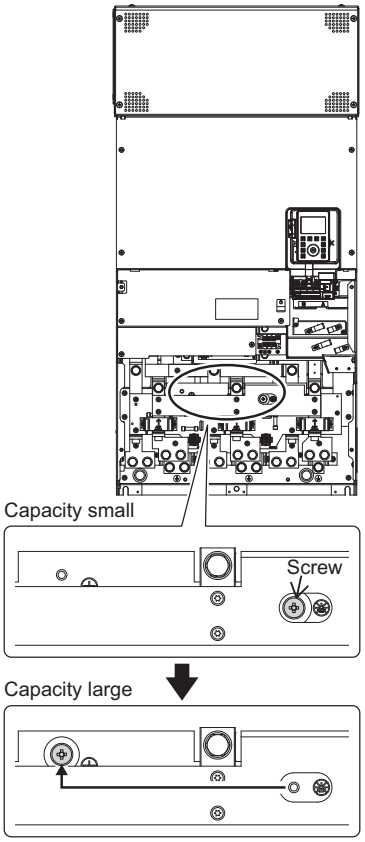
■ **With frame size A8**
VFAS3-4200KPC to 4280KPC

1 Remove the front cover and the transparent cover inside (transparent resin).
For how to remove, refer to [2. 2. 5].

2 Remove the screw for switching of grounding capacitor from the position of the grounding mark and tighten it to the position of the grounding mark.
The grounding capacitor's capacity is increased.

3 To recover the shipping state, remove the screw(s) for switching of grounding capacitor and tighten it/them to the screw hole in the position of the non-grounding mark.
The grounding capacitor's capacity is reduced.

4 After switching, mount the transparent cover and the front cover in this order.
For how to mount, refer to [2. 2. 5].



⚠ CAUTION

Prohibited

- In case of one phase grounding system (A three-phase supply power is connected in delta), do not change the connection of grounding capacitor before factory setting. If connection changed (this means the capacitance is increased), the capacitor may become damaged.

Note) If a neutral grounding system is used, changing the connection of the grounding capacitor as shown in the figure at the top (changing the capacitance from Small to Large) makes the inverter compliant with the EMC directive.

2. 3. 5 Control terminals

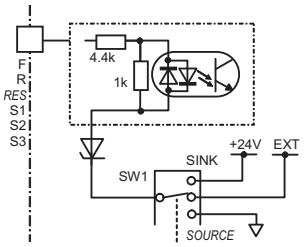
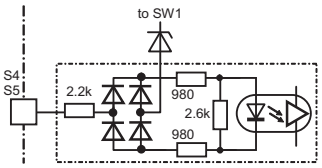
The control terminals are connected to external control equipment to control operation of the inverter and motor and monitor the state externally.

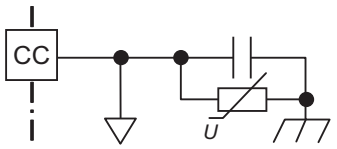
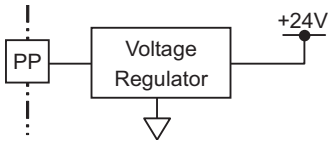
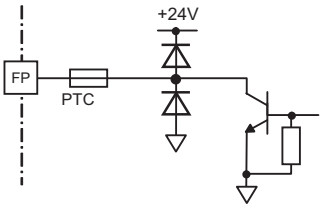
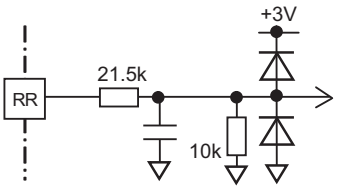
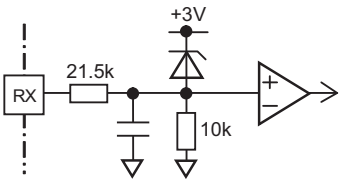
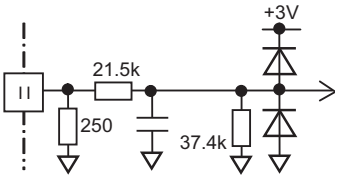
■ Functions of control terminals

The control terminal block is common to all the models.

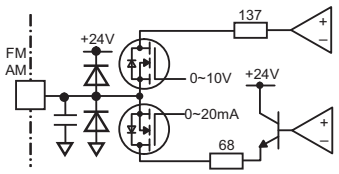
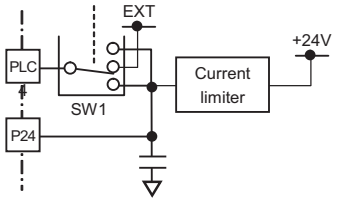
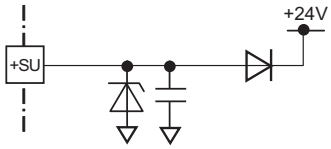


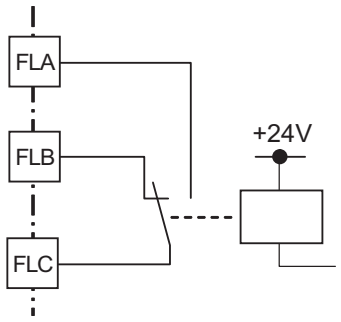
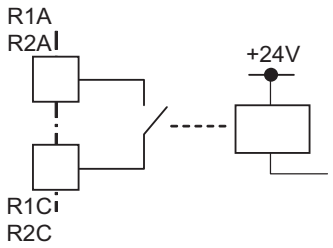
2

Terminal symbol	Input/ output	Function	Electrical specifications	Internal circuit
F	Input	Multifunction programmable digital input. In the default setting, forward run is performed with ON and deceleration stop with OFF.	Digital input. • 24 Vdc-5 mA or less Compliant with IEC61131-2 logic type 1 • Sink logic: ON < 10 V, 16 V < OFF • Source logic: OFF < 5 V, 11 V < ON Sink logic and source logic can be switched with the slide switch [SW1]	
R	Input	Multifunction programmable digital input. In the default setting, reverse run is performed with ON and deceleration stop with OFF.		
RES	Input	Multifunction programmable digital input. In the default setting, this inverter protective function is reset by ON→OFF. It has no effect when the inverter is in a normal condition.		
S1	Input	Multifunction programmable digital input. In the default setting, preset speed operation is performed with ON		
S2	Input	Multifunction programmable digital input. In the default setting, preset speed operation is performed with ON		
S3	Input	Multifunction programmable digital input. In the default setting, preset speed operation is performed with ON		
S4	Input	Multifunction programmable digital input. In the default setting, preset speed operation is performed with ON With <F146: Terminal S4 input select>, digital input, pulse train input, and PG input can be switched.	Digital input. • 24 Vdc-5 mA or less Compliant with IEC61131-2 logic type 1 • Sink logic: ON < 10 V, 16 V < OFF • Source logic: OFF < 5 V, 11 V <ON Sink logic and source logic can be switched with the slide switch [SW1] Pulse train input • Up to 30 kpps (duty 50%)	
S5	Input	Multifunction programmable digital input. In the default setting, preset speed operation is performed with ON. With <F147: Terminal S5 input select>, digital input, pulse train input, and PG input can be switched.		

Terminal symbol	Input/ output	Function	Electrical specifications	Internal circuit
CC	Common to input/ output	An equipotential terminal of the control circuit. It is allocated in three positions.	-	
PP	Output	Voltage reference output for potentiometer.	10 Vdc (allowable load current: 10 mAdc)	
FP	Output	Multifunction programmable digital/pulse train output. With <F669: Terminal FP switching>, digital output and pulse train output can be switched.	Digital output • 24 Vdc-50 mA Pulse train output • Up to 30 kpps (duty 50%)	
RR	Input	Analog input with 0 - 10 Vdc. It can be switched to PTC input, etc. with <F108: Terminal RR input select>.	0 - 10 Vdc (Input impedance: 31.5 kΩ)	
RX	Input	Analog input with -10 to +10 Vdc. With <F107: Terminal RX input voltage select>, it can be swtiched to 0 - 10 Vdc.	-10 to +10 Vdc (Input impedance: 31.5 kΩ)	
II	Input	Analog current input with 0 - 20 mAdc. The current can be changed to 4 - 20 mA, etc. with setting of the parameter.	0 - 20 mAdc (Input impedance: 250 Ω)	

2

Terminal symbol	Input/ output	Function	Electrical specifications	Internal circuit
FM	Output	Multifunction programmable analog output. 0 - 10 Vdc output with default setting. With <F681: Terminal FM switching>, meter option (0 - 1 mA), current (0 - 20 mA) output, and voltage (0 - 10 V) output can be switched.	0 - 10 Vdc (allowable load resistance: 1 kΩ or more) 4 - 20 mAdc (0 - 20 mAdc) (allowable load resistance: 500 Ω or less)	
AM	Output	Multifunction programmable analog output. 0 - 20 mAdc output with default setting. With <F686: Terminal AM switching>, meter option (0 - 1 mA), current (0 - 20 mA) output, and voltage (0 - 10 V) output can be switched.		
PLC	Output	When the slide switch [SW1] is set to the sink side or source side, it can be used as 24 Vdc power output.	24 Vdc-200 mA (200 mA in total with P24) Compliant with IEC61131-2	
	Input	When the slide switch [SW1] is set to the PLC side, it can be used as a common terminal for digital input terminal.	-	
P24	Output	24 Vdc power output.	24 Vdc-200 mA (200 mA in total with PLC) Compliant with IEC61131-2	
+SU	Input	DC power input to operate the control circuit. Connect a control power supply option or 24 Vdc power supply between [+SU] and [CC].	24 Vdc- current 1A or more	
STOA	Input	STO function that complies with the safety standard IEC61800-5-2 (this is different function from programmable digital input). Function is deactivated by shorting the terminals [STOA]-[STOB]-[PLC] with a bridge at factory. STOA and STOB should be set in same level. (both HIGH, or both LOW) When STOA/STOB are OFF during motor is running, motor becomes coast stop. Under this condition, even if STOA/STOB are ON, motor is not running unless run command is once OFF and On again. For details, refer to Safety function manual (E6582067).	Compliant with IEC61131-2 logic type 1 • Activate < 5 V, 11 V < Deactivate Refer to Safety Function Manual.	
STOB	Input			

Terminal symbol	Input/ output	Function	Electrical specifications	Internal circuit
FLA	Output	Multifunction programmable relay contact output. Operation of the protection function of the inverter is detected in the default setting. The contact across [FLA]-[FLC] is closed and [FLB]-[FLC] is opened during protection function operation.	Maximum contact capacity • 250 Vac-2 A (cosφ=1) • 30 Vdc-2 A (at resistive load) • 250 Vac-1 A (cosφ=0.4) • 30 Vdc-1A (L/R=7 ms) Minimum contact capacity • 24 Vdc-5 mA Life • 100000 times	
FLB				
FLC				
R1A	Output	Multifunction programmable relay contact output. A low-speed signal is output in the default setting.		
R1C				
R2A	Output	Multifunction programmable relay contact output. It is not assigned in the default setting. The function can be set with <F134: Terminal R2 function >.		
R2C				

2

Important

- With relay contact output, chattering (momentary ON/OFF of contact) is generated by external factors of the vibration and the impact, etc. In particular, please set a filter of 10 ms or more, or timer for measures when connecting it directly to the input unit of the programmable controller.

Reference

- To change the function of the terminals [F], [R], [RES], and [S1] - [S5] → Refer to [6. 3. 2]
- To change the function of the terminals [FP], [FL], [R1], and [R2] → Refer to [6. 3. 3]
- To change the function of the terminals [RR] and [RX] → Refer to [6. 2]
- To change the function of the terminals [FM] and [AM] → Refer to [5. 2. 6], [6. 33. 3]

■ Recommended tightening torque of control terminal screws

Control terminal torque and wire strip length

	Screw size	Torque		Strip length (mm)	Screwdriver size	
		(N・m)	(lb・in)		Width (mm)	Thickness
Relay	M3	0.5	4.4	11	3.5	0.5
Except Relay (2nd)	M3	0.5	4.4	6 or 7	3.5	0.5
Except Relay (1st)	M3	0.5	4.4	6	3.5	0.5

Wire size

	Conductor	Using one wire		Using two wires		Using two wires with twin ferule	
		(mm^2)	AWG	(mm^2)	AWG	(mm^2)	AWG
Relay	Solid wire	0.14-2.5	26-14	2x0.14 to 2x0.75	26-18	-	-
	Stranded wire	0.14-2.5	26-14	2x0.14 to 2x0.75	26-18	2x0.5 to 2x1.5	20-16
Except Relay (2nd)	Solid wire	0.14-2.5	26-14	2x0.14 to 2x1.0	26-18	-	-
	Stranded wire	0.14-1.5	26-16	2x0.14 to 2x0.75	26-18	2x0.5 to 2x1.0	20-18
Except Relay (1st)	Solid wire	0.14-1.5	26-16	2x0.14 to 2x0.75	26-18	-	-
	Stranded wire	0.14-1.5	26-16	2x0.14 to 2x0.75	26-18	2x0.5 to 2x1.0	20-18

2

■ Switching of slide switch of control terminal block

With the slide switch [SW1] of the control terminal block, the setting of sink logic, source logic and external power supply sink logic of the digital input terminals [F], [R], [RES], and [S1] - [S5] is switched.

For details of sink/source logic, refer to the following "■Sink logic and source logic."

- The slide switch [SW1] is set to the PLC side in the default setting. This is the setting when the inverter external power supply is used
- To use as sink logic, set the slide switch [SW1] to the SINK side.
- To use as source logic, set the slide switch [SW1] to the SOURCE side.

Important

- Switch the logic before turning on the power supply.
- After confirming that the sink/source setting is correct, turn on the power supply.

■ Sink logic and source logic

In Japan and the U.S., current flowing out turns digital input terminals on. This is called sink logic. The method generally used in Europe is source logic in which current flowing into digital input terminals turns them on.

Each digital input terminal is supplied with electricity from either the inverter's internal power supply or an external power supply, and its connections vary depending on the power supply used.

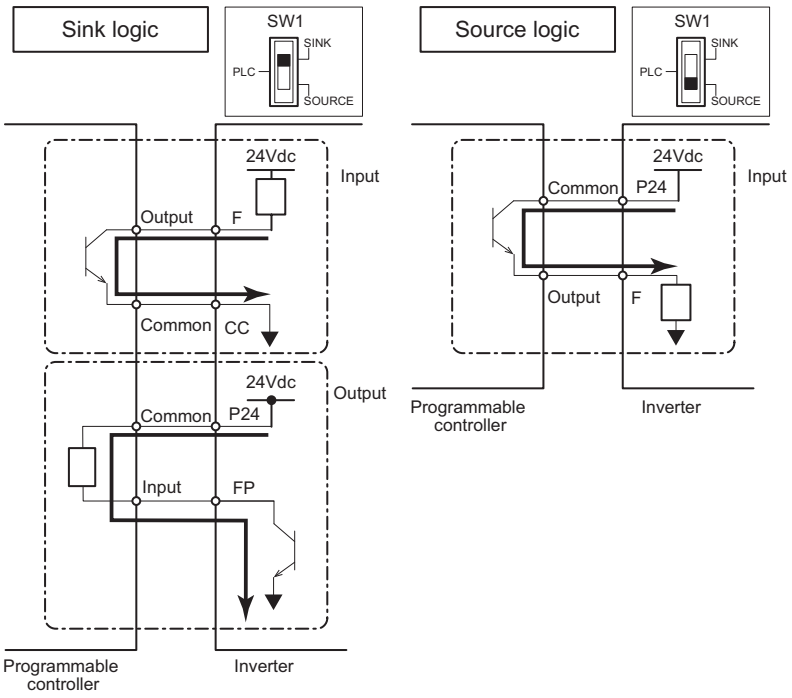
Memo

- Sink logic is sometimes referred to as negative logic, and source logic is referred to as positive logic.

1) When the inverter internal power supply is used

When the internal power supply of the inverter is used to supply electricity to digital input terminals, the connection is as shown in the diagram below.

Sink/source logic is set by the slide switch [SW1]. Refer to "■Switching of slide switch of control terminal block."

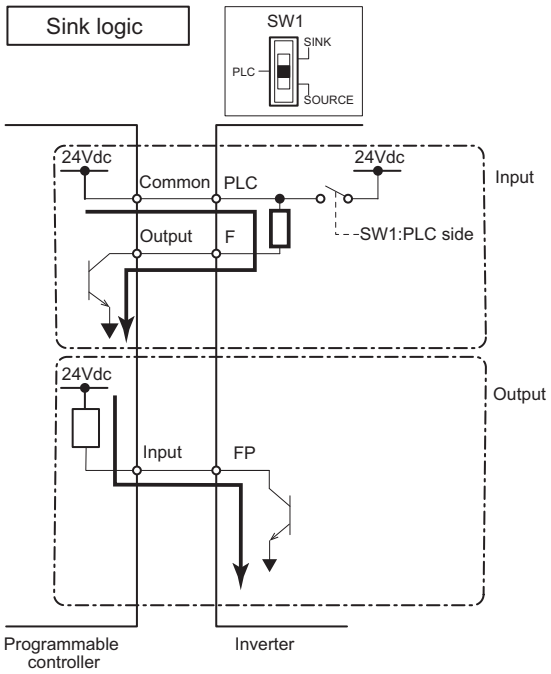


2) When an external power supply is used

The terminal [PLC] is used to connect to an external power supply or to separate a terminal from other input or output terminals.

Sink/source logic is set by the slide switch [SW1].

Refer to "■Switching of slide switch of control terminal block."



2. 3. 6 RS485 communication connectors

This inverter is equipped with two RS485 communication ports.
To use RS485, refer to "RS485 Communication Function Instruction Manual" (E6582143).

Important	• Connection of Ethernet to the RS485 communication connectors will result in a failure.

2. 3. 7 Ethernet connectors

This inverter is equipped with two Ethernet ports.
To use Ethernet, refer to "Ethernet Function Instruction Manual" (E6582125).

Important	• Connection of RS485 communication connectors to Ethernet may result in a malfunction.

2. 3. 8 Mounting of DC reactor

⚠ Caution

Mandatory action

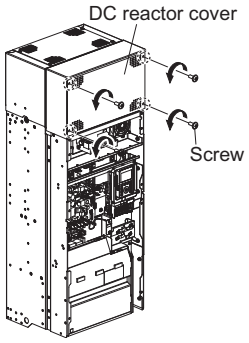
- Mount the attached DC reactor (DCL) for VFAS3-4160KPC ~ 4280KPC.
  If you do not mount the attached DC reactor (DCL), it will result in malfunction. Mount the DC reactor (DCL) between [PA/+] and [PO].

This inverter is equipped with a DC reactor (DCL) as standard, however, for VFAS3-4160KPC to 4280KPC, it is packaged together with the unit.
After installing the inverter, mount the DC reactor in the following procedure.

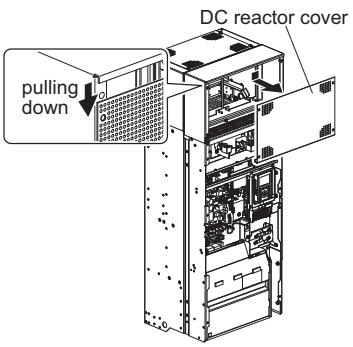
■ **With frame size A7**
VFAS3-4160KPC

1 Remove the front cover (upper) of the inverter unit in advance.
For how to remove, refer to [2. 2. 5].

2 Remove four screws of the DC reactor cover of the DC reactor.
Store the removed screws so as not to be lost.

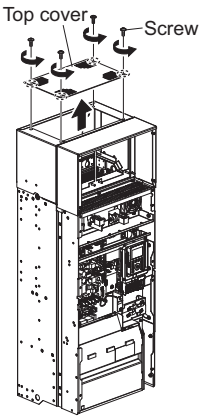


3 Remove the DC reactor cover from the DC reactor by pulling it down.
The upper side of the DC reactor cover is to be inserted.



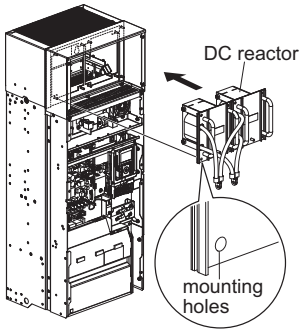
4 Remove four screws of the top cover (mesh) of the DC reactor.
Store the removed screws so as not to be lost.

5 Remove the top cover (mesh) from the DC reactor.

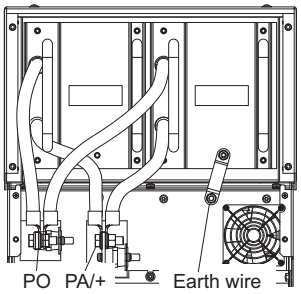


2

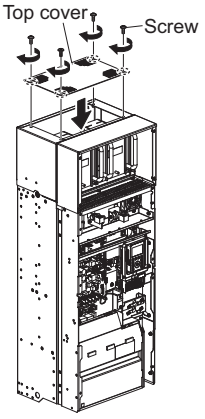
6 Check the positions of four mounting holes on the back side of the DC reactor and mount the DC reactor to the panel.



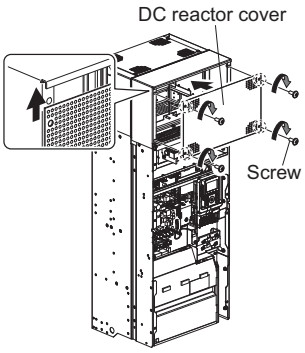
7 Wire the DC reactor and the terminals [PA/+] and [PO] of the power terminal block.
Connect two wires (with a crimp-style terminal) from each of two DC reactor units to [PA/+] and [PO].
Connect two flat braided wires for grounding to the grounding terminals respectively.



8 Mount the top cover (mesh) to the DC reactor and tighten four screws.



9 Mount the DC reactor cover to the DC reactor and tighten four screws according to necessity of other work.
After mounting the DC reactor to the inverter, mount the front cover (upper) before the DC reactor cover.

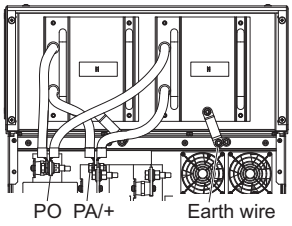


Memo

- After mounting the DC reactor to the inverter, if the DC reactor cover is mounted and fixed, the front cover (upper) cannot be mounted. Be sure to mount the front cover (upper) before the DC reactor cover.

■ With frame size A8 VFAS3-4200KPC to 4280KPC

Except for its wider unit, frame size A8 has the same enclosure and structure as frame size A7.
The mounting procedure of the DC reactor is the same as that of frame size A7, however, more wires are connected to the inverter unit.
An example of wiring is shown below.



2. 4 Cautions for application

This section introduces cautions for use of the motor and inverter, influence of leakage current on peripheral devices, and measures against it.

2. 4. 1 Motor

⚠ CAUTION

Mandatory action

- Use the inverter that conforms to specifications of the power supply and the three-phase motor to be operated.
  If you use the inappropriate inverter, not only will the three-phase motor not rotate correctly, but it will cause serious accidents such as overheating and burning out.

When this inverter and the motor are used in conjunction, pay attention to the following items.

■ Comparison with commercial power supply operation

This inverter employs the sinusoidal PWM control. However, the output voltage and output current are not perfect sine waves. They have a distorted wave that is close to sinusoidal waveform. This is why there will be a slight increase in motor temperature, noise and vibration, compared to operation with a commercial power supply.

■ Operation in low-speed range

When running continuously at low speed in conjunction with a general purpose motor, there may be a decline in that motor's cooling effect. If this happens, operate with the output lower than the ratedload.

To carry out low-speed operation continuously at the rated torque, use a constant torque motor. In this case, select "constant torque motor" of "4" -"7" in <OLM: Motor overload protection characteristic>.

For details, refer to [5. 2. 5].

■ Adjusting motor overload protection level

This inverter has a built-in electronic thermal for motor overload protection. The electronic thermal's reference current is set to the inverter's rated current in default setting, so adjust it in line with the rated current of the motor being used in combination before operation.

For how to set, refer to [5. 2. 5].

■ High speed operation over 60 Hz

Operating at frequencies over 60 Hz will increase noise and vibration. This may exceed the motor's mechanical strength limits and the bearing limits so you should inquire to the motor's manufacturer about such operation.

■ Lubricating mechanisms

Operating an oil-lubricated reduction gear and gear motor in the low-speed range will worsen the lubricating effect. Check with the manufacturer of the reduction gear to find out about operable gearing area.

■ Occurrence of instability (abnormal vibrations and overcurrent trips)

Unstable phenomena such as abnormal vibrations and overcurrent trips may occur depending on combinations of the inverter and motor, and load.

1) In the following cases, lower the settings of inverter carrier frequency.
   - Combined with a motor that is extremely below applicable motor ratings for the inverter
   - Combined with light load with a load factor of 5% or less
   - Combined with load whose inertial moment is very small
   - Combined with special motors

   For details, refer to [6. 14].

2) In the following case, set the S-pattern acceleration/deceleration function (refer to [6. 27. 1]). When vector control is selected, adjust the load moment of inertia ratio (refer to [6. 23. 1] or switch to V/f constant mode (refer to [5. 3. 4]).
   - Combined with couplings between load devices and motors with high backlash

3) When vector control is selected, adjust the load moment of inertia ratio (refer to [6. 23. 1] or switch to V/f constant control (refer to [5. 3. 4]) in the following case.
   - Combined with loads that have sharp fluctuations in rotation such as piston movements

■ Braking motor when turning off power supply

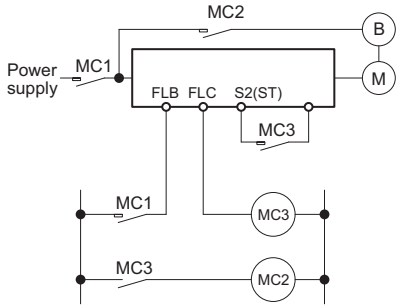
A motor with its power turn off goes into coasting state, and does not stop immediately.
To stop the motor quickly as soon as the power is turn off, install an auxiliary brake. There are different kinds of brake devices, both electrical and mechanical. Select the brake that is best for the system.

■ Load that produces regenerative torque

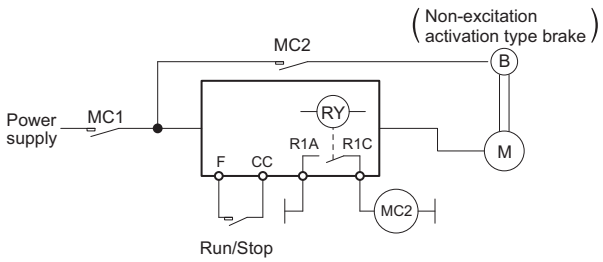
When combined with a load that produces regenerative torque, the overvoltage or overcurrent protection function may be activated to trip the inverter. Install a braking resistor to deal with it. For details of the braking resistor, refer to [10. 3. 2].

■ Motors with brake

When motors with a brake are directly connected to the inverter's output, the brake cannot be released at startup because of low voltage. Wire the brake circuit separately from the power circuit.



Circuit diagram 1



Circuit diagram 2

Circuit diagram 1 is an example in which the standby function is assigned to the terminal [S2]. This circuit can be applied to a machine that mainly operates horizontally. Set the terminal [S2] to "Open" to turn off output of the inverter and have the motor in coasting state. Then. operate the brake. If the brake is operated with inverter output, the inverter may trip due to bound current. Note that when it is applied to a machine with vertical movements, the motor may fall when it is in coasting state.
Circuit diagram 2 is an example in which low-speed signals are assigned to the terminals [R1A]-[R1C]. This circuit can be applied also to a machine with vertical movements. At the time of start, output is made from the inverter while the brake is operating. When the output frequency reaches <F100: Low-speed signal output frequency>, the brake is released by the signal output from the terminals [R1A]-[R1C]. When the machine stops, the inverter comes to deceleration stop. When the output frequency decreases under <F100>, the output signal from the terminals [R1A]-[R1C] becomes off and the brake operates.

■ Measures to protect motors against surge voltages

In a system in which a 480 V class inverter is used to control the operation of a motor, very high surge voltages may be produced depending on the wire length, wire routing and types of wires used. If such surge voltages are applied repeatedly for a long time, it may cause deterioration of insulation of motor coils.
Here are some examples of measures against surge voltages.

- Decrease <F300: Carrier frequency> of the inverter.
- Use a motor with high insulation strength.
- Insert an AC reactor or a motor-end surge voltage suppression filter between the inverter and the motor. Refer to [10. 3. 5].

2. 4. 2 Inverters

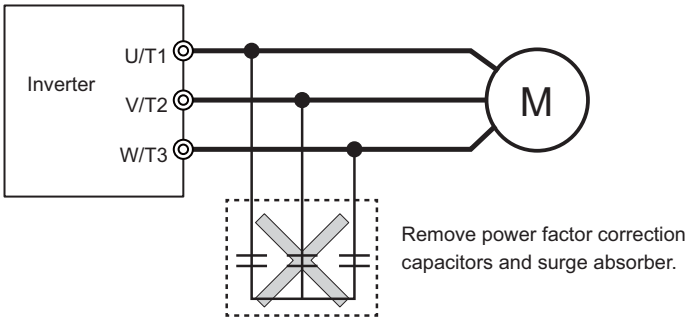
For the inverters to be used, pay attention to the following items.

■ Inverter capacity

Do not operate a motor whose capacity is larger than the inverter (e.g. a 45 kW motor with a 30 kW inverter), no matter how light the load is. Current ripple will raise the output peak current, making it easier to set off the overcurrent trip.

■ Power factor correction capacitor

Power factor correction capacitors cannot be installed on the output side of the inverter. To operate a motor with a power factor correction capacitor attached, remove the capacitor. Otherwise, it will cause an inverter malfunction and capacitor destruction.



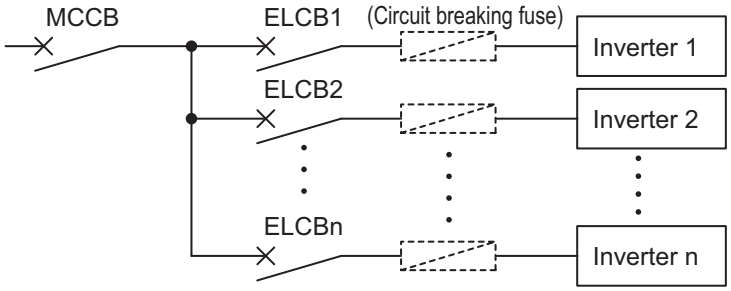
Power factor correction capacitor

■ Operating at other than rated voltage

Connections to voltages other than the rated voltage described in the rating label cannot be made. If a connection must be made to a power supply other than one with rated voltage, use a transformer to raise or lower the voltage to the rated voltage.

■ Selective circuit breaking when two or more inverters are used on the same power line

There is no fuse in the inverter's power circuit. Thus, as the diagram below shows, when more than one inverter is used on the same power line, you must select interrupting characteristics so that only ELCB (ELCB1 to ELCBn in the diagram) install in each inverter will trip and the common MCCB (MCCB in the diagram) will not trip when a short occurs in one inverter.
When you cannot select the proper characteristics, install a circuit interrupting fuse on the secondary side of ELCB1 to ELCBn.



Selective circuit breaking of inverters

* MCCB : Molded Case Circuit Breaker
* ELCB : Earth Leakage Circuit Breaker

■ If power supply distortion is not negligible

If the power supply distortion is not negligible because the inverter shares a power distribution line with other systems causing distorted waves, such as systems with thyristors or large-capacity inverters, install an input reactor to improve the input power factor, to reduce higher harmonics, or to suppress external surges.
For details, refer to [10. 3. 1].

■ Disposal

To dispose the inverter, refer to [Chapter 16].

2. 4. 3 What to do about leakage current

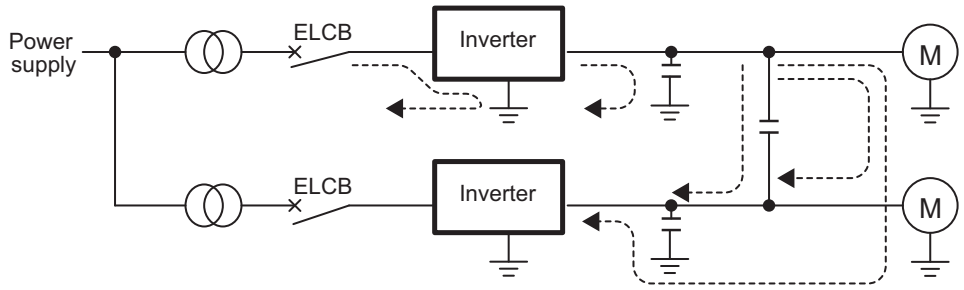
⚠ CAUTION	
Mandatory action	• Take countermeasures against leakage current. The leakage current through the stray capacitance of the input/output power wires of inverter and motor can affect peripheral devices. In that case, please take countermeasures such as reducing the carrier frequency or shortening the length of input/output power wires. When the total wire length (total length between an inverter and motors) is more than 100m, if the trip occurs with the motor no-load current, make enough space between phase wires or insert the filter (MSF: motor-end surge voltage suppression filter). • Pay attention to the cable length In case the total cable length (total of length between an inverter and motors) is 100 m or more, a trip can occur even with no-load current. Make enough space among each phase cable or install the filter (MSF) as countermeasure.

Measures should be taken for leakage current across ground and leakage current between wires because they may cause a malfunction of peripheral device.

■ Influence of leakage current across ground

Leakage current may flow not just through the inverter system but also through grounding wires to other systems. This leakage current will cause earth leakage circuit breakers (ELCB), leakage current relays, ground relays, fire alarms and sensors to operate improperly, and it will cause superimposed noise on the TV screen or display of incorrect current detection with the CT.

Leakage current path across ground



Here are some examples of measures against leakage current across ground.

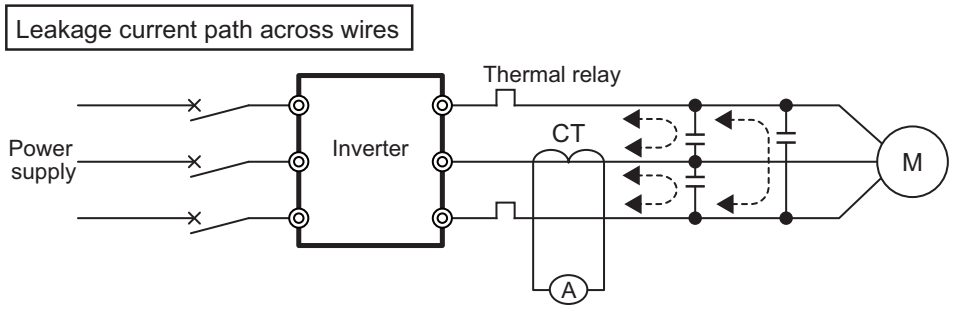
- When there is no radio-noise interference or similar problem, switch the grounding capacitor of the EMC noise filter to "disconnected" (size A1 to A5) or "small capacitance" (size A6 to A8).
  For how to switch the grounding capacitor, refer to [2. 3. 4].
- Decrease <F300: Carrier frequency>.
  When there is no concern against the magnetic noise from the motor, carrier frequency reduction is effective measure. For details, refer to [6. 14].
- Use high frequency remedial products for ELCBs.
- Zero-phase reactor
  It may be effective over the motor cable.

Built-in noise filter

The 480 V models of this inverter has a built-in EMC noise filter, so the leakage current value in the delta connection (single-phase grounding) power supply may become greater. For detail, refer to application manual "leakage current" (E6581181).

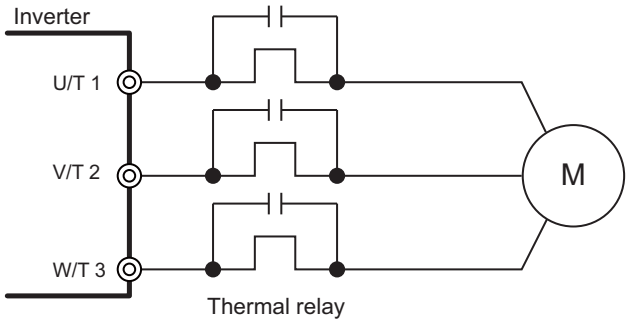
■ Influence of leakage current across lines (in case of thermal relays)

The high frequency component of current leaking into electrostatic capacity between inverter output wires will increase the effective current values and make externally connected thermal relays operate unnecessarily. When the wires are long (50 m or more) or in case of models with motors of low rated current (several A (ampere) or less), especially the 480 V class low capacity (4.0 kW or less, 5.5 kW or less with ND) models, it will be easy for the external thermal relay to activate unnecessarily, because the ratio of leakage current against the motor rating will increase.



Here are some examples of measures against leakage current across lines.

- Use the electronic thermal of the inverter.
  The setting of the electronic thermal is done with <tHrA: Motor overload protection current 1>. For details, refer to [5. 2. 5].
- Decrease <F300: Carrier frequency>.
  However, note that the motor magnetic noise is increased.
  For details, refer to [6. 14].
- Install 0.1 to 0.5μF - 1000 V film capacitor to the input/output terminals of each phase in the thermal relay.



■ Influence of leakage current across lines (in case of CT and ammeter)

If a CT and ammeter are connected externally to detect inverter output current, the leak current's high frequency component may destroy the ammeter. If the wires are long (50 m or more) or in case of models with motors of low rated current (several A (ampere) or less), especially the 480 V class low capacity (4.0 kW or less, 5.5 kW or less with ND) models, it will be easy for the high frequency component to pass through the externally connected CT and be superimposed on and burn the ammeter, because the ratio of leakage current against the motor's rated current will increase.

Here are some examples of measures against leakage current across lines.

- Connect the ammeter to the terminal [FM] and terminal [AM] of the inverter.
  For how to connect the meter and how to set parameters, refer to [5. 3. 6].
- Check the current value with the monitor function.
  For details, refer to [8. 1. 1].
- Set <F300: Carrier frequency> to 5 kHz or less.
  However, this may increase noise on the motor side.
  For details, refer to [6. 14].

3 [Basic operation] Operation panel and screen display

This chapter introduces the functions of the operation keys on the operation panel and screen display and explains how to operate them.

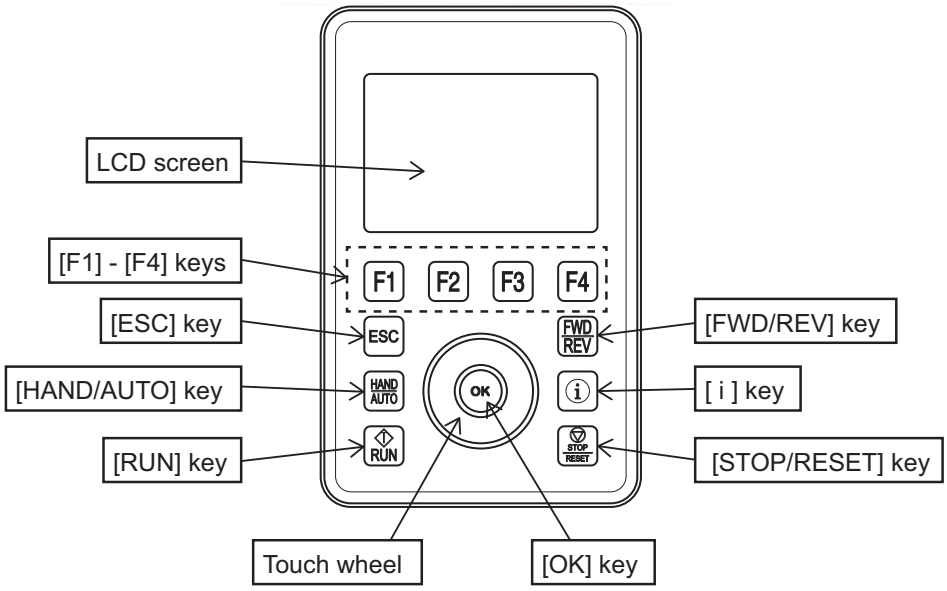
Memo

- The specifications and operation procedure of the operation panel are common to all the types of this inverter.

3. 1 Basic of operation panel

The operation panel allows you to set parameters and monitor the status. This section explains how to operate the operation panel and how to switch four types of display modes.

3. 1. 1 LCD screen and operation keys



• LCD screen

This screen displays [Standard mode], [Setting mode], [Monitor mode], and [Easy mode] according to the purpose. When an error occurs, an alarm, trip, etc. are displayed. For details, refer to [3. 1. 2].
Normally, the backlight color is white, but it turns red when a trip occurs. You can adjust the contrast and set screen settings such as automatic off time. For details, refer to [3. 1. 3].

• [F1] - [F4] keys

They are keys to execute functions displayed on the screen.
For details, refer to [■[F1] - [F4] keys] described later in this subsection.

• **[ESC] key**
This key switches the display mode.
It is also used to return to the previous item of the hierarchy of the screen.

• **[HAND/AUTO] key**
This key switches between hand (operation panel)/remote (remote control).
It is used to operate the inverter temporarily at hand (operation panel) while performing terminal operation (remote control) normally.
To enable this key, set the parameter <F750: EASY key function>.
For details, refer to [6. 37].

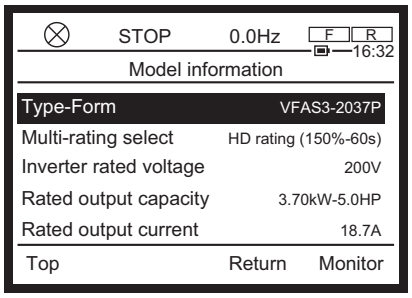
• **[RUN] key**
This key is used for a run command from the operation panel.
To enable this key, set "1" to the parameter <CMOd: Run command select>.
For details, refer to [5. 2. 1].

• **[FWD/REV] key**
This key switches between forward run and reverse run of the motor during panel run.
It is enabled when the parameter <CMOd: Run command select> is "1" and <Fr: Panel Fwd/Rev run select> is "2" or "3".
For details, refer to [5. 3. 9].

• **[i] key**
This key displays information.
When "Website (QR code)" is selected, the information is QR code. When "Model information" is selected, model information is displayed.
Necessary information is displayed when a trip occurs.
And you can see QR code for the parameter information when the parameter is selected or edited.

■ Model information

You can check the following model information.
- Type-Form
- Multi-rating select
- Inverter rated voltage
- Rated output capacity
- Rated output current
- CPU 1 version
- CPU 2 version
- Serial No.
- Region setting



■ Website (QR code)

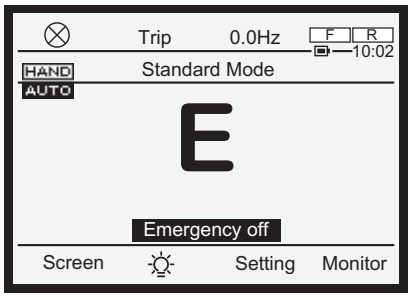
When you press the [i] key, information is displayed.
For example, you can access easily from your smartphone to our website by displaying the QR code.



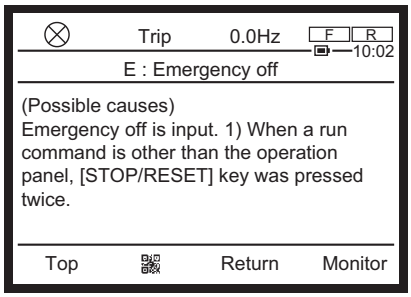
■ Trip information

You can check the trip information of possible causes and remedies. When you press the [F2] key, you can see QR code for troubleshooting.

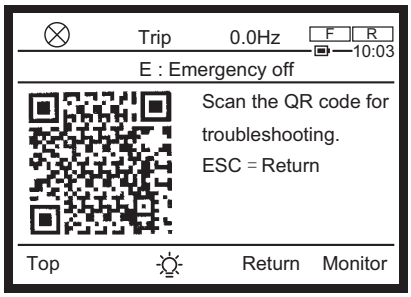
When a trip occurs, the trip title and trip name blink, and the backlight of the LCD screen turns red to inform you of a trip.



↓Press[i] key



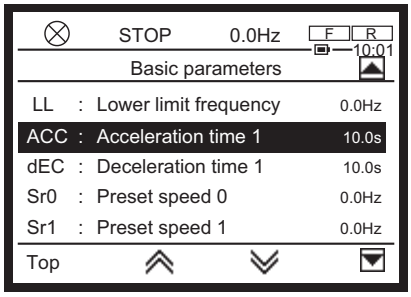
↓Press[F2] key



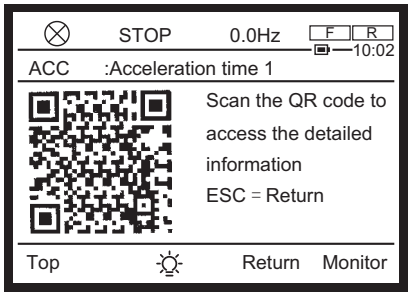
Note) If the camera cannot scan QR code because of the red screen, you can change the backlight color from red to white by pressing the [F2] key.

■ Parameter information

You can see QR code for the parameter when the parameter is selected or edited.



↓Press[i] key



• [STOP/RESET] key

This key is used for a stop command from the operation panel.
To enable the stop command by this key, set "1" to the parameter <CMOd: Run command select>.
For details, refer to [5. 2. 1].
Emergency off can be applied to the inverter except when it is operated by the operation panel. When you press this key, EOFF blinks. When you press it again, "E" is displayed and the emergency off is applied.
For details, refer to [3. 2. 3].
It is also used as a reset key when a trip occurs. The inverter can be reset by pressing this key twice in succession when a trip occurs.
For details, refer to [3. 2. 4].

• Touch wheel

Slide your finger in a circular motion to change the menu items and values on the screen.

Turning clockwise: To move to the next item or increase the value.

Turning counterclockwise: To move to the previous item or decrease the value.

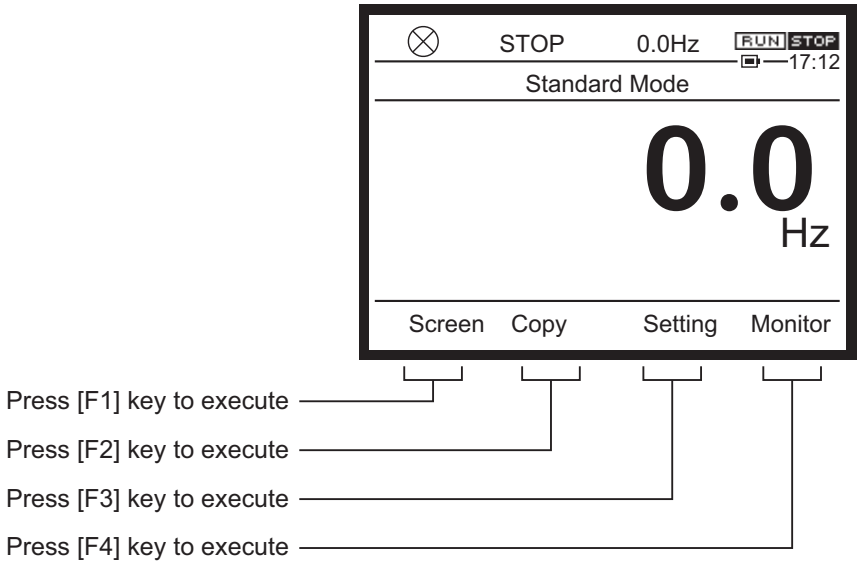
When you lightly touch the top or bottom of the circle, you can move to that direction by one item. For example, if you touch the top of the circle continuously, it works similarly to turning clockwise.

• [OK] key

This key is used to confirm the menu items and values on the screen.

■ [F1] - [F4] keys

The [F1] - [F4] keys are used to execute the items (text, symbol, icon, etc.) displayed on the lower side of the LCD screen.



The [F1] - [F4] keys corresponding to the screen display are as follows.

Key	Screen display		Function	Reference
	Displayed position	Display		
[F1]	Left end	Screen	Sets the LCD screen	[3. 1. 3]
		Top	Displays the screen for [Standard mode]	[3. 1. 2]
		A9-- to A8--	Displays parameters of previous hundreds (A900s to A800s)	[4. 2. 1]
		F9-- to F8--	Displays parameters of previous hundreds (F900s to F800s)	[4. 2. 1]
		C9-- to C8--	Displays parameters of previous hundreds (C900s to C800s)	[4. 2. 1]
		X1000	Sets the far left number	[4. 2. 3]
[F2]	Middle left	OK	Displays details monitor or Same as [OK] key	[3. 1. 4]
			Inverts the backlight color (white or red)	[3. 2. 2]
		Language	Displays the screen for language selection	[3. 1. 3]
		<	Move setting to left	[3. 1. 3] [4. 2. 1]
		^^	Page up (If there are more than six choices)	-
		Easy	Displays the screen for [Easy mode]	[3. 1. 2]
		Return	Same as [ESC] key (Return to the screen of [Setting mode])	-
		Change	Displays the setting screen of related parameters	[8. 1. 1]
		X100	Sets the number second from the left	[4. 2. 3]
		Copy	Copy function	[3. 1. 4]

Key	Screen display		Function	Reference
	Displayed position	Display		
[F3]	Middle right		Inverts the backlight color (white or red)	[3. 1. 3]
		>	Move setting to right	[3. 1. 3] [4. 2. 1]
		>>	Page down (If there are more than six choices)	-
		R (Back)	Searches backward	[4. 2. 1]
		Setting	Displays the screen for [Setting mode]	[3. 1. 2]
		Return	Same as [ESC] key (Return to the screen of [Monitor mode])	-
		X10	Sets the number third from the left	[4. 2. 3]
[F4]	Right end	Jog	The inverter performs jog run while the key is pressed	[6. 10]
		>	Move setting to right	[3. 1. 4]
		<	Move setting to left	[3. 1. 4]
		Monitor	Displays the secreen for [Monitor mode]	[3. 1. 2]
		F2-- to F1--	Displays parameters of next hundreds (F200s to F100s)	[4. 2. 1]
		C1-- to C0--	Displays parameters of next hundreds (C100s to C000s)	[4. 2. 1]
		OK	Displays details monitor	[8. 1. 1]
		F (Next)	Searches forward	[4. 2. 1]
		X1	Sets the far right number	[4. 2. 3]

3

3. 1. 2 Display mode

This inverter has four types of display modes.
The display modes can be switched in the following two ways.

- **Press the [ESC] key.**
- **Press any of the [F1] - [F4] keys to which the applicable display mode is assigned.**

(1) [Standard mode]

- This is the mode that is displayed first power on.
- The operation status (output frequency of the inverter, etc) is always displayed and alarms and trips when they occur.
  In the default setting, the output frequency is displayed. The display contents can be selected with <F710: Standard mode display>.
- Setting of the panel operation frequency, EASY key function operation, language selection, and screen setting are also made in [Standard mode].

(2) [Setting mode]

- Parameters are set in this mode.
- All the parameters are displayed.
- [Easy mode] is also available in which only the registered parameters are displayed.

(3) [Easy mode]

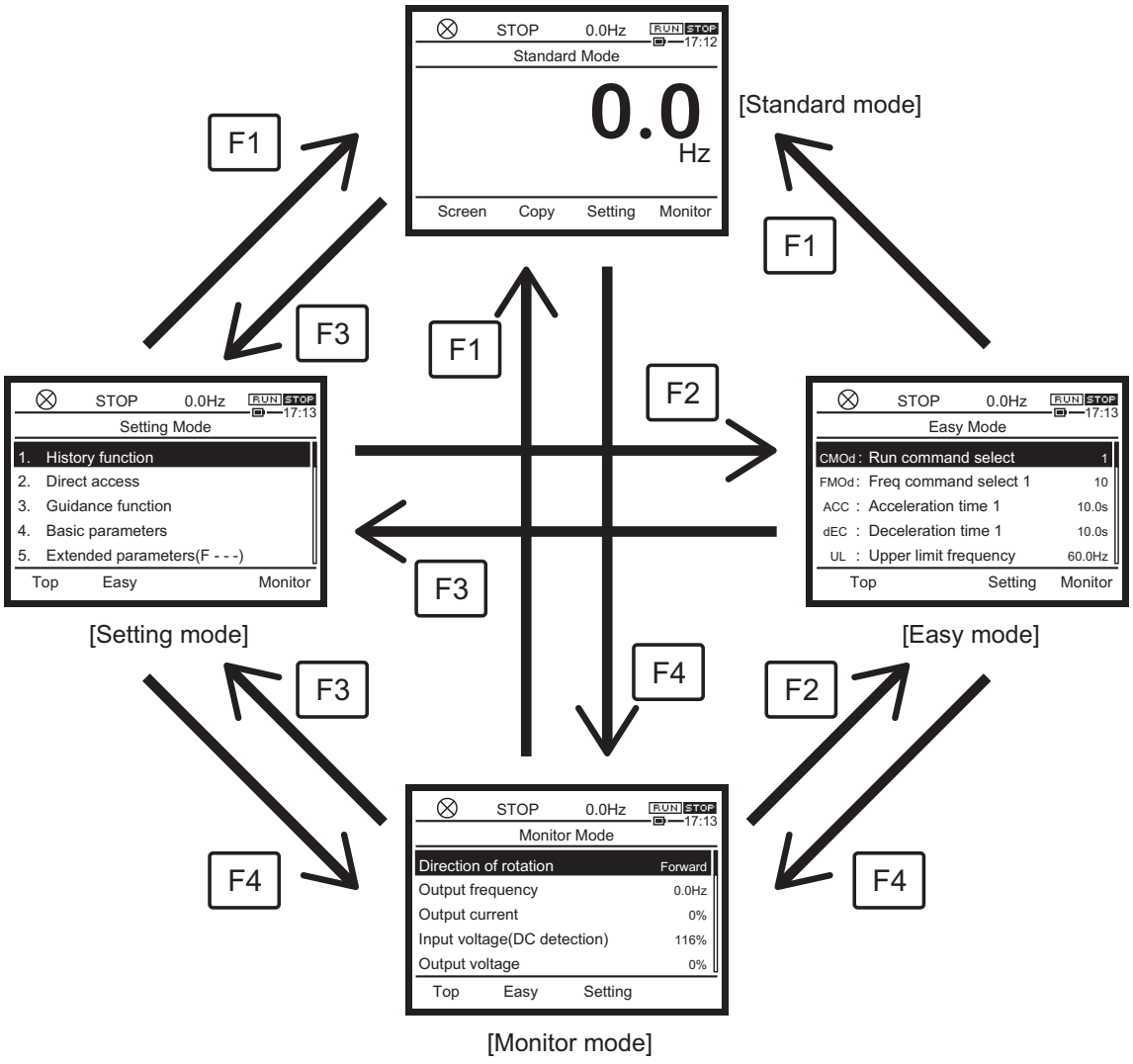
- Parameters are set in this mode.
- In this mode, only the registered parameters are displayed.

(4) [Monitor mode]

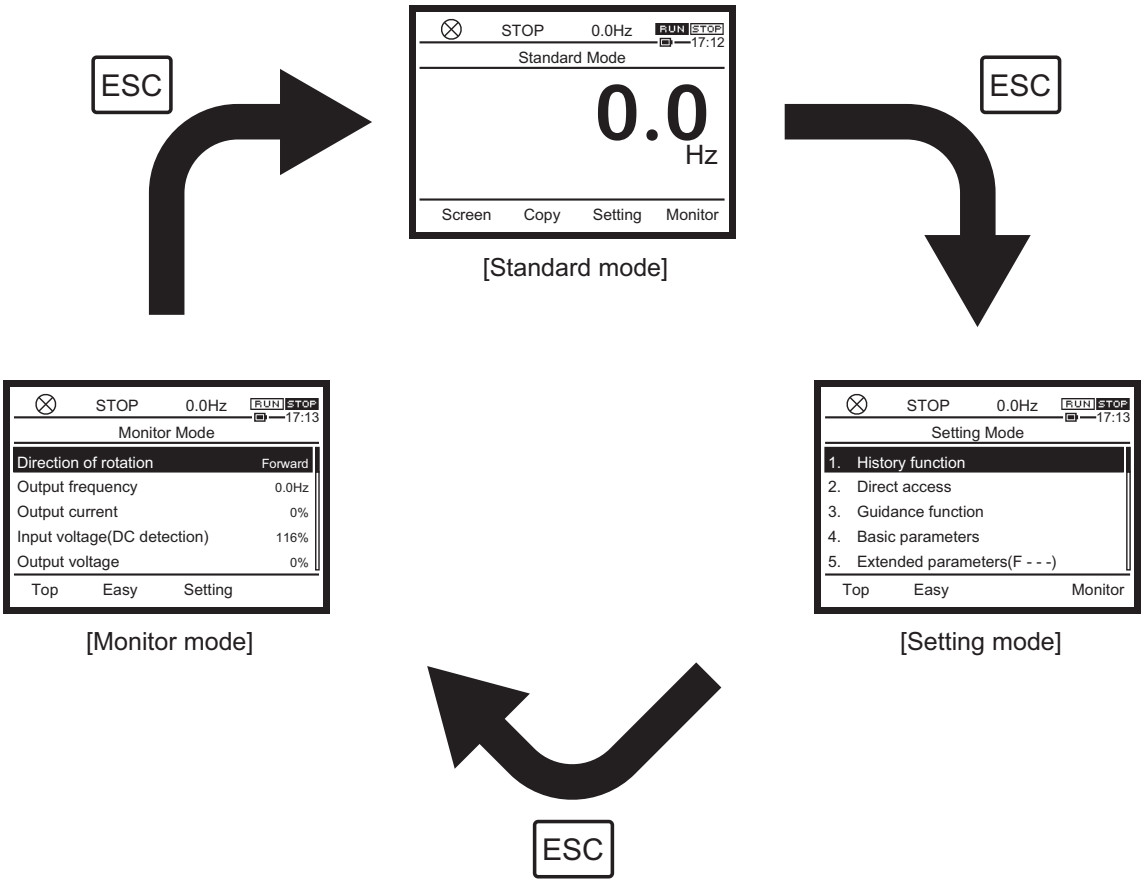
- You can check the status such as the operation status of the inverter and terminal information.

The following are the top screen of each mode and how to switch between them.

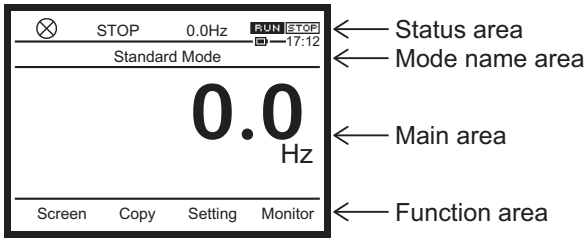
When switching with the [F1] - [F4] keys



When switching with the [ESC] key

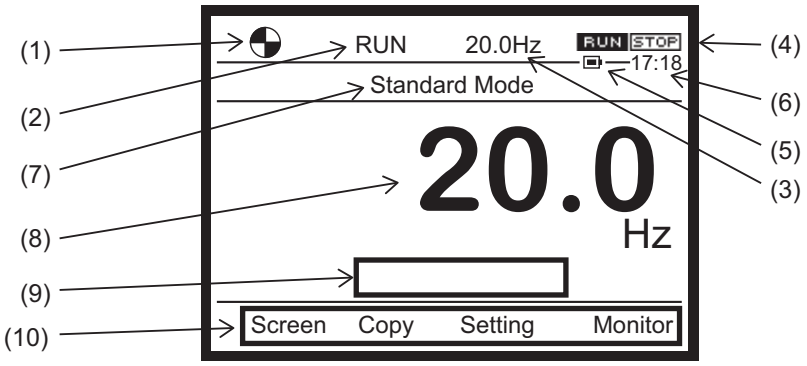


■ Screen structure



■ Screen display of [Standard mode]

This is the normal display mode of the inverter.
(1) - (6) are display contents common to [Standard mode], [Setting mode], [Easy mode], and [Monitor mode].



(1) The operation status is displayed with the following symbols.

(Rotating): In operation (clockwise for forward run, counterclockwise for reverse run)

: Stop

EOFF (Blinking): Waiting for emergency off applied with the [STOP/RESET] key (when you press the [STOP/RESET] key again while the symbol is blinking, the motor comes to an emergency off)

(2) The operation status is displayed with the following text.

"RUN": During run
"STOP": Stopped
"Trip": Trip has occurred
"JOG": In jog run

(3) The frequency command value (default setting) is displayed in Hz. Set the display contents with <F723: Status area display of operation panel>.

For details, refer to [5. 4. 3].

(4) The run commands are displayed with icons.

Run command from	Icon	Run / Stop
Terminal	F R	Stop
	F R	Fwd Run
	F R	Rev Run
Operation panel, Extension panel	RUN STOP	Stop
	RUN STOP	Run
Embedded Ethernet	Emb.Ethernet	Stop
	Emb.Ethernet	Run
RS485 communication (connector 1)	RS485-CN1	Stop
	RS485-CN1	Run

Run command from	Icon	Run / Stop
RS485 communication (connector 2)	RS485-CN2	Stop
	RS485-CN2	Run
Communication option	Com.option	Stop
	Com.option	Run

(5) The remaining capacity of the battery (yes/ no) is displayed with icons.

(6) The current time ("hour/minute") is displayed.

(7) Current display mode
[Standard mode] is displayed.

(8) Normally, the output frequency (default setting) is displayed. Set the display contents with <F710: Standard mode display>. For details, refer to [5. 4. 3].
When an alarm or trip occurs, its contents are displayed.

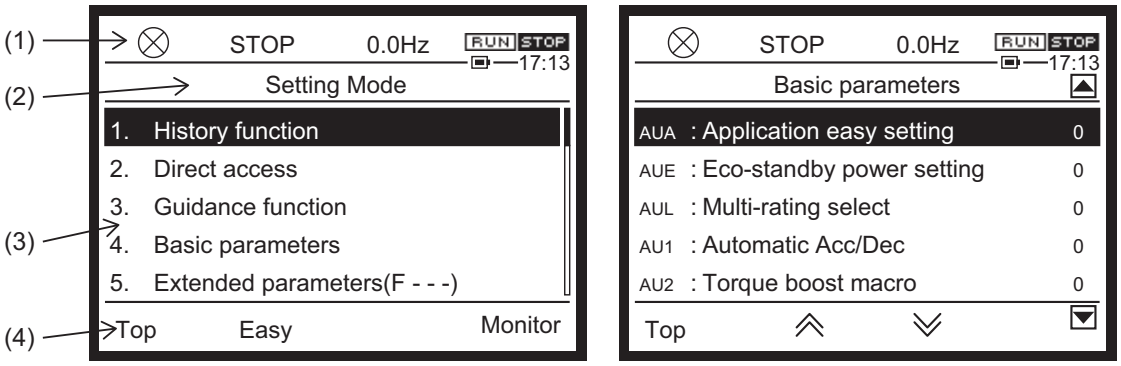
(9) When an alarm or trip occurs, the name of the alarm and a message are also displayed here.

(10) The functions assigned to the [F1] - [F4] keys are displayed.
For details, refer to [3. 1. 1].

Memo
- When emergency off, alarm, or trip has occurred, refer to [3. 2] and [Chapter 13].

■ Screen display of [Setting mode]

This is a display mode to set parameters.



Top screen of [Setting mode] Setting screen of basic parameters

(1) From the operation status to the current time, this mode has the same display as [Standard mode].

(2) The current display mode [Setting mode] is displayed.

(3) The setting items are displayed. One screen can display up to five items.
Select an item with the touch wheel and press the [OK] key. Then the setting screen is displayed.
<Setting screen of basic parameter>
"Left end": Title
"Middle": Parameter name
"Right end": Setting value

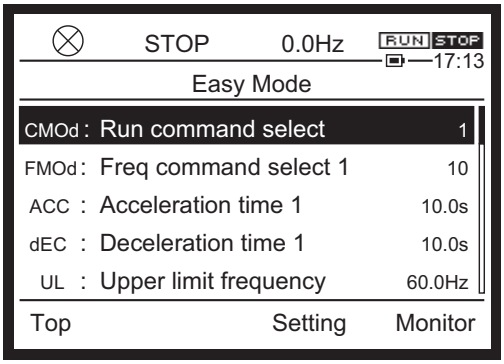
(4) The functions assigned to the [F1] - [F4] keys are displayed.
For details, refer to [3. 1. 1].

■ Screen display of [Easy mode]

This is a display mode to set parameters easily.
It is displayed in the following cases.

- When "Easy" of the [F1] - [F3] keys is pressed in [Setting mode] and [Monitor mode]
- When [Easy mode] is set in <PSEL: Parameter mode select>

Only the parameters set in <F751: Easy setting 1> - <F782: Easy setting 32>. For details, refer to [5. 2. 8].

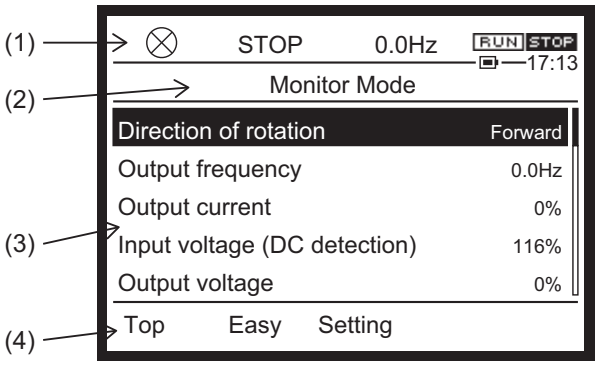


Memo

- For details of how to set parameters, refer to [4. 2. 3].

■ Screen display of [Monitor mode]

This is a display mode to monitor the inverter status (output current, input voltage, terminal information, etc.).



(1) From the operation status to the current time, this mode has the same display as [Standard mode].

(2) The current display mode [Monitor mode] is displayed.

(3) The monitor items are displayed. One screen can display up to five items.
"Left end": Monitor item name
"Right end": Value, status

Furthermore, if (OK) is displayed in the [F4] key when selecting an item with the touch wheel, detailed information is displayed when you press the [OK] key.

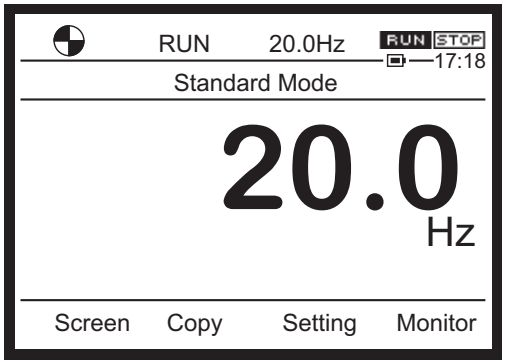
(4) The functions assigned to the [F1] - [F4] keys are displayed.
For details, refer to [3. 1. 1].

Memo
- For details of [Monitor mode], refer to [Chapter 8].

3. 1. 3 Setting of LCD screen

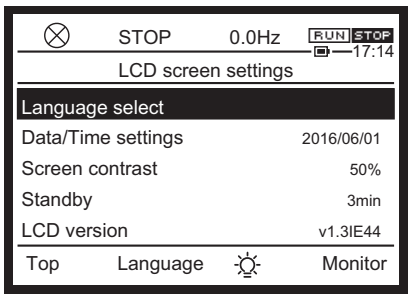
Important
- Note that if power off or a power failure occurs while the setting of the LCD screen is being changed, the LCD screen information is lost, and you may not be able to use the operation panel.

When you press the [F1] key ("Screen") in [Standard mode], the LCD setting screen is displayed.
This screen allows various settings of the LCD screen such as selection of display language, setting of current date/time, link to the website, adjustment of contrast, and automatic off time.



■ **LCD screen**

The following five items can be set.
- Selection of display language
- Setting of current date/time (date is displayed at the right end)
- Contrast adjustment of LCD screen (unit: %)
- Automatic off time setting of LCD screen backlight (unit: min)
- Link to website



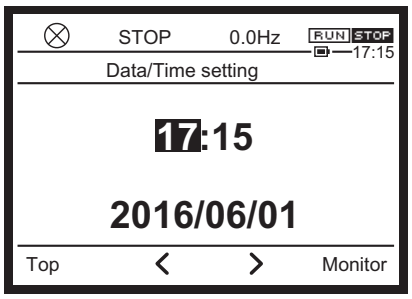
■ Language selection

Select a language to be displayed from the list.
You can select among English, German, Italian, Spanish, Portuguese, Chinese (simplified). (French and Russian are in preparation.)
The default setting is English.
A check mark is display to the right end of the selected language.



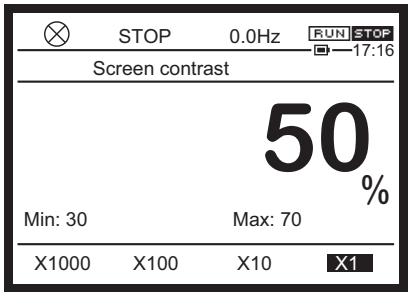
■ Date/time setting

Set the date and the time.
The time is represented in HH:MM and the date in YYYY/MM/DD.
Set the current time.
The digits that can be changed are highlighted. Press the [F2] key ❮ or [F3] key ❯ to shift the highlighted digits. Increase or decrease the value and press the [OK] key.



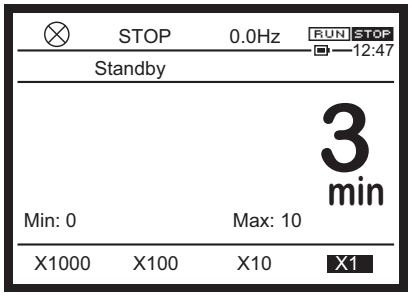
■ Contrast adjustment

The contrast can be adjusted in the range of 30 -70%.
The default setting is 50%.
If you touch the touch wheel, the value in the middle is highlighted. Increase or decrease the value and press the [OK] key.



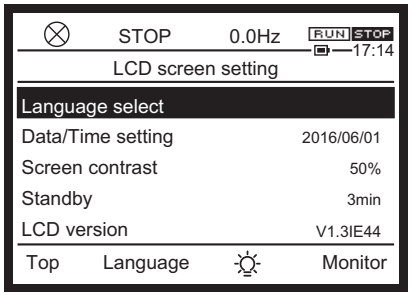
■ Automatic off time

The off time of the backlight can be set in the range of 0 min (always on) - 10 min (off after 10 minutes).
The default setting is 3 min.
If you touch the touch wheel, the value in the middle is highlighted. Increase or decrease the value and press the [OK] key.



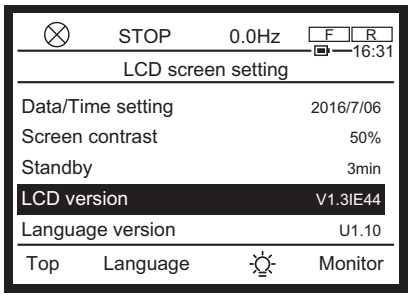
■ Switching of backlight color

When you press the [F3] key (☼ mark), you can change the color of the backlight to white or red.
The color is switched every time you press the key.



■ LCD version and Language version

You can check the version of the LCD body at the bottom of the screen.



3

Memo

- The LCD screen can be set regardless of the setting of inhibition of parameter change with <F700: Parameter reading&writing access lockout>.

3. 1. 4 Copy function

Mandatory action

- The copy function cannot be used during run. Use this function when the inverter is stopped.
- Never turn off the power of the body or attach/remove the LCD during copying. Otherwise, the memory in the LCD may be damaged, and repair (service call) may be required.

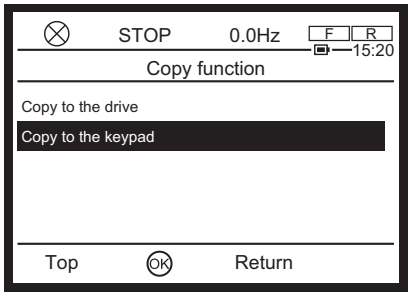
When you press the [F2] key ("Copy") in [Standard mode], the copy function screen is displayed.
The copy function allows you to upload/download the parameters of the inverter to/from the file (memory) of the LCD body.

<Limitations>

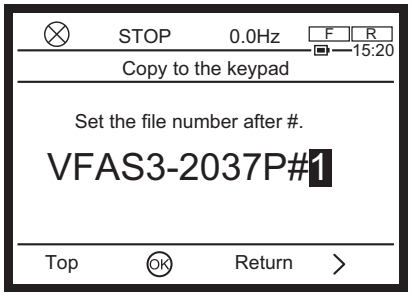
- **Copying cannot be executed between inverters with different capacities.**
- **Re-upload the file if you want to use parameters added with version upgrade.**
- **Up to 16 files can be stored. Since the 17th file cannot be created, overwrite with the same file name.**

(1) Copying to LCD (uploading)

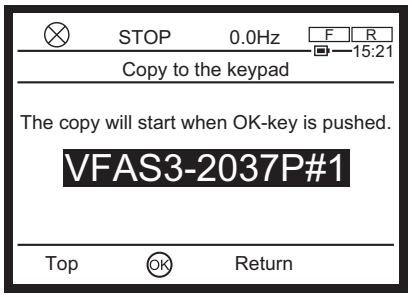
(1) Select "Copy to the keypad" and press the [OK] or [F2] key.



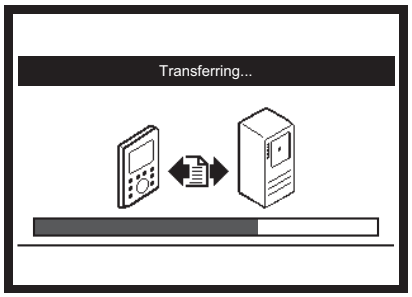
(2) Set a figure 0 - 99 after the inverter type followed by #, and press the [OK] or [F2] key.



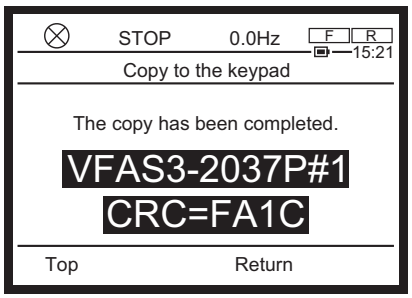
(3) The highlighted part is the file name. In the following example, "VFAS3-2037P#1" is the file name.



(4) When you press the [OK] or [F2] key, copying of the parameters of the inverter body to the file (memory) of the LCD body is started.



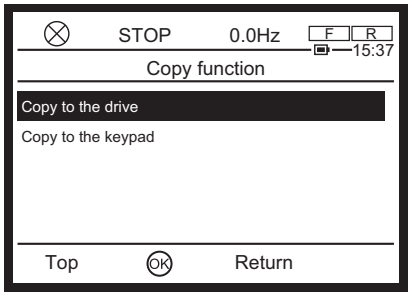
(5) When the transfer is completed normally, the file name and CRC are displayed.



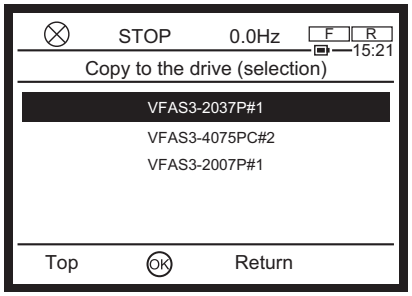
3

(2) Copying to inverter (downloading)

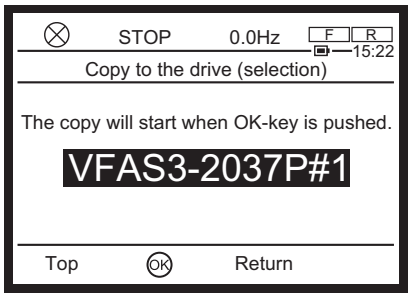
(1) Select "Copy to the drive", and press the [OK] or [F2] key.



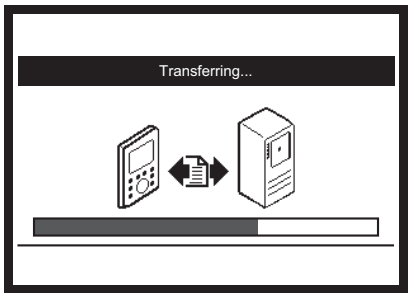
(2) Select a file to be downloaded to the inverter and press the [OK] or [F2] key.



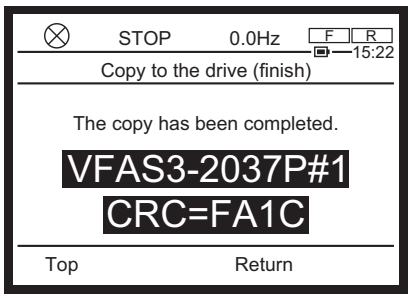
(3) The selected file is displayed.



(4) When you press the [OK] or [F2] key, copying from the file (memory) of the LCD body to the parameters of the inverter body is started.



(5) When the transfer is completed normally, the file name and CRC are displayed.

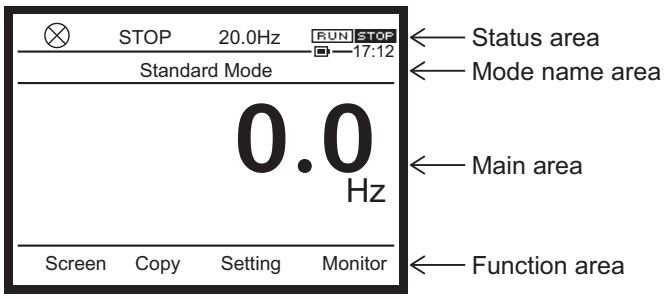


3. 2 Normal/emergency screen display

This section explains the screen display of the operation panel.
When operation such as parameter setting is not performed, the top screen of [Standard mode] is displayed. During run, output frequency, etc. are displayed, and the status of alarm and trip is displayed when an error occurs.

3. 2. 1 Normal display

When the inverter is stopped, the screen on the right is displayed.



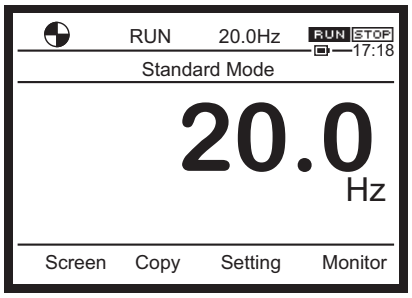
Status area

- **⊗ at the left end is stopped**
- **As status, "STOP" is displayed.**
- **The frequency command value "20.0 Hz" is displayed (<F723: Status area display of operation panel> = "1: Frequency command value")**
- **The run command is selected from operation panel, Extension panel (RUN STOP).**

Main area

- **The output frequency "0.0 Hz" is displayed (<F710: Standard mode display> = "0: Output frequency")**

During run of the motor, the screen shown on the right is displayed.



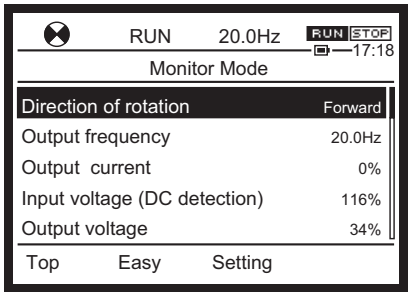
Status area

- **⊗ at the left end rotates**
- **As status, "RUN" is displayed**
- **The frequency command value "20.0 Hz" is displayed (<F723: Status area display of operation panel> = "1: Frequency command value")**
- **The run command is selected from operation panel, Extension panel (RUN STOP).**

Main area

- **The output frequency "20.0Hz" is displayed (<F710: Standard mode display> = "0: Output frequency")**

Even if [Standard mode] is switched to other display mode, you can grasp the operation status from the display in the status area.

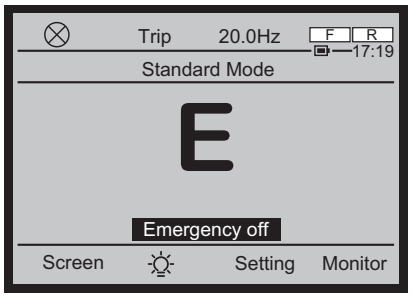


Reference

- When the LCD screen is dark -> Refer to [3. 1. 3]
- To check the output current, input/output voltage, etc. -> Refer to [3. 1. 2], [8. 1. 1]
- To check the setting value of the parameter -> Refer to [3. 1. 2], [4. 2]

3. 2. 2 Display at the time of trip

When a trip occurs, the trip title and trip name blink, and the backlight of the LCD screen turns red to inform you of a trip. Check the cause of the trip and eliminate it.
When you press the [i] key, necessary information is displayed. For details, refer to [3. 1. 1].



Memo

- If you want to return only the backlight from red to white, press the [F2] key.

Reference

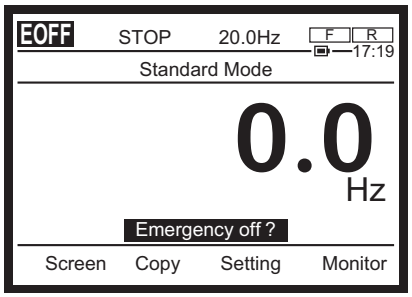
- To reset from the operation panel -> Refer to [3. 2. 4]
- To know details of the display at the time of alarm/trip, causes, and measures -> Refer to [Chapter 13]

3. 2. 3 Emergency off

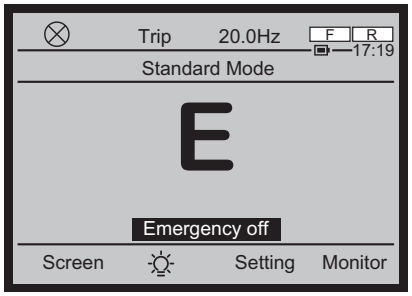
To apply emergency off from the operation panel except when the inverter is operated by the operation panel, follow the procedure below.
For how to apply emergency off by other than the operation panel (digital input, etc.), refer to [6. 30. 4].

1 Press the [STOP/RESET] key.

EOFF blinks at the left end of the status area.
In [Standard mode], "Emergency off? (STOP) key" is displayed on the lower side in the main areas.
In the cases of "Setting mode" and "Monitor mode," just EOFF blinks.



2 If you press the [STOP/RESET] key again while EOFF is blinking, the inverter comes to emergency off.
- The backlight turns red, and "E" blinks.
- "Trip" is displayed in the second position from the left of the status area.
- "Emergency off" is displayed in the main area.



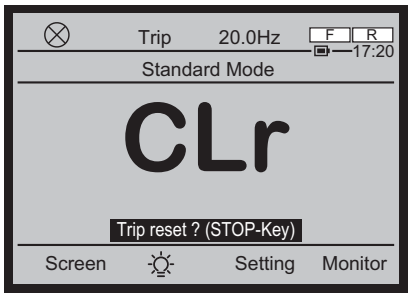
Memo

- The blinking EOFF returns to the original display status after few seconds if no operation is performed.. The inverter comes to emergency off only if you press the [STOP/RESET] key while EOFF is blinking.
- If you want to return only the backlight from red to white, press the [F2] key.

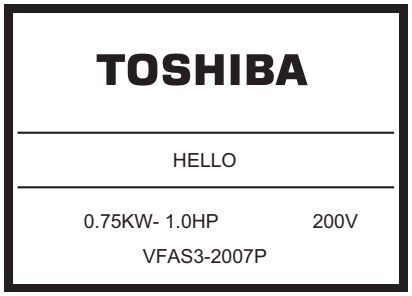
3. 2. 4 How to reset trip

If a trip occurs, you can reset it with panel operation.
For how to reset a trip by other than the operation panel (digital input, etc.), refer to [13. 1].

1 Press the [STOP/RESET] key with the trip displayed. "CLr" blinks in the main area, and "Reset? (STOP) key" is displayed on the lower side.
- The backlight is red.
  It is white when the setting of the backlight is changed.



2 If you press the [STOP/RESET] key again while "CLr" is blinking, the trip is reset.
The display on the screen once disappears, and the screen immediately after power on is displayed.
The backlight returns to while.



Important	• If the cause of the trip is not eliminated, a trip occurs again even after reset. • If the trip is caused by overload protection or overheat or when pre-alarm occurs, the trip cannot be reset. For details, refer to [13. 1].

Memo	• The blinking "CLr" returns to the trip display after few seconds if no operation is performed. The trip is reset only if you press the [STOP/RESET] key while "CLr" is blinking. • If you press keys other than the [STOP/RESET], it is considered that reset will not be done, and the screen returns to trip display.

4 [Basic operation] Operation methods of motor

⚠ WARNING

Prohibited

- Do not touch terminals when the inverter's power is on even if the motor is stopped.
  Touching the terminals while voltage is applied will result in electric shock.
- Do not touch switches when the hands are wet and do not try to clean the inverter with a damp cloth.
  This will result in electric shock.
- When the retry function is selected, stand clear of motors and machines at tripping stop.
  The motors and machines which have stopped due to tripping stop will restart suddenly, and this will result in injury.
  Take measures for securing safety even if the motor restarts unexpectedly, such as attaching a cover to the motor.
- Do not touch terminals or motor of the inverter while performing auto tuning.
  Touching the terminals or motor while voltage is applied to the terminals and motor may result in electric shock, even if the motor is stopped.
  After setting offline auto-tuning (F400 = "2"), execute the auto tuning at first start of the inverter. The auto tuning takes several seconds and the motor is stopped meanwhile, but voltage is applied to the terminals and motor. The motor may also generate a sound during the auto tuning, but this is not malfunction.
- Do not set the stall prevention level parameters (F601 and F185) extremely low.
  If the stall prevention level parameters (F601 and F185) are set at or below the motor no-load current, the stall preventive function will be always enabled and increase the frequency when it judges that regenerative braking is taking place.
  Do not set the stall prevention level parameters (F601 and F185) at 30% or less under normal use conditions.

Mandatory action

- Turn the power on only after mounting the front cover.
  When you use the inverter housed in the cabinet with the front cover removed, always close the cabinet doors first and then turn the power on. If you turn the power on with the front cover or the cabinet doors open, this will result in electric shock.
- Make sure that operation instructions are off before resetting the inverter after malfunction.
  If the inverter is reset while the operation instructions are on, the motor will restart suddenly, resulting in injury.
- Make sure to set the setup menu correctly.
  If you set the setup menu incorrectly, this will damage the inverter or cause the inverter to perform unexpected movement.
- Install circuit protection such as the mechanical brake in the crane.
  If there is no sufficient circuit protection installed in the crane, insufficient motor torque while auto tuning will cause the machine stalling/falling.

⚠ CAUTION

Prohibited

- Observe all allowable operating ranges of motors and machines in use.
  Not observing these ranges will result in damage to motors and machines and injury. Please use motors and machines within their respective allowable operating ranges by referring to their respective instruction manuals.

Mandatory action	• Use the inverter that conforms to specifications of the power supply and the three-phase motor to be operated. If you use the inappropriate inverter, not only will the three-phase motor not rotate correctly, but it will cause serious accidents such as overheating and burning out. • Take countermeasures against leakage current. The leakage current through the stray capacitance of the input/output power wires of inverter and motor can affect peripheral devices. In that case, please take countermeasures such as reducing the carrier frequency or shortening the length of input/output power wires. When the total wire length (total length between an inverter and motors) is more than 100m, if the trip occurs with the motor no-load current, make enough space between phase wires or insert the filter (MSF: motor-end surge voltage suppression filter).

The operation methods of the motor are panel run, terminal run, and communication run. In any case, parameters should be set in advance.
This chapter explains how to set parameters that are basic of motor operation.
In addition, the basic operation methods for panel run and terminal run are introduced, using examples.

4

4. 1 To run/stop motor

To run/stop the motor, the following operations are required.
- Input a run command.
- Input a frequency command (motor speed).
- Input a stop command.

The operation methods of the motor are panel run, terminal run, and communication run.
To change the motor speed, control the output frequency of the inverter.
With this inverter, the run/stop command and the frequency command can be set individually.
- Set the input method of run/stop (run command) with the parameter <CMOd: Run command select>.
- Set the input method of the frequency command with the parameter <FMOd: Frequency command select 1>.

Set the method to input each command and operate with that method.

Important	• For reasons of safety, some parameters cannot be changed while the inverter is running. For details, refer to [11. 1], [11. 3].

■ Panel run

On the operation panel, input run/stop (run command) and frequency command.
When you press the [RUN] key on the operation panel, the motor starts running. When you press the [STOP/RESET] key, it is stopped. Set the frequency command with the touch wheel and register it as a setting value of the parameter.

Memo	• For how to switch other operation method to panel run, refer to [4. 3], [5. 2. 1].

■ **Terminal run**

The motor is operated with an external signal.
Run/stop the motor with an ON/OFF signal to a digital input terminal. Also, input the frequency command with potentiometer/voltage/current signals to analog input terminals.

Memo	• For how to switch other operation methods to terminal run, refer to [4. 4], [5. 2. 1].

■ **Communication run**

The motor can be operated with an RS485 communication or Ethernet. Connect cables to RS485 communication connector 1 and 2 for the RS485 communication or to Ethernet connector 1 and 2 for the Ethernet communication. By inserting cassette options (PROFINET, etc.) to optional slots A, other communication run is also made possible.
For details, refer to "Communication Function Instruction Manual" (E6582143).

4. 2 Basic setting methods of parameters

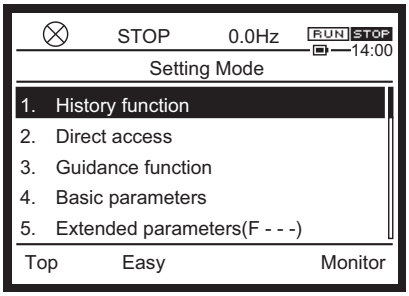
This inverter has four kinds of display modes as described in [3. 1. 2]. Switch to [Setting mode] (or [Easy mode]) and set parameters.
On the setting screen of a parameter, the title, name, and setting value of the parameter are displayed.
Each parameter has a 4-digit communication number assigned separately from the title.

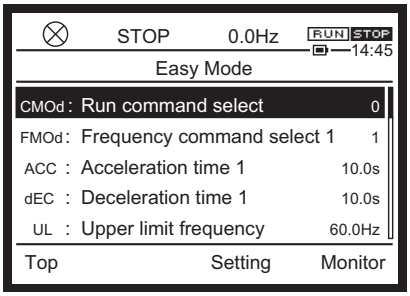
4. 2. 1 [Setting mode] and [Easy mode]

Two parameter setting methods are provided.

[Easy mode]
- Only ten basic parameters most frequently used are displayed.
- Up to 32 parameters can be registered to be displayed.
- To set parameters not displayed in [Easy mode], set to [Setting mode] to read them out.
- Since parameters registered in [Easy mode] are directly displayed on the [Easy mode] screen, you can check or change them easily.

[Setting mode]
- This is a mode to set parameters of the inverter.
- All the basic parameters, extended parameters, and other parameters are displayed.





■ How to switch [Setting mode]/[Easy mode]

To switch between [Setting mode] and [Easy mode], switch to [Standard mode] or [Monitor mode] first.

4

[Setting mode] -> [Easy mode]

• Press [F2] key("Easy") at [Setting mode] or [Monitor mode]

[Easy mode] -> [Setting mode]

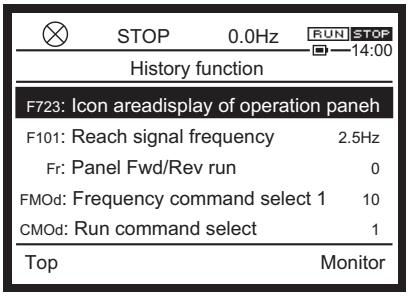
• Press [F3] key("Setting") at [Easy mode], [Standard mode] or [Monitor mode]

■ [Setting mode]

On the [Setting mode] screen, the following eight items are displayed.

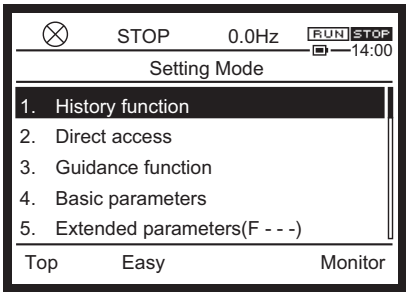
1) History function <AUH>

The history of changed parameters is displayed.
The latest five parameters whose settings have been changed on the operation panel can be searched automatically.
It is a convenient function to immediately change parameters that have been once set or to adjust parameters by changing the setting values little by little.
The changed parameters are displayed regardless of the difference from the default setting values.

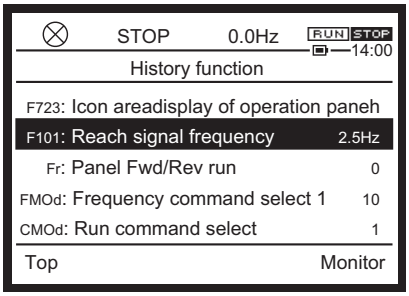


Read the history in the following procedure.

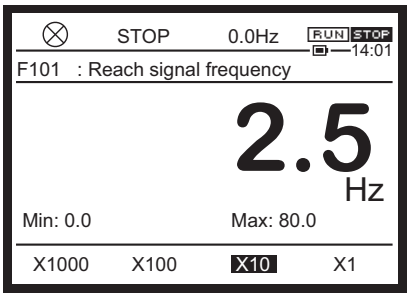
1 Select "1. History function" on the [Setting mode] screen and press the [OK] key.
The history function screen is displayed.
Up to five latest parameters that have been set or changed recently are displayed.
For each parameter, the tile, parameter name, and setting value are displayed in one line.



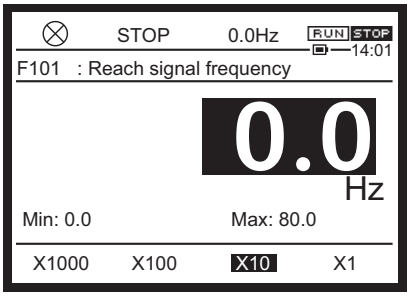
2 Select a parameter you want to change and press the [OK] key.
In the example on the right, <F101: Reach signal specified frequency> is selected.



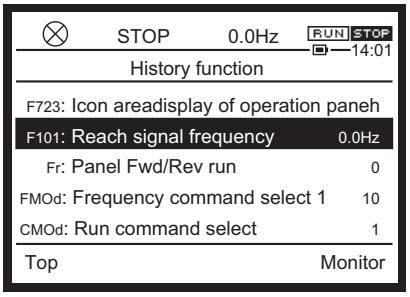
The setting screen of that parameter is opened.



3 Change the setting of the selected parameter and press the [OK] key.



The history function screen is displayed.
When you select the history function next time, the parameter changed most recently is displayed on the top.



4 Press the [ESC] key.
The screen returns to the [Setting mode] screen.

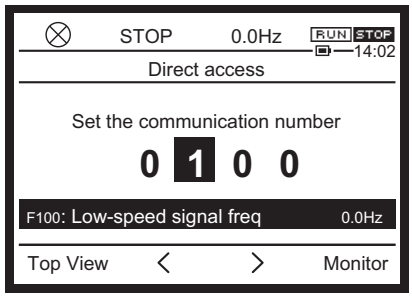
4

Memo

- The following parameters are not displayed in the history function.
  <FC: Panel run frequency>
  <AUF: Guidance function>
  <AUA: Application easy setting>
  <AUL: Multi-rating select>
  <AU1: Automatic Acc/Dec>
  <AU2: Torque boost macro>
  <SEt: Region setting check>
  <tyP: Default setting>
  <F699: Trip for test>
  <F700: Parameter reading&writing access lockout>
  <F737: Panel keys lockout>
  <F738: Password setting>
  <F739: Password verification>
  <F899: Communication option reset>

2) Direct access

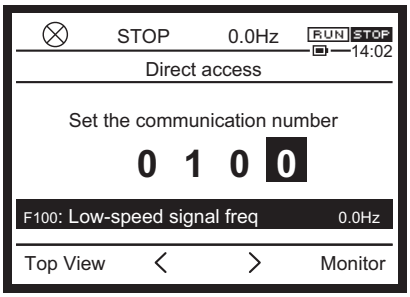
A 4-digit communication number is input to specify a parameter, and its setting screen is displayed directly.
On this setting screen, you can check or change the setting value of the parameter.
When you select "2. Direct access" on the [Setting mode] screen and press the [OK] button, the direct access screen is displayed.
A 4-digit communication number is displayed.
The selected digit is highlighted.
On the lower side of the screen, the title, name, and setting value of the parameter corresponding to the communication number are displayed.



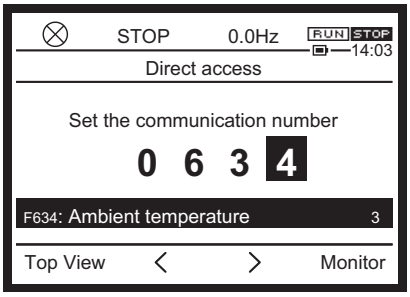
Input the communication number in the following procedure.

1 Set the digit.

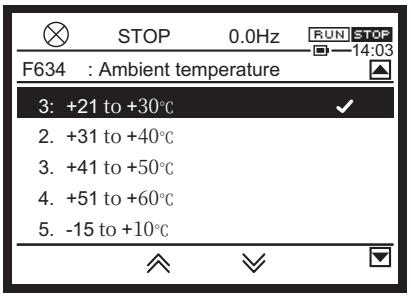
When you press the [F2] key ❮, the highlighted character is shifted to the left. When you press the [F3] key ❯, the highlighted character is shifted to the right.



2 Set the value with the touch wheel.
The first, second, and third digits from the right are changed between "0" to "9." The fourth digit from the right is changed among "0", "A", and "C."
The values are carried or borrowed.
For example, if the third digit from the right is increased to above "0900," then "A000" is displayed and increased to "A100", "A200" and so on.



3 Press the [OK] key.
The setting screen of the selected parameter is displayed.



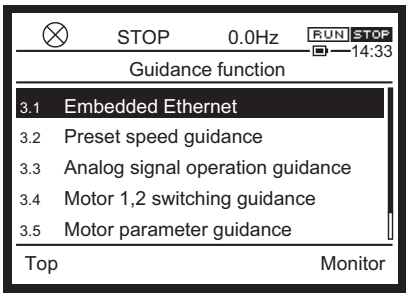
4 Press the [ESC] key.
The screen returns to the direct access screen.

Memo

- For the communication number of each parameter, refer to Chapter 11.
- For details of the concrete function and adjustment range of each parameter, refer to Chapters 5 and 6.

3) Guidance function <AUF>

Parameters required for a special purpose can be displayed as a group and set collectively.
You can set necessary parameters easily by setting parameter groups in turn that are automatically formed for special purposes.
Purpose-specific guidance such as Embedded Ethernet setting, Preset speed operation, Motor 1,2 switching, and Motor parameter is provided.



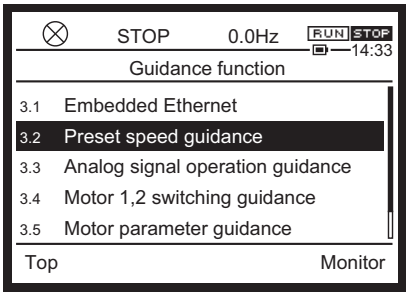
Parameter setting

Title	Parameter name	Adjustment range	Default setting
AUF	Guidance function	0: - 1: Embedded Ethernet setting 2: Preset speed operation 3: Analog frequency command 4: Motor 1,2 switching 5: Motor parameter 6: PM motor parameter	0

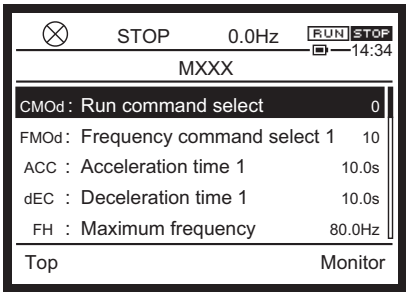
How to use

For example, set preset speed operation in the following procedure.

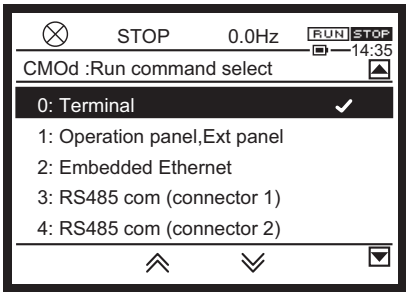
1 Select Guidance function "2: Preset speed operation" and press the [OK] key.



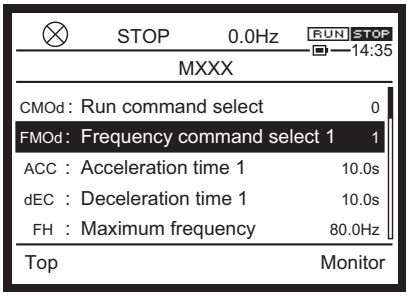
Parameters required for preset speed operation are displayed as a group.



2 Press the [OK] key with <CMOd: Run command select> on the top of the preset speed parameter group screen selected.
The selection screen of <CMOd> is displayed.



3 When you select <CMOd> and press the [OK] key, the screen returns to the preset speed parameter group screen. Select the next parameter <FMOd: Frequency command select 1> and press the [OK] key.
By setting parameter groups similarly in turn, you can set necessary parameters easily.



4

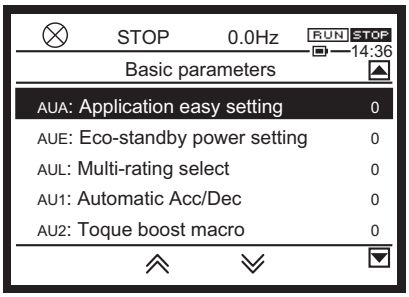
List of parameters changeable by guidance function

Embedded Ethernet setting	
<AUF>=1	
C081-C096	Device name 1-16
C610	Emb Eth. IP setting mode
C611-C614	Emb Eth. IP address setting value
C615-C618	Emb Eth. Subnet mask setting value
C619-C622	Emb Eth. Default gateway setting value
C629-C632	Emb Eth. IP address monitor
C633-C636	Emb Eth. Subnet mask monitor
C637-C640	Emb Eth. Default gateway monitor
Preset speed operation	
<AUF>=2	
CMOd	Run command select
FMOd	Frequency command select 1
ACC	Acceleration time 1
dEC	Deceleration time 1
FH	Maximum frequency
UL	Upper limit frequency
Sr1-Sr7	Preset speed 1-7
F111-F116	Terminal xx function
F287-F294	Preset speed 8-15
Analog frequency command	
<AUF>=3	
CMOd	Run command select
FMOd	Frequency command select 1
ACC	Acceleration time 1
dEC	Deceleration time 1
FH	Maximum frequency
UL	Upper limit frequency
LL	Lower limit frequency
F201	RR point 1 input value
F202	RR point 1 frequency
F203	RR point 2 input value
F204	RR point 2 frequency
F216	II point 1 input value
F217	II point 1 frequency
F218	II point 2 input value
F219	II point 2 frequency

Motor 1,2 switching	
<AUF>=4	
vL	Base frequency 1
vLv	Base frequency voltage 1
vb	Manual torque boost 1
tHrA	Motor overload protection current 1
ACC	Acceleration time 1
dEC	Deceleration time 1
F111-F116	Terminal xx function
F170	Base frequency 2
F171	Base frequency voltage 2
F172	Manual torque boost 2
F182	Motor overload protection current 2
F185	Stall prevention level 2
F415	Motor rated current
F500	Acceleration time 2
F501	Deceleration time 2
F601	Stall prevention level 1
Motor parameter	
<AUF>=5	
Pt	V/f pattern
vL	Base frequency
vLv	Base frequency voltage 1
F405	Motor rated capacity
F415	Motor rated current
F417	Motor rated speed
F400	Offline auto-tuning
PM motor parameter	
<AUF>=6	
Pt	V/f pattern
vL	Base frequency 1
vLv	Base frequency voltage 1
F402	Automatic torque boost
F405	Motor rated capacity
F415	Motor rated current
F417	Motor rated speed
F458	Current control response
F460	Speed control response 1
F461	Speed control stabilization coefficient 1
F462	Speed reference filter coefficient 1
F910	PM step-out detection current level
F911	PM step-out detection time
F912	PM q-axis inductance
F913	PM d-axis inductance
F914	Parameter for manufacturer
F915	PM control method
F916	PM starting current
F917	IPM maximum torque control
F918	IPM current phase adjustment
F919	Parameter for manufacturer
F400	Offline auto-tuning

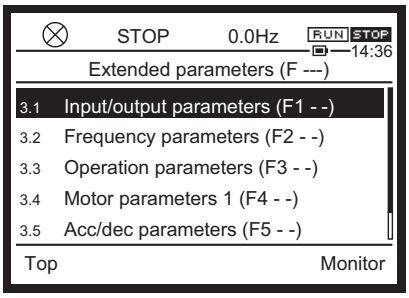
4) Basic parameter

Basic parameters for inverter operation are displayed.
For details, refer to [5. 3], [5. 4], [11. 2].



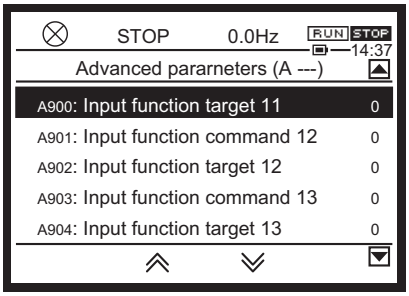
5) Extended parameter (F---)

Extended parameters used for complicated operation, detailed setting, and special applications, etc. are displayed.
Extended parameters are represented as "F" and a 3-digit number.
For details, refer to [5. 4], [Chapter 6], [11. 3].



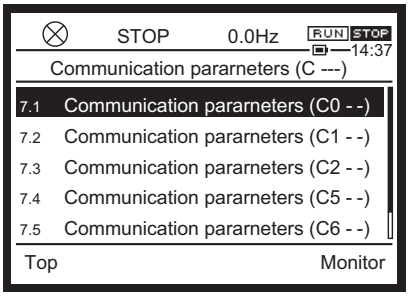
6) Advanced parameter (A---)

Parameters of My function, etc. that allows simplified programming are displayed.
Advanced parameters are represented as "A" and a 3-digit number.
For details, refer to [11. 4].



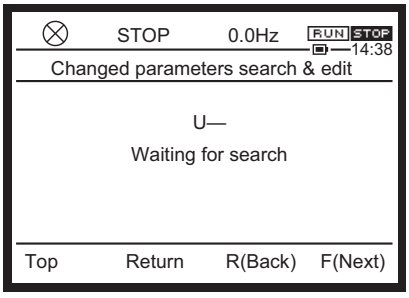
7) Communication parameter (C---)

Parameters with communication function are displayed.
Communication parameters are represented as "C" and a 3-digit number.
For details, refer to [11. 5].



8) Changed parameters search & edit <GrU>

Parameters with values different from the default setting are searched, and the titles and setting values of such parameters are displayed.
The setting values of parameters can be set during search.

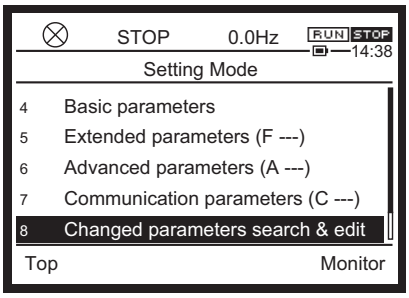


4

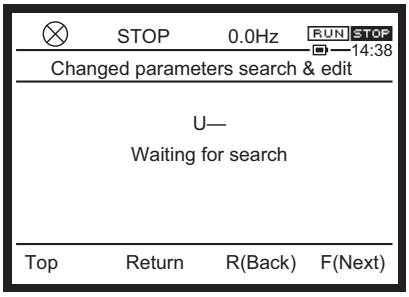
Memo	• Since all the parameters are compared with the default setting values, it may take a few seconds until parameters are displayed. • To cancel parameter search, press the [ESC] key.

Read the changed parameter in the following procedure.

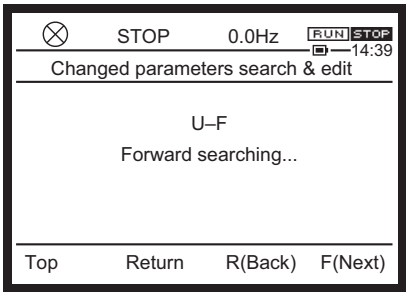
1 Select "8. Changed parameters search & edit" on the [Setting mode] screen and press the [OK] key.



The Changed parameters search & edit screen is displayed.
"U--- Waiting for search" is displayed in the main area.

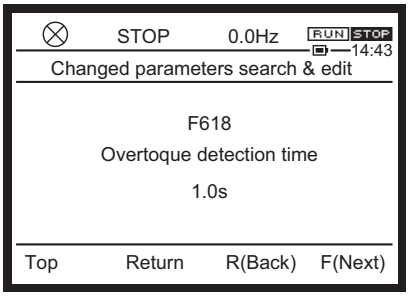


2 Press the [F4] key ("F(Next)").
During search, "U--F Forward searching..." is displayed.
Among the changed parameters, the one with the smallest 4-digit communication number is displayed.
The tile, parameter name, and setting value of the parameter are displayed.

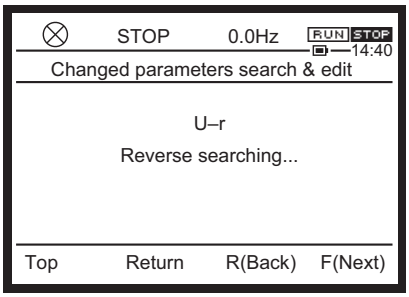


4

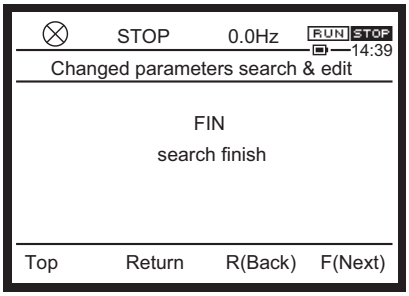
3 When you press the [F4] key ("F(Next)") repeatedly, the changed parameters are displayed one by one.



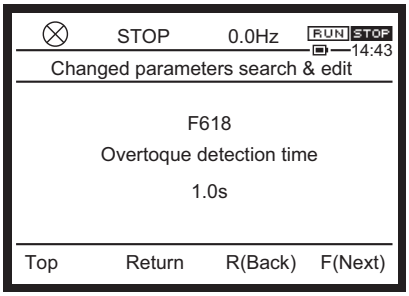
4 When you press the [F3] key ("R(Back)"), the changed parameters are displayed one by one from the one with the biggest communication number.
During search, "U--r Reverse searching..." is displayed.



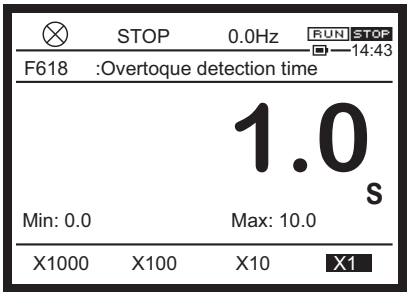
When the parameters have been searched to the last (first) one, "FIN search finish" is displayed.



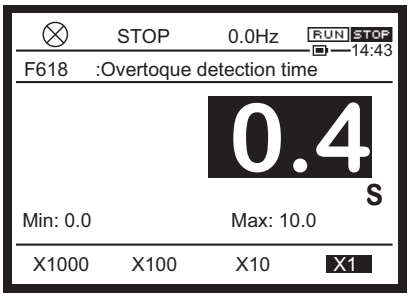
5 Press the [OK] key on the screen of the parameter you want to change.
In the example on the right, <F618: Overtorque detection time> is selected.



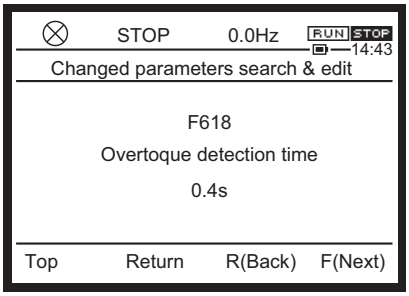
The setting screen of the parameter is opened.



6 Change the setting of the selected parameter and press the [OK] key.



The Changed parameters search & edit screen is displayed. You can check that the parameter has been changed.
You can perform forward/reverse search continuously.



7 Press the [ESC] key or [F2] key ("Return").
The screen returns to the [Setting mode] screen.

Memo

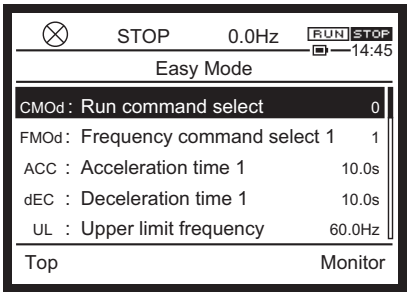
- Even if the value is changed, when it is reset to the value same as the default setting, it is not displayed in Changed parameters search & edit.
- If "3" is set in <tyP: Default setting>, the parameters are all reset to the default setting. However, the values of some parameters are designed not to return to the default setting, considering maintainability. These parameters are not displayed in Changed parameters search & edit. For details of <tyP: Default setting>, refer to [5. 2. 9].

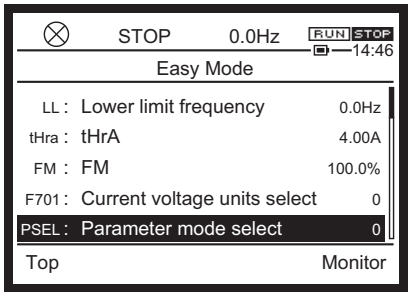
Important

- For reasons of safety, some parameters cannot be changed during run. For details, refer to [11. 2], [11. 3].

■ [Easy mode]

In [Easy mode], basic ten (default setting) parameters are displayed.
Up to 32 parameters can be registered to be displayed.





4

<CMOd: Run command select>
Set inputs (operation panel, terminal, communication) that give a run command to the inverter.
For details, refer to [5. 2. 1].

<FMOd: Frequency command select 1>
Set inputs (operation panel, terminal, communication) that give a frequency command to the inverter.
For details, refer to [5. 2. 1].

<ACC: Acceleration time 1>
Set the time that the output frequency of the inverter takes to reach <FH: Maximum frequency> from 0 Hz.
For details, refer to [5. 2. 4].

<dEC: Deceleration time 1>
Set the time that the output frequency of the inverter takes to decrease to 0 Hz from <FH: Maximum frequency>.
For details, refer to [5. 2. 4].

<UL: Upper limit frequency>
Set the upper limit of the output frequency.
For details, refer to [5. 2. 3].

<LL: Lower limit frequency>
Set the lower limit of the output frequency.
For details, refer to [5. 2. 3].

<tHrA: Motor overload protection current 1>
Set the reference current for protection with electronic thermal.
For details, refer to [5. 2. 5].

<FM: Terminal FM adjustment>
Adjust the scale of the meter connected to the terminal [FM].
For details, refer to [5. 2. 6].

<F701: Current, voltage units select>
Select the unit of current/voltage displayed on the operation panel among % or A (ampere)/V (volt).
For details, refer to [5. 2. 7].

<PSEL: Parameter mode select>
Select the parameter mode between [Setting mode] and [Easy mode].
For details, refer to [5. 2. 8].

4. 2. 2 Basic parameters and extended parameters

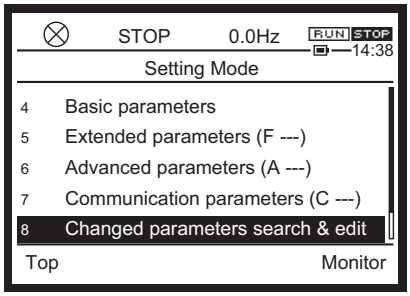
This inverter has basic parameters and other three types (with F, A, and C) of parameters.

Basic parameter
Basic parameters for inverter operation.

Extended parameter
Parameters used for complicated operation and detailed setting. They are represented as "F" and a 3-digit number.

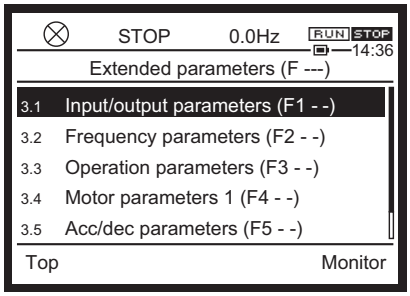
Advanced parameter
Parameters used for My function, etc. that allows simplified programming. They are represented as "A" and a 3-digit number.

Communication parameter
Parameters to set communication function. They are represented as "C" and a 3-digit number.



Since <F--->, <A--->, and <C---> types includes many parameters, select them on a screen that displays parameters by the hundred and then on an individual screen.

On the selection screen of parameters, titles, parameter names, and setting values (right end) of the parameters are displayed.



4. 2. 3 Basic operation of parameter setting

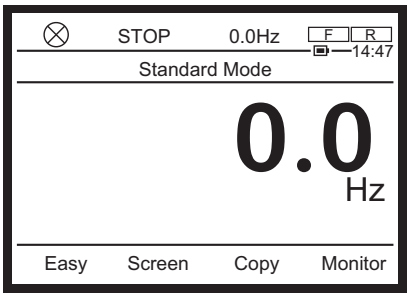
Set parameters in the following procedure.
Select an item for some parameters and set a value for others.

■ Setting of parameter for which an item should be selected

For an example, here is a procedure to set an extended parameter <F710: Standard mode display>.

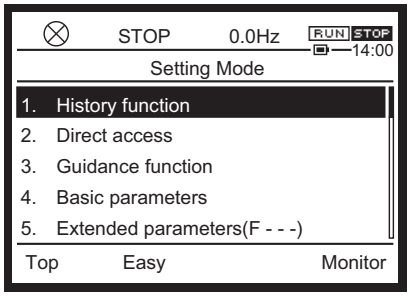
1 Press the [ESC] key to change from [Standard mode] to [Setting mode].
In the example on the right, the operation panel is in [Standard mode], and the output frequency is displayed in the middle of the screen.

- To switch from [Monitor mode], press the [F3] key ("Setting").



- Switch from [Easy mode] to [Standard mode] or [Monitor mode]. For details of switching of display modes, refer to [3. 1. 2].

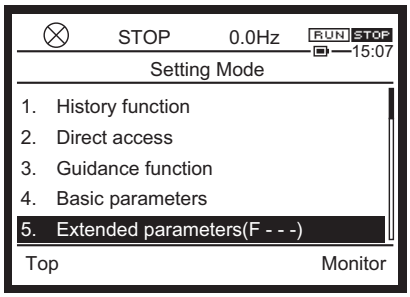
The [Setting mode] screen is displayed.



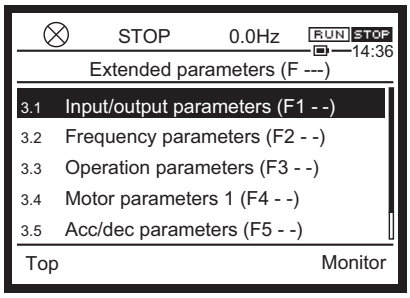
Memo

- If [Setting mode] is not displayed on the screen even after the above operation, check the <PSEL: Parameter mode select> setting. When "2: Easy mode only" is set, change the setting. For details, refer to [5. 2. 8].

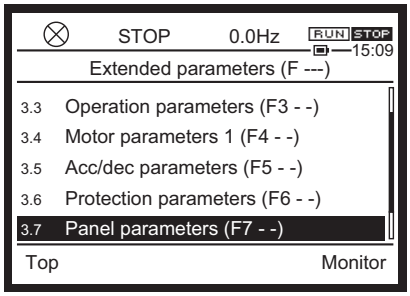
2 Select "5. Extended parameter (F---)" with the touch wheel.
The selected item is highlighted.



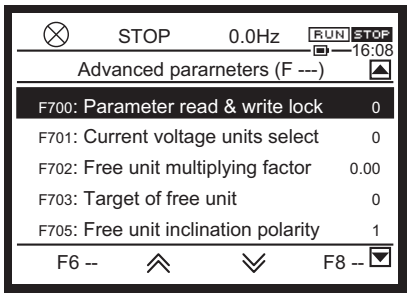
3 Press the [OK] key.
The extended parameter screen is displayed. The screen showing the list of each category with 100 parameters is displayed.



4 Select "3.7. Panel parameter (F7--)" with the touch wheel.



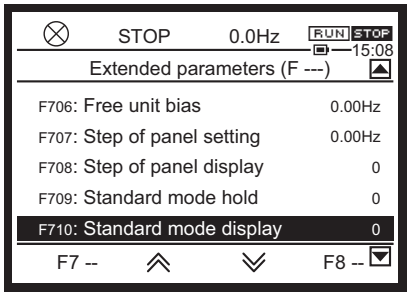
5 Press the [OK] key.
The top screen of the parameters is displayed, starting with <F700: Parameter reading&writing access lockout>.



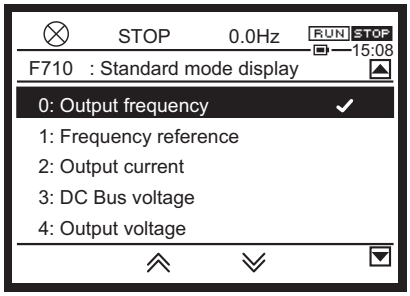
6 With the [F3] key ⩔ and the touch wheel, select <F710: Standard mode display>.

The [F3] key ⩔ scrolls down the screen that displays five parameters at a time page by page.

The [F2] key ⩓ scrolls up the screen that displays five parameters at a time page by page.
The number displayed at the right end of each item is the current setting value.



7 Press the [OK] key.
The setting screen of <F710: Standard mode display> is displayed.
The current setting value is highlighted, and a check mark is displayed at the right end.
In the example on the right, "0: Output frequency" is the current setting value.

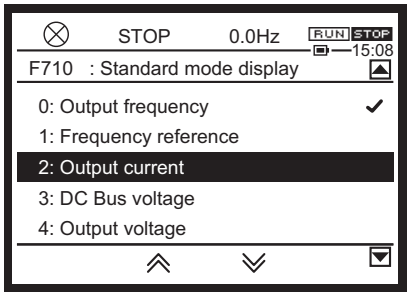


4

8 Select a new setting value.

Select it by using the touch wheel, the [F2] key ⩓, and the [F3] key ⩔.

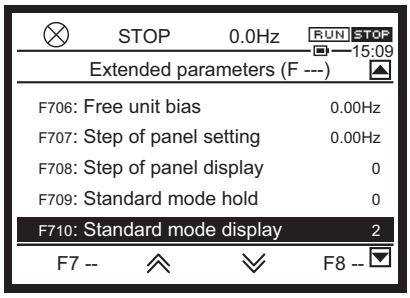
In the example on the right, the setting value is changed to "2: Output current."



9 Press the [OK] key.

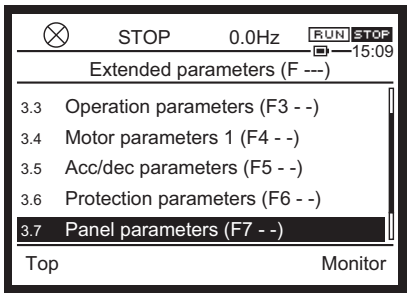
The setting value is changed. The screen display returns to the previous screen (previous one in the hierarchy), and the screen of the panel parameter is displayed.

Check that the number displayed at the right end of the item <F710: Standard mode display> has been changed ("0" -> "2" in the example on the right).



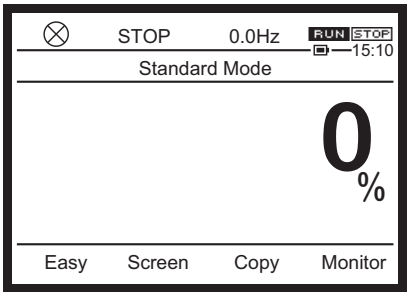
10 Press the [ESC] key.

The screen display returns to the previous one, and the extended parameter screen is displayed.



11 Press the [F1] key ("Standard") and return to [Standard mode].

In the example on the right, the display in [Standard mode] has been changed to output current (displayed in %). When you press the [F4] key/[ESC] key, the mode is switched to [Monitor mode].



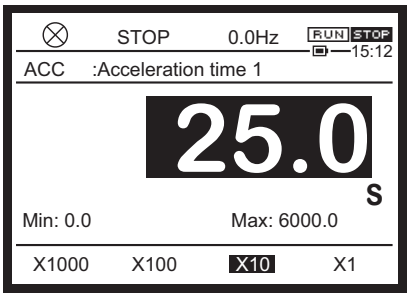
Memo

- For details of the function and adjustment range of <F710: Standard mode display>, refer to [5. 4. 3].

■ With parameters for which a value should be set

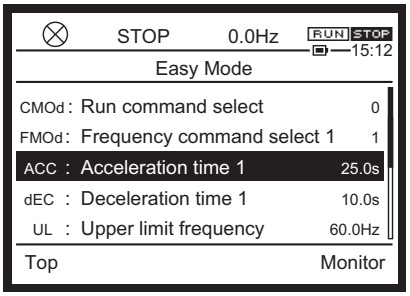
For an example, here is a procedure to set the basic parameter <ACC: Acceleration time 1>.
At that time, the current setting value, unit, setting lower limit (Min:), and setting upper limit (Max:) are displayed.

1 Change the value with the touch wheel.
When you touch the touch wheel, the value is highlighted, and you can change setting. When highlighted, the setting value is being changed.
With the [F1] to [F4] keys, the following digits are changed.



Key	Display	Meaning	Digit to be changed in this example
F1	x 1000	Change the digit that is the minimum digit x 1000	100 sec
F2	x 100	Change the digit that is the minimum digit x 100	10 sec
F3	x 10	Change the digit that is the minimum digit x 10	1 sec
F4	x 1	Change the minimum digit of the value displayed	0.1 sec

2 Press the [OK] key.
The setting value is changed, and the screen display returns to the previous one.



Memo

- For details of the function and adjustment range of <ACC: Acceleration time 1>, refer to [5. 2. 4].

4. 3 Basic panel run methods

This section introduces panel run methods with basic examples.
Input a run command and a frequency command from the operation panel.

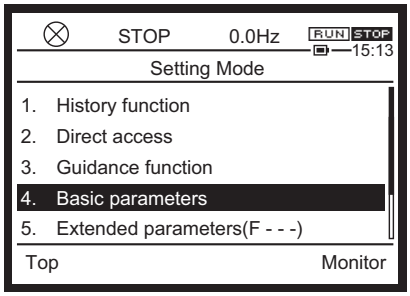
4. 3. 1 [Operation example 1] Operating with [RUN] key/ [STOP] key on operation panel

Operate only with the operation panel.

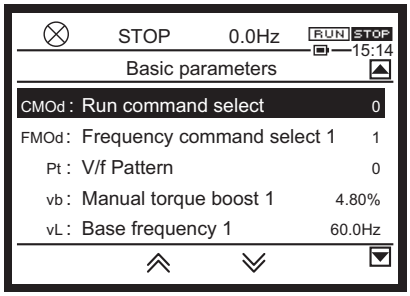
- First, make setting so that a run command and a frequency command can be input from the operation panel.
- Then, set a frequency command on the operation panel. The motor will rotate with this frequency.
- After setting the above, operate by using the keys on the operation panel.
- The parameters to be set are <CMOd: Run command select> and <FMOd: Frequency command select 1>.

Reference	• How to switch the display mode of the operation panel -> Refer to [3. 1. 2] • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details of <CMOd: Run command select>, and <FMOd: Frequency command select 1> -> Refer to [5. 2]

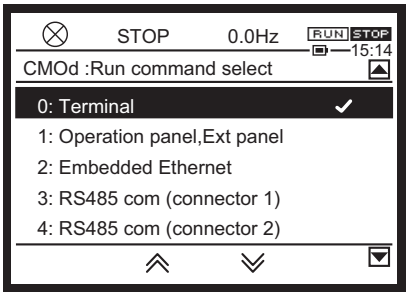
1 To set parameters, switch to [Setting mode].
Select "4. Basic parameter" and press the [OK] key. The basic parameter screen is displayed.



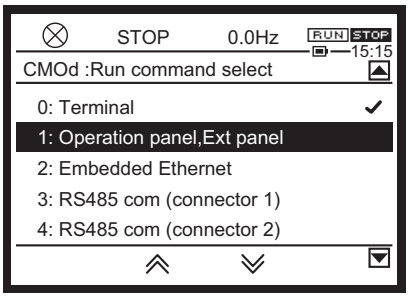
2 Select <CMOd: Run command select> and press the [OK] key.
You can also select <CMOd: Run command select> on the [Easy mode] screen.



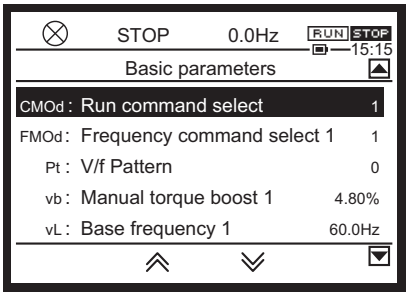
The setting screen is displayed.



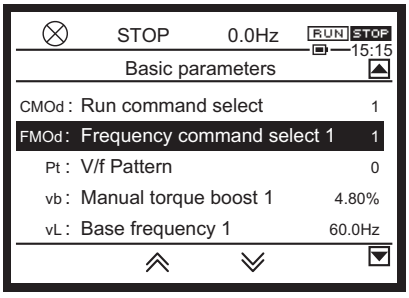
3 Select "1: Operation panel, Extension panel" and press the [OK] key.



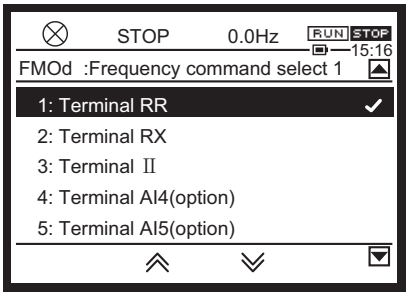
The basic parameter screen is displayed.
Check that the setting value of <CMOd: Run command select> is "1."



4 Select <FMOd: Frequency command select 1> and press the [OK] key.

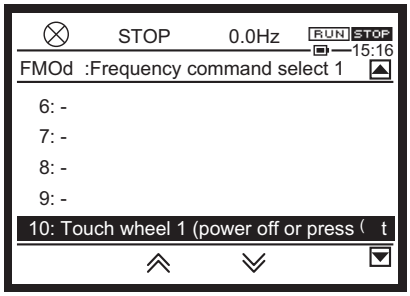


The setting screen is displayed.

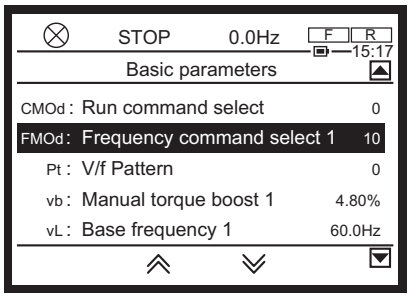


4

5 Select "10: Touch wheel 1 (power off or press OK to save)" and press the [OK] key.



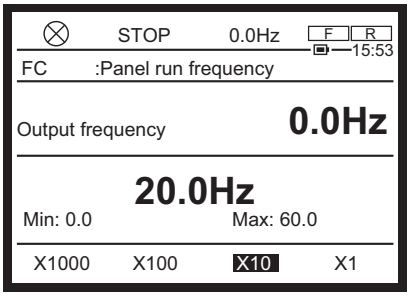
The basic parameter screen is displayed.
Check that the setting value of <FMOd: Frequency command select 1> is "10".



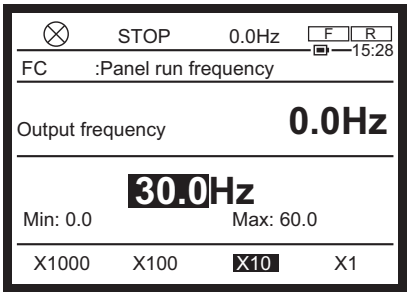
4

6 Press the [ESC] key or [F1] to [F4] keys to switch to the [Standard mode] screen.

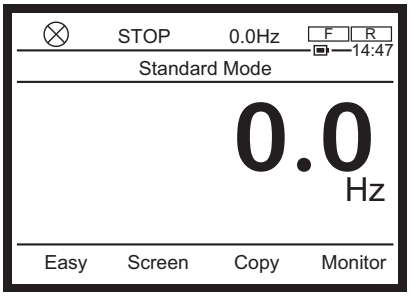
7 In [Standard mode], press the [OK] key.
The setting screen of <FC: Panel run frequency> is displayed.
If you leave this setting screen as it is, the screen returns to the [Standard mode] screen for a few seconds later.



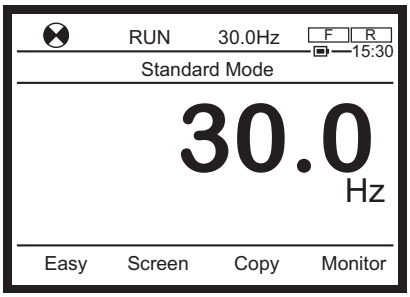
8 Change the frequency command value with the touch wheel.
When the setting value is changed, the value on the lower side of the screen is highlighted.
In the example on the right, it is set to 30.0 Hz. This becomes the frequency command value.



9 Press the [OK] key.
The screen returns to the [Standard mode] screen.



10 When you press the [RUN] key, the motor starts running.
In the main area of the [Standard mode] screen, the output frequency is displayed.
The motor accelerates according to the setting of <ACC: Acceleration time 1>, and its frequency changes to the frequency command value set with <FC: Panel run frequency> and becomes stable.
In the example on the right, it is 30.0 Hz.



The following are always displayed in the status area on the upper side of the screen regardless of display mode.
(From the left)

- The icon is rotating
- Operation status "RUN"
- Frequency command (display contents vary depending on the setting of the parameter)
- Run command icon RUN STOP

Memo	• You can change the frequency command value by pressing the [OK] key in [Standard mode] and displaying the setting screen of <FC: Panel run frequency> during run. • When you change the frequency command value with the touch wheel, the output frequency changes accordingly.

11 To stop the motor, press the [STOP] key.
The motor decelerates according to the setting of <dEC: Deceleration time 1> and stops.

4. 3. 2 [Operation example 2] Switching forward/reverse run with [FWD/REV] key during panel run

Switch the direction of rotation of the motor during run only by the operation panel.

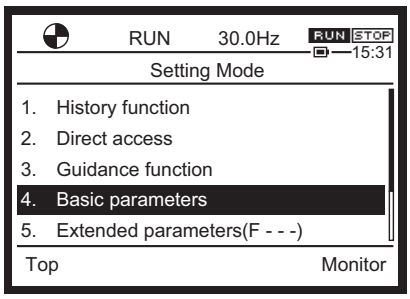
- Make setting so that forward run/reverse run can be input from the operation panel.
- The parameter to be set is <Fr: Panel Fwd/Rev run select>.

Reference	• How to switch the display mode of the operation panel -> Refer to [3. 1. 2] • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details of <Fr: Panel Fwd/Rev run select> -> Refer to [5. 3. 9]

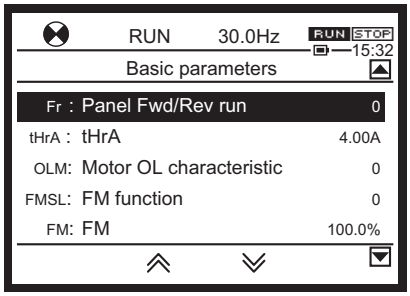
1 Operate the motor with the operation panel according to [4. 3. 1].

2 Switch to [Setting mode].

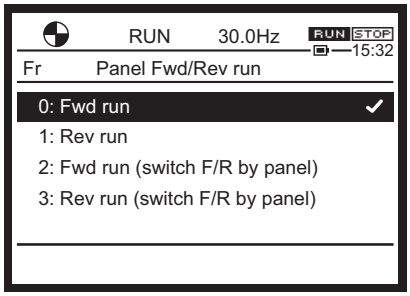
3 Select "4. Basic parameter" and press the [OK] key.
The basic parameter screen is displayed.



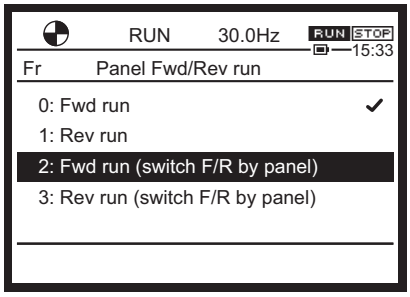
4 Select <Fr: Panel Fwd/Rev run select> and press the [OK] key.



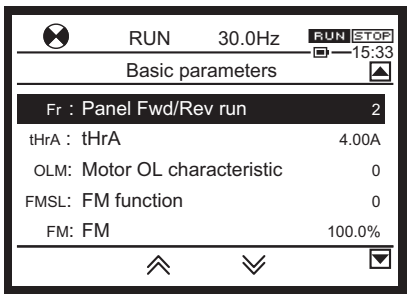
The setting screen is displayed.



5 Select "2: Fwd run (switchable F/R by panel)" and press the [OK] key.



The basic parameter screen is displayed.
Check that the setting value of <Fr: Panel Fwd/Rev run select> is "2."



Memo

- When you select "1: Rev run" and press the [OK] key, the motor decelerates and starts reverse run. [FWD/REV] key operation is not possible.

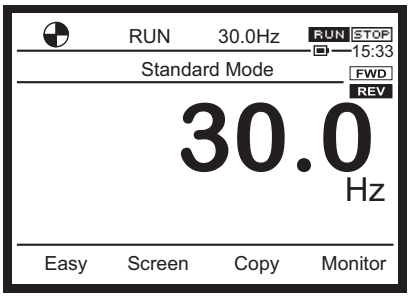
4

6 Press the [ESC] key or [F1] to [F4] keys to switch to the [Standard mode] screen.

- Icon of direction of rotation FWD REV

Only when the [FWD]/[REV] key is enabled, FWD REV FWD REV is displayed in the mode name area in the upper right of the screen.

When the motor is running forward, FWD REV is highlighted. When it is running reversely, FWD REV is highlighted.



The following are always displayed in the status area on the upper side of the screen regardless of display mode. (From the left)

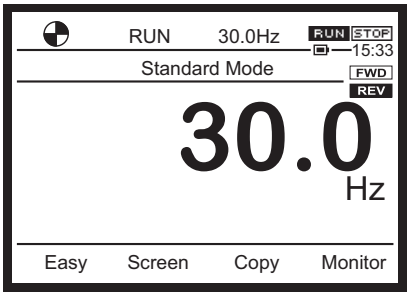
- The icon is rotating (clockwise for forward run)
- Operation status "RUN"
- Frequency command (display contents vary depending on the setting of the parameter)
- Run command icon RUN STOP

Memo

- You can also check the direction of rotation of the motor on the [Monitor mode] screen. For details, refer to [8. 1. 1].

7 When you press the [FWD/REV] key, the direction of rotation of the motor is switched to reverse run. The motor decelerates and shows 0.0 Hz once. Then, it accelerates to the frequency command value set with <FC: Panel run frequency> and becomes stable.
You can check the direction of rotation of the motor with the following display.

- The icon is rotating counterclockwise



• Icon of direction of rotation 

8 When you press the [FWD/REV] key again, the direction of rotation of the motor is switched to forward run.
The motor decelerates and shows 0.0 Hz once. Then, it accelerates to the value set with <FC: Panel run frequency> and becomes stable.

4. 4 Basic terminal run methods

⚠ WARNING	
Prohibited	• Do not touch terminals when the inverter's power is on even if the motor is stopped. Touching the terminals while voltage is applied will result in electric shock. • Do not touch switches when the hands are wet and do not try to clean the inverter with a damp cloth. This will result in electric shock.
Mandatory action	• Turn the power on only after mounting the front cover. When you use the inverter housed in the cabinet with the front cover removed, always close the cabinet doors first and then turn the power on. If you turn the power on with the front cover or the cabinet doors open, this will result in electric shock.

This section introduces terminal run methods with basic examples.
Input a run command and a frequency command from a digital signal (switch/relay, etc.) or analog signal (voltage/current) from the external.

4. 4. 1 [Operation example 1] Run/stop with external signal (frequency command with operation panel)

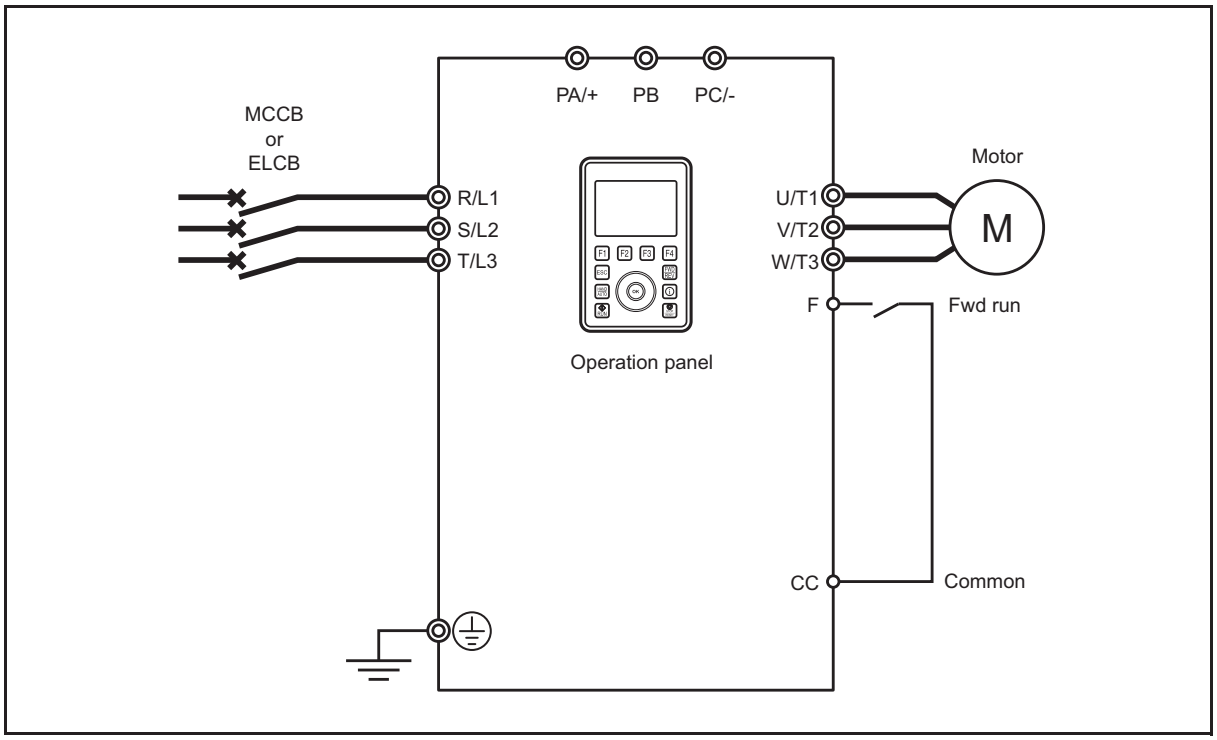
Input a run command externally and a frequency command from the operation panel.

- First, check connection from external contacts such as switch/relays to the control terminal.

Here is a case where the operation is controlled by a switch.

- Next, make setting so that a run command can be input externally (terminal) and a frequency command from the operation panel.
- Then, set a frequency command on the operation panel. The motor will run with this frequency.
- After setting the above, operate the motor by using an external switch.
- The parameters to be set are <CMOd: Run command select> and <FMOd: Frequency command select 1>.
- Control connection is explained in the case of sink logic.

Reference	
	• How to switch the display mode of the operation panel -> Refer to [3. 1. 2] • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details of <CMOd: Run command select>, and <FMOd: Frequency command select 1> -> Refer to [5. 2. 1] • Difference of connection between sink logic and source logic -> Refer to [2. 3. 5] • Details of operation by external signals -> Refer to [Chapter 7]

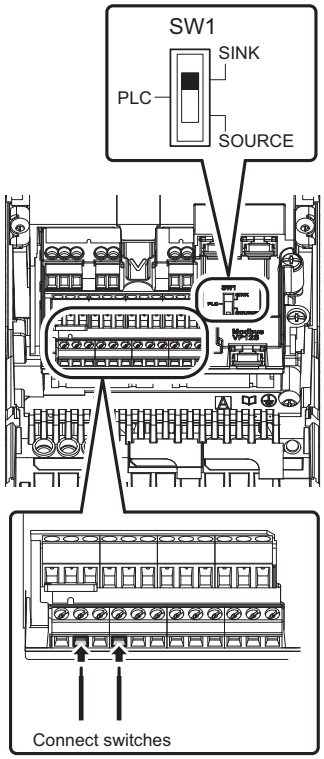


4

1 Turn off the power of the inverter.

2 Remove the covers of the control terminal block and parts required for connection. Covers to be removed vary depending on the type of the inverter.
For details of how to remove the covers, refer to [2. 2].

3 Check that the slide switch [SW1] is on the SINK side.
If it is set to PLC/SOURCE side, set it to the SINK side.
For details of the slide switch, refer to [2. 3. 5].



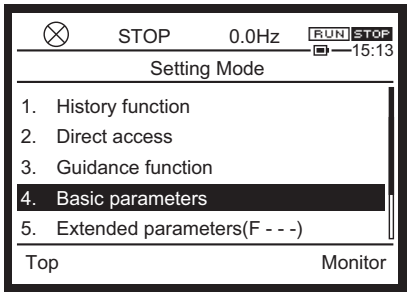
4 Check connection between the terminal [F] and terminal [CC] of the control terminal block.

The terminal [F] is used for a forward run command in the default setting.
For details of positions of the control terminal block and terminals, refer to [2. 3. 5].

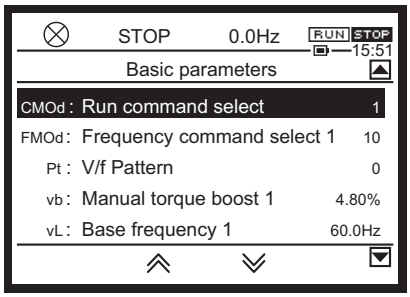
5 Mount the covers.
For how to mount them, refer to [2. 2].

6 Turn on the power of the inverter.

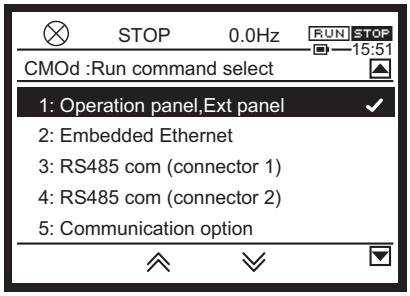
7 Switch to [Setting mode].
Select "4. Basic parameter" and press the [OK] key. The basic parameter screen is displayed.



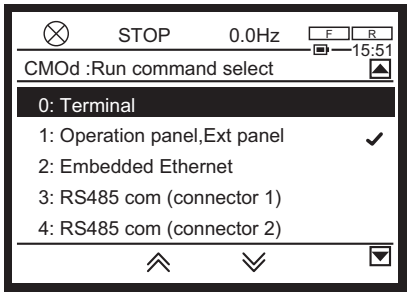
8 Select <CMOd: Run command select> and press the [OK] key.
You can also select <CMOd: Run command select> on the [Easy mode] screen.



The setting screen is displayed.

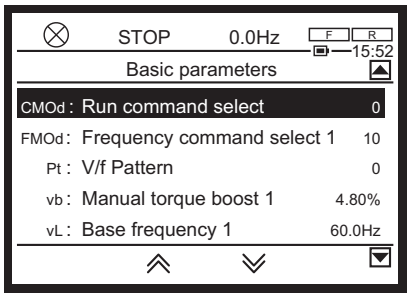


9 Select "0: Terminal" and press the [OK] key.



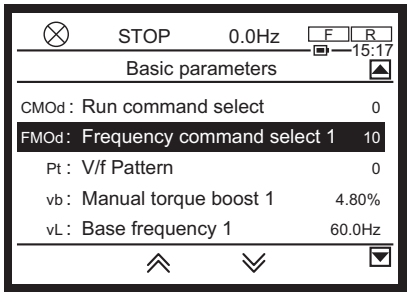
The basic parameter screen is displayed.
Check that the setting value of <CMOd: Run command select> is "0."

10 Select <FMOd: Frequency command select 1> and press the [OK] key.
The setting screen is displayed.



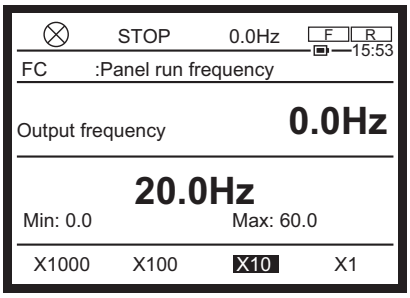
4

11 Select "10: Touch wheel 1 (power off or press OK to save)" and press the [OK] key.
The basic parameter screen is displayed.
Check that the setting value of <FMOd: Frequency command select 1> is "10".

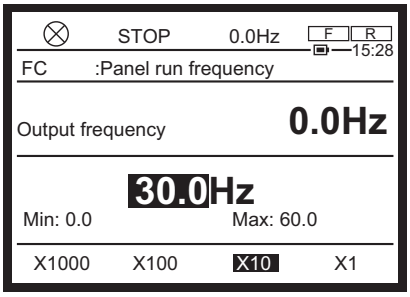


12 Press the [ESC] key or [F1] to [F4] keys to switch to the [Standard mode] screen.

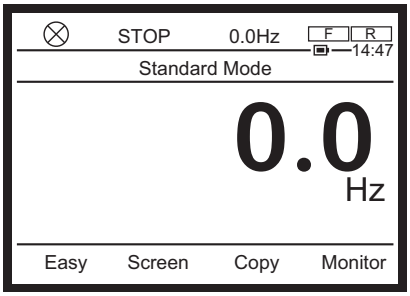
13 In [Standard mode], press the [OK] key.
The setting screen of <FC: Panel run frequency> is displayed.
If you leave this setting screen as it is, the screen returns to the [Standard mode] screen for a few seconds later.



14 Change the frequency command value with the touch wheel.
When the setting value is changed, the value on the lower side of the screen is highlighted.
In the example on the right, it is set to 30.0 Hz. This becomes the frequency command value.

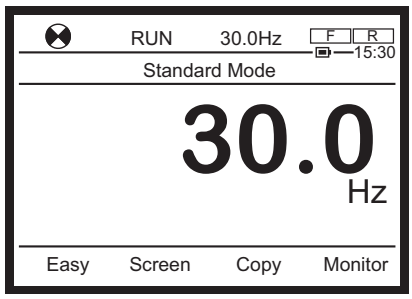


15 Press the [OK] key.
The screen returns to the [Standard mode] screen.



4

16 When you turn on the external switch, the motor starts running.
In the main area of the [Standard mode] screen, the output frequency is displayed.
The motor accelerates according to the setting of <ACC: Acceleration time 1>, and its frequency changes to the frequency command value set with <FC: Panel run frequency> and becomes stable.
In the example on the right, it is 30.0 Hz.
The following are always displayed in the status area on the upper side of the screen regardless of display mode. (From the left)



- The icon is rotating
- Operation status "RUN"
- Frequency command (display contents vary depending on the setting of the parameter)
- Run command icon F R

17 To stop the motor, turn off the external switch.
The motor decelerates according to <dEC: Deceleration time 1> and stops.

Memo	• Reverse run of the motor can be performed by connecting an external contact (switch/relay, etc.) between the terminal [R] and terminal [CC] similarly to the procedure above. For details, refer to [Chapter 7].

4. 4. 2 [Operation example 2] Setting frequency with external potentiometer/analog signal

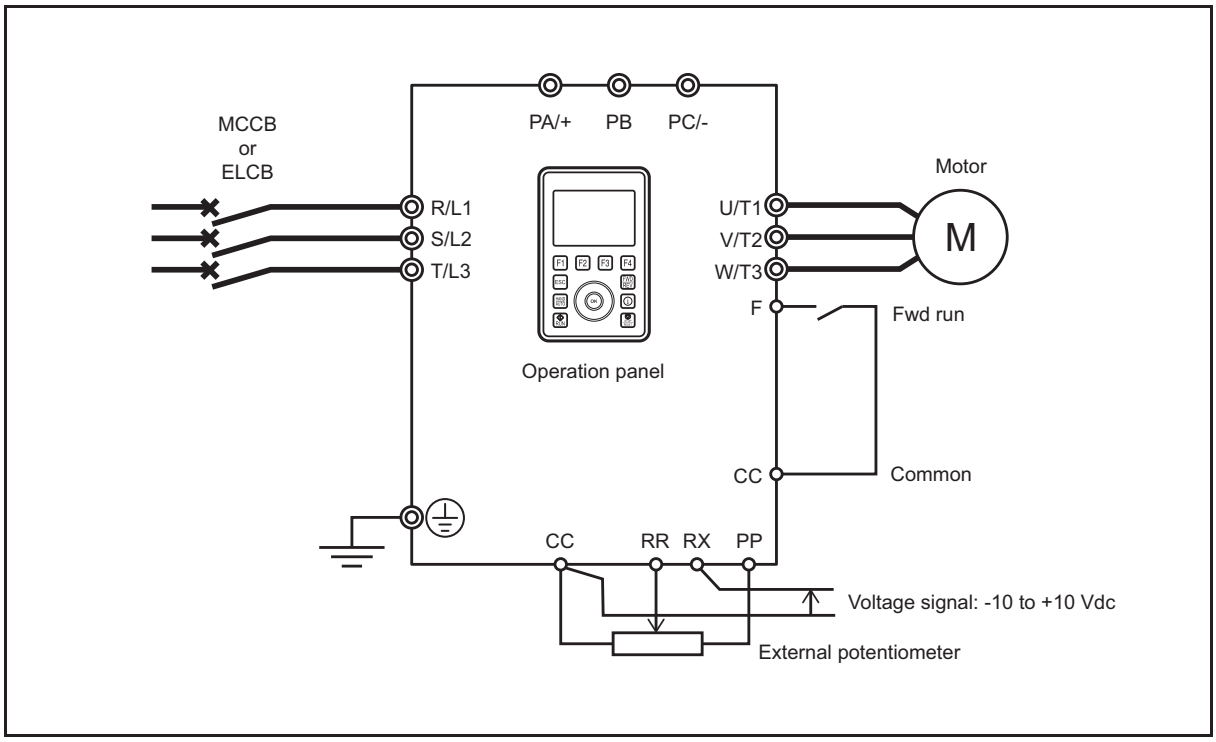
Input both run command and frequency command externally.
Set the frequency command with a potentiometer connected to outside or a voltage/current signal from outside.

- First, check connection from external contacts such as switch/relays to the control terminal.

Here is a case where run/stop is input with a switch and a frequency command is input with a potentiometer (1 - 10 kΩ, 1/4 W) or voltage (0 - 10 Vdc, -10 to +10 Vdc).

- Next, make setting so that a run command and a frequency command can be input externally (terminal).
- After setting the above, operate the motor by using the external switch/potentiometer or voltage signal.
- The parameters to be set are <CMOd: Run command select> and <FMOd: Frequency command select 1>.
- Control connection is explained in the case of sink logic.

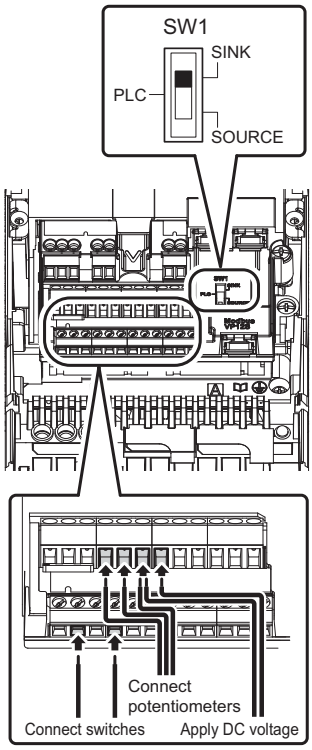
Reference	• How to switch the display mode of the operation panel -> Refer to [3. 1. 2] • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details of <CMOd: Run command select>, and <FMOd: Frequency command select 1> -> Refer to [5. 2. 1] • Difference of connection between sink logic and source logic -> Refer to [2. 3. 5] • Details of operation by external signals -> Refer to [Chapter 7]



1 Turn off the power of the inverter.

2 Remove the covers of the control terminal block and parts required for connection. Covers to be removed vary depending on the type of the inverter.
For details of how to remove the covers, refer to [2. 2].

3 Check that the slide switch [SW1] is on the SINK side.
If it is set to PLC/SOURCE side, set it to the SINK side.
For details of the slide switch, refer to [2. 3. 5].



4 Check connection of the terminals to be used on the control terminal block.
For details of positions of the control terminal block and terminals, refer to [2. 3. 5].

Digital input terminals [F], [CC]
- Connect the switch and execute forward run of the motor.

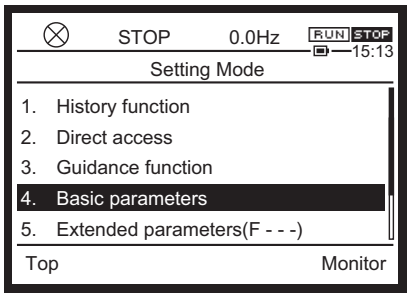
Potentiometer input terminals [PP], [RR], [CC]
- Connect both ends of the potentiometer to the terminal [PP] and terminal [CC], and the sliding terminal to the terminal [RR]. Rotate the potentiometer to change the frequency command. The terminal [PP] is used for a 10 Vdc power supply for analog input.

Analog input terminals [RX], [CC]
- Input 0 - 10 Vdc or -10 to +10 Vdc as a frequency command signal between the terminal [RX] and terminal [CC].

5 Mount the covers.
For how to mount them, refer to [2. 2].

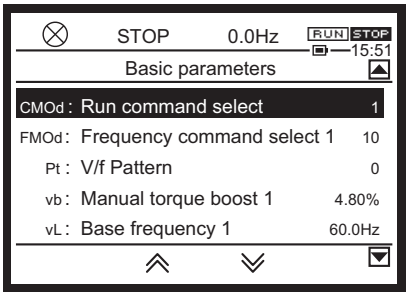
6 Turn on the power of the inverter.

7 Switch to [Setting mode].
Select "4. Basic parameter" and press the [OK] key. The basic parameter screen is displayed.

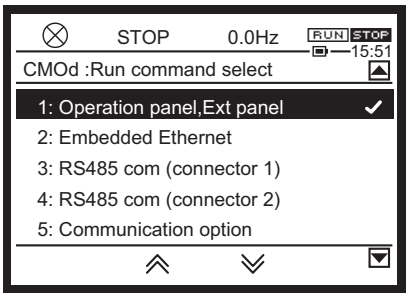


4

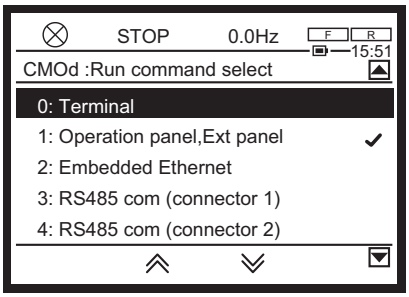
8 Select <CMOd: Run command select> and press the [OK] key.
You can also select <CMOd: Run command select> on the [Easy mode] screen.



The setting screen is displayed.

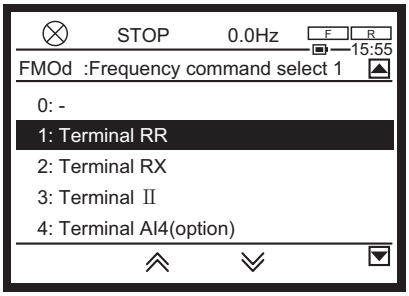


9 Select "0: Terminal" and press the [OK] key.
The basic parameter screen is displayed.
Check that the setting value of <CMOd: Run command select> is "0."



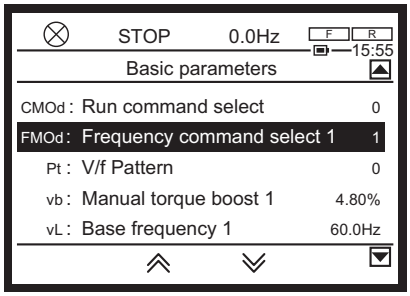
10 Select <FMOd: Frequency command select 1> and press the [OK] key.
The setting screen is displayed.

11 Select "1: Terminal RR" and press the [OK] key.



4

The basic parameter screen is displayed.
Check that the setting value of <FMOd: Frequency command select 1> is "1."
In this setting, the voltage signal input to the terminal [RR] should be the frequency command.
Here, the voltage input to the terminal [RR] is adjusted with the potentiometer.



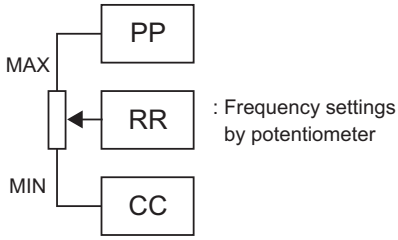
12 Press the [ESC] key or [F1] to [F4] keys to switch to the [Standard mode] screen.
In the main area of the [Standard mode] screen, the output frequency (0.0 Hz) is displayed.

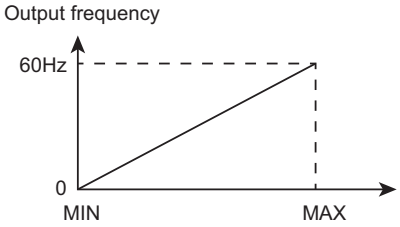
13 Turn on the external switch.

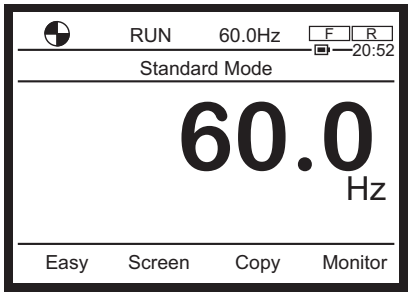
4

14 When you rotate the potentiometer, the frequency command value increases, and the motor starts running.
The following are always displayed in the status area on the upper side of the screen regardless of display mode. (From the left)

- The icon is rotating
- Operation status "RUN"
- Frequency command (display contents vary depending on the setting of the parameter)
- Run command icon F R





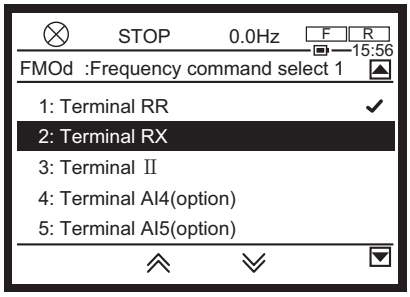


Memo

- In some cases, for example, when the potentiometer is set to the maximum/minimum, you can set the two frequency command points. The default setting is 0.0 Hz/60.0 Hz. For details, refer to [7. 3. 2].

15 When you turn off the external switch, the motor decelerates and stops.

16 In [Setting mode], change the setting value of <FMOd: Frequency command select 1> to "2: Terminal RX."
In this setting, set the frequency command with the voltage signal (0 - 10 Vdc or -10 to +10 Vdc) connected to the terminal [RX].
Even if the potentiometer is connected to the terminal [RR], a frequency command by the potentiometer is disabled.

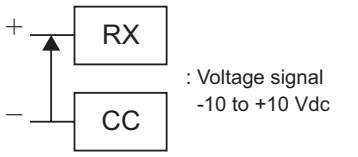


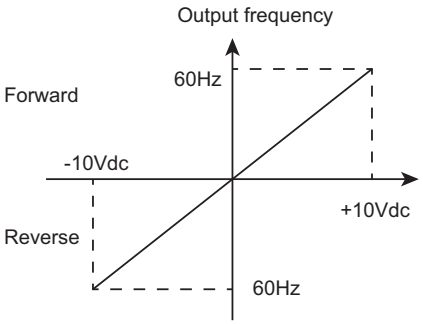
17 In [Standard mode], turn on the external switch.

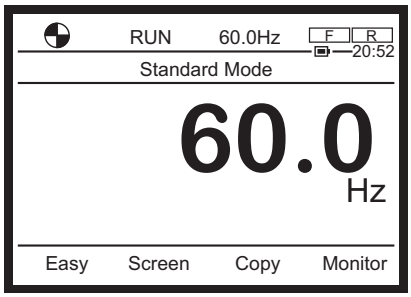
4

18 When the voltage signal is increased from 0 V, the frequency command is increased, and the motor starts running.
By inputting a positive/negative voltage signal, forward run/reverse run can be switched.
The following are always displayed in the status area on the upper side of the screen regardless of display mode. (From the left)

- The icon is rotating
- Operation status "RUN"
- Frequency command (display contents vary depending on the setting of the parameter)
- Run command icon F R







Memo

- In some cases, for example, when the voltage is set to the minimum (0 V)/maximum (+10 V), you can set the two frequency command points. The default setting is 0 V: 0.0 Hz, 10 V: 60.0 Hz.
For details, refer to [7. 3. 4].
Set the input voltage to the terminal [RX] to "0: 0 - +10 V" or "1: -10 to +10 V" with <F107: Terminal RX input voltage select>.

19 When you turn off the external switch, the motor decelerates and stops.

Memo	• You can also change the input specification of the terminal [RR] to PTC input, etc. For details, refer to [6. 2. 3].

4. 4. 3 [Operation example 3] Switching run/stop and frequency with external switch

Digital input both a run command and a frequency command externally.

- First, check connection from external contacts such as switch/relays to the control terminal.

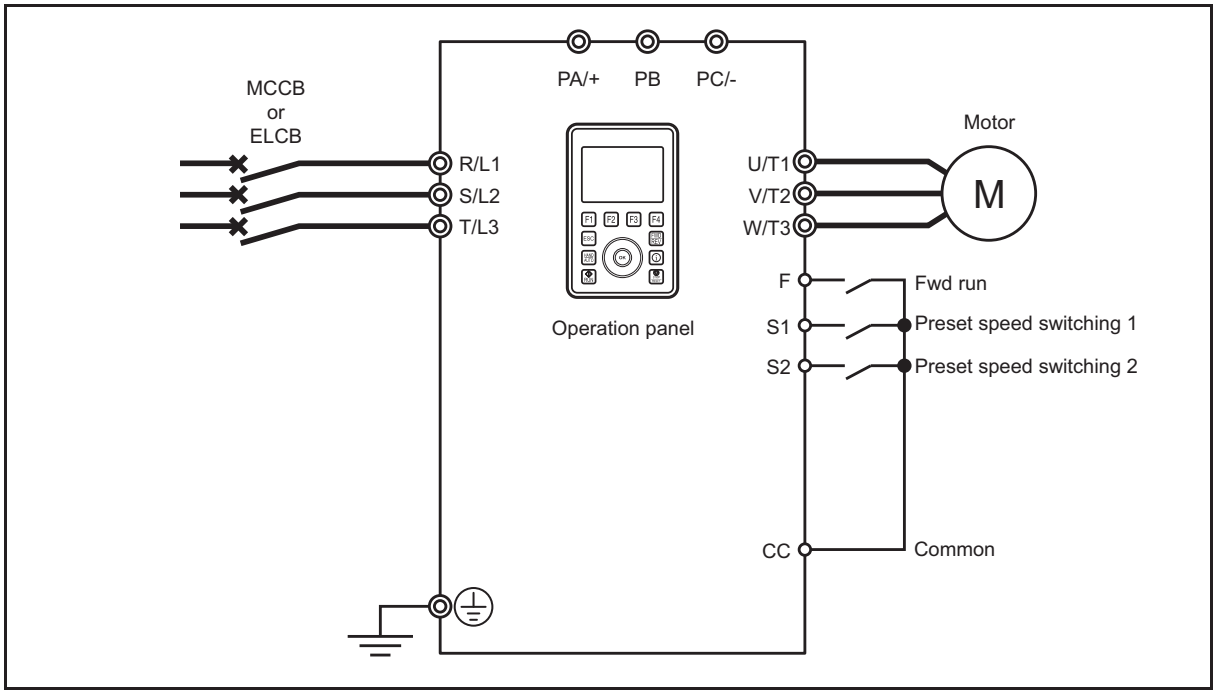
Here is a case where run/stop is input by a switch and a frequency command is operated by 3-speed operation (controlled with two relays).

- Next, make setting so that a run command and a frequency command can be input externally (terminal).
- After setting the above, operate the motor by using the external switch or external signal.
- The parameters to be set are <CMOd: Run command select>, <Sr1: Preset speed 1>, <Sr2: Preset speed 2>, and <Sr3: Preset speed 3>.
- Control connection is explained in the case of sink logic.

4

Reference

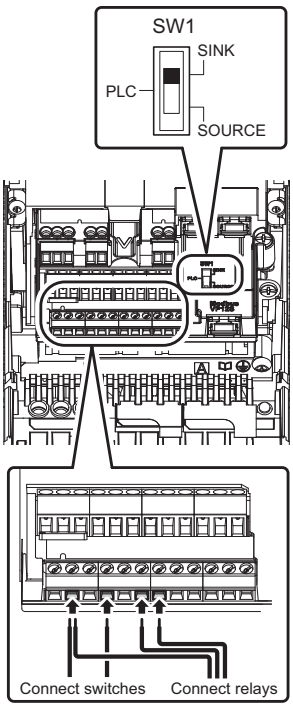
- How to switch the display mode of the operation panel -> Refer to [3. 1. 2]
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details of <CMOd: Run command select> -> Refer to [5. 2. 1]
- Difference of connection between sink logic and source logic -> Refer to [2. 3. 5]
- Details of operation by external signals -> Refer to [Chapter 7]



1 Turn off the power of the inverter.

2 Remove the covers of the control terminal block and parts required for connection. Covers to be removed vary depending on the type of the inverter.
For details of how to remove the covers, refer to [2. 2].

3 Check that the slide switch [SW1] is on the SINK side.
If it is set to PLC/SOURCE side, set it to the SINK side.
For details of the slide switch, refer to [2. 3. 5].



4 Check connection of the terminals to be used on the control terminal block.

For details of positions of the control terminal block and terminals, refer to [2. 3. 5].

Digital input terminals [F], [CC]
- Connect the switch and execute forward run of the motor.

Digital input terminals [S1], [CC]
- Connect relay 1 to perform preset speed operation.

Digital input terminals [S2], [CC]
- Connect relay 2 to perform preset speed operation.

Memo
- With combination of relay 1 ON, relay 2 ON, and both relay 1 and relay 2 ON, you can set three types of frequency command values.

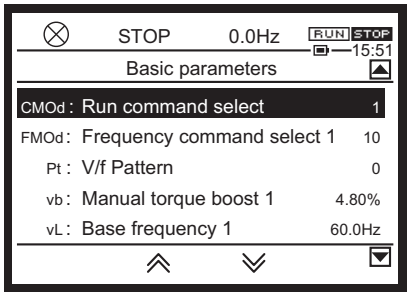
5 Mount the covers.
For how to mount them, refer to [2. 2].

6 Turn on the power of the inverter.

7 Switch to [Setting mode].

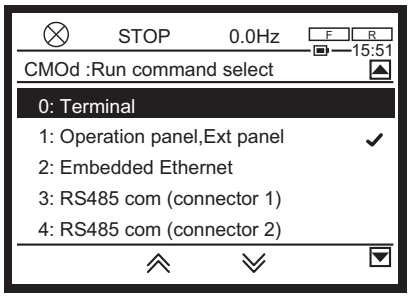
8 Select "4. Basic parameter" and press the [OK] key.
The basic parameter screen is displayed.

9 Select <CMOd: Run command select> and press the [OK] key.

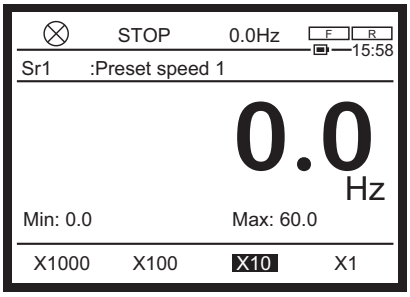


The setting screen is displayed.

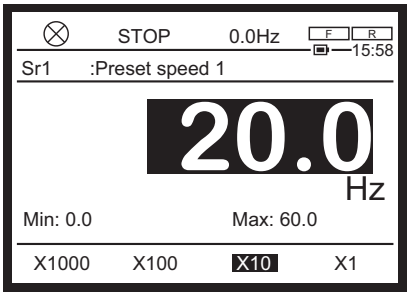
10 Select "0: Terminal" and press the [OK] key.
The basic parameter screen is displayed.
Check that the setting value of <CMOd: Run command select> is "0."



11 Select <Sr1: Preset speed 1> and press the [OK] key.
The setting screen is displayed.
The default setting is 0.0 Hz.



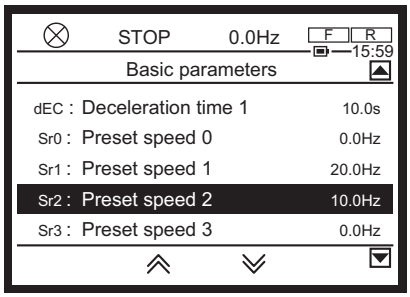
12 Change the setting value with the touch wheel.
When the setting value is changed, the value on the screen is highlighted.
In the example on the right, it is set to 20.0Hz. This is the frequency command value of Preset speed 1.



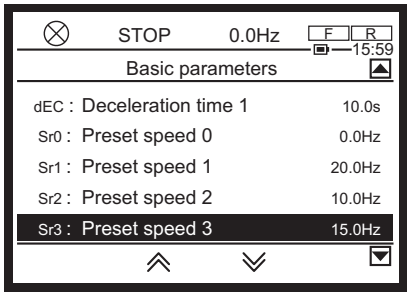
4

13 Press the [OK] key.
The screen returns to the basic parameter screen.

14 Similarly, select <Sr2: Preset speed 2> and <Sr3: Preset speed 3> and change the setting values.



In the example on the right, <Sr2: Preset speed 2> is set to 10.0 Hz and <Sr3: Preset speed 3> to 15.0 Hz.

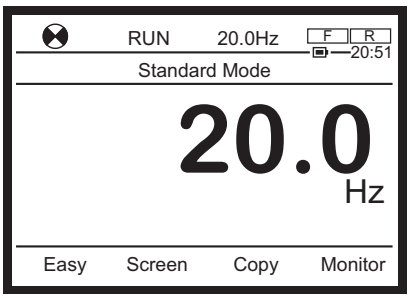


15 Press the [OK] key to return to the basic parameter screen.

16 Turn on the external switch.
Leave the two relays off.

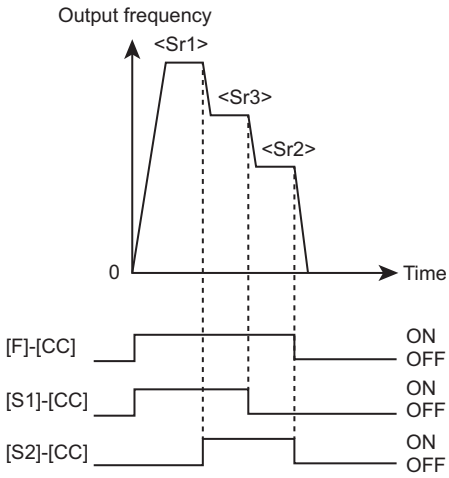
17 When you turn on relay 1, the frequency command value of <Sr1> is enabled, and the motor starts running.
In the main area of the [Standard mode] screen, the output frequency is displayed.

The output frequency changes to the frequency command value set with <Sr1: Preset speed 1> and becomes stable.
In the example on the right, it is 20.0 Hz.



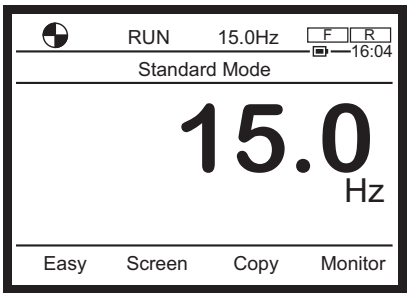
The following are always displayed in the status area on the upper side of the screen regardless of display mode. (From the left)

- The ⊗ icon is rotating
- Operation status "RUN"
- Frequency command (display contents vary depending on the setting of the parameter)
- Run command icon F R



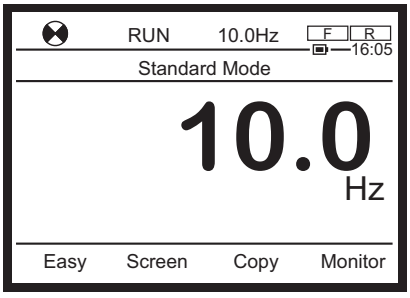
18 When you turn on relay 2 with relay 1 on, the frequency command value of <Sr3> is enabled, and the output frequency changes.

The output frequency changes to the frequency command value set with <Sr3: Preset speed 3> and becomes stable.
In the example on the right, it is 15.0 Hz.



19 When you turn off relay 1 with relay 2 on, the frequency command value of <Sr2> is enabled, and the output frequency changes.

The output frequency changes to the frequency command value set with <Sr2: Preset speed 2> and becomes stable.
In the example on the right, it is 10.0 Hz.



20 When you turn off the external switch, the motor decelerates and stops.

Memo

- For details of preset speed operation, refer to [5. 3. 7].

5 [Fundamental operation] How to use parameters

Frequently set parameters include default 10 parameters in [Easy mode] and basic parameters. This chapter describes these parameters.

5. 1 Table of parameter access

5. 2 Settings of main parameters

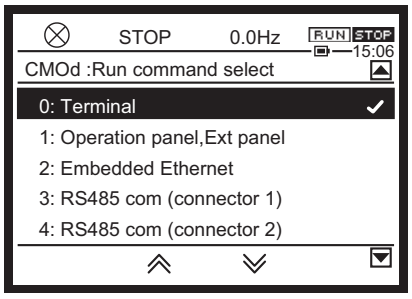
This section describes how to select run and frequency commands required for operating the motor, how to limit the output frequency, how to set acceleration/deceleration time, how to set the electronic thermal for motor protection, and how to adjust the meter.

5. 2. 1 Selecting how to input run and frequency commands

(1) Selecting how to input run/stop

<CMOd: Run command select>

Basic parameter → Easy mode



■ **Function**

Select where to input a run command to the inverter.

■ **Parameter setting**

Title	Parameter name	Adjustment range	Default setting
CMOd	Run command select	0: Terminal 1: Operation panel, Extension panel 2: Embedded Ethernet 3: RS485 communication (connector 1) 4: RS485 communication (connector 2) 5: Communication option	0

■ Selecting a setting value

0: Terminal

Run/stop the inverter with an external ON/OFF signal.
For how to set terminals and parameters to be used, refer to [4. 4].
For details of operation by external signals, refer to [Chapter 7].

1: Operation panel, Extension panel

Press the [RUN], [STOP] key on the operation panel to run/stop the inverter.
You can do it even on the optional extension panel.
For how to set this value, refer to [4. 3].

2: Embedded Ethernet

Connect a communication cable to the Ethernet connector 1 or 2, and run/stop the inverter through the Ethernet communication.
For details, refer to "Communication Function Instruction Manual" (E6582125).

5

3: RS485 communication (connector 1)

This has the operation panel mounted when shipped from the factory. Remove the operation panel and connect a communication cable, and you can run/stop the inverter through the RS485 communication.
For details, refer to E6582143.

4: RS485 communication (connector 2)

Connect a communication cable to the RS485 communication connector 2 next to the control terminal block. Then, you can run/stop the inverter through the RS485 communication.
For details, refer to [6. 38].

5: Communication option

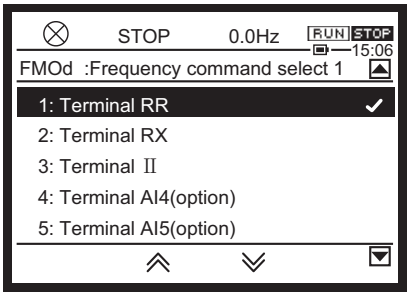
Run/stop the inverter with a communication option command.
For details, refer to Each "Communication function instruction manual."

Memo	• Assign the input terminal function "108: Terminal operation priority" to an unused input terminal. When the input terminal is ON, run command is terminal run. For details, refer to the table of input terminal functions in [7. 2. 1] or [11. 8]. • The priority command from the communication or terminal precedes the command set with <CMOd: Run command select>.

(2) Selecting how to input a frequency command

<FMOd: Frequency command select 1>

Basic parameter → Easy mode



■ Function

Select where to input a frequency command to the inverter.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
FMOd	Frequency command select 1	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 9: - 10: Touch wheel 1 (power off or press OK to save) 11: Touch wheel 2 (press OK to save) 12: Sr0 13, 14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18, 19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	1

5

■ Selecting a setting value

1: Terminal RR

Analog signal: Input a frequency command with 0 - 10 Vdc.
For details of the control terminal, refer to [2. 3. 5].
For details of operation by external signals, refer to "Chapter 7".

2: Terminal RX

Analog signal: Input a frequency command with -10 to +10Vdc.
For details of the control terminal, refer to [2. 3. 5].
For details of operation by external signals, refer to "Chapter 7".

3: Terminal II

Analog signal: Input a frequency command with 4 - 20 mAdc (0 - 20 mAdc).
For details of the control terminal, refer to [2. 3. 5].

For details of operation by external signals, refer to "Chapter 7".

4: Terminal AI4 (option)
The terminal [AI4] is included in the cassette option. Input a frequency command with an analog signal.
For details of the optional terminal [AI4], refer to [10. 4. 1].

5: Terminal AI5 (option)
The terminal [AI5] is included in the cassette option. Input a frequency command with an analog signal.
For details of the optional terminal [AI5], refer to [10. 4. 1].

10: Touch wheel 1 (power off or press OK to save)
Use the touch wheel on the operation panel to input a frequency command.
Even if you turn off the power supply without pressing the [OK] key, a frequency command value will be saved.
On the extension panel, use the up and down arrow keys to input a frequency command.
Even if you turn off the power supply without pressing the [ENT] key, a frequency command value will be saved.
For how to set this value, refer to [4. 3. 1] and [4. 4. 1].

11: Touch wheel 2 (press OK to save)
Use the touch wheel on the operation panel to input a frequency command.
Press the [OK] key, and a frequency command value will be saved.
On the extension panel, use the up and down arrow keys to input a frequency command.
Press the [ENT] key, a frequency command value will be saved.
For how to set this value, refer to [4. 3. 1] and [4. 4. 1].

12: Sr0
Set the value of the parameter <Sr0: Preset speed 0> as a setting value of a frequency command.
For details of <Sr0: Preset speed 0>, refer to [5. 3. 7].

15: Terminal Up/Down frequency
Input a frequency command with an Up/Down command to the input terminal.
For details of how to set parameters and terminals, refer to [6. 6. 5].

16: Pulse train
Input a frequency command with a pulse train signal (up to 30 kpps) to the terminals [S4] and [S5].
For how to set this value, refer to [6. 6. 4].

17: High resolution pulse train (option)
Input a frequency command with a high resolution pulse train signal to the input terminal.
For how to set this value, refer to "Digital Encoder Instruction Manual" (E6582148).

20: Embedded Ethernet
Connect a communication cable to the Ethernet connector 1 or 2, and input a frequency command through the Ethernet communication.
For details, refer to "Ethernet Function Instruction Manual" (E6582125).

21: RS485 communication (connector 1)
Remove the operation panel, connect a communication cable, and input a frequency command through the RS485 communication.
For details, refer to [6. 38].

22: RS485 communication (connector 2)
Connect a communication cable to the RS485 communication connector 2 next to the control terminal block, and input a frequency command through the RS485 communication.
For details, refer to [6. 38].

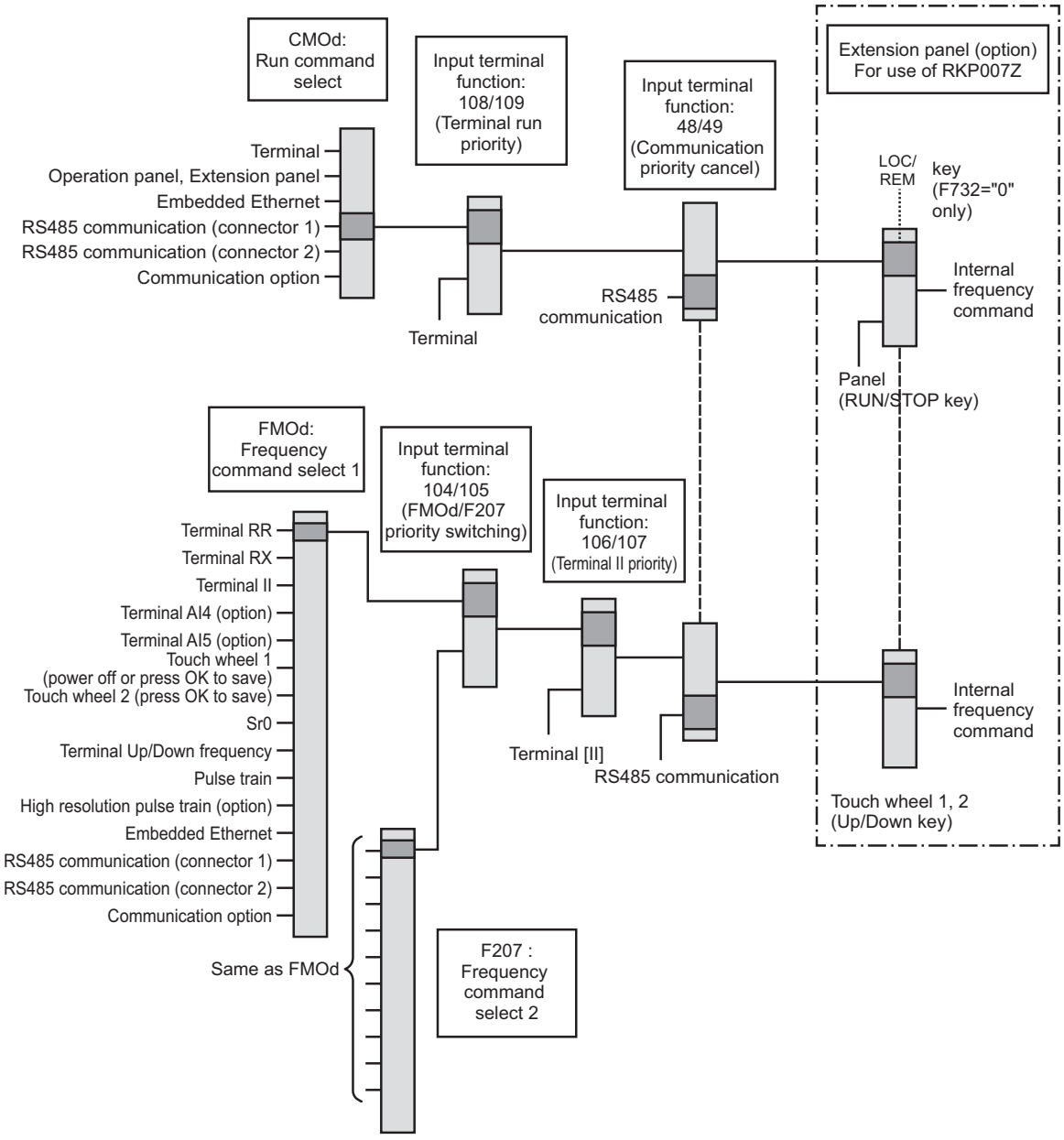
23: Communication option
Input a frequency command with a communication option command.
For details, refer to Each "Communication function instruction manual."

Memo

- The following functions set for the input terminal are always enabled regardless of the settings of <CMOd: Run command select> and <FMOd: Frequency command select 1>.
  - Reset (enabled at trip only)
  - Standby
  - External thermal trip
  - Coast stop command
- Set <CMOd: Run command select> and <FMOd: Frequency command select 1> after stopping the inverter.
  You cannot set them during run.
  However, when <F736: CMOd/FMOd change lockout during run> is set to "0: Unlocked", you can change them during run. For details, refer to [6. 34. 1].
- The priority command from the communication or terminal precedes the setting of <FMOd: Frequency command selection 1>.
- <F207: Frequency command select 2> is provided.
  Use <FMOd: Frequency command select 1> in the default setting. However, you can switch between two frequency command selections. For details, refer to [5. 4. 1].

(3) Example of switching run and frequency commands

The figure below shows an example of switching run and frequency commands.

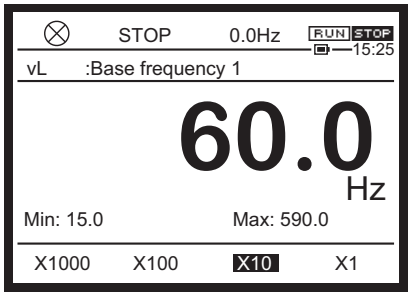


5

5. 2. 2 Setting rated frequency and rated voltage of motor

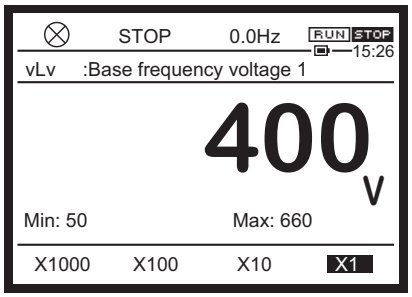
<vL: Base frequency 1>

Basic parameter



<vLv: Base frequency voltage 1>

Basic parameter



5

■ Function

These parameters are used to set the rated frequency and rated voltage of the motor according to machinery. They are important parameters to decide the control range of the inverter.

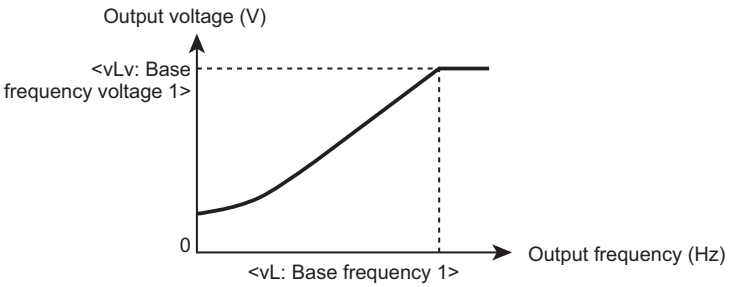
■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
vL	Base frequency 1	15.0 - 590.0	Hz	50.0/60.0 *1
vLv	Base frequency voltage 1	240V class: 50-330 480V class: 50-660	V	*1

*1 Depending on the setup menu. Refer to [5. 3. 10].
The value of <VL> should be equal or smaller than that of <FH>.

■ Reference of setting

Set the rated frequency (50 Hz, 60 Hz, etc.) and rated voltage (200 V, 220 V, etc.) of the motor according to the specifications of machinery.
The inverter is controlled based on the rating of the motor specified with these parameters.



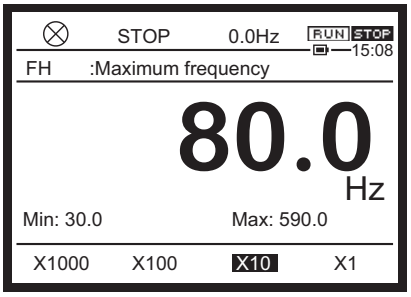
Memo	• You can set four types of motor rating. For details including <F170: Base frequency 2>, refer to [6. 4].

5. 2. 3 Setting the output frequency limit

(1) Setting the maximum frequency of the inverter

<FH: Maximum frequency>

Basic parameter



■ Function

Set the maximum value of the frequency output from the inverter.
This frequency is also the criteria of acceleration and deceleration time.

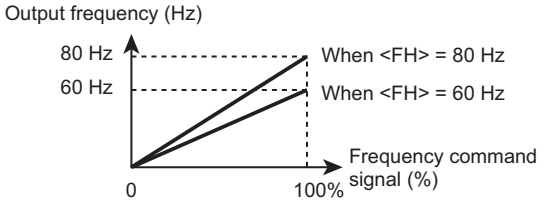
■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
FH	Maximum frequency	30.0 - 590.0	Hz	80.0 *1

*1 Depending on the setup menu. Refer to [5. 3. 10].
The value of <FH> should be equal or greater than that of <VL>.

■ Guideline for the setting

Set the maximum frequency suited for the rating of the motor and load.



Memo

- Set <FH: Maximum frequency> after stopping the inverter. You cannot set it during run.
- When increasing the value of <FH: Maximum frequency>, you should also set the corresponding value of <UL: Upper limit frequency> as required. --> Refer to the following "Setting the upper and lower limits of the output frequency".

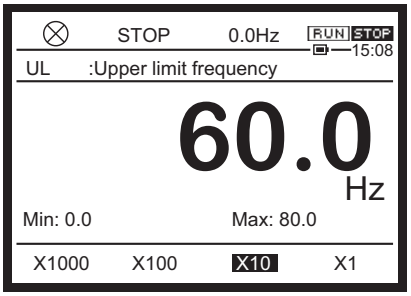
(2) Setting the upper and lower limits of the output frequency

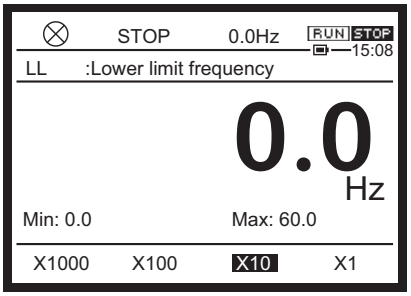
<UL: Upper limit frequency>

Basic parameter → Easy mode

<LL: Lower limit frequency>

Basic parameter → Easy mode





5

■ Function

Set the upper limit frequency to decide the upper limit of the output frequency and the lower limit frequency to decide the lower limit.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
UL	Upper limit frequency	0.0 - FH	Hz	50.0/60.0 *1
LL	Lower limit frequency	0.0 - UL	Hz	0.0

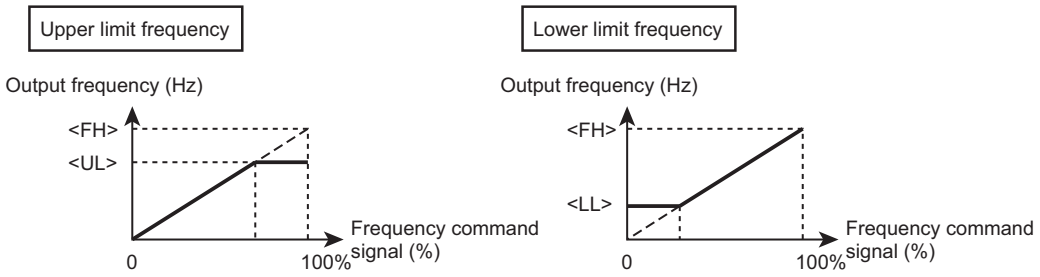
*1 Depending on the setup menu. Refer to [5. 3. 10].

■ Guideline for the setting

Set <UL: Upper limit frequency> to a value which is ten times or less the values of <vL: Base frequency 1>.

If the output frequency is exceeding to 10 times of <vL>, the "A-05" alarm will appear, and the value of the output frequency will be limited to a value which is 10 times the value of <vL: Base frequency 1>.

The same holds for Base frequency 2 - 4. (Refer to [6. 4].)



Memo

- Frequencies under the setting value of <F240: Start frequency> are not output. --> Refer to [6. 7. 1].
- During operation of the stall prevention, the inverter may run at the frequency exceeding the value of <UL: Upper limit frequency> or the frequency under the value of <LL: Lower limit frequency>.

5

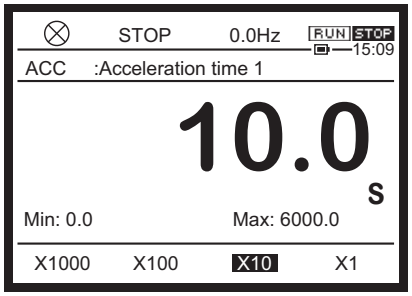
5. 2. 4 Setting acceleration/deceleration time

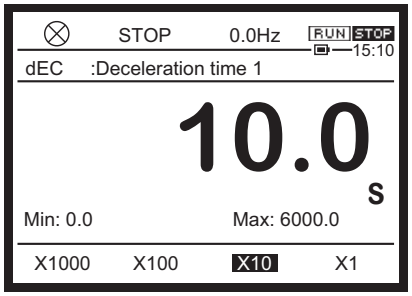
<ACC: Acceleration time 1>

Basic parameter → Easy mode

<dEC: Deceleration time 1>

Basic parameter → Easy mode





5

■ Function

Set a time for acceleration and deceleration.

In <ACC: Acceleration time 1>, set a time before the output frequency of the inverter reaches the value of <FH: Maximum frequency> from 0.0 Hz.

In <dEC: Deceleration time 1>, set a time before the output frequency of the inverter decreases to 0.0 Hz from the value of <FH: Maximum frequency>.

Unit for a setting time is selected with <F519: Unit of Acc/Dec time>.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
ACC	Acceleration time 1	0.0 - 6000 (600.0)	s	*1
dEC	Deceleration time 1	0.0 - 6000 (600.0)	s	*1

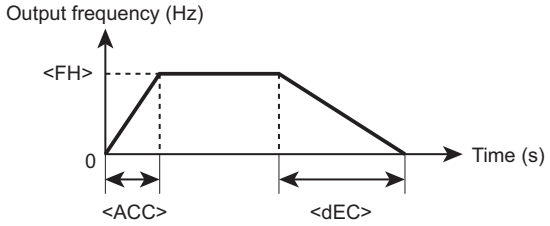
*1 The default is 10.0/30.0/60.0 (s) depending on the capacity. Refer to [11. 6].

Title	Parameter name	Adjustment range	Default setting
F519	Unit of Acc/Dec time	0: - 1: 0.01s unit (0 after execution) 2: 0.1s unit (0 after execution)	0

■ Guideline for the setting

The criteria of acceleration time and deceleration time is the value of <FH: Maximum frequency>. Note that it is not the value of <UL: Upper limit frequency>.

You can use <F519: Unit of Acc/Dec time> to switch the unit of setting time between 0.1s and 0.01s. With acceleration/deceleration time set to 0.0 second, the unit of 0.05 second is used internally for <F519> is "2: 0.1s unit" (default setting), and the unit of 0.01 second for <F519> is "1: 0.01s unit".



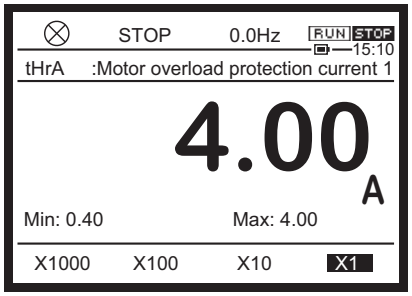
Memo

- When you set a time shorter than the optimum acceleration/deceleration time determined by the load condition, the stall prevention action may cause the acceleration/deceleration time to be longer than the setting value.
- If you set a further shorter acceleration/deceleration time, the inverter may stop due to an overcurrent trip or overvoltage trip for protection. For details, refer to "Chapter 13".
- The stop methods of the motor are the deceleration stop by <dEC: Deceleration time 1> or the coast stop. For details, refer to [6. 3. 1].
- You can set four types of options for each acceleration and deceleration time. For Acceleration time 2 through 4 and Deceleration time 2 through 4, refer to [6. 27. 2].

5. 2. 5 Protecting the motor from overload

<tHrA: Motor overload protection current 1>

Basic parameter → Easy mode



■ Function

Set a protection characteristic of the electronic thermal suited for the rating and characteristic of the motor. The electronic thermal operates based on the set current value, and any trip occurs. This will protect the motor.

5

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
tHrA	Motor overload protection current 1	Depending on capacity *1	A *1	*1

*1 The range, unit, and default setting are depending on the capacity. Refer to [11. 6].

■ Reference of setting

Set <tHrA> suited for the motor rated current. Set necessary parameters for the used motor or operation.

■ Selecting a motor type and protective function: <OLM: Motor overload protection characteristic>, <F606: Motor overload reduction frequency threshold>

Select a motor type and whether the motor overload trip "OL2" and overload stall are enabled or disabled.

The inverter overload trip "OL1" is always detected to protect the inverter.

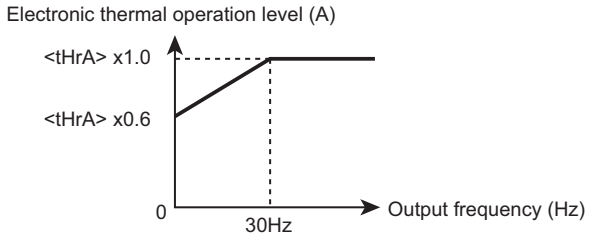
Title	Parameter name	Adjustment range	Unit	Default setting
OLM	Motor overload protection characteristic	0: Standard motor, OL2, No stall 1: Standard motor, OL2, Stall 2: Standard motor, No OL2 trip, No stall 3: Standard motor, No OL2 trip, Stall 4: Constant torque motor, OL2, No stall 5: Constant torque motor, OL2, Stall 6: Constant torque motor, No OL2 trip, No stall 7: Constant torque motor, No OL2 trip, Stall		0
F606	Motor overload reduction frequency threshold	0.0 - 60.0	Hz	6.0

Memo	**What is overload stall?** • The overload stall function can apply to variable torque characteristic load where a lower frequency reduces load current, such as a fan, pump, and blower. When the inverter detects overload, this function automatically lowers the output frequency before the motor overload trip "OL2" occurs. This function enables you to run the inverter at the frequency where load current balances. As a result, the inverter can continue to run without trip. • Do not apply the overload stall function to constant torque characteristic load (load with constant load current regardless of the frequency, for example, in a conveyor).

1) When the general purpose motor is used

When the motor runs at low speed (low frequency), its cooling effect will degrade. To prevent overheat of the motor caused by this problem, the inverter starts to detect overload earlier than usual when using the general purpose motor.

<OLM: Motor overload protection characteristic> = "0" to "3"



The reduction start frequency of the electronic thermal is fixed to 30 Hz.

2) When the constant-torque motor is used

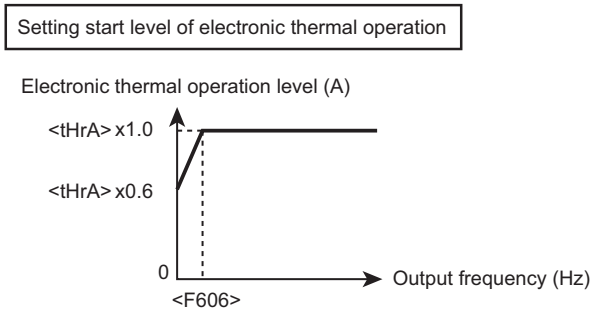
The constant-torque motor can run at constant torque at lower speed (lower frequency) compared to the general purpose motor. However, an extremely low speed will cause the cooling effect of the motor to decrease.

Set the value of <F606: Motor overload reduction frequency threshold> suited for the motor characteristic.

<OLM: Motor overload protection characteristic> = "4" to "7"

Setting of <F606: Motor overload reduction frequency threshold>

We recommend the estimation of across 6 Hz (default setting) (refer to the following figure).



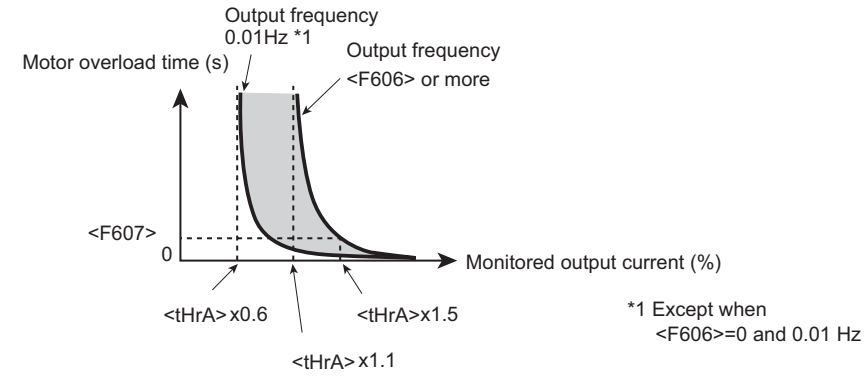
■ Setting a time before the trip of the electronic thermal occurs: <F607: Motor overload time>

Setting a time before the trip of the electronic thermal occurs: <F607: Motor overload time>
Set a time before the overload trip "OL2" occurs at the motor overload of 150%.

Title	Parameter name	Adjustment range	Unit	Default setting
F607	Motor overload time	10 - 2400	s	300

Monitored output current (%)		Motor overload time (s) (Outline data)			
		F607=600 is set		F607=300 is set	
tHrA=100	tHrA=50	F606 or more	0.01 Hz	F606 or more	0.01 Hz
68	34	-	7200	-	3600
70	35	-	3600	-	1800
80	40	-	1000	-	500
90	45	-	600	-	300
100	50	-	420	-	210
112	56	12000	310	6000	155
120	60	2400	270	1200	135
130	65	1200	230	600	115
140	70	800	190	400	95
150	75	600	170	300	85
200	100	270	110	135	55

Motor overload protection characteristics



■ Selecting how to detect inverter overload: <F631: Inverter overload detection>

This function enables to automatically increase the continuous output current and the inverter overload capacity when the ambient temperature is low.

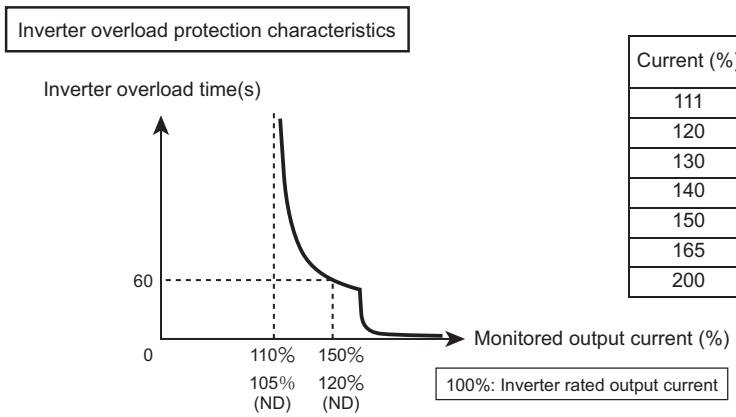
Title	Parameter name	Adjustment range	Default setting
F631	Inverter overload detection	HD 0: 150%-60s 1: Temperature estimation ND 0: 120%-60s 1: Temperature estimation	10

Set <F631: Inverter overload detection> to "1: Temperature estimation".

- If the inverter overload trip "OL1" occurs, you can clear it by decreasing the value of <F601: Stall prevention level 1> or setting <ACC: Acceleration time 1> or <dEC: Deceleration time 1> to a longer value.
- To protect the inverter unit, you cannot turn off inverter overload detection.

0: 150%-60s (HD rating) or 0: 120%-60s (ND rating)

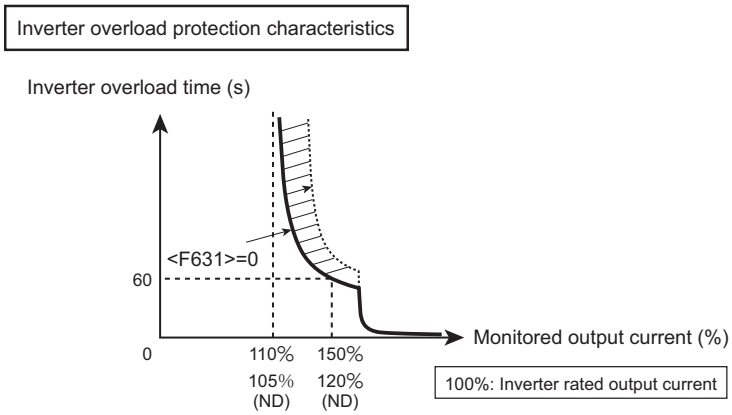
The inverter is protected with the uniform overload curve of 150%-60s (120%-60s for ND rating), regardless of temperature.



Current (%)	Inverter overload time (s) (Outline data)
111	2400
120	240
130	120
140	80
150	60
165	2
200	0.5

1: Temperature estimation

Estimate inverter internal temperature rise and automatically adjust overload protection characteristics (the diagonally shaded area in the following figure).



- When the output frequency is 0.1 Hz or less, or when the output current is 150% or more, the overload trip "OL1" or overcurrent trips "OC1 through OC3" may occur in shorter time to protect the inverter.

• The overload detection level depends on the output frequency or carrier frequency.

■ Saving an overload integral value at power off : <F632: Electronic thermal memory target>

Set a target to reset the integral value of overload at power off. It applies to both the motor electronic thermal and overload detection for inverter protection.

Title	Parameter name	Adjustment range	Default setting
F632	Electronic thermal memory target	0: No.1 to 4 motor, memory disabled 1: No.1 to 4 motor, memory enabled 2: No.1 motor, memory disabled 3: No.1 motor, memory enabled	0

0: No.1 to 4 motor, memory disabled

2: No.1 motor, memory disabled

Reset the integral value. "0" applies to No.1 to 4 motors and "2" to the No.1 motor only.

1: No.1 to 4 motor, memory enabled

3: No.1 motor, memory enabled

For memory enabled, the overload integral values of the motor and inverter are saved at power off. When power supply is ON again, the calculation process is resumed from the state when it is powered off.

However, with the RTC enabled (with operation panel), the subtraction process is performed according to virtual cooling curves, regardless of the setting.

■ Overload pre-alarm output

When the motor overload level reaches the setting value (%) of <F657: Overload alarm level> for the overload trip "OL2" integral value, "L" appears. Also, an overload pre-alarm signal can be output from the output terminal. For details, refer to [7. 2. 2].

Title	Parameter name	Adjustment range	Unit	Default setting
F657	Overload alarm level	10 - 100	%	50

5. 2. 6 Adjusting the meter connected to the inverter

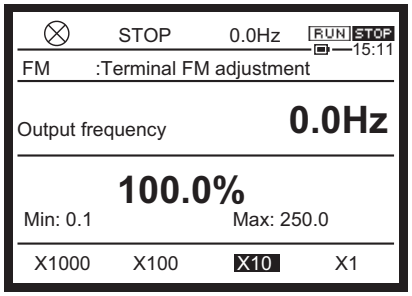
<FM: Terminal FM adjustment>

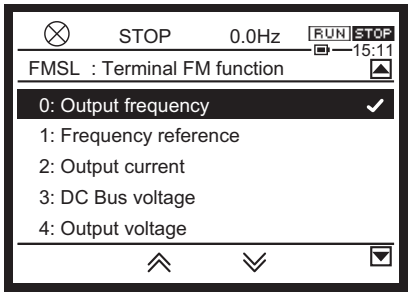
Basic parameter → Easy mode

<FMSL: Terminal FM function>

Basic parameter

<F671: Terminal AM adjustment>
<F670: Terminal AM function>





5

■ Function

To indicate the output frequency and output current of the inverter in the meter, connect the meter to the terminal [FM] or [AM].
After connecting them, you should adjust the scale of the meter.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
FM	Terminal FM adjustment	0.1 - 250.0	%	100.0
F671	Terminal AM adjustment	0.1 - 250.0	%	100.0

Select the content to be indicated in the meter by <FMSL: Terminal FM function> and <F670: Terminal AM function>.

Title	Parameter name	Adjustment range	Default setting
FMSL	Terminal FM function	0: Output frequency 1: Frequency command value 2: Output current 3: Input voltage (DC detection) 4: Output voltage 5: Stator frequency 6: Speed feedback frequency (real time) 7: Speed feedback frequency (1-second filter) 8: Torque 9: Torque command	0

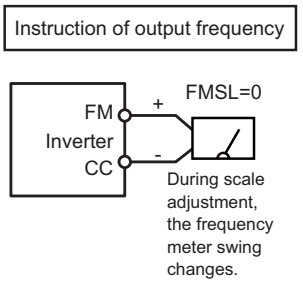
Title	Parameter name	Adjustment range	Default setting
		10: Output frequency during run. Frequency command value during stop. 11: Torque current 12: Exciting current 13: PID feedback value 14: Motor overload factor (OL2 data) 15: Inverter overload factor (OL1 data) 16: Braking resistor overload factor (OLr data) 17: Braking resistor load factor (%ED) 18: Input power 19: Output power 20: Input cumulative power 21: Output cumulative power 22: Fixed output 1 23: Fixed output 2 24: Terminal RR input value 25: Terminal RX input value 26: Terminal II input value 27: Motor speed command 28: Terminal FM output value 29: Terminal AM output value 30: - 31: Communication data output 32 - 33: - 34: Motor load factor 35: Inverter load factor 36 - 40: - 41: Terminal FP pulse train output value 42: - 43: - 44: Terminal AI4 input value 45: Terminal AI5 input value 46 - 49: My function monitor output 1 - 4 50 - 61: - 62: PID result frequency 63: PID set value 64: Light-load high-speed switching load torque 65: Light-load high-speed torque during constant speed run 66 - 70: - 71: Motor speed (estimated value) 72 - 75: - 76: Terminal S4/S5 pulse train input value 77 - 78: - 79: Dancer control PID result frequency 80 - 119: - 120: Internal temperature 1 121 - 123: - 124: Power circuit board temperature 125 - 129: -	

Title	Parameter name	Adjustment range	Default setting
		130: External PID3 set value 131: External PID3 feedback value 132: External PID3 result value 133: External PID4 set value 134: External PID4 feedback value 135: External PID4 result value 136 - 149: - 150: Signed output frequency 151: Signed frequency command value 152: Signed stator frequency 153: Signed speed feedback frequency (real time) 154: Signed speed feedback frequency (1-second filter) 155: Signed torque 156: Signed torque command 157: - 158: Signed torque current 159: Signed PID feedback value 160: Signed terminal RX input value 161: Signed terminal AI4 input value 162: Signed terminal AI5 input value	
F670	Terminal AM function	Same as <FMSL>	2

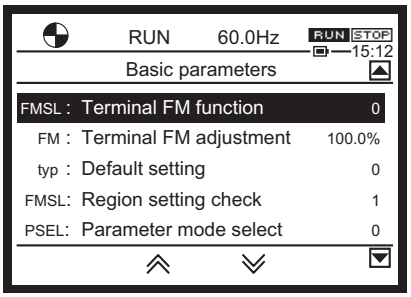
■ How to adjust the scale of the meter with the inverter run

As an example, this section describes how to adjust the scale of the frequency meter connected to the terminal [FM].
Use the adjustment screw of the meter to set a zero point in advance.
This method can apply to the meter connected to the terminal [AM] as well.

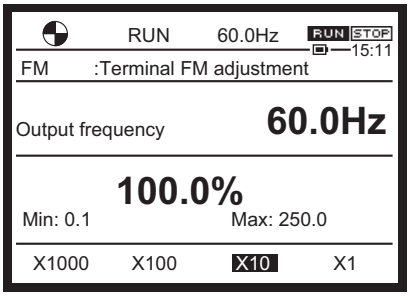
1 Connect the frequency meter as shown in the figure below.
For how to connect it to the control terminal block, refer to [2. 3. 5] and [4. 4].



2 In the basic parameters of [Setting mode], set <FMSL: Terminal FM function> to "0: Output frequency".
The default setting of <FMSL> is "0".



3 In the basic parameters of [Setting mode], select <FM: Terminal FM adjustment> and press the [OK] key.
The output frequency of the inverter is displayed in the upper part of the screen, and the output level (%) of the terminal [FM] in the lower part.



4 Turning the touch wheel will change the indication of the meter and the output level (%) of the terminal [FM] in the lower field of the screen. Adjust the scale so that the indication of the meter matches the output frequency.



5 Press the [OK] key to complete the adjustment of the meter.

■ How to adjust the scale of the meter with the inverter stopped

You can adjust the scale of the meter even at the inverter stop state.
When <FMSL: Terminal FM adjustment> and <F670: Terminal AM adjustment> are set "22", signal value is fixed at the following values.

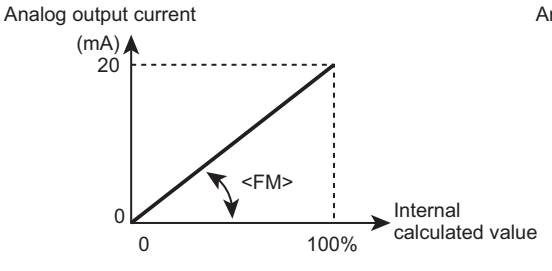
<FMSL>/<F670>

- 0, 1, 5, 6, 7, 10, 13, 62, 63, 79, 130, 131, 132, 133, 134, 135, 150, 151, 152, 153, 154, 159 : Maximum frequency (FH)
- 2, 11, 12, 108 : 200% of rated current
- 3, 4 : 150% of rated voltage
- 8, 9, 64, 65, 155, 156 : 250% of rated torque
- 14,15,16 : Maximum value of OL factor (100%)
- 34 : Maximum value of OL2 factor (600%)
- 35 : Maximum value of OL1 factor (250%)
- 17 : %ED value of braking resistor

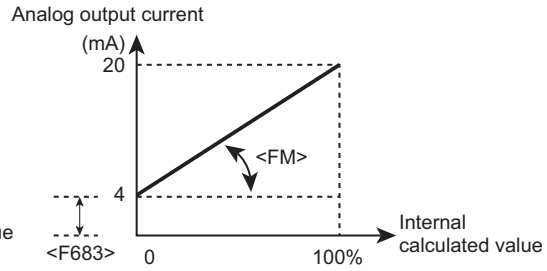
- 18, 19 : 200% of rated power
- 20, 21 : 1000 x F749
- 24, 25, 26, 28, 29, 31, 41, 44, 45, 74, 75, 76, 160, 161, 162 : Maximum value
- 27, 71 : FH x 60/F856
- 46, 47 : 65535
- 48, 49 : 32767
- 120, 124 : 200°C

When <FMSL: Terminal FM adjustment> and <F670: Terminal AM adjustment> are set "23", signal value is fixed at half of the above values.

■ For 4 - 20 mA output



This is when <F682: Terminal FM inclination polarity> is "1: Positive inclination (upward slope)" and <F683: Terminal FM bias> is "0". When<F682> is set to "0: Negative inclination (downward slope)", the inclination becomes negative.



This is when <F682> is "1" and <F683: Terminal FM bias> is "20". 20% value (4mA) of the full scale output current (20 mA in this case) will be the output current at internal calculated value of 0%.

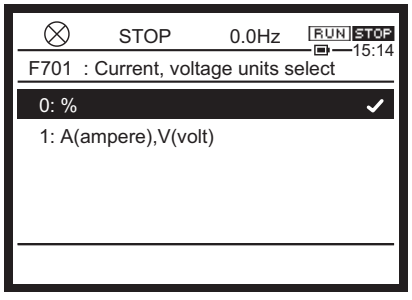
Adjust the values of <F682: Terminal FM inclination polarity> and <F683: Terminal FM bias> for 4 - 20 mA output.
For details, refer to [6. 33. 3].

Memo	• The maximum resolution is 1/1024 for both the terminals [FM] and [AM]. • To use the terminals [FM] and [AM] for current output, set external load resistance to 600Ω or less. • To use the terminals [FM] and [AM] for voltage output, set external load resistance to 1kΩ or more.

5. 2. 7 Selecting the display units for current and voltage

<F701: Current, voltage units select>

Easy mode



■ Function

Select the display units of parameters and monitors represented in current and voltage.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F701	Current, voltage units select	0: % 1: A (ampere), V (volt)	0

■ Applicable parameters and monitors

The following list shows parameters and monitors whose display units can be changed with <F701: Current, voltage units select>.

Displayed in A (amperes)

- Parameter
  <F251: DC braking current>
  <F601: Stall prevention level 1>, <F185: Stall prevention level 2>
  <F326: Brake release undercurrent threshold>
  <F611: Undercurrent detection level>
- Monitor
  Output current
  Torque current
  Exciting current

Displayed in V (volts)

- Parameter
  <F191: V/f 5-point VF1 voltage>
  <F193: V/f 5-point VF2 voltage>
  <F195: V/f 5-point VF3 voltage>
  <F197: V/f 5-point VF4 voltage>
  <F199: V/f 5-point VF5 voltage>
- Monitor
  Input voltage
  Output voltage

<vLv: Base frequency voltage 1>, <F171: Base frequency voltage 2>, <F175: Base frequency voltage 3>, and <F179: Base frequency voltage 4> are always displayed in V (volts). You cannot change it.

■ Selecting a setting value

0: %

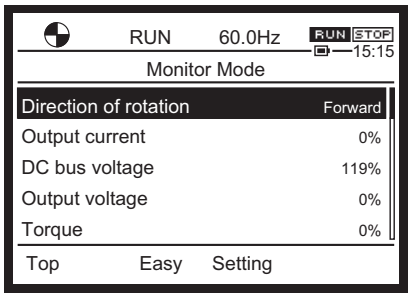
Current and voltage are displayed in percent.
For current (A), 100% means the rated current of the inverter.
For voltage (V), 100% with 200 V for 240 V class and 400 V for 480 V class.

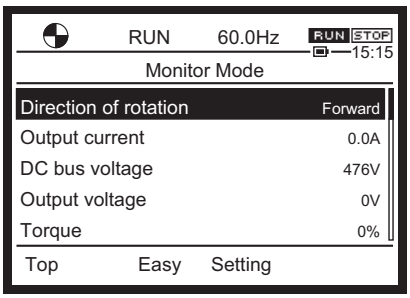
1: A (ampere), V (volt)

Current is displayed in A (amperes) and voltage in V (volts).

■ **Setting example**

While a model with a rated current of ●● A is used at the rated load (100% load), the monitor mode is displayed as follows:



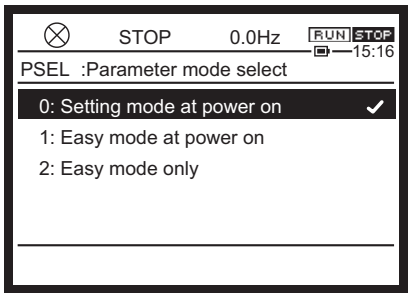


5

5. 2. 8 Selecting the parameter mode between [Setting mode] and [Easy mode]

<PSEL: Parameter mode select>





■ Function

Select the display mode of parameter settings between [Setting mode] and [Easy mode].
You can select a mode at power on and use the operation key to switch it or see only [Easy mode].
How to read parameters depends on a mode.

[Easy mode]

- Register frequently set parameters as [Easy mode] parameters in advance. Only the registered parameters (up to 32) appear.
- Ten parameters are selected in the default setting. You can change them as required.

[Setting mode]

- You can read all parameters in the standard [Setting mode].

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
PSEL	Parameter mode select	0: Setting mode at power on 1: Easy mode at power on 2: Easy mode only	0

■ Selecting a setting value

0: Setting mode at power on

The parameter mode is set to [Setting mode] at power on.
You can use the operation key to switch between [Setting mode] and [Easy mode].

- Operation panel: [ESC] key or [F1] key
  For details, refer to [3. 1. 2].
- Extension panel: [EASY] key (if any)

1: Easy mode at power on

The parameter mode is set to [Easy mode] at power on.
You can use the operation key to switch between [Setting mode] and [Easy mode].

- Operation panel: [ESC] key or [F1] key
  For details, refer to [3. 1. 2].
- Extension panel: [EASY] key (if any)

2: Easy mode only

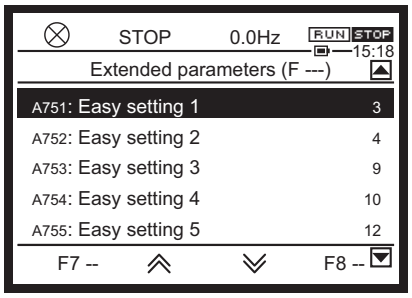
The parameter mode is always [Easy mode].
You cannot see the [Setting mode] screen.

■ Setting parameters in [Easy mode]

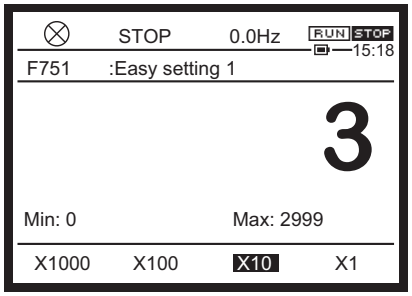
Up to 32 parameters are displayed in [Easy mode]. Set among <F751: Easy setting 1> through <F782: Easy setting 32>.

Title	Parameter name	Adjustment range	Default setting
F751	Easy setting 1	0 - 2999	3<CMOd>
F752	Easy setting 2	0 - 2999	4<FMOd>
F753	Easy setting 3	0 - 2999	9<ACC>
F754	Easy setting 4	0 - 2999	10<dEC>
F755	Easy setting 5	0 - 2999	12<UL>
F756	Easy setting 6	0 - 2999	13<LL>
F757	Easy setting 7	0 - 2999	31<tHrA>
F758	Easy setting 8	0 - 2999	6<FM>
F759 - F780	Easy setting 9 through Easy setting 30	0 - 2999	999 (No function)
F781	Easy setting 31	0 - 2999	701<F701>
F782	Easy setting 32	0 - 2999	50<PSEL>

In [Easy mode], only parameters registered with <F751: Easy setting 1> through <F782: Easy setting 32> appear in the order of registration.



Set communication numbers of registered parameters for <F751: Easy setting 1> through <F782: Easy setting 32>.
For communication numbers, refer to [11. 2] - [11. 5].
Set the parameter address you want to display to F751-F782.
For example,



- in case the parameter F123 is set to F751, set 123 to F751.
- in case the parameter A456 is set to F752, set 1456 to F752.
- in case the parameter C789 is set to F753, set 2789 to F753.

Memo

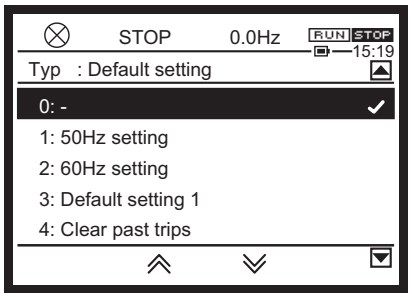
- When no parameter should be registered, set <F751: Easy setting 1> through <F782: Easy setting 32> to "999".

5

5. 2. 9 Returning parameters to their default settings Clearing each history

<tyP: Default setting>

Basic parameter



■ Function

You can return parameters to their default settings at a time, clear run times, and store/rewrite parameters specified by users.

5

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
tyP	Default setting	0: - 1: 50Hz setting 2: 60Hz setting 3: Default setting 1 4: Clear past trips 5: Clear cumulative run time 6: Initialize typeform 7: Store user settings 8: Rewrite user settings 9: Clear cumulative fan run time 10, 11: - 12: Clear number of starting 13: Default setting 2 (complete initialization) 14: Clear number of external equipment starting 15: Clear cumulative overcurrent time	0

Note) The setting value becomes 0 after execution, but a check mark is added to the previous setting value.

■ Selecting a setting value

1: 50Hz setting

The following parameters are set for the base frequency 50 Hz.

Setting values of other parameters are not changed.

When you select a parameter and press the [OK] key, nothing appears momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

<FH: Maximum frequency>	50Hz
<UL: Upper limit frequency>	*1 % display
<vL: Base frequency 1>	
<F170: Base frequency 2>	
<F174: Base frequency 3>	
<F178: Base frequency 4>	
<F204: RR point 2 frequency>	
<F213: RX point 2 frequency>	
<F219: II point 2 frequency>	
<F225: AI4 point 2 frequency>	
<F231: AI5 point 2 frequency>	
<F237: S4/S5 Pulse train input point 2 frequency>	
<F330: Light-load high-speed automatic operation frequency>	
<F355: Commercial power switching>	
<F364: PID1 deviation upper-limit>	
<F365: PID1 deviation lower-limit>	
<F367: PID1 set value upper-limit>	
<F370: PID1 output upper-limit>	
<F426: Fwd speed limit level>	
<F428: Rev speed limit level>	
<F814: Communication point 2 frequency>	
<A220: Pump increase detection frequency>	
<A229: Pump decrease switching frequency>	
<A230: PID start frequency at pump decrease switching>	
<A316: PID2 deviation upper-limit>	
<A317: PID2 deviation lower-limit>	
<A319: PID2 set value upper-limit>	
<A322: PID2 output upper-limit>	
<A538: PTI position frequency UL>	
<F417: Motor rated speed>	1400 - 1480min^{-1} (Depending on capacity)

5

2: 60Hz setting

The following parameters are set for the base frequency 60Hz.
Setting values of other parameters are not changed.
When you select a parameter and press the [OK] key, nothing appears momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

<FH: Maximum frequency>	60Hz
<UL: Upper limit frequency>	*1 % display
<vL: Base frequency 1>	
<F170: Base frequency 2>	
<F174: Base frequency 3>	
<F178: Base frequency 4>	
<F204: RR point 2 frequency>	
<F213: RX point 2 frequency>	
<F219: II point 2 frequency>	
<F225: AI4 point 2 frequency>	
<F231: AI5 point 2 frequency>	
<F237: S4/S5 Pulse train input point 2 frequency>	
<F330: Light-load high-speed automatic operation frequency>	
<F355: Commercial power switching>	
<F364: PID1 deviation upper-limit>	
<F365: PID1 deviation lower-limit>	
<F367: PID1 set value upper-limit>	
<F370: PID1 output upper-limit>	
<F426: Fwd speed limit level>	
<F428: Rev speed limit level>	
<F814: Communication point 2 frequency>	
<A220: Pump increase detection frequency>	
<A229: Pump decrease switching frequency>	
<A230: PID start frequency at pump decrease switching>	
<A316: PID2 deviation upper-limit>	
<A317: PID2 deviation lower-limit>	
<A319: PID2 set value upper-limit>	
<A322: PID2 output upper-limit>	
<A538: PTI position frequency UL>	
<F417: Motor rated speed>	1680 - 1775min^{-1} (Depending on capacity)

3: Default setting 1

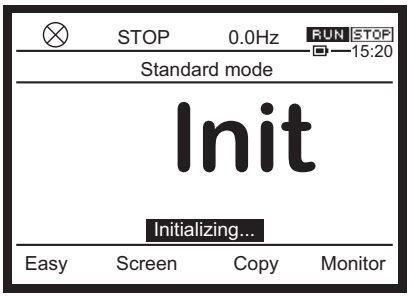
Return parameters except for some ones to their default settings.

When you select the setting and press the [OK] key, "Init" blinks in the main area and "Initializing" appears under it for a while.

They disappear momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

The history of past trip data is cleared.

To initialize all parameters, set <tyP: Default setting> to "13".



5

Memo

- The values of the following parameters are designed not to return to their default settings, considering maintainability.
  Also, these parameters do not appear in the <Changed parameters search & edit> even if they are set to values different from default settings.
  - <FMSL: Terminal FM function>
  - <FM: Terminal FM adjustment>
  - <SEt: Region setting check>
  - <F107: Terminal RX input voltage select>
  - <F108: Terminal RR input select>
  - <F148: Terminal AI4 input select>
  - <F149: Terminal AI5 input select>
  - <F379: PG option voltage>
  - <F470: RR input bias>
  - <F471: RR input gain>
  - <F472: RX input bias>
  - <F473: RX input gain>
    to
  - <F479: AI5 input gain>
  - <F669: Terminal FP switching>
  - <F670: Terminal AM function>
  - <F671: Terminal AM adjustment>
  - <F681: Terminal FM switching>
  - <F682: Terminal FM inclination polarity>
  - <F683: Terminal FM bias>
  - <F685: Terminal FM upper-limit level>
  - <F686: Terminal AM switching>
  - <F687: Terminal AM inclination polarity>
  - <F688: Terminal AM bias>
  - <F690: Terminal AM upper-limit level>
  - <F750: EASY key function>
  - <F790: Panel display at power on>
  - <F791: 1st and 2nd characters of F790> - <F798: 15th and 16th characters of F790>
  - <F809: Operation panel connection priority>
  - <F880: Free memorandum>
  - <A005 - A008: >
  - <C081 - C096: >

4: Clear past trips

Initialize (clear) the history information of eight past trips.
No parameter is changed.
When you select the setting and press the [OK] key, nothing appears momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

5: Clear cumulative run time

Clear cumulative run time to 0.
When you select the setting and press the [OK] key, nothing appears momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

6: Initialize typeform

Clear a trip if the type error "EtyP" occurs.
However, if it occurs, contact your Toshiba distributor.

When you select the setting and press the [OK] key, nothing appears momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

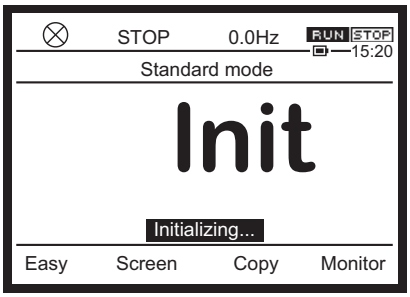
7: Store user settings
Store the setting values of all current parameters.

8: Rewrite user settings
Rewrite the setting values of the parameters stored in "7: Store user settings" to the inverter.
You can use parameter initial settings specific for users with "7: Store user settings" and "8: Rewrite user settings."

9: Clear cumulative fan run time
Clear cumulative fan run time to 0.
Set it, for example, when you have replaced the cooling fan.
When you select the setting and press the [OK] key, nothing appears momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

12: Clear number of starting
Clear the values on the monitor to 0 for the number of starting, the number of forward starting, and the number of reverse starting.
When you select the setting and press the [OK] key, nothing appears momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].

13: Default setting 2 (complete initialization)
Return all parameters to their default settings at a time.
When you select the setting and press the [OK] key, "Init" blinks in the main area and "Initializing" appears under it for a while.
They disappear momentarily, the same content displayed at power on appears, and the mode enters [Standard mode].
All parameters are returned to their default settings, and the history data of past trips is also cleared.



Memo
- Set <tyP: Default setting> after stopping the inverter. You cannot set it during run.

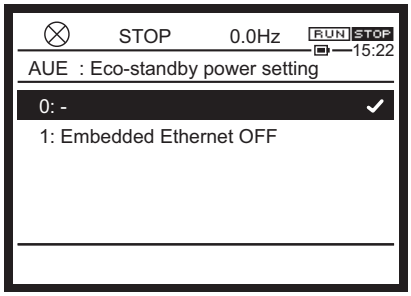
5. 3 Setting other basic parameters

This section describes basic parameters not included in [5.2].
Set any parameter in the [Setting mode].

5. 3. 1 Setting energy savings

<AUE: Eco-standby power setting>

Basic parameter



5

■ Function

Turn off the unused function to reduce standby electricity.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
AUE	Eco-standby power setting	0: - 1: Embedded Ethernet OFF	0

Note) The setting value becomes 0 after execution, but a check mark is added to the previous setting value.

■ Selecting a setting value

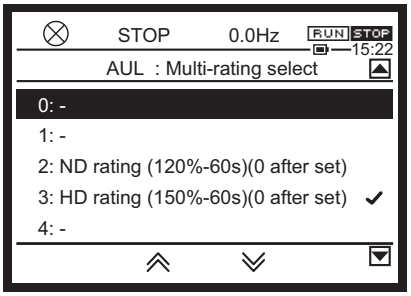
1: Embedded Ethernet OFF

Standby electricity can be reduced when you do not use the embedded Ethernet.

5. 3. 2 Selecting an overload protection characteristic

<AUL: Multi-rating select>

Basic parameter



■ Function

Select an inverter overload protection characteristic suited for the torque characteristic of the machine.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
AUL	Multi-rating select	0,1: - 2: ND rating (120%-60s) (0 after execution) 3: HD rating (150%-60s) (0 after execution) 4 - 8: -	3

Note) The setting value becomes 0 after execution, but a check mark is added to the previous setting value.

■ Selecting a setting value

2: ND rating (120%-60s) (0 after execution)

Select this value when applying the machine with variable torque characteristic.
Example) Fan, pump, blower, etc.

3: HD rating (150%-60s) (0 after execution)

Select this value when applying the machine with constant torque characteristics.
Example) Conveyor, load transporting machinery, crane, concrete mixer, compressor, making machine, machine tool, etc.

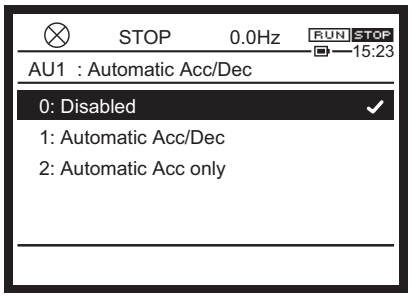
Memo

- The default setting of some parameters are different between HD rating and ND rating. Refer to [11. 6].

5. 3. 3 Acceleration/deceleration time adjustment automatically according to load

<AU1: Automatic Acc/Dec>

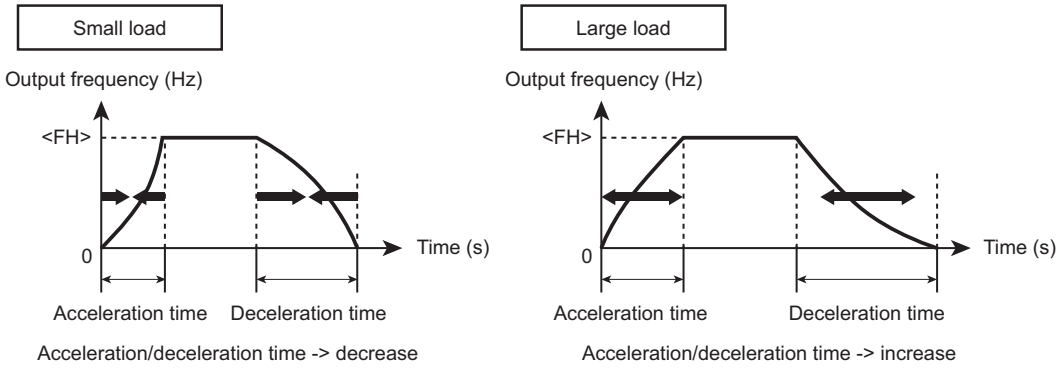
Basic parameter



■ Function

This is a parameter that automatically adjusts the acceleration/deceleration time according to the load condition to prevent an overcurrent trip during acceleration/deceleration.

5



■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
AU1	Automatic Acc/Dec	0: Disabled 1: Automatic Acc/Dec 2: Automatic Acc only	1

■ Selecting a setting value

1: Automatic Acc/Dec

The acceleration/deceleration time is adjusted automatically in the range in which the output current does not exceed the rated current of the inverter. The adjustment range is 1/8 to 8 times as long as the time set with <ACC: Acceleration time 1> and <dEC: Deceleration time 1>. If you set suitable values for the average load with <ACC: Acceleration 1> and < d EC: Deceleration 1> in advance, it will be easy to deal with load fluctuation.

2: Automatic Acc only

Only the acceleration time is adjusted automatically. The speed is decelerated according to the setting of <dEC: Deceleration time 1>.

Important

- Use this parameter with the motor connected.
- When the inverter is used with a load that fluctuates considerably, it may fail to adjust the acceleration or deceleration time in time, and therefore may be tripped.
- When using the optional braking resistor or braking unit, do not set <AU1: Automatic Acc/Dec> to "1". Otherwise, braking resistor overload may occur during deceleration.

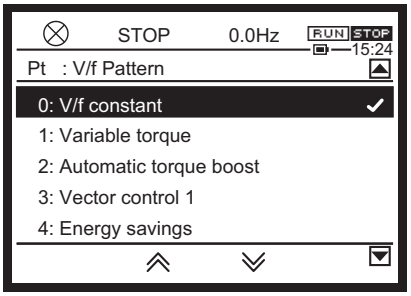
Memo

- When the acceleration/deceleration time is automatically set, the acceleration/deceleration time is always changed according to the load. For machinery that requires constant acceleration/deceleration time, accelerate or decelerate with the setting time of <ACC: Acceleration time 1> and <dEC: Deceleration time 1> instead of using this function. For details, refer to [5. 2. 4].

5. 3. 4 Selecting motor control method

<Pt: V/f Pattern>

Basic parameter



■ Function

This is a parameter to select the motor control method according to the characteristics and application of the machinery.

Memo

- With <AU2: Torque boost macro>, you can set <Pt> of this parameter to "2: Automatic torque boost", "3: Vector control 1"、and "4: Energy savings" and <F400: Offline auto-tuning > to "2" simultaneously.

■ Parameter setting

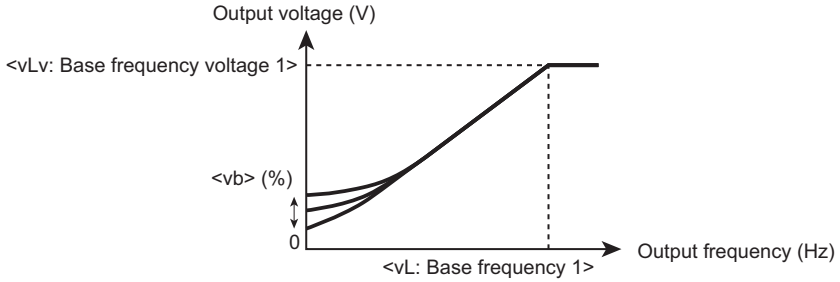
Title	Parameter name	Adjustment range	Default setting
Pt	V/f Pattern	0: V/f constant 1: Variable torque 2: Automatic torque boost 3: Vector control 1 4: Energy savings 5: Dynamic energy savings (for fan and pump) 6: PM motor control 7: V/f 5-point setting 8: - 9: Vector control 2 (speed / torque) 10: PG feedback control 11: PG feedback vector control (speed / torque) 12: -	0

■ Selecting a setting value

0: V/f constant

This is a typical control method of an inverter, and the inverter is controlled so that the ratio of the output frequency (f) and the output voltage (V) becomes almost constant.

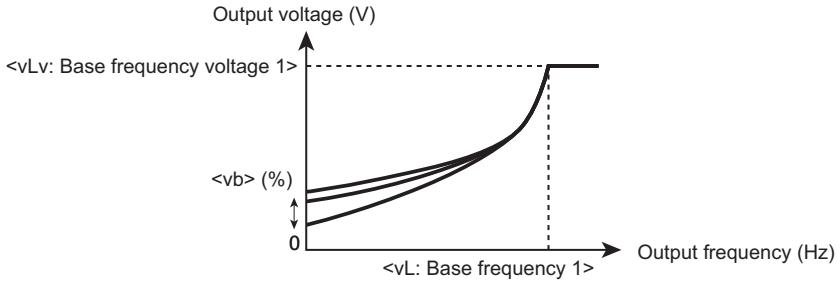
It is applied to loads with equipment like conveyors that requires the same torque at low speeds as at rated speeds.



To increase the torque at low speeds, increase the setting value of <vb: Manual torque boost 1>. For details, refer to [5. 3. 6].

1: Variable torque

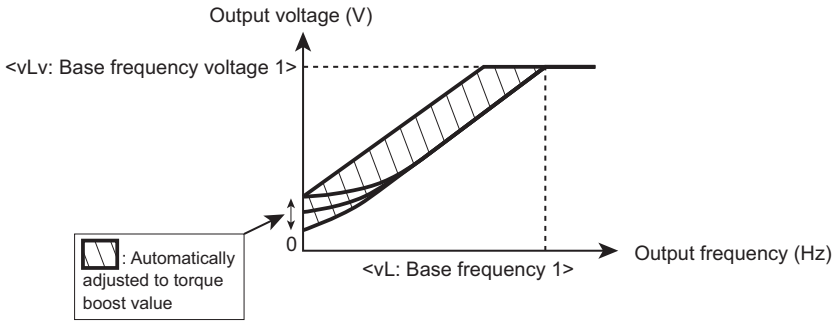
This is applied to loads such as fans, pumps and blowers in which the torque is proportional to the square of load motor speed.



2: Automatic torque boost

The load current in the speed range from startup to base frequency is detected and the output voltage (torque boost) from the inverter is automatically adjusted. This gives steady torque for stable operation.

It is applied to loads that require torque.



Operation may become unstable depending on loads. In this case, set <Pt> = "0: V/f constant" and increase the value of <vb: Manual torque boost 1>.

Setting of motor parameters

When <Pt> is "2", setting of motor parameters is required.

When the motor you are using is a 4P Toshiba premium efficiency motor which has the same capacity as the inverter, there is basically no need to set the parameters.
First, look at the motor name plate and set the following parameters.
- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Next, perform auto-tuning. Two parameter setting methods are provided.

1) Setting with <AU2: Torque boost macro>

Set <AU2: Torque boost macro> to "1". Set <Pt> to "2: Automatic torque boost" and <F400: Offline auto-tuning> to "2" simultaneously.
For details, refer to [5. 3. 5].

2) Setting with <F400: Offline auto-tuning>

Set <F400: Offline auto-tuning> to "5".
For details, refer to [6. 23. 1].
* If an auto-tuning error occurs, set motor parameters individually by referring to [6. 23. 1] "■Setting method 4: Manually setting motor parameter".

5

3: Vector control 1

High-torque and high-precision stable operation is realized in the speed range from startup to base frequency.
It is applied to load transporting machinery and elevators that require high torque and machine tools that require high precision.

- High starting torque can be obtained.
- It is effective when smooth stable operation from a low speed is required.
- The change of motor speed caused by load fluctuation is suppressed to realize high-precision operation.

When <Pt> is "3", setting of motor parameters is required.
When the motor you are using is a 4P Toshiba premium efficiency motor which has the same capacity as the inverter, there is basically no need to set the parameters.
In other cases, look at the motor name plate and set the following parameters.
- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Three parameter setting methods are provided.

1) Setting with <AU2: Torque boost macro>

Set <AU2: Torque boost macro> to "2". Set <Pt> to "3: Vector control 1" and <F400: Offline auto-tuning> to "2" simultaneously.
For details, refer to [5. 3. 5].

2) Setting with <F400: Offline auto-tuning>

Set <F400: Offline auto-tuning> to "5".
For details, refer to [6. 23. 1].

* If an auto-tuning error occurs, set motor parameters individually by referring to [6. 23. 1] "■Setting method 4: Manually setting motor parameter".

3) Manual setting

Set each motor constant.
For details, refer to [6. 23. 1].

4: Energy savings

Energy can be saved in all speed ranges by detecting load current and flowing the optimum current that fits the load.

When <Pt> is "4", setting of motor parameters is required.
When the motor you are using is a 4P Toshiba premium efficiency motor which has the same capacity as the inverter, there is basically no need to set the parameters.
In other cases, look at the motor name plate and set the following parameters.

- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Three parameter setting methods are provided.

1) Setting with <AU2: Torque boost macro>

Set <AU2: Torque boost macro> to "3". Set <Pt> to "4: Energy savings" and <F400: Offline auto-tuning> to "2" simultaneously.
For details, refer to [5. 3. 5].

2) Setting with <F400: Offline auto-tuning>

Set <F400: Offline auto-tuning> to "5".
For details, refer to [6. 23. 1].
* If an auto-tuning error occurs, set motor parameters individually by referring to [6. 23. 1] "■Setting method 4: Manually setting motor parameter".

3) Manual setting

Set each motor constant.
For details, refer to [6. 23. 1].

5: Dynamic energy savings (for fan and pump)

Energy can be saved in all speed ranges by detecting load current and flowing the optimum current that fits the load. Even in a low-speed range with especially decreased efficiency, more substantial energy savings than those provided when <Pt> is "4: Energy savings" can be achieved by controlling to maximize the efficiency.

The inverter cannot respond to rapid load fluctuations, so this setting should be used only for loads, such as fans and pumps that have less load fluctuations.

When <Pt> is "5", setting of motor parameters is required.
When the motor you are using is a 4P Toshiba premium efficiency motor which has the same capacity as the inverter, there is basically no need to set the parameters.
In other cases, look at the motor name plate and set the following parameters.

- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)

- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Two parameter setting methods are provided.

1) Setting with <F400: Offline auto-tuning>

Set <F400: Offline auto-tuning> to "5".
For details, refer to [6. 23. 1].
* If an auto-tuning error occurs, set motor parameters individually by referring to [6. 23. 1] "■Setting method 4: Manually setting motor parameter".

2) Manual setting

Set each motor constant.
For details, refer to [6. 23. 1].

6: PM motor control

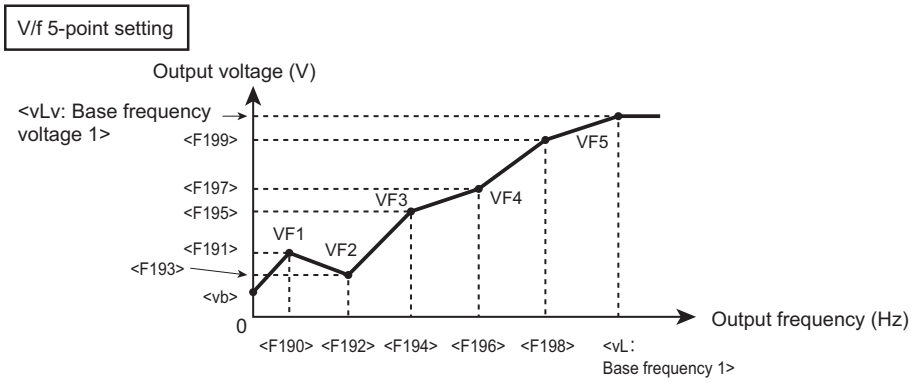
Permanent magnet motors (PM motors) that are highly efficient can be operated in sensor-less operation.
Setting of parameters for PM motor is required. For details, refer to [6. 23. 2].

7: V/f 5-point setting

V/f control characteristics can be created according to machinery. Set frequency and voltage in five points and run the inverter with V/f control characteristics derived by connecting these points.
Set five points from VF1 to VF5 with the following parameters <F190> to <F199>.

Title	Parameter name	Adjustment range	Unit	Default setting
F190	V/f 5-point VF1 frequency	0.0 - FH	Hz	0.0
F191	V/f 5-point VF1 voltage	0.0 - 125.0	% *1	0.0
F192	V/f 5-point VF2 frequency	0.0 - FH	Hz	0.0
F193	V/f 5-point VF2 voltage	0.0 - 125.0	% *1	0.0
F194	V/f 5-point VF3 frequency	0.0 - FH	Hz	0.0
F195	V/f 5-point VF3 voltage	0.0 - 125.0	% *1	0.0
F196	V/f 5-point VF4 frequency	0.0 - FH	Hz	0.0
F197	V/f 5-point VF4 voltage	0.0 - 125.0	% *1	0.0
F198	V/f 5-point VF5 frequency	0.0 - FH	Hz	0.0
F199	V/f 5-point VF5 voltage	0.0 - 125.0	% *1	0.0

*1 100% with 200 V for 240 V class and 400 V for 480 V class.



Important

- Set <vb: Manual torque boost 1> to approximately 0 to 3% of the base frequency voltage. If the setting value is too large, it may impair the linearity between points.
- If the inclination of the set V/f is above 8.25%/Hz, Points setting alarm 2 "A-02" occurs. When "A-02" alarm occurs, internal V/f is limited to 8.25%/Hz.

5

9: Vector control 2 (speed / torque)

It is applied to torque control.

Vector control realize high-torque and high-precision stable operation in the speed range from startup to base frequency.

It is applied to load transporting machinery and elevators that require high torque and machine tools that require high precision.

- High starting torque can be obtained.
- It is effective when smooth stable operation from a low speed is required.
- The change of motor speed caused by load fluctuation is suppressed to realize high-precision operation.

When <Pt> is "9", setting of motor parameters is required.

When the motor you are using is a 4P Toshiba premium efficiency motor which has the same capacity as the inverter, there is basically no need to set the parameters.

In other cases, look at the motor name plate and set the following parameters.

- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Two parameter setting methods are provided.

1) Setting with <F400: Offline auto-tuning>

Set <F400: Offline auto-tuning> to "5".

For details, refer to [6. 23. 1].

* If an auto-tuning error occurs, set motor parameters individually by referring to [6. 23. 1] "■Setting method 4: Manually setting motor parameter".

2) Manual setting

Set each motor constant.

For details, refer to [6. 23. 1].

10: PG feedback control

Vector control is performed by using speed feedback signals from the motor.
Attach the PG feedback option to the inverter. Use a motor with speed sensor (encoder) and connect signals from the encoder to the PG feedback option.

In the following cases, use <Pt> = "11: PG feedback vector control (speed / torque)"
- To perform torque control
- To perform speed control that requires high precision
- When low-speed operation (with motor slip frequency or less) of regeneration is required

When <Pt> is "10", setting of motor parameters is required.
Look at the motor name plate and set the following parameters first.
- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Two parameter setting methods are provided.

1) Automatic setting with auto-tuning

Set <F400: Offline auto-tuning> to "5".
For details, refer to [6. 23. 1].

2) Manual setting

Set each motor constant.
For details, refer to "Digital Encoder Instruction Manual" (E6582148).

11: PG feedback vector control (speed / torque)

Vector control is performed by using feedback signals from the motor. It is applied to high-precision speed control and torque control.
Attach the PG feedback option to the inverter. Use a motor with speed sensor (encoder) and connect signals from the encoder to the PG feedback option.
Torque control is performed based on the torque command, so the motor speed depends on the relationship between the load torque and the motor generated torque.
.
When <Pt> is "11", setting of motor parameters is required.
Look at the motor name plate and set the following parameters first.
- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Two parameter setting methods are provided.

1) Automatic setting with auto-tuning

Set <F400: Offline auto-tuning> to "5".
For details, refer to [6. 23. 1].

2) Manual setting

Set each motor constant.
For details, refer to "Digital Encoder Instruction Manual" (E6582148).

■ Cautions for automatic torque boost and vector control

- Look at the motor name plate and be sure to set the following parameters.
  - <vL: Base frequency 1> (Rated frequency)
  - <vLv: Base frequency voltage 1> (Rated voltage)
  - <F405: Motor rated capacity>
  - <F415: Motor rated current>
  - <F417: Motor rated speed>
- The vector control exerts its characteristics effectively within the speed range of <vL: Base frequency 1>. The same characteristics will not be obtained in speed ranges over the base frequency.
- When using vector control, set <vL: Base frequency 1> in the range of 40 to 120 Hz.
- Use a three-phase motor with a capacity that is the same as the inverter's rated capacity or one rank below. The minimum applicable motor capacity is 0.1 kW.
- Use a motor that has 2 to 16 P.
- Operate one motor in combination with one inverter. Vector control cannot be used when one inverter is operated with more than one motor. When using a combination of several motors, set <Pt> to "0: V/f constant".
- The maximum length of wires between the inverter and motor is 30 m. If the wires are longer than 30 m, be sure to perform offline auto-tuning with the wires connected. However, the effects of voltage drop due to resistance of wiring cause motor-generated torque in the vicinity of base frequency to be somewhat lower.
- When a reactor or motor-end surge voltage suppression filter is connected between the inverter and a motor, the motor's generated torque may fall. Performing offline auto-tuning may also cause a trip "Etn1". When a trip has occurred, connect the inverter and the motor directly to perform offline auto-tuning, or set motor parameters by referring to the test record of the motor.
- Attach the speed sensor used for PG feedback control directly to the motor. If it is attached via a gear, etc., rigidity is not ensured, causing hunting of the motor or a trip of the inverter.
- If the motor is not connected or a motor with extremely small capacity is connected for operation for the purpose of operation check of the inverter, etc., set <Pt> to "0: V/f constant" temporarily. If it is set to Automatic torque boost, Vector control, PM control, PG feedback control, or PG feedback vector control, normal operation may not be possible.

Memo	• <Pt: V/f Pattern> is valid only with No.1 motor. • If it is switched to No.2 to 4 motor, V/f constant control is applied regardless of the setting of <Pt>.

■ Cautions for PM motor control

- If the motor is not connected or a motor with extremely small capacity is connected for operation for the purpose of operation check of the inverter, etc., set <Pt> to "0: V/f constant" temporarily. If it is set to PM motor control, normal operation may not be possible.

■ Cautions for motor control

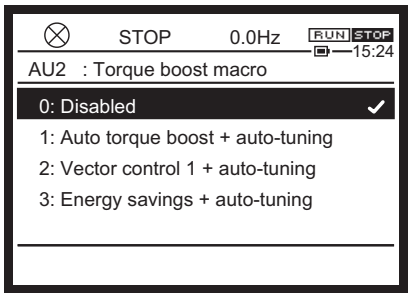
- Set the upper limit for frequency command to a value which is three or four times the value of <vL>.
- The value of run frequency is limited to a value which is ten times or less the values of <vL>, and the alarm "A-05" will appear when it is exceeded.

- If the inclination of the set V/f is over 8.25%/Hz, the alarm "A-02" will appear. When "A-02" alarm occurs, internal V/f is limited to 8.25%/Hz.

5. 3. 5 Setting parameters for torque boost and energy saving easily

<AU2: Torque boost macro>

Basic parameter



■ Function

This parameter is used to set V/f Pattern of the inverter and offline auto-tuning of motor parameters simultaneously for machinery that requires torque boost and energy saving.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
AU2	Torque boost macro	0: Disabled 1: Automatic torque boost + offline auto-tuning 2: Vector control 1 + offline auto- tuning 3: Energy savings + offline auto-tuning	0

Important

- Before setting <AU2: Torque boost macro>, look at the motor name plate and be sure to set the following parameters.
  - <vL: Base frequency 1> (Rated frequency)
  - <vLv: Base frequency voltage 1> (Rated voltage)
  - <F405: Motor rated capacity>
  - <F415: Motor rated current>
  - <F417: Motor rated speed>

  Set other motor parameters as necessary.

■ Selection of setting value

1: Automatic torque boost + offline auto-tuning

This is applied to loads that require torque.

The load current in the speed range from startup to base frequency is detected and the output voltage (torque boost) from the inverter is automatically adjusted. This gives steady torque for stable operation.

- When <AU2: Torque boost macro> is set to "1", <Pt: V/f Pattern> is set to "2" automatically.
- The same characteristics can be obtained by setting <Pt> to "2: Automatic torque boost" and <F400: Offline auto-tuning> to "2: Auto-tuning at run command (0 after execution)". For details, refer to [6. 23. 1].

2: Vector control 1 + offline auto- tuning

This is applied to load transporting machinery and elevators that require high torque and machine tools that require high precision.

High-torque and high-precision stable operation is realized in the speed range from startup to base frequency.

- When <AU2: Torque boost macro> is set to "2", <Pt: V/f Pattern> is set to "3" automatically.
- The same characteristics can be obtained by setting <Pt> to "3: Vector control 1" and <F400: Offline auto-tuning> to "2: Auto-tuning at run command (0 after execution)". For details, refer to [6. 23. 1].

3: Energy savings + offline auto-tuning

This is applied to machinery such as fans and pumps that requires energy saving.

Energy can be saved in all speed ranges by detecting load current and flowing the optimum current that fits the load.

- When <AU2: Torque boost macro> is set to "3", <Pt: V/f Pattern> is set to "4" automatically.
- The same characteristics can be obtained by setting <Pt> to "4: Energy savings" and <F400: Offline auto-tuning> to "2: Auto-tuning at run command (0 after execution)". For details, refer to [6. 23. 1].

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■ If vector control cannot be set

First read the precautions about vector control in [5. 3. 4].

If the desired torque cannot be obtained, refer to [6. 23], [6. 25].

If auto-tuning error "Etn1" appears, refer to [6. 23. 1], [6. 23. 2].

■ Parameters set simultaneously with <AU2: Torque boost macro>

<AU2: Torque boost macro> is a parameter to set <Pt: V/f Pattern> and <F400: Offline auto-tuning> simultaneously.

Therefore, if <AU2> is changed, the following relevant parameters are changed automatically.

		Automatically set parameters			
<AU2>		<Pt>		<F400>	
0	0 is displayed after resetting it	-	Check the setting value of <Pt>.	-	-
1	Automatic torque boost + offline auto-tuning	2	Automatic torque boost	2	Execute (0 after execution)
2	Vector control + offline auto-tuning	3	Vector control 1	2	Execute (0 after execution)
3	Energy savings + offline auto-tuning	4	Energy savings	2	Execute (0 after execution)

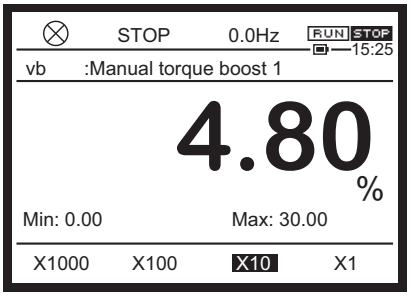
Memo

- For details of offline auto-tuning, refer to [6. 23. 1].

5. 3. 6 Increasing starting torque

<vb: Manual torque boost 1>

Basic parameter



■ Function

The starting torque is increased by increasing the setting value when starting torque is required. It is valid when the setting value of <Pt: V/f Pattern> is "0: V/f constant", "1: Variable torque", or "7: V/f 5-point setting".

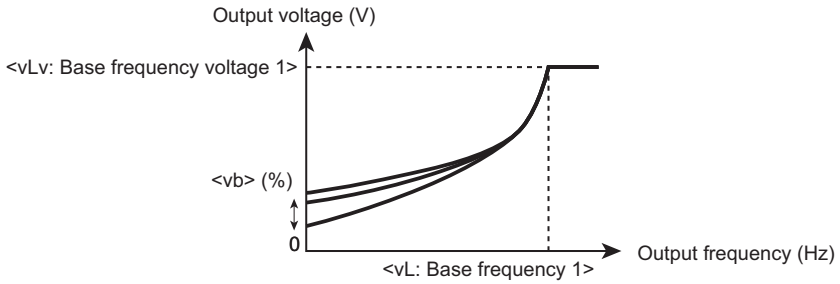
■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
vb	Manual torque boost 1	0.00 - 30.00	%	*1

*1 Depending on the capacity. Refer to [11. 6].

■ Reference of setting

100% is based on 200V, or 400V.
Set the value within +2% of the default setting, generally.



Important

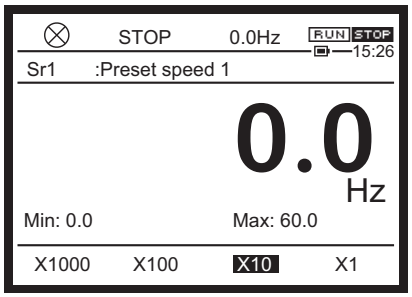
- The optimum value is programmed for each inverter capacity by default setting. When a value larger than the reference value is set, an overcurrent trip may occur at startup.
- Repeated operation with excessive torque boost may cause failure of IGBT in the power circuit. When larger stating torque is required, consider using vector control. For details, refer to [5. 3. 4].

5. 3. 7 Operating by switching frequency command with external logic signal

<Sr0: Preset speed 0> to <Sr7: Preset speed 7>

Basic parameter

<F287: Preset speed 8> to <F294: Preset speed 15>
<F964: Preset speed 16> to <F979: Preset speed 31>



■ Function

The frequency commands are switched with external logic signals. For example, high speed and low speed are switched with 1-speed and 2-speed. Up to 31-speed can be set.
They can be used as interruption frequency commands because they have priority over other frequency commands.

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■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
Sr0	Preset speed 0	LL - UL	Hz	0.0
Sr1 to Sr7	Preset speed 1 - 7	LL - UL	Hz	0.0
F287 to F294	Preset speed 8 - 15	LL - UL	Hz	0.0
F964 to F979	Preset speed 16 - 31	LL - UL	Hz	0.0

Important

- They are valid in the case of run/stop with terminals. Set <CMOd: Run command select> to "0". For details, refer to [5. 2. 1].
- Preset speed 16 to 31 are set only by terminal input. They cannot be set via communication.
- Preset speed 16 to 31 do not support preset speed with the functions. If these functions are required, select preset speed 1 to 15.

■ Reference of setting

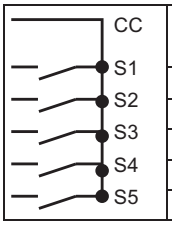
Set the frequency to be used for preset speed 1 to 31 with <Sr1: Preset speed 1> to <F979: Preset speed 31>.
When the preset speed command (external logic signal) is off, the frequency command set with <FMOd: Frequency command select 1> is valid. When <FMOd: Frequency command select 1> is "12: Sr0", the setting value of <Sr0: Preset speed 0> becomes the frequency command.

Memo

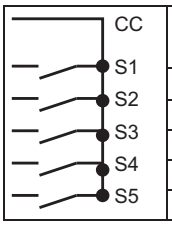
- The preset speed command is always given priority when other frequency commands are input at the same time.

■ Setting example of preset speed frequency

Here is a case of sink logic (when the slide switch [SW1] is set to SINK).



Terminal	Preset speed operation														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
[S1]	✓	-	✓	-	✓		✓	-	✓	-	✓	-	✓	-	✓
[S2]	-	✓	✓	-	-	✓	✓	-	-	✓	✓	-	-	✓	✓
[S3]	-	-	-	✓	✓	✓	✓	-	-	-	-	✓	✓	✓	✓
[S4]	-	-	-	-	-	-	-	✓	✓	✓	✓	✓	✓	✓	✓
[S5]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



Terminal	Preset speed operation															
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
[S1]	-	✓	-	✓	-	✓	-	✓	-	✓	-	✓	-	✓	-	✓
[S2]	-	-	✓	✓	-	-	✓	✓	-	-	✓	✓	-	-	✓	✓
[S3]	-	-	-	-	✓	✓	✓	✓	-	-	-	-	✓	✓	✓	✓
[S4]	-	-	-	-	-	-	-	-	✓	✓	✓	✓	✓	✓	✓	✓
[S5]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

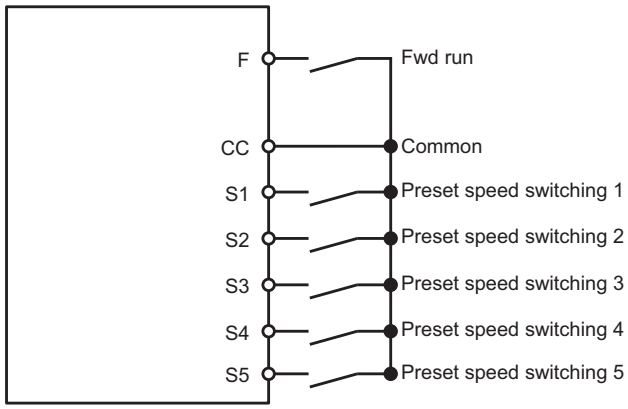
✓: ON, - : OFF (When it is all OFF, then frequency command other than Preset speed operation is enabled.)

Set the input terminal functions as follows.

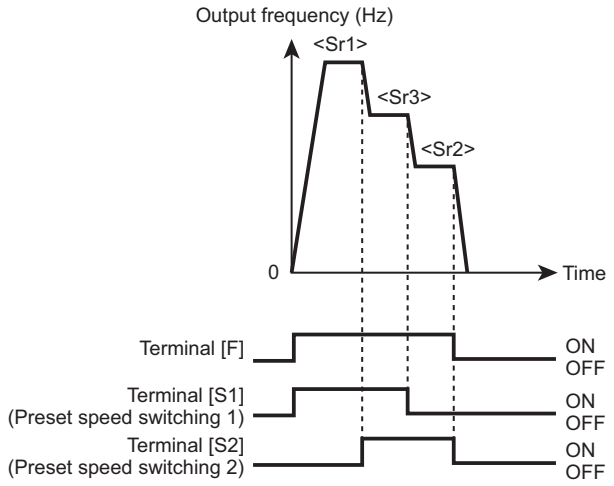
- <F114: Terminal S1 function 1> = "10: Preset speed switching 1"
- <F115: Terminal S2 function> = "12: Preset speed switching 2"
- <F116: Terminal S3 function> = "14: Preset speed switching 3"
- <F117: Terminal S4 function> = "16: Preset speed switching 4"
- <F118: Terminal S5 function> = "118: Preset speed switching 5"

Connect them as shown in the digram below.

In case of sink logic



The following is an operation example of preset speed 1 - 3.
In this case, set <Sr1: Preset speed 1> to <Sr3: Preset speed 3>.



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■ When changing frequency command during run

The frequency command can be changed during run with preset speed command.
Set <F724: Frequency setting target by touch wheel> to "1: FC + Preset speed". When you operate the touch wheel during run with preset speed command, the frequency command can be changed.
When you press the [OK] key, the setting value of the preset speed frequency can be changed.

Title	Parameter name	Adjustment range	Default setting
F724	Frequency setting target by touch wheel	0: Panel run frequency command (FC) 1: FC + Preset speed	0

0: Panel run frequency command (FC)
Sets the frequency command from the operation panel.

1: FC + Preset speed
Sets the frequency command from the operation panel during run with the preset speed command.

Memo

- While the frequency command is being adjusted, the frequency for running is switched if other preset speed command is input. However, the screen display and the adjustment target of the touch wheel are not switched. When you press the [OK] key, the display is switched to the current frequency for running.

■ Setting of operation function

For preset speed frequency commands of 1-speed to 15-speed, functions such as direction of rotation, acceleration/deceleration time, V/f control, and torque limit can be set.
After setting <F560: Preset speed operation style> to "1: With function", set functions with <F561 Preset speed 1> to <F576: Preset speed 15>.

Title	Parameter name	Adjustment range	Default setting
F560	Preset speed operation style	0: Frequency only 1: With function	0

0: Frequency only

Only the frequency command is valid.

1: With function

For each preset speed commands of 1-speed to 15-speed, direction of rotation, acceleration/deceleration time, V/f control, and torque limit can be set.

In this case, the direction of rotation of the motor is as set with <F561: Operation function (1-speed)> to <F576: Operation function (0-speed)>, not as the input of terminal [F] or terminal [R].

Title	Parameter name	Adjustment range	Default setting
F561 - F575	Operation function (1-speed) to Operation function (15-speed)	0: Fwd run +1: Rev run +2: Acc/Dec switching signal 1 +4: Acc/Dec switching signal 2 +8: V/f switching signal 1 +16: V/f switching signal 2 +32: Torque limit switching signal 1 +64: Torque limit switching signal 2	0
F576	Operation function (0-speed)		

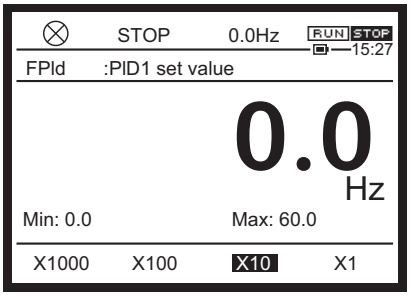
Add the values of the functions to be used for setting. For example, when using the functions of Rev run (+1) and Acc/Dec switching signal 1 (+2), set "3" (+1+2=+3).

Do not set +8, or +16 to F576.

5. 3. 8 Setting PID control

<FPId: PID1 set value>

Basic parameter



■ Function

This parameter is applied to process control including keeping airflow, pressure, and the amount of flow constant.

The set value and the feedback signal (4 - 20 mA, 0 - 10 V) from the detector are compared, and the frequency is changed toward the set value.

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■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
FPId	PID1 set value	F368 to F367	Hz	0.0

■ Reference of setting

1) Selecting set value and feedback input

Set the set value of PID control with <F389: PID1 set value select> and the feedback input value with <F360: PID1 feedback input select>.

- For <F389>, do not set the signal used for <F360>.
- When the feedback value and the set value match, the signal can be output. Assign function "144: PID 1, 2 frequency command agreement" to the output terminals.

Title	Parameter name	Adjustment range	Default setting
F389	PID1 set value select	0: selected by FMOd/F207 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 11: - 12: FPId 13, 14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18, 19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	0
F360	PID1 feedback input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 16: - 17: High resolution pulse train (option)	0

5

2) Setting contents of PID control

Set <F359: PID control 1> to "1: Process PID control".

Title	Parameter name	Adjustment range	Unit	Default setting
F359	PID control 1	0: Disabled 1: Process PID control 2: Speed PID control 3: Easy positioning P control 4: Dancer control 5 - 10: - 11: Minus Process PID control 12: Minus Speed PID control 13: Minus Easy positioning P control 14: Minus Dancer control		0
F367	PID1 set value upper-limit	0.0 - FH	Hz	50.0/60.0
F368	PID1 set value lower-limit	0.0 - F367	Hz	0.0

Set <ACC: Acceleration time 1> and <dEC: Deceleration time 1> to the time that is suitable for the system. Refer to [5. 2. 4].

To limit the setting values, set the following parameters.

- To limit the set value: <F367: PID1 set value upper-limit>, <F368: PID1 set value lower-limit >
- To limit the output frequency: <UL: Upper limit frequency>, <LL: Lower limit frequency> (Refer to [5. 2. 3].)

Memo	• PID control can be temporarily turned off with an external signal. Assign "36: PID control OFF" to an input terminal. • PID control should be OFF when very low speed drive is needed. • If speed PID is selected, motor is possibly rotating forward and reverse. If you don't want to rotate reverse, set <F311: Reverse inhibited> or select process PID (<F359>=1, or 11).

3) Adjusting PID control gain level

Adjust the PID control gain level according to the set values, the feedback signals, and the object to be controlled.

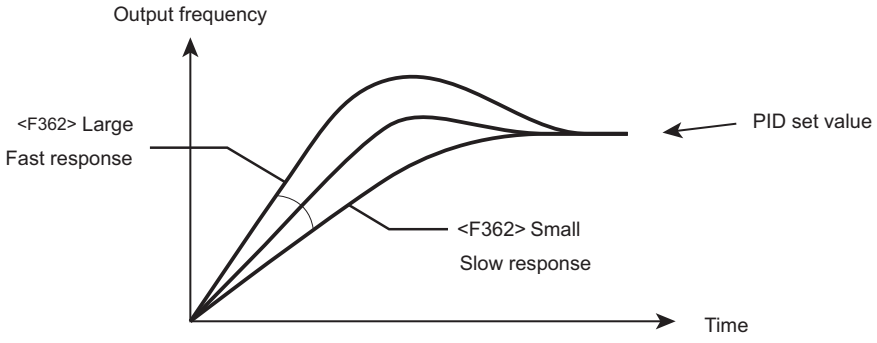
Title	Parameter name	Adjustment range	Unit	Default setting
F362	PID1 proportional gain	0.01 - 100.0	-	0.30
F363	PID1 integral gain	0.01 - 100.0	s^{-1}	0.20
F366	PID1 differential gain	0.00 - 2.55	s	0.00

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<F362: PID1 proportional gain>

This parameter adjusts the proportional gain level of PID control. A correction value proportional to the particular deviation (the difference between the set value and the feedback value) is obtained by multiplying this deviation by the parameter setting.

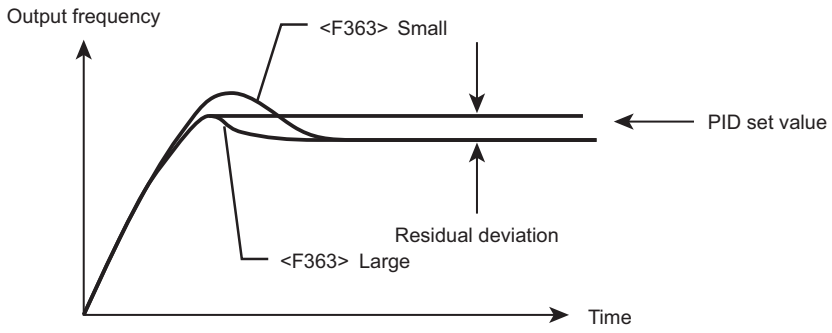
A larger P-gain adjustment value gives faster response. Too large an adjustment value, however, results in an unstable event such as hunting.



<F363: PID1 integral gain>

This parameter adjusts the integral gain level of PID control. Any remaining deviations (residual deviation offset) during proportional action are cleared to zero.

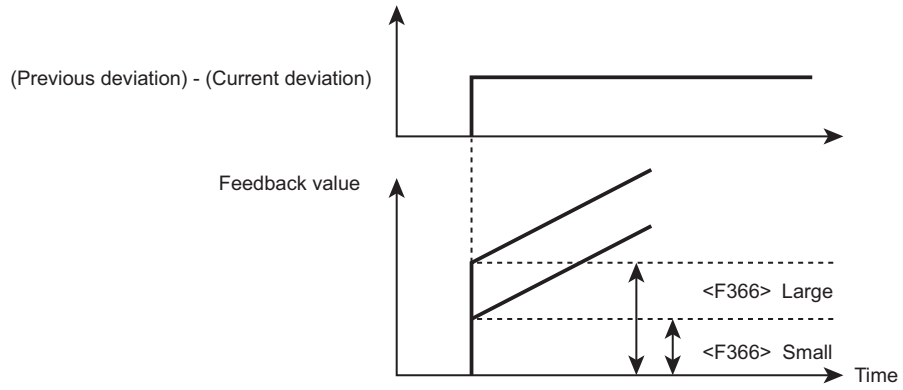
A larger I-gain adjustment value reduces residual deviations. Too large an adjustment value, however, results in an unstable event such as hunting.



The integral/derivative amount of PID control can be reset with an external signal. Assign function number "52: PID differential/integral reset" to an input terminal.

<F366: PID1 differential gain>

This parameter adjusts the differential gain level of PID control. This gain increases the speed of response to a rapid change in deviation (difference between the set value and the feedback value). Note that setting the gain beyond necessity may cause fluctuations in output frequency, and thus operation to become unstable.

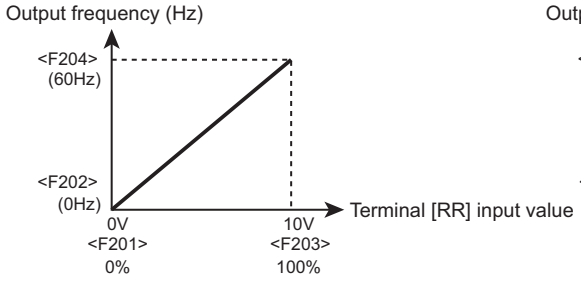


The integral/derivative amount of PID control can be reset with an external signal. Assign "52: PID differential/integral reset" to an input terminal.

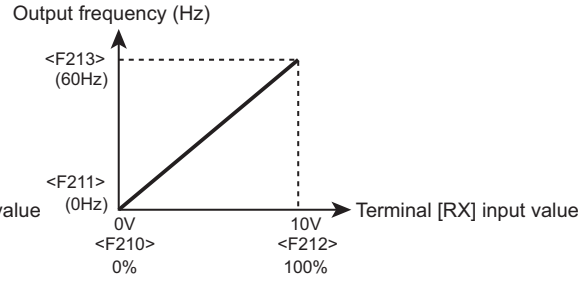
4) Adjusting feedback input

Make adjustment by converting input level of the feedback value into frequency. Refer to [6. 6. 2].

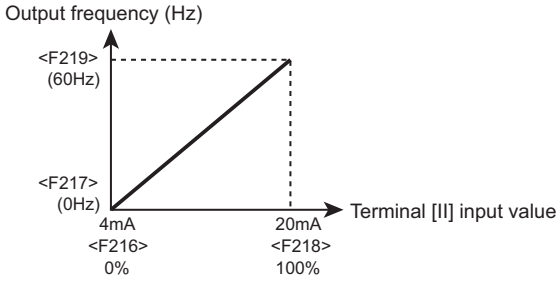
Example of 0 - 10 Vdc voltage input setting



Example of -10 - +10 Vdc voltage input setting



Example of 4 - 20 mAdc current input setting



5

5) Setting the time elapsed before PID control starts

Waiting time until starting PID control system can be set to avoid PID control until the control system becomes stable at power on.

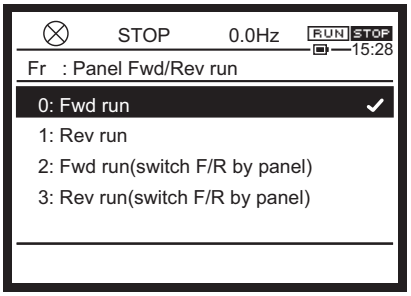
The inverter ignores feedback input signals and runs at the frequency determined by the frequency command value for the period of time set with <F369: PID1 start wait time>, and enters PID control after the elapsed time.

Title	Parameter name	Adjustment range	Unit	Default setting
F369	PID control start wait time	0 - 2400	s	0

5. 3. 9 Switching direction of rotation during panel run

<Fr: Panel Fwd/Rev run select>

Basic parameter



■ Function

This parameter is used to select the direction of rotation of the motor during panel run.
The direction of rotation can be changed during run by using the [FWD/REV] key on the operation panel.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
Fr	Panel Fwd/Rev run select	0: Fwd run 1: Rev run 2: Fwd run (switchable F/R by panel) 3: Rev run (switchable F/R by panel)	0

■ Selecting a setting value

0: Fwd run

When you press the [RUN] key on the operation panel, the motor runs forward.
Forward run/reverse run cannot be switched.

1: Rev run

When you press the [RUN] key on the operation panel, the motor runs reversely.
Forward run/reverse run cannot be switched.

2: Fwd run (switchable F/R by panel)

When you press the [RUN] key on the operation panel, the motor runs forward.
When you press the [FWD/REV] key during forward run, the motor starts running reversely. When you press the [FWD/REV] key again, the motor starts running forward.
The command given before "MOFF" display is remained at the power off.

3: Rev run (switchable F/R by panel)

When you press the [RUN] key on the operation panel, the motor runs reversely.
When you press the [FWD/REV] key during reverse run, the motor starts running forward. When you press the [FWD/REV] key again, the motor starts running reversely.
The command given before "MOFF" display is remained at the power off.

■ Direction of rotation of motor

You can check the direction of rotation of the motor with the following display.

- FWD / REV display of the rotation direction icon.
- Direction of rotation of the rotating icon
- "Forward"/"Reverse" display of the direction of rotation in [Monitor mode].

When the [FWD]/[REV] key is valid, FWD REV is displayed at the upper right of the LCD screen.

When the motor is running forward, FWD is highlighted. When it is running reversely, REV is highlighted.

Memo	• This function is valid when the motor is run/stopped from the operation panel or extension panel (<CMOd: Run command select> = "1"). • In the case of terminal run, setting with <Fr: Panel Fwd/Rev run select> is invalid. Switch forward/reverse run with the terminal [F] and the terminal [R]. Terminal [F]: Fwd run Terminal [R]: Rev run For details of terminal run, refer to "Chapter 7".

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5. 3. 10 Automatic setting of main parameters by region used

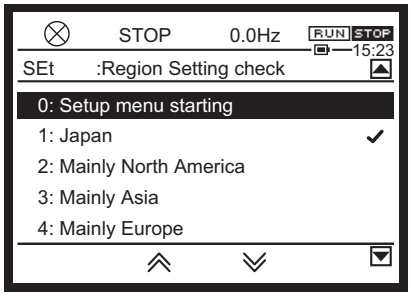
⚠ WARNING

Mandatory action

- Make sure to set the setup menu correctly.
  If you set the setup menu incorrectly, this will damage the inverter or cause the inverter to perform unexpected movement.

<SEt: Region setting check>

Basic parameter



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■ Function

When you select a region using in the setup menu at initial Power on, parameters such as the base frequency of the motor is set automatically according to the selected region.
You can check the region that has been set or reset it by starting the setup menu.

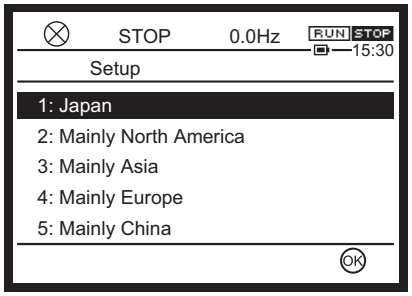
■ Parameter setting

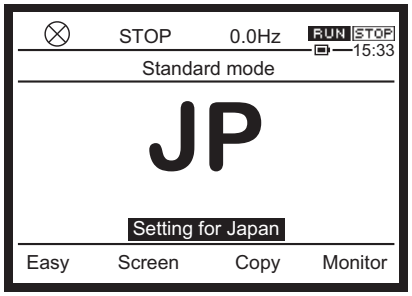
Title	Parameter name	Adjustment range	Default setting
SEt	Region setting check	0: Setup menu starting 1: Japan (read only) 2: Mainly North America (read only) 3: Mainly Asia (read only) 4: Mainly Europe (read only) 5: Mainly China (read only)	0

■ Selecting a setting value

0: Setup menu starting

The setup menu to select the region where the inverter is used is started.
When you select the region, parameters such as the base frequency and the base frequency voltage of the motor that are described on the separate table are automatically set.





Important

- While the setup menu is started, you cannot return to the previous step even if you press the [ESC] key.
- Note that all parameters return to status of default setting and the trip history data is cleared.

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1: Japan (read only)
2: Mainly North America (read only)
3: Mainly Asia (read only)
4: Mainly Europe (read only)
5: Mainly China (read only)
All of 1 to 5 are display to check the setting. Even if you select any of them and press the [OK] key, new setting cannot be made.
There is a mark at the right end of the region selected in the setup menu.

■ Parameters set with setup menu

Parameter title	Function	Mainly North America	Mainly Asia	Mainly Europe	China	Japan
FH	Maximum frequency (Hz)	80.0	80.0	80.0	50.0	80.0
F307	Supply voltage compensation	2	2	2	2	3
F319	Regenerative over-flux upper limit (%)	120	120	120	140	140
F417	Motor rated speed (min^{-1})	*1	*1	*1	*1	*1
vLv, F171, F175, F179	Base frequency Voltage (V)	230	230	230	200	200
		460	400	400	380	400
vL, UL, F170, F174, F178, F204, F213, F219, F225, F231, F237, F330, F335, F364, F367, F370, F426, F428, F814, A316, A319, A322, A346, A349, A352, A376, A379, A382	Frequency (Hz)	60.0	50.0	50.0	50.0	60.0

Parameter title	Function		Mainly North America	Mainly Asia	Mainly Europe	China	Japan
F606, F643	Frequency (max of set value) (Hz)		60.0	50.0	50.0	50.0	60.0
F405	Motor rated Capacity (kW)	3.7	4.0	4.0	4.0	3.7	3.7
		0.4	0.4	0.4	0.4	0.37	0.4
F704	Reference Website		0	1	1	1	1

*1 Depending on the region and the capacity. Refer to [11. 6].

Memo

- The setting values of the parameters set with the setup menu can be changed as in the case of other parameters.

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5. 4 Setting of extended parameters that are especially important

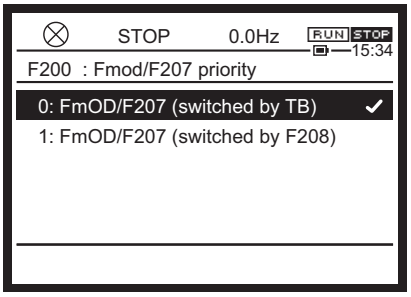
This section explains the parameters that are especially important among the extended parameters. For other extended parameters not introduced here, refer to "Chapter 6".

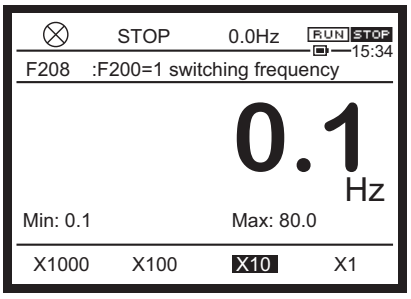
5. 4. 1 Switching two frequency commands

<FMOd: Frequency command select 1>

Basic parameter → Easy mode

<F207: Frequency command select 2>
<F200: Frequency command priority select>
<F208: Frequency command switching frequency>





■ Function

Two frequency commands, for example manual setting with external potentiometer and automatic setting with 4 - 20 mA signals, can be switched.

Switch two frequency commands set with <FMOd: Frequency command select 1> and <F207: Frequency command select 2> with input terminal signals or switching frequency set with <F200: Frequency command priority select>.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
FMOd	Frequency command select 1	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 9: - 10: Touch wheel 1 (power off or press OK to save) 11: Touch wheel 2 (press OK to save) 12: Sr0 13, 14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18, 19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	1
F207	Frequency command select 2		3

Title	Parameter name	Adjustment range	Default setting
F200	Frequency command priority select	0: FMOd/F207 (switched by TB) 1: FMOd/F207 (switched by <F208>)	0

Title	Parameter name	Adjustment range	Unit	Default setting
F208	Frequency command switching frequency	0.1 - FH	Hz	0.1

■ Setting of two frequency commands

Set with <FMOd: Frequency command select 1> and <F207: Frequency command select 2>. The adjustment range is the same.

Refer to "■ Selection of setting value" of <FMOd: Frequency command select 1> in [5. 2. 1].

■ Setting of <F200: Frequency command priority select>

0: FMOd/F207 (switched by TB)

The frequency commands set with <FMOd: Frequency command select 1> and <F207: Frequency command select 2> are switched with input terminal signals.

Setting of the function number of the input terminal is required.

1: FMOd/F207 (switched by <F208>)

The frequency commands set with <FMOd: Frequency command select 1> and <F207: Frequency command select 2> are switched with frequency.

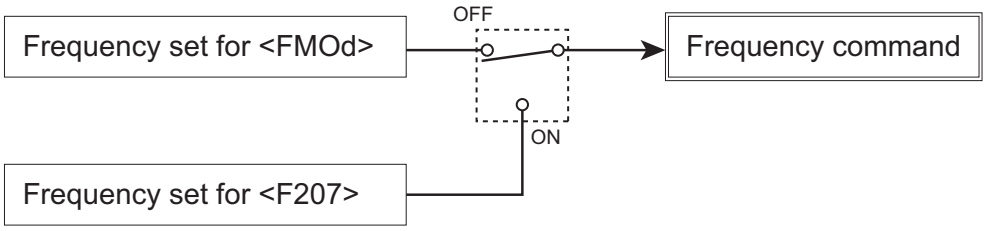
Set the switching frequency with <F208: Frequency command switching frequency>.

■ Switching with input terminal <F200> = "0"

Set <F200: Frequency command priority select> to "0".

Assign "104: FMOd/F207 priority switching" to an unused input terminal. For details, refer to [7. 2. 1].

- When the input terminal is OFF, run the motor with the frequency command set with <FMOd: Frequency command select 1>.
- When the input terminal is ON, run the motor with the frequency command set with <F207: Frequency command select 2>.

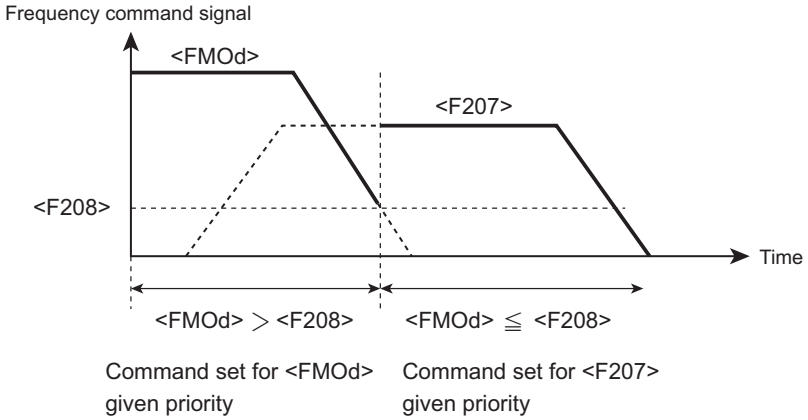


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■ Automatic switching with switching frequency <F200> = "1"

Set <F200: Frequency command priority select> to "1" and set the frequency with <F208: Frequency command switching frequency>.

- If the frequency command set with <FMOd: Frequency command select 1> is larger than the value set with <F208>, the value set with <FMOd> becomes the frequency command.
- If the frequency command set with <FMOd> is larger than the value set with <F208>, the value set with <F207: Frequency command value 2> becomes the frequency command.



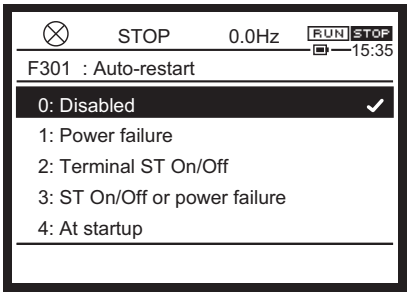
5. 4. 2 Restarting smoothly after momentary power failure

⚠ CAUTION

Mandatory action

- When the auto-restart after momentary stop function is selected, stand clear of motors and machines at momentary power failure.
  The motors and machines which have stopped due to momentary power failure will restart suddenly after power is restored, and this will result in injury.
- Attach caution labels indicating functions programmed for Auto restart, on inverters, motors and machines.
  Please prevent accidents with the caution labels.

<F301: Auto-restart>



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■ Function

The motor that is coasting due to momentary power failure is accelerated immediately after the power is restored (auto-restart function).
In addition, this parameter detects the motor speed and direction of rotation of the motor during coasting at the time of startup, and allows switching from commercial power operation to inverter operation without stopping the motor(motor speed search function).

■ Parameter setting

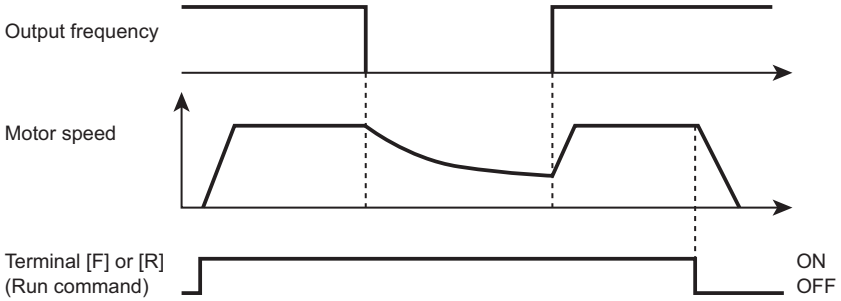
Title	Parameter name	Adjustment range	Default setting
F301	Auto-restart	0: Disabled 1: Power failure 2: Terminal ST On/Off 3: Terminal ST On/Off or power failure 4: At startup	0

■ Selecting a setting value

1: Power failure

The motor that is coasting due to momentary power failure is accelerated immediately after the power is restored.

It is operated after power is restored after power circuit undervoltage is detected. Turn on the run command.



2: Terminal ST On/Off

The motor speed and direction of rotation of the coasting motor are detected to start it smoothly (motor speed search function).

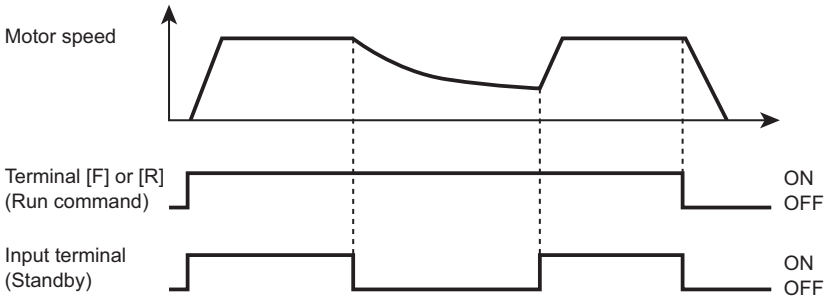
The input terminal to which "ST: Standby" is assigned is turned off. It is operated when the input terminal is turned on again. Turn on the run command.

Since "ST: Standby" is always ON in default setting, make setting as follows.

- Set <F110: Always active function 1> to "0: No function" (Refer to [6. 3. 1])
- Assign "6: ST: Standby" to an unused input terminal

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For assignment of a function to an input terminal, refer to [7. 2. 1].



3: Terminal ST On/Off or power failure

It is operated both in "1" and "2"

4: At startup

A motor speed search is executed each time at startup.

When the motor is rotated by the external factor before running by the inverter, it can be started without trip.

Important

- At restart, it takes about 1 second for the inverter to check the motor speed. For this reason, the startup takes more time than usual.
- Use this function when operating a system with one motor connected to one inverter. This function may not operate properly in a system configuration when multiple motors are connected to one inverter.
- When using this parameter, do not set <F605: Output phase loss detection> to "1", "2", or "4". For details, refer to [6. 30. 5].
- Do not apply it for cranes.
  The load may be lowered during waiting time from input of the run command to startup. To apply the inverter to cranes, therefore, set <F301: Auto-restart> to "0: Disabled". Do not use the retry function, either.
- This function is always enabled at torque control. (independent to <F301> setting)

Memo

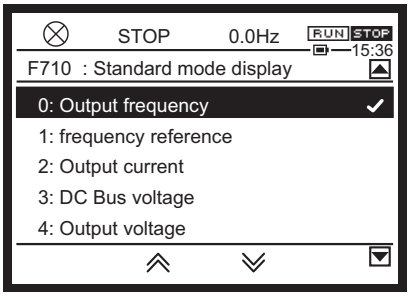
- When the motor is restarted from retry, this function is operated regardless of the setting of this parameter.
- It is not malfunction that abnormal noise might be heard from the motor during the motor speed search at the auto-restart.

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5. 4. 3 Customizing display

(1) Selecting contents displayed in [Standard mode]

<F710: Standard mode display>
<F720: Standard mode display of extension panel>



■ Function

The display contents in [Standard mode] can be changed. Different contents can be displayed on the operation panel of the inverter unit and the extension panel (optional).
Select the display contents in [Standard mode] when the power is turned on. In the default setting, the output frequency is displayed.

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■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F710	Standard mode display	0 - 162*1	0
F720	Standard mode display of extension panel	0 - 162 *1	0

*1 For details, refer to the table at the end of this subsection.

■ Reference of setting

With <F710: Standard mode display>, set the contents to be displayed in [Standard mode] on the operation panel when the power is turned on. Set the extension panel with <F720: Standard mode display of extension panel>.
In either case, "0: Output frequency" in the default setting.

Memo

- Different contents can be displayed on the operation panel of the inverter unit and the extension panel (optional).

■ Setting list of <F710: Standard mode display> and <F720: Standard mode display of extension panel>

Set-ting value	Function name	Display unit	Set-ting value	Function name	Display unit
0	Output frequency	0.1 Hz	71	Motor speed (estimated value)	1
1	Frequency command value	0.1 Hz	72	Communication option Receiving counter	1
2	Output current	1%/<F701> setting	73	Communication option Abnormal counter	1
3	Input voltage (DC detection)	1%/<F701> setting	76	Terminal S4/S5 pulse train input value	0.10%
4	Output voltage	1%/<F701> setting	77	My function COUNT1	1
5	Stator frequency	0.1 Hz	78	My function COUNT2	1
6	Speed feedback frequency (real time)	0.1 Hz	79	Dancer control PID result frequency	0.1 Hz
7	Speed feedback frequency (1-second filter)	0.1 Hz	80	Embedded Ethernet Transmission counter	1
8	Torque	1%	81	Embedded Ethernet Receiving counter	1
9	Torque command	1%	82	Embedded Ethernet Abnormal counter	1
10	Output frequency during run. Frequency command value during stop.	Hz/free unit	83	Connected option number	1
11	Torque current	1%	84	My function COUNT3	1
12	Exciting current	1%	85	My function COUNT4	1
13	PID feedback value	0.1 Hz	86	My function COUNT5	1
14	Motor overload factor (OL2 data)	1%	90	Cumulative power ON time	100 hours
15	Inverter overload factor (OL1 data)	1%	91	Cumulative cooling fan run time	100 hours
16	Braking resistor overload factor (OLr data)	1%	92	Cumulative run time	100 hours
17	Braking resistor load factor (%ED)	1%	93	Cumulative overcurrent time	100 hours
18	Input power	0.1 kW	95	Pump 0 run time	100 hours
19	Output power	0.1 kW	96	Pump 1 run time	100 hours
20	Input cumulative power	<F749> set-ting	97	Pump 2 run time	100 hours
21	Output cumulative power	<F749> set-ting	98	Pump 3 run time	100 hours

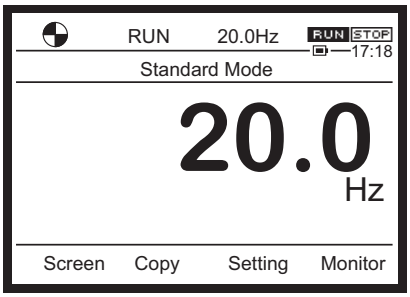
Set-ting value	Function name	Display unit	Set-ting value	Function name	Display unit
22	-	-	99	Pump 4 run time	100 hours
23	-	-	100	Number of starting	10000 times
24	Terminal RR input value	1%	101	Number of Fwd starting	10000 times
25	Terminal RX input value	1%	102	Number of Rev starting	10000 times
26	Terminal II input value	1%	103	External equipment counter	Time
27	Motor speed command	-	105	Pump 5 run time	100 hours
28	Terminal FM output value	1	106	Pump 6 run time	100 hours
29	Terminal AM output value	1	107	Pump 7 run time	100 hours
30	-	-	108	Pump 8 run time	100 hours
31	Communication data output	*1	109	Pump 9 run time	100 hours
32	Slot A option CPU version	-	110	Number of trip	Time
33	Slot B option CPU version	-	111	Number of serious failure trip	1
34	Motor load factor	%	112	Number of slight failure trip	1
35	Inverter load factor	%	113	Number of specified trip 1	1
36	Inverter rated current	A	114	Number of specified trip 2	1
37	Inverter rated current (with carrier frequency correction)	A	115	Number of specified trip 3	1
38	Actual carrier frequency	kHz	120	Internal temperature 1	°C
39	Slot C option CPU version	-	124	Power circuit board temperature	°C
40	Embedded Ethernet CPU version	-	130	External PID3 set value	0.1 Hz
41	Terminal FP pulse train out-put value	pps	131	External PID3 feedback value	0.1 Hz
43	Terminal FM/AM gain setting value	-	132	External PID3 result value	0.1 Hz
44	Terminal AI4 input value	1%	133	External PID4 set value	0.1 Hz
45	Terminal AI5 input value	1%	134	External PID4 feedback value	0.1 Hz
46	My function monitor output 1	-	135	External PID4 result value	0.1 Hz
47	My function monitor output 2	-	150	Signed output frequency	0.1 Hz
48	My function monitor output 3	-	151	Signed frequency command value	0.1 Hz
49	My function monitor output 4	-	152	Signed stator frequency	0.1 Hz
62	PID result frequency	0.1 Hz	153	Signed speed feedback frequency (real time)	0.1 Hz

Set-ting value	Function name	Display unit	Set-ting value	Function name	Display unit
63	PID set value	0.1 Hz	154	Signed speed feedback frequency (1-second filter)	0.1Hz
64	Light-load high-speed switching load torque	1%	155	Signed torque	1%
65	Light-load high-speed torque during constant speed run	1%	156	Signed torque command	1%
66	Pattern operation group number	0.1	158	Signed torque current	1%
67	Pattern operation remaining cycle number	1	159	Signed PID feedback value	0.1 Hz
68	Pattern operation preset speed number	1	160	Signed terminal RX input value	1%
69	Pattern operation remaining time	0.1	161	Signed terminal AI4 input value	1%
70	Inverter rated voltage	1	162	Signed terminal AI5 input value	1%

*1 For details, refer to “RS485 Communication Function Instruction Manual” (E6582143).

(2) Selecting contents displayed in the status area

<F723: Status area display of operation panel>



■ Function

Sets the content displayed third from the left end of the status area. Default setting displays the frequency command value.

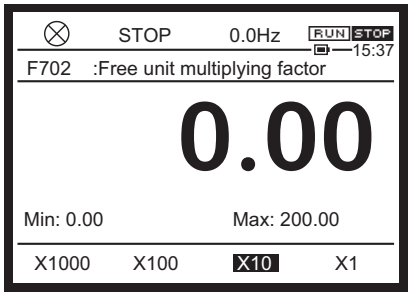
■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F723	Status area display of operation panel	0 - 162*1	1

*1 For details, refer to the table at the end of the previous subsection (1).

(3) Displaying frequency by converting to other unit

<F702: Free unit multiplication factor>
<F703: Target of free unit>
<F705: Free unit inclination polarity>
<F706: Free unit bias>



■ Function

The monitor display and the frequency display of parameters can be converted into the motor speed or load speed.
The unit of the set value or that of feedback can be changed at PID control for easy setting.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F702	Free unit multiplication factor	0.00: Disabled 0.01 - 200.0	times	0.00
F703	Target of free unit	0: All frequencies 1: PID frequencies	-	0
F705	Free unit inclination polarity	0: Negative inclination (downward slope) 1: Positive inclination (upward slope)	-	1
F706	Free unit bias	0.00 - FH	Hz	0.00

■ Reference of setting

The value obtained by multiplying the displayed frequency by the setting value of <F702: Free unit multiplication factor> is displayed.
"Value displayed" = "Monitor-displayed" or "parameter-set frequency" x <F702>

■ Parameters converted with <702: Free unit multiplication factor>

When <F703: Target of free unit> is "0"
It applies to all the frequency.

- Frequency monitor display: Frequency command value, Output frequency, PID feedback value, Stator frequency, During stop: Frequency command value (During run: Output frequency)
- Frequency-related parameters: <FC>, <FH>, <UL>, <LL>, <FPId>, <Sr0> - <Sr7>, <F100>, <F101>, <F102>, <F190>, <F192>, <F194>, <F196>, <F198>, <F202>, <F204>, <F208>, <F211>, <F213>, <F217>, <F219>, <F223>, <F225>, <F229>, <F231>, <F235>, <F237>, <F240>, <F241>, <F242>, <F243>, <F244>, <F250>, <F260>, <F265>, <F267>, <F268>, <F270> - <F275>, <F287> - <F294>, <F321>, <F322>, <F330>, <F331>, <F346>, <F350>, <F352>, <F355>, <F364>, <F365>, <F367>, <F368>, <F370>, <F371>, <F374>, <F383>, <F391> - <F393>, <F426>, <F428>, <F431>, <F432>, <F466>, <F505>, <F513>, <F517>, <F606>, <F623>, <F624>, <F643>, <F649>, <F812>, <F814>, <F964> - <F979>

<A220>, <A222>, <A226>, <A227>, <A229>, <A230>, <A316>, <A317>, <A319>, <A320>, <A322>, <A323>, <A326>, <A327>, <A923> - <A927>
<C154>, <C155>, <C697>

When <F703: Target of free unit> is "1"

It applies only to the PID control-related frequency.

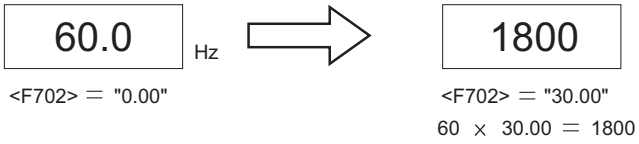
- PID control-related parameters: <FPId>, <F364>, <F365>, <F367>, <F368>, <F374>, <A316>, <A317>, <A319>, <A320>, <A326>, <A327>

Memo	• Base frequency is always Hz. <vL: Base frequency 1>, <F170: Base frequency 2>, <F174: Base frequency 3>, <F178: Base frequency 4>

■ Setting example of <F702: Free unit multiplicaton factor>

1) Motor speed display

When output frequency 60 Hz is displayed as 1800min^{-1} at the time of 4-pole motor operation

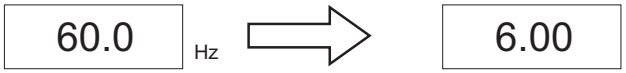


<F702> = "0.00"

<F702> = "30.00"
60 × 30.00 = 1800

2) Load speed display

When output frequency 60 Hz is displayed as conveyor speed of 6m/min



<F702> = "0.00"

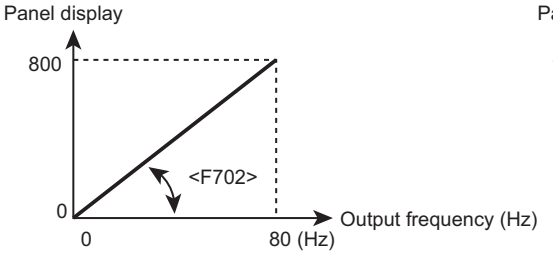
<F702> = "0.10"
60 × 0.10 = 6.00

■ Setting of <F705: Free unit inclination polarity> and <F706: Free unit bias>

The inclination of the free unit can be changed, and the bias can be set.
The following are examples of setting and screen display (when <F702> = "10.0", <FH> = "80.0").

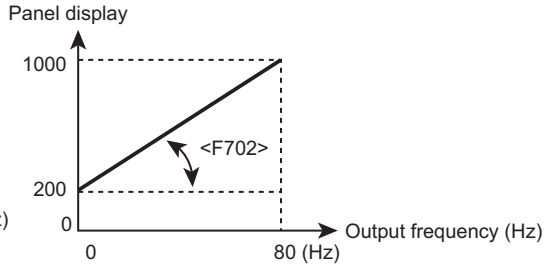
Positive inclination

<F705>="1 ", <F706>="0.00"



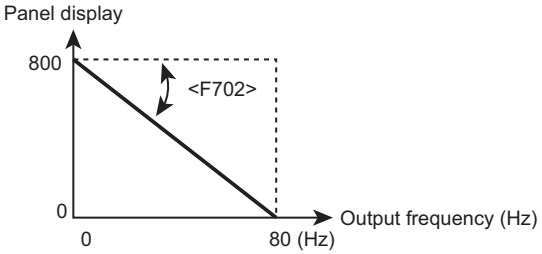
Positive inclination with bias

<F705>="1", <F706>="20.00"



Negative inclination

<F705>="0", <F706>="80.00"



5

Important

- This parameter is a function to display the output frequency of the inverter multiplied by the factor. It does not display the actual motor speed or line speed precisely.

6 [Advanced] How to use parameters

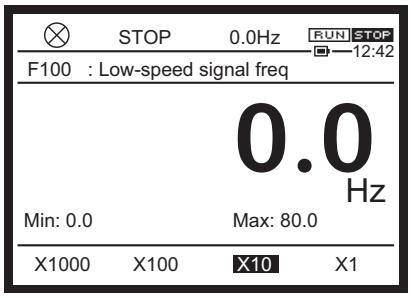
This inverter has basic parameters and other three types of parameters such as extended parameters (with F), advanced parameters, (with A), and communication parameters (with C). These parameters are used for sophisticated operations, detailed settings, special purposes, etc. This chapter explains how to use the parameters that are not mentioned in the previous chapters.

6. 1 Output signals from the control terminals

Various signals are output for motor operation.
For details on the output terminal functions, refer to [7. 2. 2].

6. 1. 1 Output the running signal and the brake signal (output the low-speed signal)

<F100: Low-speed signal output frequency>



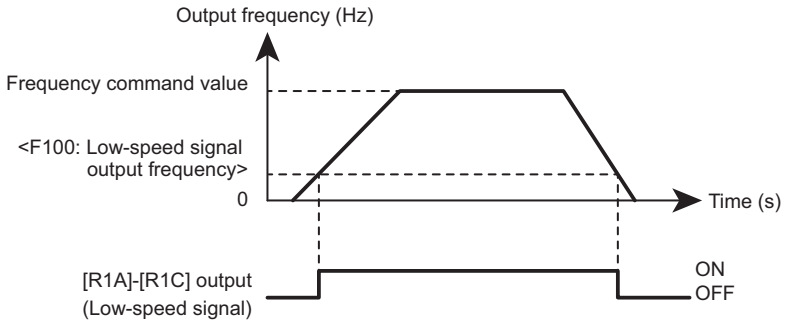
■ **Function**

When the output frequency becomes over <F100: Low-speed signal output frequency>, the low-speed signal is output from the output terminal.

- When <F100: Low-speed signal output frequency> is set to "0.0", the ON signal is output when the output frequency is over 0.0 Hz. Therefore, this setting can be used as a running signal.
- This signal can be also used as brake/release signal for the electromagnetic brake.

■ **Parameter setting**

Title	Parameter name	Adjustment range	Unit	Default setting
F100	Low-speed signal output frequency	0.0-FH	Hz	0.0



■ Output terminal parameter setting

Low-speed signal is the default setting for terminal [R1].

Title	Parameter name	Adjustment range	Default setting
F133	Terminal R1 function 1	0-255 *1	4

*1 For details on the output terminal functions, refer to [7. 2. 2].

6

Memo

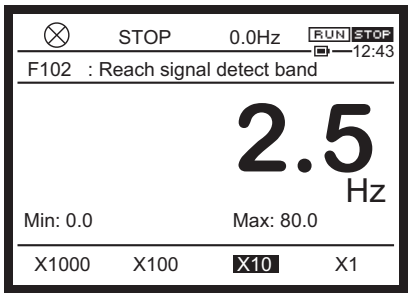
- When you want to output the inversion signal (OFF signal), set "5".
- The signals can be also output from the other output terminals depending on the parameter setting.
  When you want to output the signals from the relay logic output terminals [FLA]-[FLB]-[FLC], set "4" or "5" for <F132: Terminal FL function>. When you want to output the signals from the terminals [R2A]-[R2C], set "4" or "5" for <F134: Terminal R2 function>. When you want to output the signals from the terminal [FP], set "4" or "5" for <F130: Terminal FP function 1>.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 1. 2 Output a signal when reached to a frequency command (output the Acc/Dec completed signal)

<F102: Reach signal detection band>

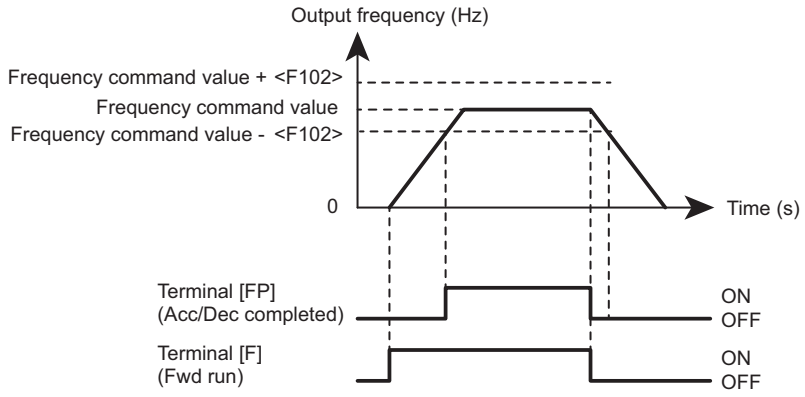


■ Function

When the output frequency becomes the frequency command ±<F102: Reach signal detection band>, the Acc/Dec completed signal is output from the output terminal.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F102	Reach signal detection band	0.0-FH	Hz	2.5



■ Output terminal parameter setting

Acc/Dec completed signal is the default setting for output terminal [FP].

Title	Parameter name	Adjustment range	Default setting
F130	Terminal FP function 1	0-255*1	6

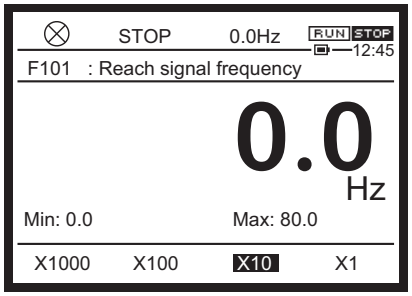
*1 For details on the output terminal functions, refer to [7. 2. 2].

Memo	• When you want to output the inversion signal (OFF signal), set "7". • The signals can be also output from the other output terminals depending on the parameter setting. When you want to output the signals from the [FLA]-[FLB]-[FLC] relay logic output terminals, set at <F132: Terminal FL function>. When you want to output the signals from the terminals [R1A]-[R1C], set at <F133: Terminal R1 function 1>. When you want to output the signals from the terminals [R2A]-[R2C]. set at <F134: Terminal R2 function >. • When the run command (Fwd signal or Rev signal) is OFF, the Acc/Dec completed signal is also OFF.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]. • Details on operation by external signals -> Refer to [Chapter 7].

6. 1. 3 Output a signal when reached to a specified frequency (output the specified frequency attainment signal)

<F101: Reach signal specified frequency>
<F102: Reach signal detection band>

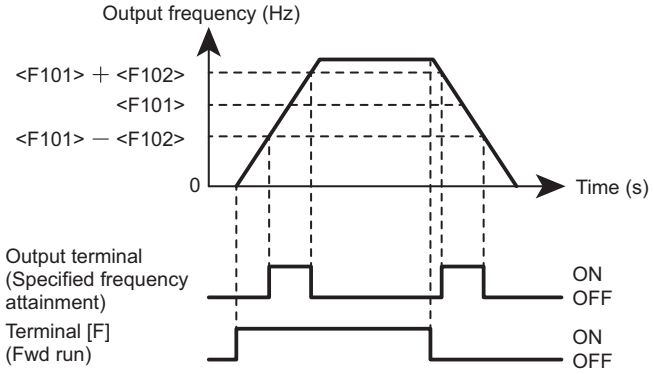


■ Function

When the output frequency becomes the frequency that is equal to the value for <F101: Reach signal specified frequency> plus or minus the value for <F102: Reach signal detection band>, the ON signal (specified frequency attainment signal) is output from a specified output terminal.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F101	Reach signal specified frequency	0.0-FH	Hz	0.0
F102	Reach signal detection band	0.0-FH	Hz	2.5



■ Output terminal parameter setting

When you want to output the specified frequency attainment signal to the output terminal [FP], set "8" for <F130: Terminal FP function 1>.

When you want to output the signal from the relay logic output terminals [FLA]-[FLB]-[FLC], set <F132: Terminal FL function>. When you want to output the signal from the [R1A]-[R1C] terminals, set <F133: Terminal R1 function 1>. When you want to output the signal from the terminals [R2A]-[R2C] set <F134: Terminal R2 function >.

Memo	• When you want to output the inversion signal (OFF signal), set "9". • When a run command (Fwd signal or Rev signal) is OFF, the specified frequency attainment signal is also OFF.

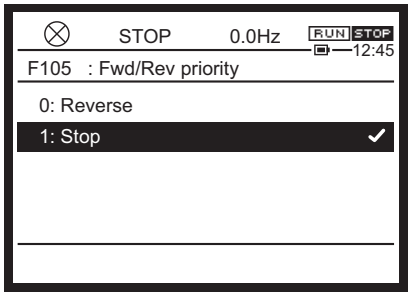
Reference	• How to operate the operation panel -> Refer to [3. 1. 1. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]. • Details on operation by external signals -> Refer to [Chapter 7].

6. 2 Input signals to the control terminals

Various signals are input to the inverter for motor operation.
For details on the input terminal function, refer to [7. 2. 1].

6. 2. 1 Selecting operation at simultaneous input of Fwd/ Rev commands

<F105: Fwd/Rev priority of both close>



6

■ Function

This parameter selects operation performed (reverse run or deceleration stop) when the Fwd and Rev signals are simultaneously input.

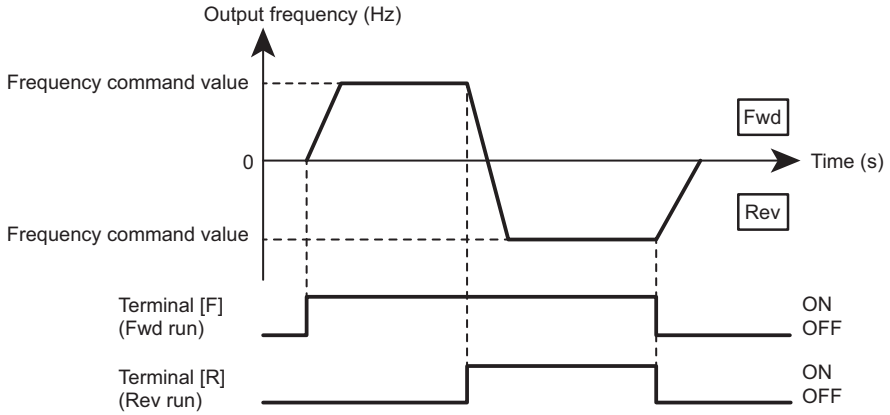
■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F105	Fwd/Rev priority of both close	0: Reverse 1: Stop	1

■ Difference between the settings

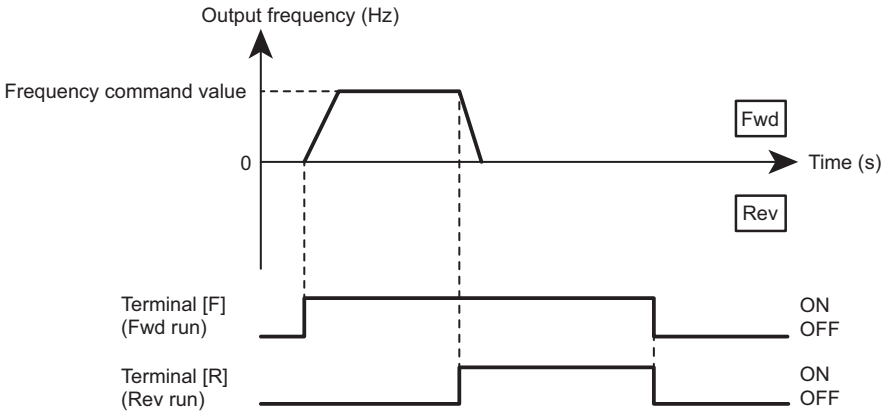
0: Reverse

When the Fwd and Rev signals are simultaneously input, reverse run is performed.



1: Stop

When the Fwd and Rev signals are simultaneously input, deceleration stop is performed.

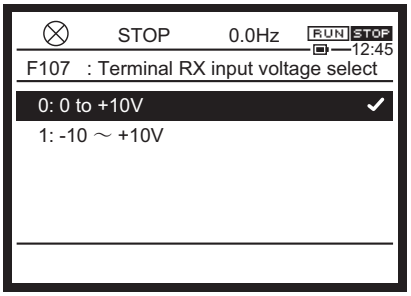


Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]. • Details on operation by external signals -> Refer to [Chapter 7].

6

6. 2. 2 Selecting input voltage of the terminal [RX]

<F107: Terminal RX input voltage select>



■ Function

This parameter selects the input voltage of the terminal [RX].

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F107	Terminal RX input voltage select	0: 0 to +10 V 1: -10 to +10 V	0

■ Difference between the settings

0: 0 to +10 V

Input 0 to 10 Vdc between the terminals [RX]-[CC].
The resolution is 1/1000 at the maximum at 0 to 10 Vdc.

1: -10 to +10 V

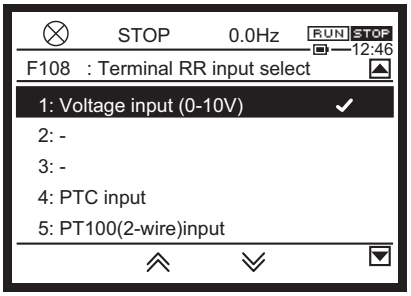
Input -10 to +10 Vdc between the terminals [RX]-[CC].
The resolution is 1/2000 at the maximum at -10 to +10 Vdc.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 2. 3 Selecting input signal of the terminal [RR]

<F108: Terminal RR input select>



■ Function

This parameter selects the input signal of the terminal [RR].

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F108	Terminal RR input select	1: Voltage input (0-10 V) 2, 3: - 4: PTC input 5: PT100 (2-wire) input 6: - 7: PT1000 (2-wire) input 8: - 9: KTY84 input	1

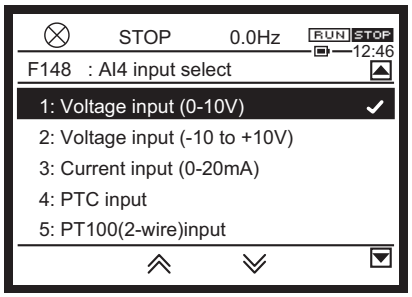
6

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 2. 4 Selecting input signals of the optional terminals [AI4] and [AI5]

<F148: Terminal AI4 input select>
<F149: Terminal AI5 input select>



■ Function

These parameters select an input signal for the optional terminals [AI4] and [AI5].

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F148	Terminal AI4 input select	1: Voltage input (0-10 V) 2: Voltage input (-10 to +10 V) 3: Current input (0-20 mA) 4: PTC input 5: PT100 (2-wire) input 6: PT100 (3-wire) input 7: PT1000 (2-wire) input 8: PT1000 (3-wire) input 9: KTY84 input	1
F149	Terminal AI5 input select		1

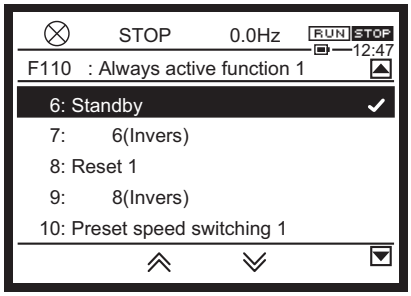
Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3].

6. 3 Selecting terminal functions

6. 3. 1 Always enabling the input terminal functions (always ON)

<F110: Always active function 1>
<F127: Always active function 2>
<F128: Always active function 3>



■ Function

These parameters select an input terminal function to be always enabled (always ON). You can set three points.

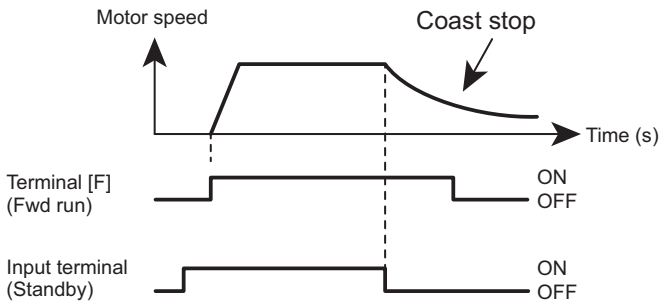
■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F110	Always active function 1	0-177*1	6
F127	Always active function 2		0
F128	Always active function 3		0

*1 For details on the input terminal functions, refer to [7. 2. 1].

Memo

- Coast stop is a stop pattern where the inverter output is turned OFF, and the motor rotation stops spontaneously.
  The deceleration stop is performed by default setting (the frequency is decreased to 0 Hz by the inverter deceleration time).
- When "ST" (standby) is turned OFF, the motor performs coast stop.
- "ST"(standby)is always ON by default setting. Therefore, change the setting as shown below:
  - <F110: Always active function 1> = "0: No function"
  - Assign "6: ST" (standby) to an unused input terminal.
- When the terminal where "ST" (standby) is assigned is turned OFF, coast stop will be performed.



Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3].
- Details on operation by external signals -> Refer to [Chapter 7].

6. 3. 2 Changing the input terminal functions

<F111: Terminal F function 1>
<F112: Terminal R function 1>
<F113: Terminal RES function 1>
<F114: Terminal S1 function 1>
<F115: Terminal S2 function>
<F116: Terminal S3 function>
<F117: Terminal S4 function>
<F118: Terminal S5 function>
<F119: Terminal DI11 function>
<F120: Terminal DI12 function>
<F121: Terminal DI13 function>
<F122: Terminal DI14 function>
<F123: Terminal DI15 function>
<F124: Terminal DI16 function>
<F140: Terminal F response time>
<F141: Terminal R response time>
<F142: Terminal RES response time>
<F143: Terminal S1 response time>
<F144: Terminal S2-S5 response time>
<F145: Terminal DI11-DI16 response time>
<F146: Terminal S4 input select>
<F147: Terminal S5 input select>
<F151: Terminal F function 2>
<F152: Terminal R function 2>
<F153: Terminal RES function 2>
<F154: Terminal S1 function 2>
<F155: Terminal F function 3>
<F156: Terminal R function 3>
<F157: Terminal RES function 3>
<F158: Terminal S1 function 3>

For details on the input terminal functions, refer to [7. 2. 1].

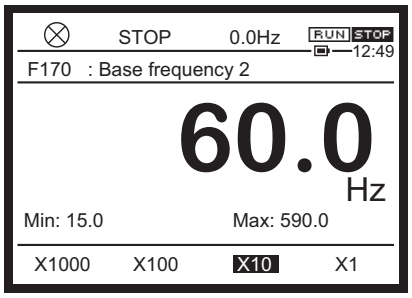
6. 3. 3 Changing the output terminal functions

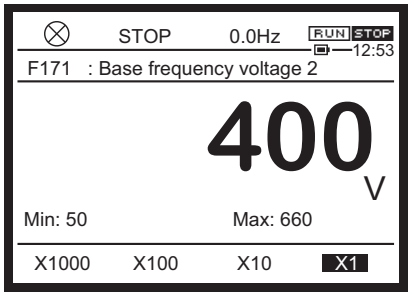
<F130: Terminal FP function 1>
<F132: Terminal FL function >
<F133: Terminal R1 function 1>
<F134: Terminal R2 function >
<F135: Terminal R1 delay time>
<F136: Terminal R2 delay time>
<F137: Terminal FP function 2>
<F138: Terminal R1 function 2>
<F139: Terminal FP, R1 logic selct>
<F159: Terminal DQ11 function>
<F160: Terminal DQ12 function>
<F161: Terminal R4 function>
<F162: Terminal R5 function>
<F163: Terminal R6 function>

For details on the output terminal functions, refer to [7. 2. 2].

6. 4 Switching two to four types of motor characteristics

<F170: Base frequency 2>
<F171: Base frequency voltage 2>
<F172: Manual torque boost 2>
<F174: Base frequency 3>
<F175: Base frequency voltage 3>
<F176: Manual torque boost 3>
<F178: Base frequency 4>
<F179: Base frequency voltage 4>
<F180: Manual torque boost 4>
<F182: Motor overload protection current 2>
<F183: Motor overload protection current 3>
<F184: Motor overload protection current 4>





6

■ Function

These parameters are used for setting when you want to switch up to four types of motors for an inverter, or when you want to switch the motor V/f characteristics (four types) according to the purpose or operation method.
V/f1 to V/f4 are switched by the input terminal signals.

Memo

- <Pt: V/f Pattern> is valid only for V/f1.
  When V/f2 to V/f4 are selected, V/f constant control is applied regardless of the setting of <Pt>.
- Do not switch the motors when <Pt: V/f Pattern> is set to "7" or "8".
- For the parameters that are selected when V/f1 to V/f4 are switched, refer to the following table.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F170	Base frequency 2	15.0-590.0	Hz	50.0/60.0 *1
F171	Base frequency voltage 2	240V class: 50-330V 480V class: 50-660V	V	*1
F172	Manual torque boost 2	0.00-30.00	%	*2
F174	Base frequency 3	15.0 - 590.0	Hz	50.0/60.0 *1
F175	Base frequency voltage 3	240V class: 50-330V 480V class: 50-660V	V	*1

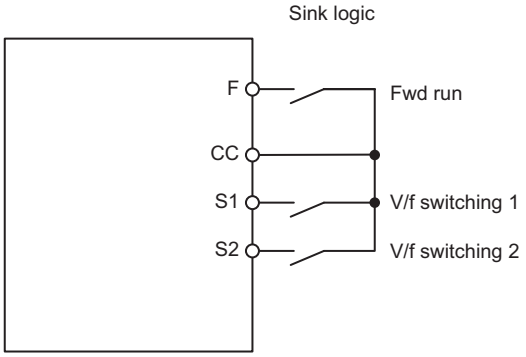
Title	Parameter name	Adjustment range	Unit	Default setting
F176	Manual torque boost 3	0.00-30.00	%	*2
F178	Base frequency 4	15.0 - 590.0	Hz	50.0/60.0 *1
F179	Base frequency voltage 4	240V class: 50-330V 480V class: 50-660V	V	*1
F180	Manual torque boost 4	0.00-30.00	%	*2
F182	Motor overload protection current 2	Depending on capacity*2	A*2	*2
F183	Motor overload protection current 3	Depending on capacity*2	A*2	*2
F184	Motor overload protection current 4	Depending on capacity*2	A*2	*2

*1 Depending on the setup menu. For details, refer to [5. 3. 10], [11. 10].
*2 Depending on capacity. For details, refer to [11. 6].

■ Switch terminal setting

V/f1 to V/f4 switching functions are not assigned to the input terminals by default setting. Thus, assign them to unused input terminals.

Example: When V/f switching 1 function is assigned to the terminal [S1], and V/f switching 2 function to the terminal [S2].



Input terminal		V/f	Parameters selected	Output terminal (function number)	
S1-CC	S2-CC			No.186	No.188
OFF	OFF	1	Base frequency 1: <vL> Base frequency voltage 1: <vLv> Manual torque boost 1: <vb> Motor overload protection current 1: <tHrA>	OFF	OFF
ON	OFF	2	Base frequency 2: <F170> Base frequency voltage 2: <F171> Manual torque boost 2: <F172> Motor overload protection current 2: <F182>	ON	OFF

Input terminal		V/f	Parameters selected	Output terminal (function number)	
S1-CC	S2-CC			No.186	No.188
OFF	ON	3	Base frequency 3: <F174> Base frequency voltage 3: <F175> Manual torque boost 3: <F176> Motor overload protection current 3: <F183>	OFF	ON
ON	ON	4	Base frequency 4: <F178> Base frequency voltage 4: <F179> Manual torque boost 4: <F180> Motor overload protection current 4: <F184>	ON	ON

- Be sure to perform V/f switching in the stop state. Switching is impossible during run. It takes 0.1 second before switching. Therefore, be sure to wait 0.1 second or more after inputting a switching signal, and then start operation.
- When you want to use the vector control and V/f 5-point setting, select V/f1. When V/f2 to V/f4 are selected, V/f constant is obtained, and thus making the vector control impossible.
- When you use an input terminal where a variety of functions can be assigned, you can link the switching of torque limit or acceleration/deceleration time to V/f switching.

For operation panel run, you can also set the acceleration/deceleration time at <F504: Panel Acc/Dec select>. For details, refer to [6. 27. 2].

6

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3].
- Details on operation by external signals -> Refer to [Chapter 7].

6. 5 V/f 5-point setting

<F190: V/f 5-point VF1 frequency>
<F191: V/f 5-point VF1 voltage>
<F192: V/f 5-point VF2 frequency>
<F193: V/f 5-point VF2 voltage>
<F194: V/f 5-point VF3 frequency>
<F195: V/f 5-point VF3 voltage>
<F196: V/f 5-point VF4 frequency>
<F197: V/f 5-point VF4 voltage>
<F198: V/f 5-point VF5 frequency>
<F199: V/f 5-point VF5 voltage>

Refer to [5. 3. 4].

6. 6 Setting the frequency commands

You can set the frequency commands in various methods. Select a frequency command setting method according to operation. You can also switch the frequency commands using signals to the terminals.

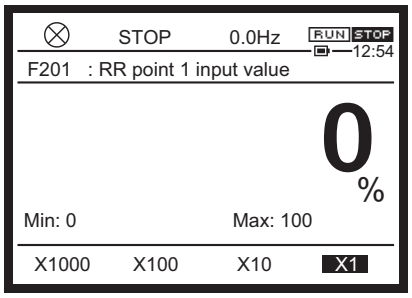
6. 6. 1 Switching two types of frequency commands

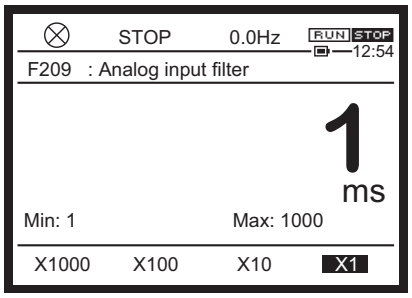
<F200: Frequency command priority select>
<FMOd: Frequency command select 1>
<F207: Frequency command select 2>
<F208: Frequency command switching frequency>

Refer to [5. 4. 1].

6. 6. 2 Setting frequency command characteristics by analog signals

<F107: Terminal RX input voltage select>
<F108: Terminal RR input select>
<F148: Terminal AI4 input select>
<F149: Terminal AI5 input select>
<F201: RR point 1 input value>
<F202: RR point 1 frequency>
<F203: RR point 2 input value>
<F204: RR point 2 frequency>
<F205: RR point 1 rate>
<F206: RR point 2 rate>
<F209: Analog input filter>
<F210: RX point 1 input value>
<F211: RX point 1 frequency>
<F212: RX point 2 input value>
<F213: RX point 2 frequency>
<F214: RX point 1 rate>
<F215: RX point 2 rate>
<F216: II point 1 input value>
<F217: II point 1 frequency>
<F218: II point 2 input value>
<F219: II point 2 frequency>
<F220: II point 1 rate>
<F221: II point 2 rate>
<F222: AI4 point 1 input value>
<F223: AI4 point 1 frequency>
<F224: AI4 point 2 input value>
<F225: AI4 point 2 frequency>
<F226: AI4 point 1 rate>
<F227: AI4 point 2 rate>
<F228: AI5 point 1 input value>





<F229: AI5 point 1 frequency>
<F230: AI5 point 2 input value>
<F231: AI5 point 2 frequency>
<F810: Communication frequency point select>
<F811: Communication point 1 input value>
<F812: Communication point 1 frequency>
<F813: Communication point 2 input value>
<F814: Communication point 2 frequency>

■ Function

These parameters set the output frequencies for the frequency commands of the analog signals.
You can use the following terminals. The terminals [AI4] and [AI5] are optional.

Voltage input (0 to 10 V) : terminals [RR], [RX], [AI4], and [AI5]
Voltage input (-10 to +10 V) : terminals [RX], [AI4], and [AI5]
Curret input (4 to 20 mA) : terminals [II], [AI4], and [AI5]

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F107	Terminal RX input voltage select	0: 0 to +10 V 1: -10 to +10 V	-	0
F108	Terminal RR input select	1: Voltage input (0-10 V) 2: - 3: - 4: PTC input 5: PT100 (2-wire) input 6: - 7: PT1000 (2-wire) input 8: - 9: KTY84 input	-	1
F148	Terminal AI4 input select	1: Voltage input (0-10 V) 2: Voltage input (-10 to +10 V) 3: Current input (0-20 mA) 4: PTC input 5: PT100 (2-wire) input 6: PT100 (3-wire) input 7: PT1000 (2-wire) input 8: PT1000 (3-wire) input 9: KTY84 input	-	1
F149	Terminal AI5 input select			1
F201	RR point 1 input value	0-100	%	0
F202	RR point 1 frequency	0.0-590.0	Hz	0.0
F203	RR point 2 input value	0-100	%	100
F204	RR point 2 frequency	0.0-590.0	Hz	50.0/60.0 *1
F205	RR point 1 rate	0-250	%	0
F206	RR point 2 rate	0-250	%	100
F209	Analog input filter	1: Disabled 2-1000	ms	1

Title	Parameter name	Adjustment range	Unit	Default setting
F210	RX point 1 input value	-100 to +100	%	0
F211	RX point 1 frequency	0.0-590.0	Hz	0.0
F212	RX point 2 input value	-100 to +100	%	100
F213	RX point 2 frequency	0.0-590.0	Hz	50.0/60.0 *1
F214	RX point 1 rate	-250 to +250	%	0
F215	RX point 2 rate	-250 to +250	%	100
F216	II point 1 input value	0-100	%	0
F217	II point 1 frequency	0.0-590.0	Hz	0.0
F218	II point 2 input value	0-100	%	100
F219	II point 2 frequency	0.0-590.0	Hz	50.0/60.0 *1
F220	II point 1 rate	0-250	%	0
F221	II point 2 rate	0-250	%	100
F222	AI4 point 1 input value	-100 to +100	%	0
F223	AI4 point 1 frequency	0.0-590.0	Hz	0.0
F224	AI4 point 2 input value	-100 to +100	%	100
F225	AI4 point 2 frequency	0.0-590.0	Hz	50.0/60.0 *1
F226	AI4 point 1 rate	-250 to +250	%	0
F227	AI4 point 2 rate	-250 to +250	%	100
F228	AI5 point 1 input value	-100 to +100	%	0
F229	AI5 point 1 frequency	0.0-590.0	Hz	0.0
F230	AI5 point 2 input value	-100 to +100	%	100
F231	AI5 point 2 frequency	0.0-590.0	Hz	50.0/60.0 *1
F810	Communication frequency point select	0: Disabled 1: RS485 (1) 2: RS485 (2) 3: Communication option 4: Embedded Ethernet		0
F811	Communication point 1 input value	0-100	%	0
F812	Communication point 1 frequency	0.0-FH	Hz	0.0
F813	Communication point 2 input value	0-100	%	100
F814	Communication point 2 frequency	0.0-FH	Hz	50.0/60.0 *1

*1 Depending on the setup menu. Refer to [11. 10].

■ Setting method

Set a frequency command for an analog input amount at two points.

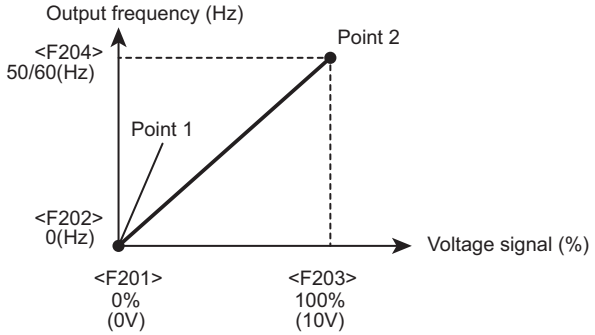
For the corresponding parameters of each terminal and the setting method, refer to the following.

As default setting, the range between the minimum and maximum input amounts is set to 0 to 50.0/60.0 Hz for main analog signal of the terminals. For example, the terminal [RR] is set to 0 to 50.0/60.0 Hz at 0-10 V.

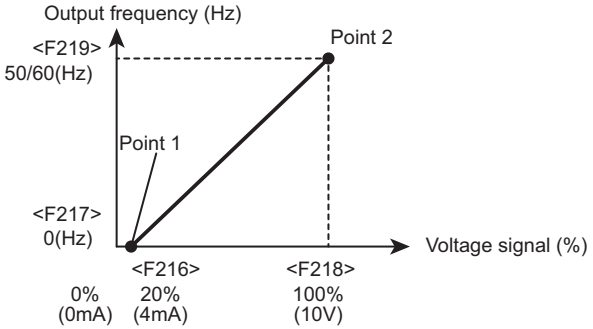
- For the terminal [RX], select the voltage for <F107: Terminal RX input voltage select>.
- For the terminal [AI4], select the analog signal for <F148: Terminal AI4 input select>. For the terminal [AI5], select the analog signal for <F149: Terminal AI5 input select>. The terminals [AI4] and [AI5] are optional.
- If noise disturbs stable operation, increase the value for <F209: Analog input filter>. Doing so eliminates the noise of the frequency setting circuit.
- Do not set the same value for point 1 and point 2. Failure to do so displays "Err1".

For details on the analog signal setting, refer to [7. 3].

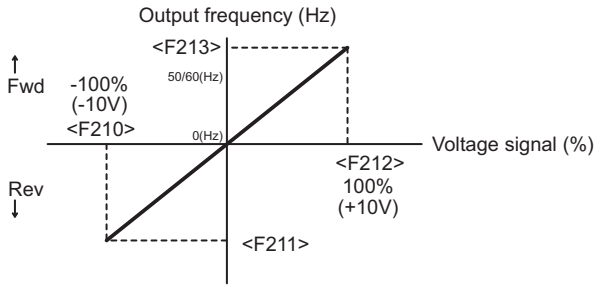
1) For setting the voltage input of 0-10 V (terminals [RR]), refer to the following figure.



2) For setting current input of 4-20 mA (terminal [II]), refer to the following figure.



3) For setting voltage input of -10 to +10 V (terminal [RX]), refer to the following figure.



<F107: Terminal RX input voltage select> = "-10 to +10 V"

Memo

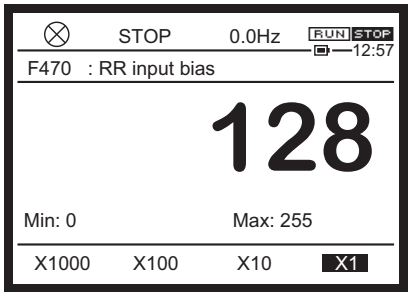
- When you want to fine adjust the frequency command characteristics, adjust the bias and gain of each input terminal at <F470: RR input bias>-<F479: AI5 input gain>. For details, refer to [6. 6. 3].
- When you want to set an analog signal for a frequency command, set at <FMOd: Frequency command select 1> (or <F207: Frequency command select 2>).
  1: Terminal RR
  2: Terminal RX
  3: Terminal II
  4: Terminal AI4 (option)
  5: Terminal AI5 (option)

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3].
- Details on operation by external signals -> Refer to [Chapter 7].

6. 6. 3 Fine adjusting the analog frequency commands

<F470: RR input bias>
<F471: RR input gain>
<F472: RX input bias>
<F473: RX input gain>
<F474: II input bias>
<F475: II input gain>
<F476: AI4 input bias>
<F477: AI4 input gain>
<F478: AI5 input bias>
<F479: AI5 input gain>



■ Function

These parameters fine adjust the characteristics set in [6. 6. 2] "Setting frequency command characteristics by analog signals".

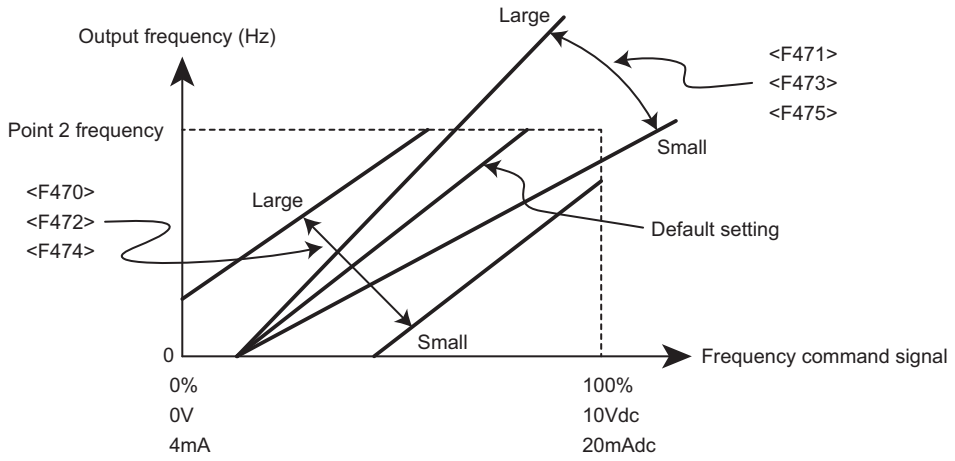
The allowance is zero setting on default setting.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F470	RR input bias	0-255	-	128
F471	RR input gain	0-255	-	128
F472	RX input bias	0-255	-	128
F473	RX input gain	0-255	-	128
F474	II input bias	0-255	-	128
F475	II input gain	0-255	-	128
F476	AI4 input bias	0-255	-	128
F477	AI4 input gain	0-255	-	128
F478	AI5 input bias	0-255	-	128
F479	AI5 input gain	0-255	-	128

■ Adjustment method

For the frequency commands to be input to the analog terminals and the output frequency characteristics, refer to the following figure.



Analog input terminal bias adjustment (<F470>, <F472>, <F474>, <F476>, and <F478>)

To avoid the influence of noise, there is a tolerance for the minimum input amount so that the inverter starts output after some voltage/current is applied to the analog input terminal by default setting.

To decrease this tolerance value, increase the bias value for a corresponding terminal.

However, if the set value is too large, frequency may be output even when the frequency command is set to 0 (zero).

Analog input terminal gain adjustment (<F471>, <F473>, <F475>, <F477>, and <F479>)

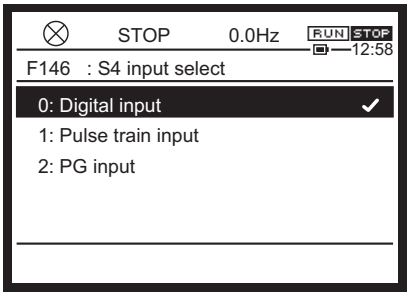
The set maximum frequency is output before voltage/current reach the maximum value to avoid trouble such as voltage drop by default setting.

When you want to output the set maximum frequency at the maximum voltage and current values, decrease the gain value for a corresponding terminal.
However, if the set value is too small, the maximum frequency may not be output even when voltage and current reach the maximum values.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]. • Details on operation by external signals -> Refer to [Chapter 7].

6. 6. 4 Input the frequency commands by pulse trains

<F146: Terminal S4 input select>
<F147: Terminal S5 input select>
<F234: Pulse train input point 1 input value>
<F235: Pulse train input point 1 frequency>
<F236: Pulse train input point 2 input value>
<F237: Pulse train input point 2 frequency>
<F376: PG phases number select>
<F378: Pulse train input pulses number>
<F679: Pulse train input filter>



■ Function

These parameters set the frequency command characteristics by pulse train input.
You can use the terminals [S4] and [S5].
When you want to use pulse train input, set <FMOd: Frequency command select 1> (or <F207: Frequency command select 2>) to "16: Pulse train".

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F146	Terminal S4 input select	0: Digital input 1: Pulse train input 2: PG input		0
F147	Terminal S5 input select	0: Digital input 1: Pulse train input 2: PG input		0
F378	Pulse train input pulses number	1-9999	pps	1000
F679	Pulse train input filter	1-1000	ms	1
F234	Pulse train input point 1 input value	0 - 100	%	0
F235	Pulse train input point 1 frequency	0.0 - 590.0	Hz	0.0
F236	Pulse train input point 2 input value	0 - 100	%	100
F237	Pulse train input point 2 frequency	0.0 - 590.0	Hz	50.0/60.0 *1
F376	PG phases number select	0: PTI (Command) - PTI (FB) 1: PTI (Command) - Digital option (FB) 2 - 5: - 6: Digital option (Command) - Non FB 7 - 9: - 10: PTI (Command) - PTI (FB inversion) 11: PTI (Command) - Digital option (FB inversion) 12 - 15: - 16: Digital option (Command inversion) - Non FB		0

*1 Depending on the setup menu. For details, refer to [5. 3. 10], [11. 10].

■ Guideline for the setting

When you want to use the terminal [S4], set <F146: Terminal S4 input select> to "1: Pulse train input". When you want to use the terminal [S5], set <F147: Terminal S5 input select> to "1: Pulse train input".

Set the number of pulses per 1 Hz of output frequency at <F378; Pulse train input pulses number>.

The minimum number of pulses that can be input to the terminals [S4] and [S5] is 10 pps, and the maximum number of pulses 30 kpps. The duty is 50 ±10%.

The maximum frequency that can be output is 200 Hz.

■ Setting example

<F378> setting value	Input signal	Output frequency
25 (pps)	25 (pps)	1.0 (Hz)
	100 (pps)	4.0 (Hz)
	2k (pps)	80.0 (Hz)
50 (pps)	50 (pps)	1.0 (Hz)
	100 (pps)	2.0 (Hz)
	2k (pps)	40.0 (Hz)

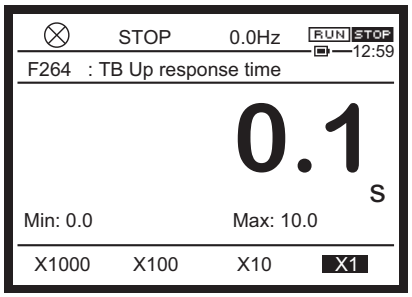
6

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3].
- Details on operation by external signals -> Refer to [Chapter 7].
  For use as PG feedback, refer to "Digital Encoder Instruction manual" (E6582148).
- Pulse train must be input after F146 or F147 is set to 1.
  If pulse train is input when F146 or F147 is set to 0 (default value), preset speed works.

6. 6. 5 Changing frequency by the terminal UP and DOWN signal

<F264: Terminal Up response time>
<F265: Terminal Up frequency step>
<F266: Terminal Down response time>
<F267: Terminal Down frequency step>
<F268: Initial Up/Down frequency>
<F269: Up/Down frequency rewrite>



■ Function

These parameters are the frequency commands that input the logic signals to the two input terminals for the UP and DOWN signals. You can input a logic signal either as a continuous signal or as a pulse signal.
Set <FMOd: Frequency command select 1>= "15".

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F264	Terminal Up response time	0.0-10.0	s	0.1
F265	Terminal Up frequency step	0.0-FH	Hz	0.1
F266	Terminal Down response time	0.0-10.0	s	0.1
F267	Terminal Down frequency step	0.0-FH	Hz	0.1
F268	Initial Up/Down frequency	LL-UL	Hz	0.0
F269	Up/Down frequency rewrite	0: F268 is not changed. 1: F268 is changed after power off.		1

■ Input terminal parameter setting

Three input terminals are used.
Two of the three input terminals are used for the UP and DOWN signals. The other input terminal is used for the signal that clears the set frequency command.

Input terminal function		ON	OFF
88	Terminal Up frequency	Frequency setting increase	-
90	Terminal Down frequency	Frequency setting decrease	-
92	Terminal Up, Down frequency clear	OFF → ON: Input terminal up/down frequency command clear	<F268> setting

When the signals are simultaneously input

- When the clear signal, and an UP or a DOWN signal are simultaneously input, the clear signal takes priority.
- When an UP signal and a DOWN signal are simultaneously input, the frequency changes according to the up rate and the down rate.

Memo	• The next number of each function number ("89", "91", or "93") is an inversion signal. • When <F702: Free unit multiplication factor>="1.00", you can make setting in steps of 0.01 Hz.

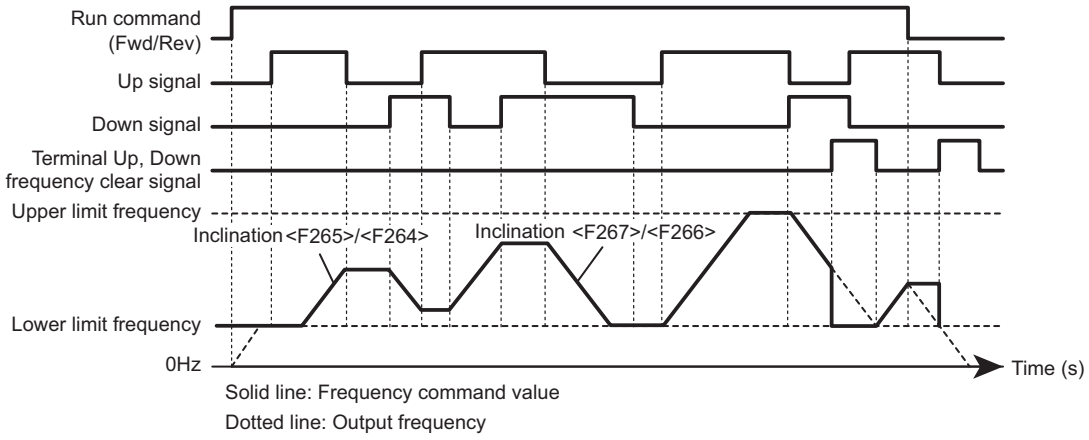
■ Setting example 1: Increase or decrease by the continuous signals

When you want to increase or decrease the output frequency in proportion to the input time of the UP and DOWN signals, set the parameters as shown below:

UP/DOWN frequency increase inclination=Setting time for <F265>/<F264>
UP/DOWN frequency decrease inclination=Setting time for <F267>/<F266>

When you want to increase or decrease the output frequency almost in synchronization with the increase or decrease in the UP/DOWN frequency command, set the parameters as shown below:

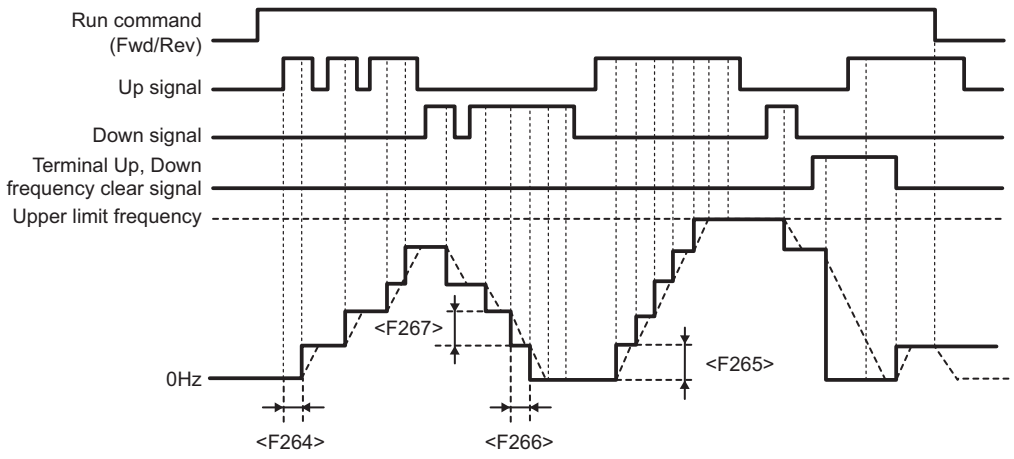
<F264>=<F266> = "0.1"
<FH>/<ACC> ≧ (Setting time for <F265>/<F264>)
<FH>/<dEC> ≧ (Setting time for <F267>/<F266>)



■ Setting example 2: Increase or decrease by the pulse signals

When you want to increase or decrease the frequency per pulse stepwise, set the parameters as shown below:

<F264>, <F266> ≦ Pulse ON time
<F265>, <F267> = Frequency that increases or decreases per pulse
However, no response is obtained to the pulse below the time set for <F264> and <F266>. Set 12 ms or more for the clear signal.



Solid line: Frequency command value
Dotted line: Output frequency

■ Initial UP/DOWN frequency setting method

When you want to set a specified frequency other than 0.0 Hz at first after power on, set <F268: Initial Up/Down frequency>.
Also, set <F269: Up/Down frequency rewrite> to "0: F268 is not changed".

Save the frequency before power off. When you want to start at the saved frequency the next time the power is turned ON, set <F269: Up/Down frequency rewrite> to "1: F268 is changed after power off."
Keep in mind that <F268: Initial Up/Down frequency> is changed every time the power is turned OFF.

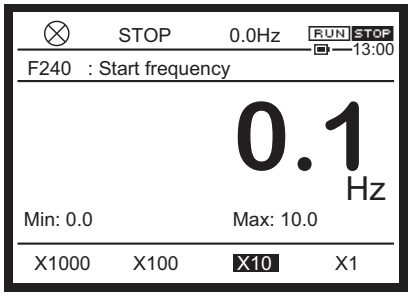
The adjustment range of <F268: Initial Up/Down frequency> is <LL: Lower limit frequency> to <FH: Maximum frequency>. When Terminal Up, Down frequency clear (function number: "92" or "93") is input, the lower limit frequency is set for the frequency command.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]. • Details on operation by external signals -> Refer to [Chapter 7].

6. 7 Setting the start and end frequencies

6. 7. 1 Setting the starting frequency and the end frequency

<F240: Start frequency>
<F243: End frequency>



■ Function

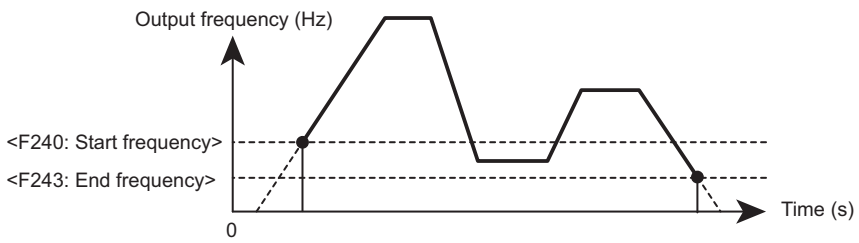
The frequency set for <F240: Start frequency> is instantly output at startup.
This parameter is used when the delayed response of starting torque caused by the acceleration/ deceleration time affects the frequency.
When the output frequency is decreased to the frequency set for <F243: End frequency>, the frequency instantly becomes 0 Hz when stopping.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F240	Start frequency	0.0-10.0	Hz	0.1
F243	End frequency	0.0-30.0	Hz	0.0

■ Setting method

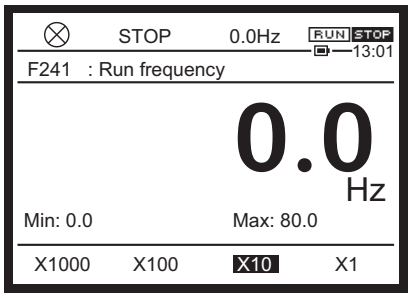
Use the parameters when the delayed response of starting torque caused by the acceleration/ deceleration time affects the frequency. For the setting values, 0.1-3.0 Hz (5 Hz or less) is recommended. Overcurrent can be reduced by setting the value to the motor rated slippage or less.
Set the values so that <F240: Start frequency> is higher than <F243: End frequency>.
When <F240> is lower than <F243>, no operation is performed by any frequency command lower than <F243>.



Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3].

6. 7. 2 Run/stop with a frequency command

<F241: Run frequency>
<F242: Run frequency hysteresis>



■ Function

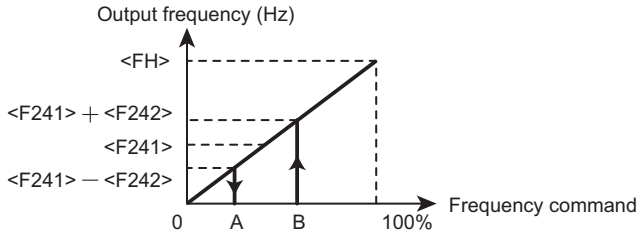
You can run/stop the motor with only a frequency command when a run command remains ON. When the frequency command reaches the set frequency value, the inverter will start to run. When it becomes below the set value, the inverter will stop.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F241	Run frequency	0.0 - FH	Hz	0.0
F242	Run frequency hysteresis	0.0 - FH	Hz	0.0

■ Setting method

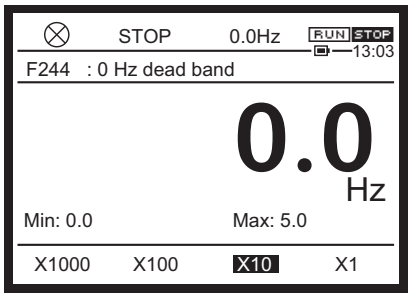
When the frequency command reaches the setting value of <F241: Run frequency>, the inverter will start to run. When the command becomes below the setting value, the inverter will stop.
To prevent the inverter from repeatedly running/stopping around the frequency set with <F241: Run frequency>, use <F242: Run frequency hysteresis> to provide hysteresis.
Set the parameter, referring to the following figure.



Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 7. 3 Setting a frequency command to 0 Hz securely

<F244: 0 Hz dead band>



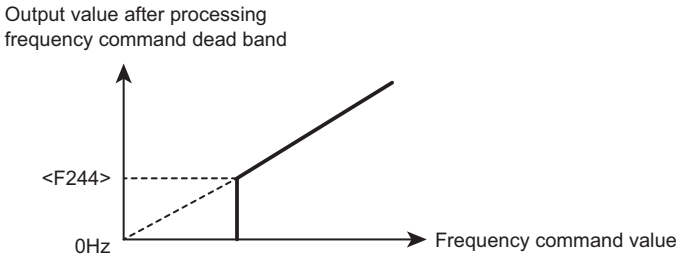
6

■ Function

Set the frequency command to 0 Hz when it is under the setting value of <F244: 0 Hz dead band>. This function is used to securely set the frequency command to 0 Hz in the following case: although an analog signal is set to 0 Hz in order to use the vector control with a sensor to fix the motor shaft, it does not become 0 Hz due to a drift or offset.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F244	0 Hz dead band	0.0 - 5.0	Hz	0.0



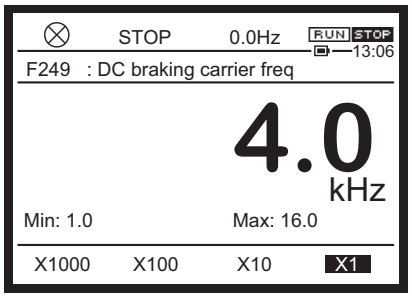
Memo	• This function is invalid for a preset speed frequency command. • It is valid for frequency commands which are prioritized in <FMOd: Frequency command selection 1>, <F207: Frequency command selection 2>, and communications. • For the override function, values are added or multiplied for frequencies with this function enabled.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 8 DC braking

6. 8. 1 Obtaining large torque with DC braking

<F249: DC braking carrier frequency>
<F250: DC braking frequency>
<F251: DC braking amount>
<F252: DC braking time>
<F253: Fwd/Rev DC braking priority>



■ Function

Apply direct current to the motor to obtain braking torque. This will stop the motor. It is used, for example, to securely decelerate and stop the motor.
You can set the amount and time of direct current applied to the motor and the start frequency.

6

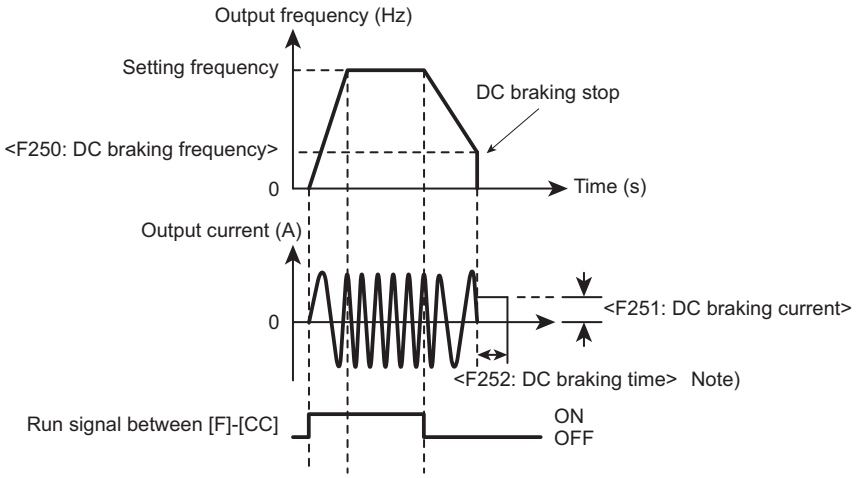
■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F249	DC braking carrier frequency	1.0 - 16.0	kHz	*1
F250	DC braking frequency	0.0 - FH	Hz	0.0
F251	DC braking current	0 - 100	%	50
F252	DC braking time	0.0 - 25.5	s	1.0
F253	Fwd/Rev DC braking priority	0: Disabled 1: Enabled		0

*1 Depending on capacity. For details, refer to [11. 6].

Important

- The inverter has high sensitivity for overload protection when DC braking is in progress. It may automatically adjust the DC braking amount to prevent a trip.



Note) Actually it will be longer than the setting value of <F252> because of the reduced voltage operation.

6

■ DC braking with the set frequency

When the inverter decelerates until the setting value of <F250: DC braking frequency>, it applies DC braking.

Set the DC braking amount with <F251: DC braking current>. Set the amount based on 100% meaning the rated current of the inverter. With <F701: Current, voltage units select> set to "1: A (ampere), V (volt)", specify a current value (A).

■ DC braking with an external signal

A signal input to the terminal can forcibly cause the inverter to apply DC braking.

Assign "22: DC braking" ("23" for inversion) to the input terminal.

DC braking is applied while the terminal is turned ON regardless of the settings of <F250: DC braking frequency> and <F252: DC braking time>.

Even when the terminal is turned OFF, it is applied for the period set with <F252: DC braking time>.

The DC braking amount depends on the setting of <F251: DC braking current>.

Memo

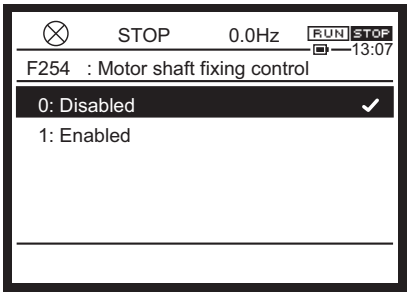
- The carrier frequency when DC braking is in progress is the setting value of either <F249: DC braking carrier frequency> or <F300: Carrier frequency> which is lower.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 8. 2 Fixing the motor shaft with DC braking

<F254: Motor shaft fixing control>



■ Function

Use DC braking to temporarily fix the motor shaft.
This function is used to avoid the free rotation of the motor or to preheat the motor.

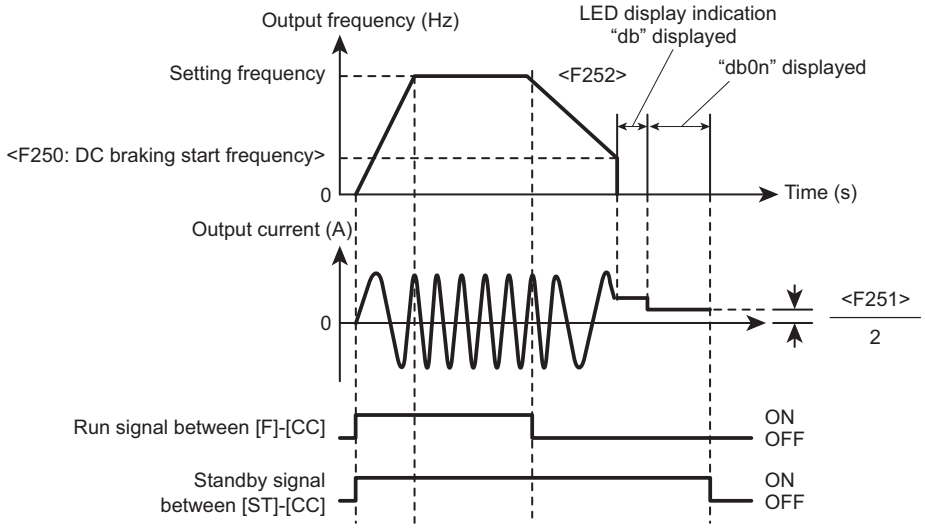
■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F254	Motor shaft fixing control	0: Disabled 1: Enabled	0

■ Selecting a setting value

1: Enabled

Continue to apply DC braking at half the DC braking amount specified with <F251: DC braking current> after the normal DC braking action.
During shaft fixing control, "dbOn" appears on the LCD screen.



■ How to use

To perform motor shaft fixing control, set <F254: Motor shaft fixing control> to 1.
To cancel it, turn OFF standby (ST signal).

Since standby (ST) is always turned ON in the default setting, you should set values as shown below.

- Set <F110: Always active function 1> to "1: No function".
- Assign "6:ST" (standby) to an unused input terminal.

Cancel motor shaft fixing control if the following problems occur during motor shaft fixing control: the inverter coasts due to power failure, or it is restored with the retry function after a trip.

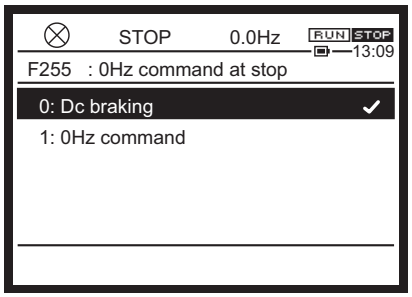
Even when DC braking is activated with a signal from the input terminal, the almost same motor shaft fixing control can be performed.

Memo	• The carrier frequency during shaft fixing control is the setting value of either <F249: DC braking carrier frequency> or <F300: Carrier frequency> which is lower.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 8. 3 Making the motor standstill with PG feedback control

<F255: 0Hz command select at stop>
<F250: DC braking frequency>
<F252: DC braking time>



■ Function

This function works only for the speed control of PG feedback control. Use a way other than DC braking to make the motor standstill.
When this function is set, the inverter outputs a 0 Hz command instead of applying DC braking when stopping to make the motor standstill for the specified time.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F255	0Hz command select at stop	0: DC braking 1: 0 Hz command		0
F250	DC braking frequency	0.0 - FH	Hz	0.0
F252	DC braking time	0.0 - 25.5	s	1.0

■ How to select a setting value

0: DC braking

This function works as the DC braking function described in [6. 8. 1].

1: 0 Hz command

This function works only for the speed control of PG feedback control.
The inverter outputs 0 Hz for the period set with <F252: DC braking time> when the frequency reaches the setting value of <F250: DC braking frequency>.
It does not work when <F250: DC braking frequency> is set to "0.0".
With this function enabled, <F254: Motor shaft fixing control> cannot be used.

■ How to use

This function is used for PG feedback control (<Pt: V/f Pattern> = "10", "11").
You should set the terminals [S4] and [S5] or have any option for PG feedback.
The normal DC braking action (the same action set with <F255> = "0") is performed for non-PG feedback control.

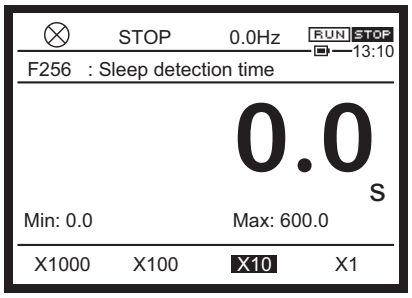
Important	• Note that a higher value of <250: DC braking frequency> will cause a command indicating the sudden stop of the motor from a high rotation state. A trip may occur depending on a load condition.

Memo	• When <F255: 0Hz command select at stop> is set to "1", the inverter outputs a 0 Hz command instead of applying the following DC braking. DC braking with a command from the terminal or communication (input terminal function "22"/ "23", communication command) Emergency DC braking of DC braking emergency stop (<F603: Emergency off stop pattern> = "2") when the DC braking stop of the jog stop pattern is specified (<F261: Jog stop select> = "2")

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Option for PG feedback -> Refer to "Digital Encoder Instruction manual" (E6582148). • Details on operation by external signals -> Refer to [Chapter 7].

6. 9 Automatic stop when run continues at the lower limit frequency (sleep function)

<F256: Run sleep detection time>
<F259: Run sleep detection time at startup>
<F391: Sleep detection hysteresis>
<F392: Wakeup deviation>
<F393: Wakeup feedback>



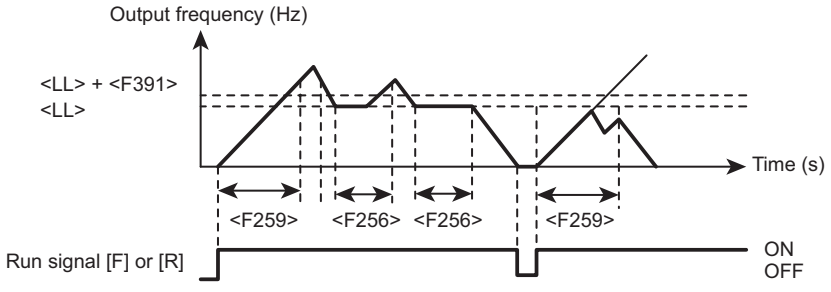
■ Function

This function is used to automatically decelerate and stop the inverter in the following case: the inverter continues to run at the frequency set with <LL: Lower limit frequency>, which has a low workload, for the period specified in <F256: Run sleep detection time> for energy-saving, etc. (sleep function).
The LCD screen displays "LStP" during sleep.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F256	Run sleep detection time	0.0: Disabled 0.1 - 600.0	s	0.0
F259	Run sleep detection time at startup	0.0: Disabled 0.1 - 600.0	s	0.0
F391	Sleep detection hysteresis	0.0 - UL	Hz	0.0
F392	Wakeup deviation	0.0 - UL	Hz	0.0
F393	Wakeup feedback	0.0 - UL	Hz	0.2



■ Guideline for the setting

This function is used to automatically decelerate and stop the inverter when it continues to run at the frequency set with <LL: Low limit frequency>.
Set a duration with <F256: Sleep detection time>.

When the inverter starts to run, the sleep function works after the output frequency is over the value of <LL: Lower limit frequency>.
Also, when it starts, this function enables you to automatically stop the inverter after the period set with <F259: Run sleep detection time at startup> if the output frequency does not increase to the value of <LL> due to a load error. However, if the output frequency is over the value of <LL>, the function of <F259> is invalid until the run signal is turned OFF

For non-PID control, this function is canceled when the frequency command value is over the values of <LL: Lower limit frequency> and <F391: Sleep detection hysteresis> (Hz) or when the run command is turned OFF.

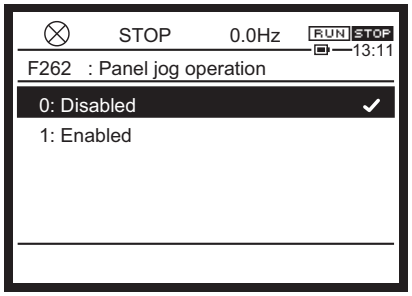
For PID control, set values with <F392: Wakeup deviation> and <F393: Wakeup feedback>.
For details, refer to the PID control instruction manual (E6582112).

This function is also valid when you switch between forward and reverse run.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 10 Jog run

<F262: Panel jog run>
<F260: Jog frequency>
<F261: Jog stop select>



■ Function

Jog run represents inching the motor.
When you input a jog run signal, the inverter immediately outputs a jog run frequency regardless of the set acceleration time.
You can start/stop jog run even on the operation panel.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F262	Panel jog run	0: Disabled 1: Enabled		0
F260	Jog frequency	F240 - 20.0	Hz	5.0
F261	Jog stop select	0: Deceleration stop 1: Coast stop 2: DC braking stop		0

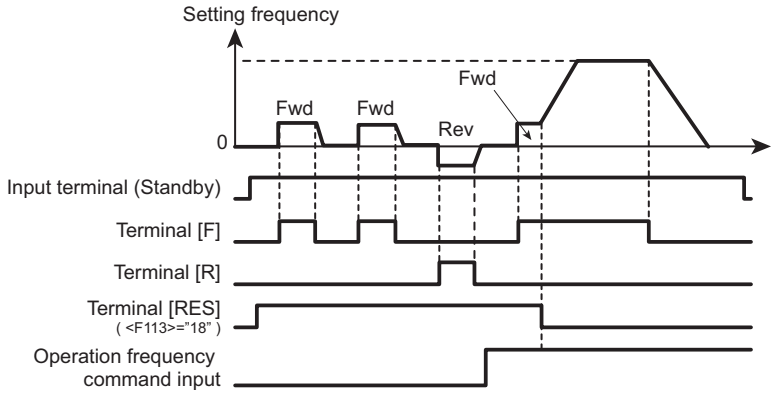
■ Setting example

Assign "18: jog run" to the unused input terminal.
While that input terminal is turned ON, the inverter can perform jog run.
To use only the panel jog run, you should not assign it to the input terminal.

Example) When it is assigned to the terminal [RES]: <F113: Terminal RES function 1> = "18"

The inverter outputs a low-speed detection signal but does not output an output frequency attainment signal during jog run. Also, PID control is disabled.

<Example of jog run>
Terminal [RES] (JOG): ON + terminal [F]: Forward jog run when the terminal is turned ON
Terminal [RES] (JOG): ON + terminal [R]: Reverse jog run when the terminal is turned ON
(Frequency command + terminal [F]: Forward run when the terminal is turned ON, terminal [R]: Reverse run when the terminal is turned ON)



- The terminal [RES] (JOG) is valid when the output frequency is the jog frequency or less. It does not work when the output frequency is higher than the jog frequency.
- The inverter can perform jog run while the terminal [RES] (JOG) is turned ON.
- Jog run is prioritized even if a run command is input on the way.
- Even when <F261: Jog stop select> is set to "0" or "1", DC braking is applied for emergency DC braking (F603: Emergency off stop pattern = "2").
- The jog frequency is not limited by <UL: Upper limit frequency>.

6

■ Panel jog run (when <F262: Panel jog run> is set to 1)

Each time you press the [FWD/REV] key, the state of jog run is switched as follows:

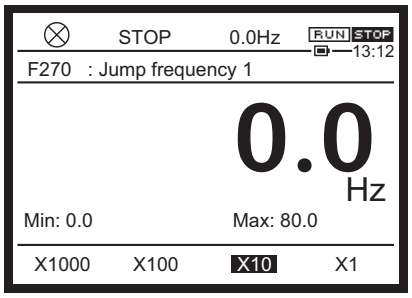
- The inverter performs forward jog run while the [F4] key is pressed.
- The inverter performs reverse jog run while the [F4] key is pressed.
- When you press the key for 20 seconds or more, the key failure alarm "A-17" appears.

The inverter cannot move to panel jog run while it runs or a run command is input.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 11 Jumping the frequency to avoid the resonant frequency

<F270: Jump frequency 1>
<F271: Jump frequency 1 band>
<F272: Jump frequency 2>
<F273: Jump frequency 2 band>
<F274: Jump frequency 3>
<F275: Jump frequency 3 band>



■ Function

When you want to avoid resonance caused by the natural frequency of the mechanical system to run the inverter, the resonant frequency can be jumped.
This characteristic has hysteresis given to the jump frequency.

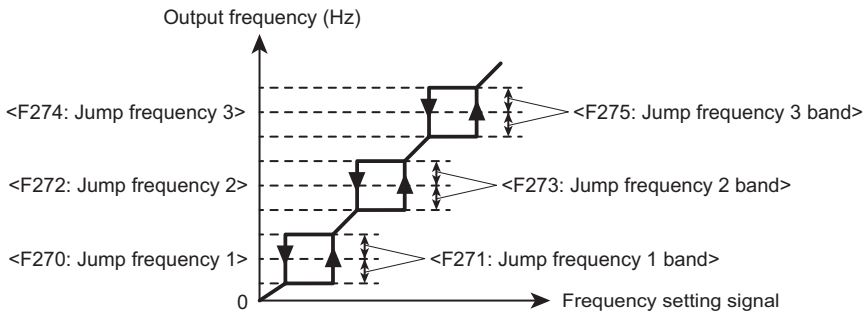
6

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F270	Jump frequency 1	0.0 - FH	Hz	0.0
F271	Jump frequency 1 band	0.0 - 30.0	Hz	0.0
F272	Jump frequency 2	0.0 - FH	Hz	0.0
F273	Jump frequency 2 band	0.0 - 30.0	Hz	0.0
F274	Jump frequency 3	0.0 - FH	Hz	0.0
F275	Jump frequency 3 band	0.0 - 30.0	Hz	0.0

■ Setting method

You can set three jump frequencies. To do that, avoid the overlap of the adjustment range of each jump frequency.
The frequency does not jump during acceleration or deceleration.



Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 12 Setting the preset-speed operation frequency

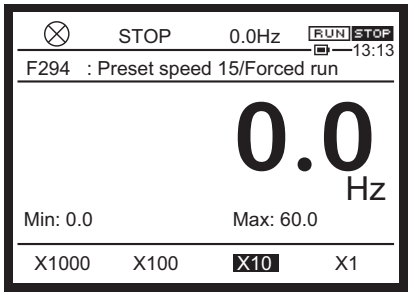
6. 12. 1 Setting the preset-speed operation frequency

<F287: Preset speed 8>
<F288: Preset speed 9>
<F289: Preset speed 10>
<F290: Preset speed 11>
<F291: Preset speed 12>
<F292: Preset speed 13>
<F293: Preset speed 14>
<F294: Preset speed 15 / Forced run speed>
<F560: Preset speed operation style>
<F561: Operation function (1-speed)> through <F575: Operation function (15-speed)>
<F576: Operation function (0-speed)>

For details of preset speed operation, refer to [5. 3. 7].

6. 12. 2 Forced run in emergency

<F294: Preset speed 15 / Forced run speed>



■ Function

You can run the inverter at a specified speed (frequency) in emergencies or continue to forcibly run it during slight failure. When the input terminal with the assigned function is turned ON, the inverter runs at the frequency set with <F294: Preset speed 15 / Forced run speed> regardless of run and frequency commands.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F294	Preset speed 15 / Forced run speed	LL - UL	Hz	0.0

■ Guideline for the setting

Assign the function to unused input terminal.

- When the inverter runs at a specified speed in an emergency

Input terminal function "58: Fire speed run"

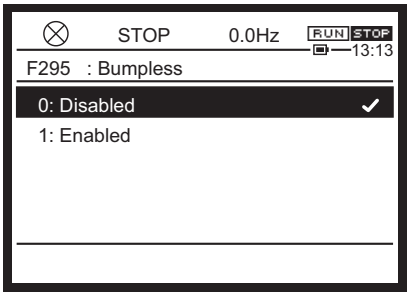
- When the inverter continues to forcibly run even during slight failure

  Input terminal function "56: Forced run"

When the input terminal with the assigned function is turned ON, the inverter runs at the frequency set with <F294: Preset speed 15 / Forced run speed>.

6. 13 Bumpless operation

<F295: Bumpless>



■ Function

This function is used to pass on the run/stop state and output frequency under the automatic operation to the manual operation when a switch between the two operation modes is made.
When a switch from the manual to automatic operation is made, the operation status under the manual operation is not passed on to the automatic operation.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F295	Bumpless	0: Disabled 1: Enabled	0

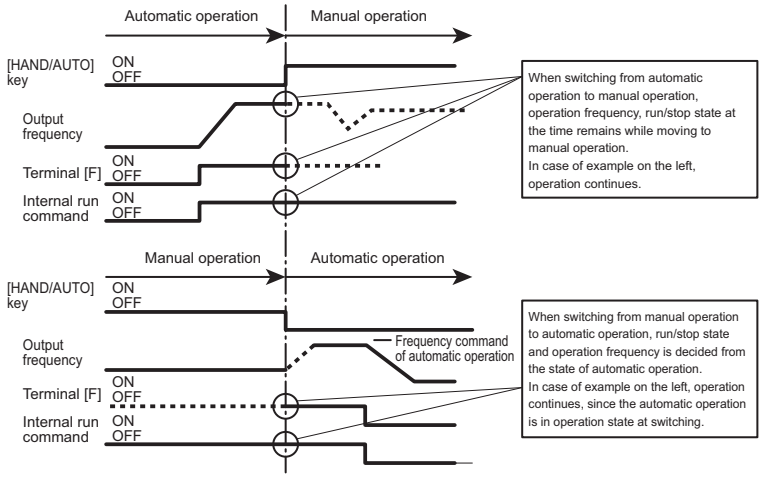
■ How to use

The [HAND/AUTO] key is used to make a switch between the manual and automatic operations.

- [HAND] indicates the panel operation at hand. (Manual operation)
- [AUTO] indicates the operation method selected by <CMOd: Run command select> or <FMOd: Frequency command select 1> (or <F207: Frequency command select 2>). (Automatic operation)

■ Operation example

When <CMOd: Run command select> is "0: Terminal" under the automatic operation

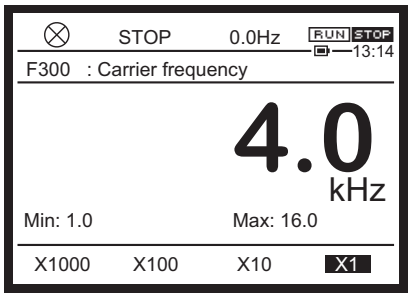


When you do not want to pass on the run/stop state and output frequency under the automatic operation to the manual operation, set <F295> to "0: Disabled".

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 14 Changing carrier frequency to reduce noise and magnetic noise

<F300: Carrier frequency>
<F312: Random switching>
<F316: Carrier frequency control>



6

■ Function

The inverter noise can be reduced by decreasing the carrier frequency.
You can respond to unpleasant motor acoustic noise by increasing the carrier frequency or changing the tone with the random switching.
Adjustment of carrier frequency is effective when a resonance with a load machine or motor fan cover occurs.
However, note that a low carrier frequency causes the motor acoustic noise to increase, and a high carrier frequency causes the inverter electro-magnetic noise to increase.

■ Parameter setting

■ <F300: Carrier frequency> setting

Some models require current reduction depending on the <F300: Carrier frequency> setting and ambient temperature.

■ <F312: Random switching> setting

When you want to reduce the motor acoustic noise with a low carrier frequency, set <F312: Random switching>. The tone can be changed.
This function works in the low output frequency range producing unpleasant acoustic noise from the motor.
<F312: Random switching> has three different tones: "1", "2" and "3". Select the appropriate setting for the load.
With <F300: Carrier frequency> set to 8.0 kHz or more, the motor acoustic noise decreases, and thus the random switching does not function.

■ <F316: Carrier frequency control> setting as a measure to protect motors against surge voltages

When a 480 V class inverter is used to operate a motor, very high surge voltages may be produced depending on the wire length, wire routing and types of wires used.
Here are some examples of measures against surge voltages.

- Decrease <F300: Carrier frequency>.

- When the wire length between the inverter and motor is long (approx. 20 to 100 m), set <F316: Carrier frequency control> to "2" or "3".
- Turn off power to set <F316: Carrier frequency control> to "2" or "3".
- Install a sinusoidal filter to the output side of inverter. In this case, set <F316: Carrier frequency control> to "4" or "5".
- Use a motor with high insulation strength.

Important	• When no decrease of carrier frequency is selected while a high carrier frequency is set, a trip occurs by Overheat (OH), etc. more easily than the case with automatic decrease. • With <F316: Carrier frequency control> set to "2" or "3", the carrier frequency is restricted to 4 kHz or less automatically. • With <F316: Carrier frequency control> set to "4" or "5", the carrier frequency is 4 kHz or more automatically. • With <Pt: V/f pattern> set to "2" - "6" or "9" - "12", the carrier frequency is 2 kHz or more automatically.

■ Reduction of load current

When the ambient temperature is above 40 or 50°C, reduce the current according to "Instruction manual for load reduction" (E6582116).

An IGBT overload pre-alarm "L" or overheat pre-alarm "H" is displayed when the IGBT overload "OL3" or overheat "OH" protection level nears.

With <F316: Carrier frequency control> set to "1", "3" or "5", carrier frequency is decreased at IGBT overload pre-alarm, or overheat pre-alarm to try to prevent "OL3" or "OH"trip. When the cumulative amount of overload further increases, an "OL3" or "OH" trip will occur. In this case, decrease <F601: Stall prevention level 1> to avoid trips.

Even when <F300: Carrier frequency> is set to a low value, the carrier frequency increases in the high output frequency range to ensure stable operation.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 15 Avoiding trips

Occurrences of trips may be avoided using the appropriate function in consideration of the causes of alarms or trips.

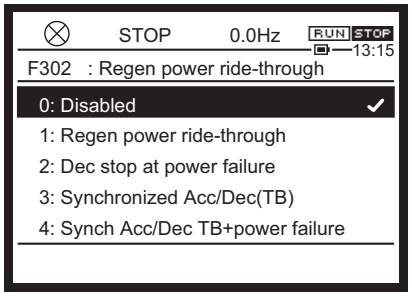
6. 15. 1 Restarting smoothly after momentary power failure (restarting from motor coasting state)

<F301: Auto-restart>

For detailed settings of auto-restart, refer to [5. 4. 2].

6. 15. 2 Selecting operation for momentary power failure

<F302: Regenerative power ride-through>
<F310: Dec time at power failure>
<F313: Ridethrough time>
<F317: Synchronized stop time>
<F318: Synchronized reach time>
<F625: Undervoltage detection level>
<F629: Regenerative power ride-through level>



6

■ Function

Select the reaction to a momentary power failure during operation from regenerative power ride-through, deceleration stop at power failure and synchronized Acc/Dec.

- Regenerative power ride-through: When a momentary power failure occurs, the operation is continued using the regenerative energy of the motor.
- Deceleration stop at power failure: When a momentary power failure occurs, the operation is stopped forcibly and swiftly using the regenerative energy of the motor. The deceleration time varies by the control. "StOP" is displayed on the operation panel during the stop. After the deceleration stop at power failure, the stop state is kept until the run command is turned OFF.
- Synchronized Acc/Dec: For a spindle winder of textile machine or the like, multiple machines are stopped in a lined-up manner or brought to reach the frequency command simultaneously during momentary power failure or restoration of power to prevent thread breakage.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F302	Regenerative power ride-through	0: Disabled 1: Regenerative power ride-through 2: Deceleration stop at power failure 3: Synchronized Acc/Dec (TB) 4: Synchronized Acc/Dec (TB + power failure)		0
F310	Dec time at power failure	0.0 - 320.0	s	2.0

Title	Parameter name	Adjustment range	Unit	Default setting
F313	Ridethrough time	0.0: Continuous 0.1 - 320.0	s	2.0
F317	Synchronized stop time	0.0 - 6000	s	2.0
F318	Synchronized reach time	0.0 - 6000	s	2.0
F625	Undervoltage detection level	50 - 79 80: Auto	%	80
F629	Regenerative power ridethrough level	55 - 100	%	75

■ Selecting the setting value

When using the regenerative power ride-through: <F302: Regenerative power ride-through> = "1"

- Set <F302> to "1: Regenerative power ride-through".
- A motor is controlled according to <F313: Ridethrough time>.
  Note that the available time to continue the operation varies by the mechanical inertia or load condition. The motor may enter the coasting state depending on the load condition.
- Set the operation level of regenerative power ride-through with <F629: Regenerative power ride-through level>.
  100% reference is 200 V (240V class), 400 V (480V class)
  Set it to a value equal to <F625: Undervoltage detection level> decreased by 5%, or more. Or, set it to a value equal to <F629: Regenerative power ridethrough level> increased by 5%, If the setting is inappropriate, the regenerative power ride-through control time may become too short. This is not required when <F625> is "80: Auto".
- When <F303: Retry> is used together, you can restart a motor without stopping it in case a trip occurs.
- To restart a motor smoothly after restoration of power, use <F301: Auto-restart> together.
- This does not function during torque control.

When using the deceleration stop at power failure: <F302: Regenerative power ride-through> = "2"

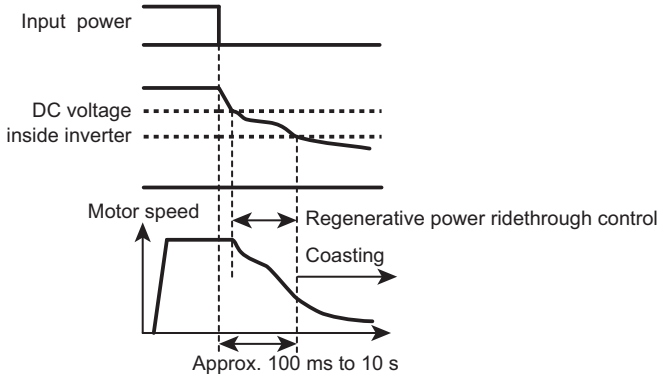
- Set <F302> to "2: Deceleration stop at power failure".
- A motor makes a deceleration stop according to <F310: Dec time at power failure>. The deceleration time is from <FH: Maximum frequency> to 0 Hz. With <F302> set to "2", <F310> cannot be written during run.
- Set the operation level of deceleration stop at power failure with <F626: Overvoltage limit operation level>. 100% reference is 200 V (240V class), 400 V (480V class).
- When the voltage falls to <F625: Undervoltage detection level> or less during a deceleration stop due to power failure, the motor will enter the coasting state.
- "StOP" is displayed on the operation panel during the stop. The stop state is kept until the run command is turned OFF.
- This does not function during torque control.

When using the synchronized Acc/Dec: <F302: Regenerative power ride-through> = "3" or "4"

- Set <F302> to "3: Synchronized Acc/Dec (TB)" or "4: Synchronized Acc/Dec (TB + power failure)".
- The deceleration time set by <F317: Synchronized stop time> and acceleration time set by <F318: Synchronized reach time> are used.
- This does not function during torque control.
- The jog run is disabled while this function is set.

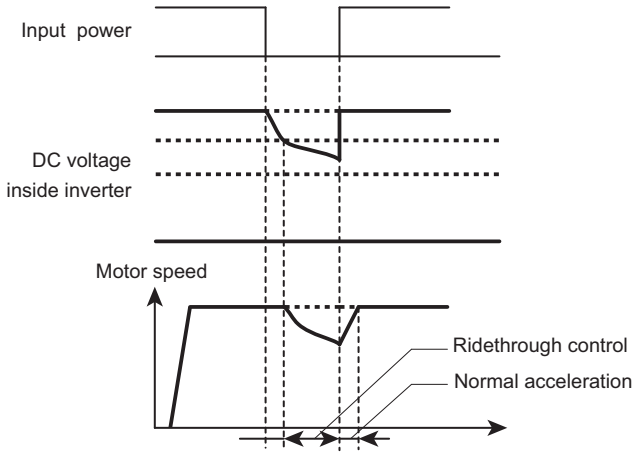
■ **Setting example of <F302: Regenerative power ride-through> = "1"**

1) When the power supply is shut off



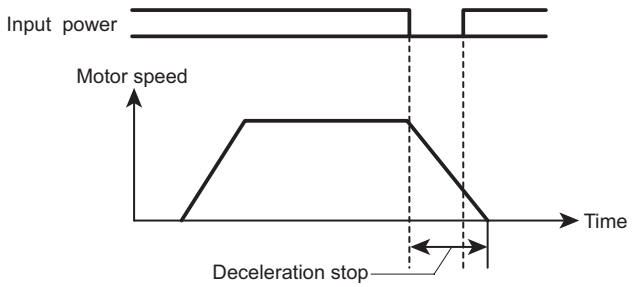
* Available time to continue the operation varies by the mechanical inertia or load condition. Perform verification test when using this function.
* Using retry function at the same time enables to automatically restart without failure stop.
When the power supply is shut off during deceleration stop, deceleration stop corresponding to F302=2 is operated instead of regenerative power ride through.
This function does not work well at high speed in PM control.
Do not set this function in case of PM high speed drive.

2) When a momentary power failure occurs



When a momentary power failure occurs during deceleration stop, the regenerative power ride-through does not function.

■ **Setting example of <F302: Regenerative power ride-through> = "2"**

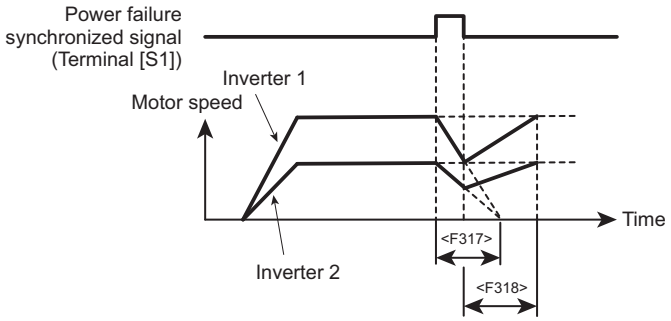


- The motor makes a deceleration stop also when the power is restored. However, when the voltage in power circuit inside the inverter falls to or below a certain value, the control is stopped and the motor enters the coasting state.
- A motor makes a deceleration stop according to <F310: Dec time at power failure>. The deceleration time is from <FH: Maximum frequency> to 0 Hz.
- When the voltage falls to <F625: Undervoltage detection level> or less during a deceleration stop due to power failure, the motor will enter the coasting state. The display shows "StOP", and the motor is kept in the coasting state after power is restored.

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■ **Setting example of <F302: Regenerative power ride-through> = "3"**

When <F114: Terminal S1 function 1> is set to "62: Synchronized Acc/Dec", and a power failure synchronized signal is allocated to the terminal [S1].

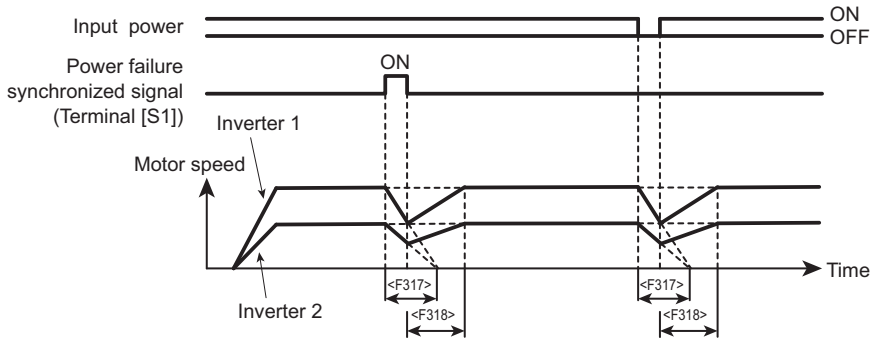


- When the terminal [S1] is turned ON with <F317: Synchronized stop time> and <F318: Synchronized reach time> of acceleration/deceleration set to the same value, multiple motors can be stopped almost at the same time. After power is restored, the motors can reach respective frequency command values almost at the same time.
- When the terminal [S1] is turned ON, linear deceleration is performed for the specified time by <F317> from the output frequency at this point to 0 Hz. The S-pattern deceleration and brake sequence are unavailable.
  "StOP" is displayed when the stop process is completed.
- When the terminal [S1] is turned OFF during synchronized deceleration, linear acceleration is performed for the specified time by <F318: Synchronized reach time> from the output frequency at this point to the output frequency at which the synchronized deceleration was started or frequency command value, whichever is lower. The S-pattern acceleration, brake sequence and auto-tuning are unavailable.
  "StOP" disappears when acceleration is started.

- When a Fwd/Rev switching or stop command is input during synchronized deceleration, synchronized acceleration/deceleration stops.
- To operate a motor again after a synchronized deceleration function stop, turn OFF the terminal [S1].
- When using the synchronized deceleration function, check that the overvoltage stall prevention function is not working during deceleration.

■ Setting example of <F302: Regenerative power ride-through> = "4"

When <F114: Terminal S1 function 1> is set to "62: Synchronized Acc/Dec", and a power failure synchronized signal is allocated to the terminal [S1].
Synchronized deceleration is performed when the terminal [S1] is ON or power failure occurs, and synchronized acceleration is performed when the terminal [S1] is OFF or restoration of power occurs.



- When <F302> is set to "1", "2" or "4", the voltage in power circuit inside the inverter is controlled between <F625: Undervoltage detection level> and <F629: Regenerative power ride-through level>.
- When the voltage falls to <F625: Undervoltage detection level> or less, the power circuit undervoltage (MOFF) alarm is displayed and the motor enters the coasting state. If "MOFF" is displayed immediately after a power failure, adjust by decreasing the <F625> setting or slightly increasing the <F629: Regenerative power ride-through level> setting.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

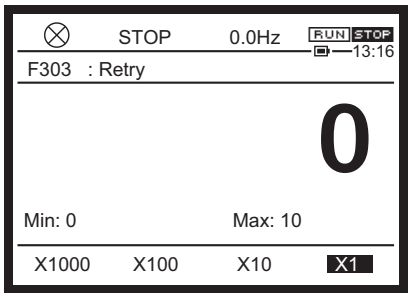
6. 15. 3 Automatic reset at trip (retry function)

⚠ CAUTION

Mandatory action

- Do not go near the motor or machine.
  When the retry function is selected, the motor/machine stopped at an occurrence of alarm will be started after a selected period of time (suddenly). Going near the motor/machine may result in unexpected injury.
- Affix the caution label about sudden restart in retry function to the inverter, motor and machine.
  Take a preventive measure against accidents.

<F303: Retry>



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■ Function

The inverter is reset automatically when a trip occurs.
During retry, the motor speed search is activated automatically as occasion demands to start a motor smoothly.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F303	Retry	0: Disabled 1 - 10	Times	0

■ How to use

The following table shows the causes of trip and retry processes.

Cause of trip	Retry process	Stop condition
Overcurrent Overvoltage Overload Overheat Step out (PM only)	Consecutive retries up to 10 times 1st time: Approx. 1 second after occurrence of a trip 2nd time: Approx. 2 seconds after occurrence of a trip 3rd time: Approx. 3 seconds after occurrence of a trip . . . 10th time: Approx. 10 seconds after occurrence of a trip	A trip other than overcurrent, overvoltage, overload, overheat and step-out detection occurs during retry. Retry fails with the specified number of times.

Followings are the trips of retry targets.
"OC1" , "OC2" , "OC3" , "OP1" , "OP2" , "OP3" , "OL1" , "OL2" , "OL3" , "OLr" , "OH" , "SOUT"

During retry, "rtry" is displayed on LCD screen.
The retry count is cleared (number of retry: 0) after a specified time without occurrence of trips from a retry success.
A retry success means that the output frequency reaches the frequency command value without tripping.

Important

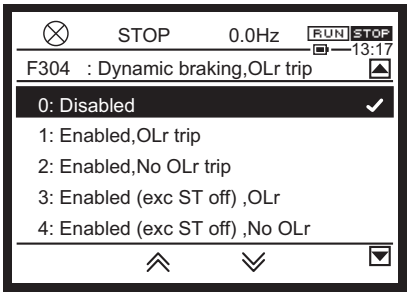
- A failure signal is not output during retry.
  A "10: Failure signal 1" is allocated to the [FLA]-[FLB]-[FLC] terminals in the default setting.
- To output a failure signal during retry, allocate the function "116: Failure signal 4" or "117" to the output terminal.
- The virtual cooling time is provided for the overload trips "OL1", "OL2", and "OLr".
  A retry is performed after the virtual cooling time and retry time elapse.
- For the overvoltage trips "OP1", "OP2" and "OP3", a retry is performed after the voltage in the DC section decreases.
- For the overheat trip "OH", a retry is performed after the inverter internal temperature decreases to the operable level.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 15. 4 Dynamic braking - Abrupt motor stop

<F304: Dynamic braking, OLr trip>
<F308: Braking resistance>
<F309: Braking resistor capacity>
<F626: Overvoltage limit operation level>
<F639: Braking resistor overload time>



■ Function

The dynamic braking function can be enabled by connecting an external braking resistor.

- When an abrupt deceleration is necessary
- When an overvoltage "OP" trip occurs at a deceleration stop
- When the continuous regenerative state, such as moving down of a lifting gear and winding-out operation for tension control, is entered
- When the regenerative state is entered by load fluctuation during constant speed run of a press machine, etc.

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■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F304	Dynamic braking, OLr trip	0: Disabled 1: Enabled, OLr trip 2: Enabled, No OLr trip 3: Enabled (except during ST OFF), OLr trip 4: Enabled (except during ST OFF), No OLr trip 5: Enabled (except during trip), OLr trip 6: Enabled (except during trip) ,No OLr trip 7: Enabled (except during trip & ST OFF), OLr trip 8: Enabled (except during trip & ST OFF), No OLr trip		0
F308	Braking resistance	0.5 - 1000	Ω	*1
F309	Braking resistor capacity	0.01 - 600.0	kW	*1
F626	Overvoltage limit operation level	100 - 150	%	134
F639	Braking resistor overload time	0.1 - 600.0	s	5.0

*1 Depending on capacity, refer to [11. 6].

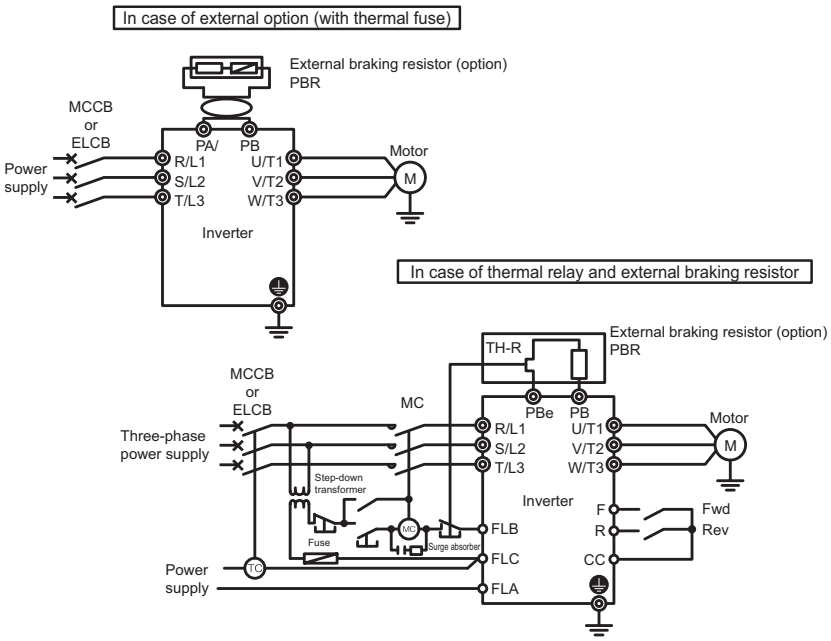
■ How to use

To use dynamic braking, set <F304: Dynamic braking, OLr trip> to "1" - "8" (dynamic braking enabled). At this time, the overvoltage limit operation is automatically disabled as in the case of <F305: Overvoltage limit operation> ="1: Disabled", and the regenerative energy of the motor is consumed by a braking resistor. (Refer to [6. 15. 5].)

Set <F308: Braking resistance> and <F309: Braking resistor capacity> according to the braking resistor to be connected.
Set the overload time of braking resistor with <F639: Braking resistor overload time>. Set a value so that a trip occurs at a value 10 times the <F309: Braking resistor capacity> setting. The default setting is intended for our recommended braking resistors (DGP600 Series excluded). To use the DGP600 Series, use the characteristic value of overload relay as a guide.
Set the operation level of dynamic braking with <F626: Overvoltage limit operation level>.
To output an overload of braking resistor, allocate the braking resistor overload (OLr) pre-alarm (function number: "30" , "31") to the output terminal.

■ Setting example

When using an external braking resistor (option)



The above connection is for the case where MCCB or ELCB with a trip coil is used instead of MC for TC (trip coil).
Prepare a step-down transformer for the 480V class. It is not required for the 240V class.

Important

- Be sure to install a thermal relay (THR) to prevent fire.
  The inverter is equipped with the functions that protect a braking resistor from overload or overcurrent. A thermal relay needs to be activated when these protective functions become disabled.
  Select the appropriate thermal relay (THR) according to the braking resistor capacity (watt).
- "Thermal overload relay" is recommended, install it for each motor to be protected.
  "Thermal relay with CT" is not available.

For an application that requires the continuous regenerative state, such as moving down of a lifting gear, press and tension control, or when a deceleration stop is performed for a machine with large load inertial moment, increase the braking resistor capacity according to the operation rate.

Connect a braking resistor with a resistance value greater than the minimum allowable resistance value (resultant resistance value). Be sure to set <F308: Braking resistance> and <F309: Braking resistor capacity> for overload protection.
To use a braking resistor without thermal fuse, connect a thermal relay to shut off the power.

■ Braking resistor option

Following table shows the optional braking resistors. Operation rate is 3%ED.

Rating shows resultant resistance capacities (watt) and resultant resistance values (ohm).
A braking resistor for frequent regenerative braking is also available. Please contact your Toshiba distributor for information.
The type-form "PBR-" features built-in thermal fuse, and "PBR7-" features built-in thermal fuse and thermal relay.
The default settings of <F308: Braking resistance> and <F309: Braking resistor capacity> are intended for the optional braking resistors.

■ Minimum resistance of connectable braking resistor

Following shows the minimum resistance of connectable braking resistor.
Use a braking resistor with a resistance value greater than the minimum allowable resistance value (resultant resistance value).

■ Minimum resistances of connectable braking resistors

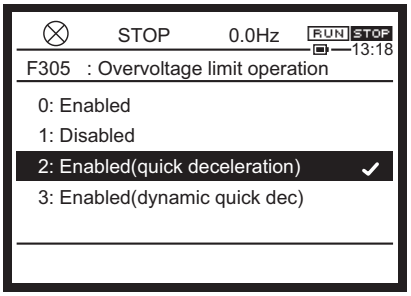
Voltage class	Inverter output capacity (kW at HD)	Minimum allowable resistance (Ω)
3-phase 240V	0.4 to 4.0	7.9
	5.5, 7.5	5.3
	11, 15	5
	18.5	4.5
	22 to 55	1
3-phase 480V	0.4 to 1.5	78
	2.2, 4.0	31.2
	5.5, 7.5	22.3
	11 to 18.5	15.6
	22, 30	12
	37	7.9
	45 to 75	2.5
	90 to 160	1.9
	220 to 280	1

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 15. 5 Avoiding overvoltage trip

<F305: Overvoltage limit operation>
<F319: Regenerative over-flux upper limit>
<F626: Overvoltage limit operation level>



■ Function

These parameters are used to temporarily maintain the output frequency constant or increase the frequency to prevent overvoltage tripping when the voltage in the DC section rises during deceleration or while constant speed run is in progress (overvoltage limit operation).

Important

- During overvoltage limit operation, deceleration time may be longer than the time set.
- During overvoltage limit operation, the overvoltage (OP) pre-alarm is displayed.

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■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F305	Overvoltage limit operation	0: Enabled 1: Disabled 2: Enabled (quick deceleration) 3: Enabled (dynamic quick deceleration)		2
F319	Regenerative over-flux upper limit	100 - 160	%	*1
F626	Overvoltage limit operation level	100 - 150	%	134 *1

*1 Depending on the setup menu. For details, refer to [11. 6].

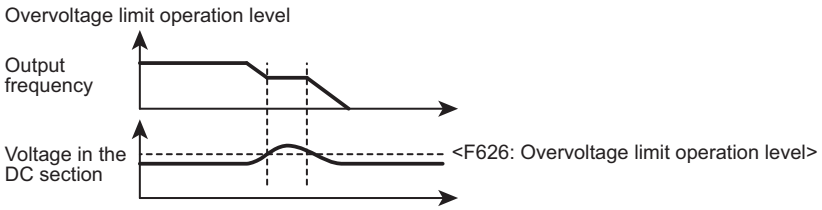
■ Difference in specific settings

<F305: Overvoltage limit operation> = "2"
This value sets quick deceleration.
When the voltage reaches the overvoltage limit operation level during deceleration, the motor may be decelerated more quickly than normal deceleration by increasing the voltage to be applied to the motor (over-excitation control) to increase the amount of energy consumed by the motor.

<F305: Overvoltage limit operation> = "3"
This value sets dynamic quick deceleration.
The motor may be decelerated more quickly than quick deceleration by increasing the voltage to be applied to the motor (over-excitation control) to increase the amount of energy consumed by the motor as soon as the motor starts decelerating.

<F319: Regenerative over-flux upper limit> is enabled when <F305: Overvoltage limit operation> is set to "2" or "3".
This parameter is used to adjust the maximum value of energy the motor consumes during deceleration. Increase this value if overvoltage tripping occurs during deceleration.

<F626: Overvoltage limit operation level> also serves as the parameter to set the dynamic braking level.



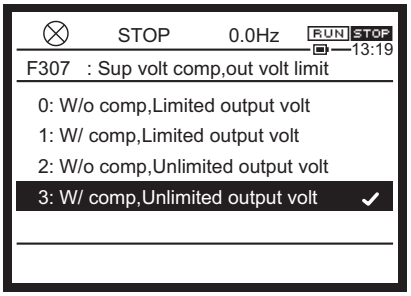
Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

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6. 15. 6 Adjusting and limiting output voltage

<F307: Supply voltage compensation, Output voltage limitation>



■ Function

- Supply voltage compensation: maintains a constant V/f ratio even when the input voltage fluctuates to suppress torque reduction in the low-speed range.
- Output voltage limitation: limits the output voltage so that voltage set with <vLv: Base frequency voltage 1> or more will not be output at frequency set with <vL: Base frequency 1> or more. This function is used when operating a special motor with low induced voltage.

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■ Parameter setting

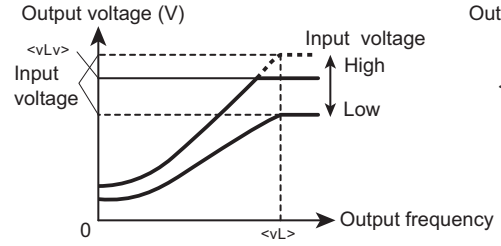
Title	Parameter name	Adjustment range	Default setting
F307	Supply voltage compensation, Output voltage limitation	0: Without supply voltage compensation, Limited output voltage 1: With supply voltage compensation, Limited output voltage 2: Without supply voltage compensation, Unlimited output voltage 3: With supply voltage compensation, Unlimited output voltage	*1

*1 Depending on the setup menu. Refer to [5. 3. 10], [11. 10].

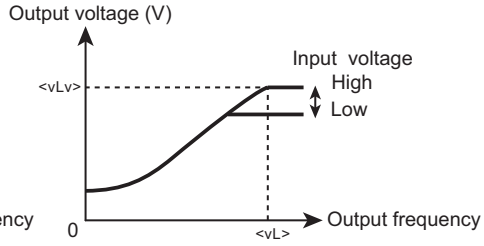
■ Selecting a setting value

- To maintain a constant V/f ratio even when the input voltage fluctuates to suppress torque reduction in the low-speed range, set <F307: Supply voltage compensation, Output voltage limitation> to "1" or "3" (With supply voltage compensation).
  When <F307> is set to "0" or "2", output voltage will change in proportion to the input voltage.
- The output voltage can be limited according to the motor rating. When <F307> is set to "0" or "1", the output voltage will be limited to <vLv: Base frequency voltage 1> when operated at frequency set with <vL: Base frequency 1> or more.
- Even if <vLv> is set to the input voltage or more, the output voltage will not exceed the input voltage.
- When <Pt: V/f Pattern> is set to "2" - "6" or "9" - "12", With supply voltage compensation will be set regardless of the <F307> setting.

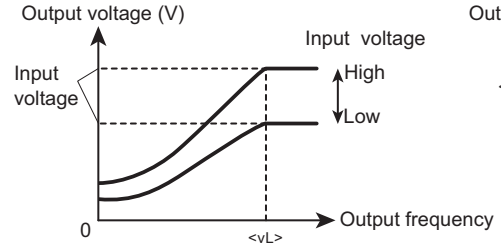
<F307>= "0: Without supply voltage compensation, Limited output power"



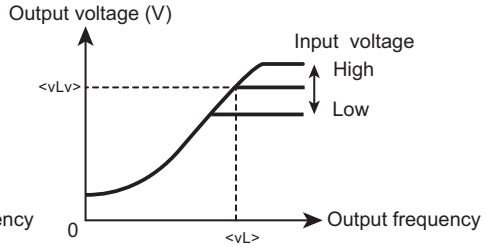
<F307>= "1: With supply voltage compensation, Limited output power"



<F307>= "2: Without supply voltage compensation, Unlimited output power"



<F307>= "3: With supply voltage compensation, Unlimited output power"

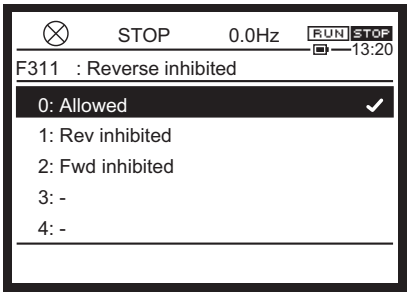


Rated voltages are fixed to values 240 V class: 200 V and 480 V class: 400 V.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 15. 7 Inhibiting Reverse run

<F311: Reverse inhibited>



■ Function

This function limits the direction of rotation when the wrong Fwd or Rev run command is input.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F311	Reverse inhibited	0: Allowed 1: Rev inhibited 2: Fwd inhibited 3, 4: -	0

6

Important

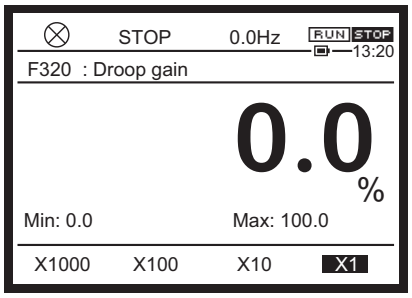
- When the motor is operated in the inhibited direction during operations such as preset speed operation with functions or jog run, the run command will be set to OFF.
- If the motor parameters are not set to the appropriate values when vector control or automatic torque boost is set, the motor may run in the reverse direction at approximately the slip frequency.
  Set <F243: End frequency> to approximately the slip frequency.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 16 Single load sharing by multiple inverters (droop control)

<F320: Droop gain>
<F321: Frequency at 0% droop gain>
<F322: Frequency at F320 droop gain>
<F323: Droop deadband torque>
<F324: Droop output filter>



■ Function

Droop control is a function that prevents loads from concentrating at a specific motor due to load imbalance when multiple inverters and motors are used to drive a common load.
These parameters are used to allow the motor to slip (drooping characteristic) according to the load torque.
These parameters are used to adjust the frequency range, deadband torque, and gain.

6

■ Parameter setting

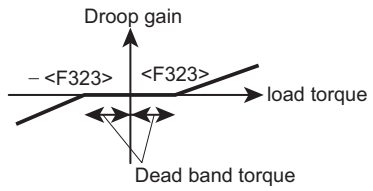
Title	Parameter name	Adjustment range	Unit	Default setting
F320	Droop gain	0.0 - 100.0 *1	%	0.0
F321	Frequency at 0% droop gain	0.0 - 320.0	Hz	10.0
F322	Frequency at F320 droop gain	0.0 - 320.0	Hz	100.0
F323	Droop deadband torque	0 - 100	%	10
F324	Droop output filter	0.1 - 200.0	rad/s	100.0

*1 Range that can be changed during run is 0.1 - 100.0%. Setting or changing to 0.0 (no droop) must be performed after stop.

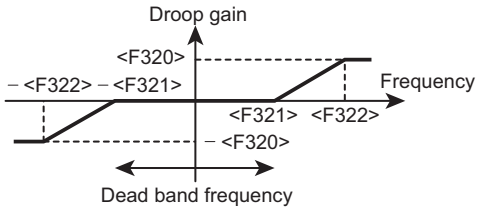
■ Setting methods

- Droop control is enabled when <Pt: V/f Pattern> is set to "3", "9", "10", or "11".
- When the applied torque is equal to or more than the deadband torque value, output frequency is reduced during power running or increased during regeneration.
- Droop control is enabled at frequency range <F321: Frequency at 0% droop gain> or more.
- The amount of droop will vary depending on the output frequency for frequency ranges <F321: Frequency at 0% droop gain> or more or <F322: Frequency at F320 droop gain> or less.
- For the frequency range over <vL: Base frequency 1>, the amount of error for <F323: Droop deadband torque> will increase. Therefore, we recommend you use this parameter at base frequency or less.
- Output frequency in droop control will not be limited by <FH: Maximum frequency>.

Gain 1



Gain 2



■ Calculating formula

The amount of output frequency adjusted by droop control can be calculated with the following formula.

1) Gain based on internal torque command (Gain 1)

- When internal torque command (%) >= 0,
  Gain 1 = (load torque - <F323>)/100
  Note that 0 (zero) or a positive number must be set to Gain 1.
- When internal torque command (%) < 0,
  Gain 1 = (load torque + <F323>)/100
  Note that 0 (zero) or a negative number must be set to Gain 1.

2) Gain based on frequency after acceleration (Gain 2)

- When <F321> < <F322>
  When |frequency after acceleration| <= <F321>,
  Gain 2 = 0
  When |frequency after acceleration| > <F322>,
  Gain 2 = <F320>/100
  When <F321> < |frequency after acceleration| <= <F322>,
  Gain 2 = (<F320>/100) x ((|frequency after acceleration| - <F321>)/(<F322> - <F321>))
- When <F321> >= <F322>
  When |frequency after acceleration| <= <F321>,
  Gain 2 = 0
  When |frequency after acceleration| > <F321>,
  Gain 2 = <F320>/100

3) Droop frequency

Droop frequency = <vL: Base frequency 1> x Gain 1 x Gain 2

Note that, when <vL: Base frequency 1> is over 100 Hz, this value is calculated as 100 Hz.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 17 High-speed operation with light load on cranes

<F328: Light-load high-speed operation>
<F329: Light-load high-speed learning function>
<F330: Light-load high- speed automatic operation frequency>
<F331: Light-load high-speed operation switching lower-limit frequnecy>
<F332: Light-load high-speed operation load detection wait time>
<F333: Light-load high-speed operation load detection time>
<F334: Light-load high-speed operation heavy load detection time>
<F335: Switching load torque during power running>
<F336: Heavy-load torque during power running>
<F337: Heavy-load torque during constant speed power running>
<F338: Switching load torque during regen>

For details, refer to "Crane Application Function Manual" (E6582104) (light-load high-speed operation, brake sequence, learning).

6. 18 Brake sequence

6. 18. 1 Brake sequence

<F325: Brake release wait time>
<F326: Brake release undercurrent threshold>
<F340: Creep time 1>
<F341: Brake function>
<F342: Load torque input select>
<F343: Hoisting torque bias>
<F344: Lowering torque bias rate>
<F345: Brake releasing time>
<F346: Creep frequency>
<F347: Creep time 2>
<F348: Brake learning>
<F630: Brake answer wait time>

For details, refer to "Crane Application Function Manual" (light-load high-speed operation, brake sequence, learning) (E6582104).

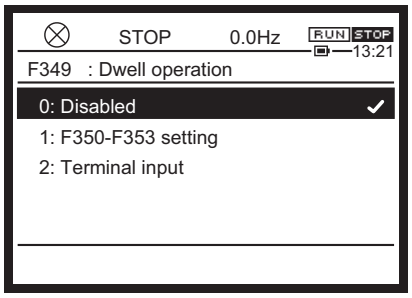
6. 18. 2 Hit and stop control

<F382: Hit and stop control>
<F383: Hit and stop frequency>
<F384: Hit and stop torque limit>
<F385: Hit and stop detection time>
<F386: Hit and stop continuation torque limit>

For details, refer to Hit and Stop Function Instruction Manual (E6582096).

6. 19 Constant speed run with Acc/Dec suspended (dwell operation)

<F349: Dwell operation>
<F350: Acc suspended frequency>
<F351: Acc suspended time>
<F352: Dec suspended frequency>
<F353: Dec suspended time>



■ Function

This function suspends acceleration/deceleration temporarily and let the inverter run in constant speed according to the brake delay during run/stop for transportation of heavy load. This will prevent occurrence of overcurrent at startup or slippage when stopping by adjusting the timing with the brake.

There are two ways to set dwell operation: automatic stop by setting the stop frequency and stop time and stop by using signals to the input terminal.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F349	Dwell operation	0: Disabled 1: F350-F353 setting 2: Terminal input		0
F350	Acc suspended frequency	0.0 - FH	Hz	0.0
F351	Acc suspended time	0.0 - 10.0	s	0.0
F352	Dec suspended frequency	0.0 - FH	Hz	0.0
F353	Dec suspended time	0.0 - 10.0	s	0.0

■ Setting method

Select whether to automatically suspend acceleration/deceleration by parameter settings or by signal input to the input terminal. This is set with <F349: Dwell operation>.

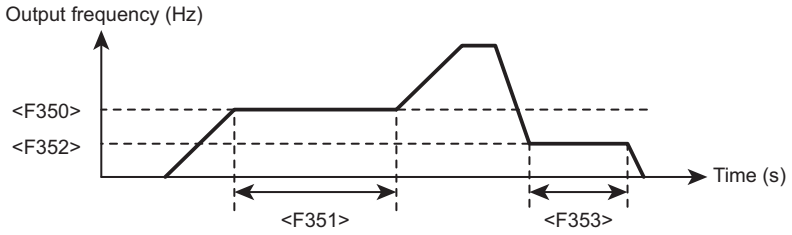
- When <F349> is set to "1", you must also set parameters <F350: Acc suspended frequency> through <F353: Dec suspended time>.
  <F350: Acc suspended frequency> must be set to a value over <F240: Start frequency>.
  <F352: Dec suspended frequency> must be set to a value over <F243: End frequency>.
  When the frequency command value is the same as values set for <F350> and <F352> settings, dwell operation will not be enabled.
- When <F349> is set to "2", you must also assign function numbers "60", "61" (dwell operation) to the unused input terminal.

Important

- When output frequency falls due to the stall preventive function, dwell operation may be enabled.

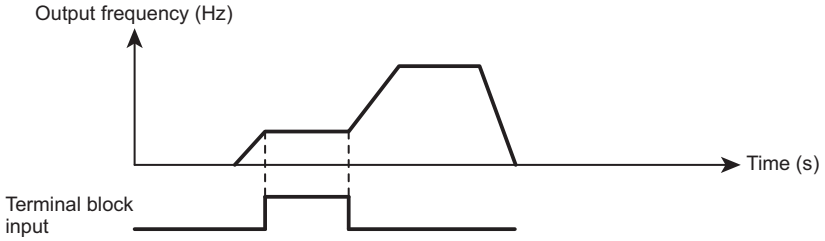
■ Setting example: for automatic dwell operation

Set <F350: Acc suspended frequency>, <F352: Dec suspended frequency>, <F351: Acc suspended time>, and <F353: Dec suspended time>. Then set <F349: Dwell operation> to "1".
When the output frequency reaches the set frequency, operation will automatically switch to constant speed run (acceleration/deceleration suspended).



■ Setting example: for dwell operation by external signal input

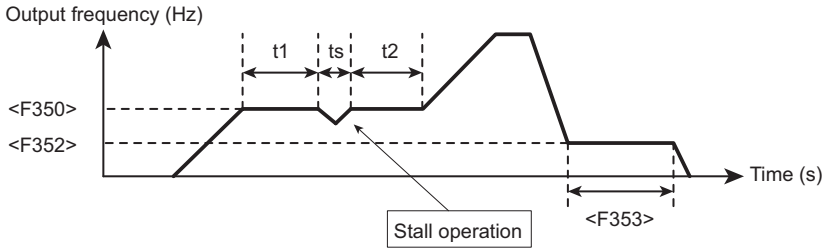
Assign function numbers "60", "61" (dwell operation) to the unused input terminal.
Dwell operation will be performed while the input terminal is ON.



When you set run command ON after you set the dwell operation signal ON, operation will start at <F240: Start frequency>.

■ If the stall preventive function is enabled during dwell operation

Duration of any temporary output frequency change due to the stall preventive function will be included in the acceleration/deceleration suspended time.



Memo

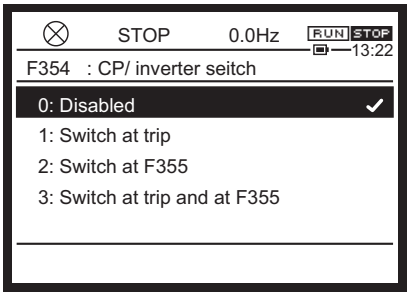
- The stall preventive function automatically changes the output frequency when overcurrent, overload or overvoltage occurs. Specific functions that are set with each parameter are as follows:
  - Overcurrent stall: <F601: Stall prevention level 1>
  - Overload stall: <OLM: Motor overload protection characteristic>
  - Overvoltage stall; <F305: Overvoltage limit operation>

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 20 Switching to commercial power run

<F354: Commercial power/Inverter switching>
<F355: Commercial power switching frequency>
<F356: Inverter switching wait time>
<F357: Commercial power switching wait time>
<F358: Commercial power switching frequency continuous time>



■ Function

This function allows output of switching signals to an external sequence (such as MC) so that when tripping occurs, operation will be switched to commercial power run without stopping the motor.
For details, refer to Commercial power/Inverter switching (E6582108).

■ Parameter setting

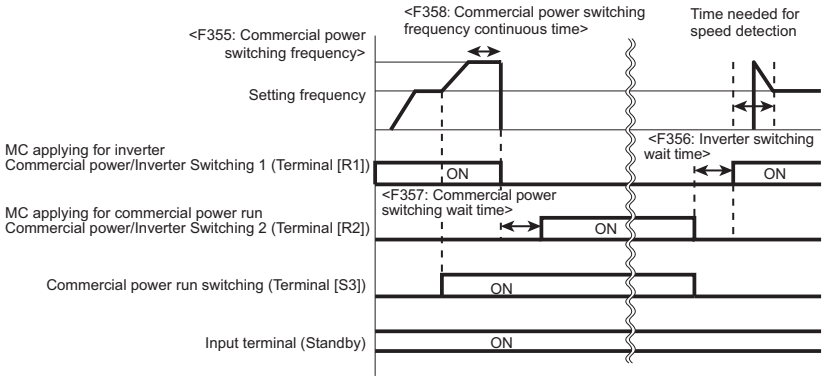
Title	Parameter name	Adjustment range	Unit	Default setting
F354	Commercial power/ Inverter switching	0: Disabled 1: Switch at trip 2: Switch at F355 3: Switch at trip and at F355		0
F355	Commercial power switching frequency	0 - UL	Hz	50.0/60.0 *1
F356	Inverter switching wait time	0.10 - 10.00	s	*2
F357	Commercial power switching wait time	0.10 - 10.00	s	0.62
F358	Commercial power switching frequency continuous time	0.10 - 10.00	s	2.00

*1 Depending on the setup menu. Refer to [5. 3. 10], [11. 10].
*2 Depending on capacity. For details, refer to [11. 5].

Trips that are automatically switched are those not displayed as "OCL", "E", "EF1", and "EF2".

<F341: Brake function> will not be enabled.

■ Timing chart (setting example)



When function numbers "102", "103" (switch to commercial power run) is set to terminal [S3].
Terminal [S3] ON: commercial power operation
Terminal [S3] OFF: inverter operation
Switching cannot be performed properly if standby function is OFF.

6

Title	Parameter name	Setting example	Unit
F354	Commercial power/ Inverter switching	2: Switch at F355 or 3: Switch at trip and at F355	-
F355	Commercial power switching frequency	Power supply frequency, etc.	Hz
F356	Inverter switching wait time	Depending on capacity *1	s
F357	Commercial power switching wait time	0.62	s
F358	Commercial power switching frequency continuous time	2.00	s
F116	Terminal S3 function	102: Commercial powr run switching	-
F133	Terminal R1 function 1	46: Commercial power/Inverter Switching 1	-
F134	Terminal R2 function	48: Commercial power/Inverter Switching 2	-

*1 Depending on capacity. For details, refer to [11. 6].

Important

- To allow switching to commercial power operation, forward run of the inverter and the direction of rotation of the motor for commercial power operation must match.
- Do not set <F311: Reverse inhibited> to "2: Fwd inhibited". The inverter will not be able to forward run and switching to commercial power cannot be accomplished.
- This function can only be used in induction motors. Do not use this function with PM motors.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 21 PID control

<FPId: PID1 set value>
<F359: PID control 1>
<F360: PID1 feedback input select >
<F361: PID1 filter>
<F362: PID1 proportional gain>
<F363: PID1 integral gain>
<F364: PID1 deviation upper-limit>
<F365: PID1 deviation lower-limit>
<F366: PID1 differential gain>
<F367: PID1 set value upper-limit>
<F368: PID1 set value lower-limit>
<F369: PID1 start wait time>
<F370: PID1 output upper-limit>
<F371: PID1 output lower-limit>
<F372: PID1 set value increase time>
<F373: PID1 set value decrease time>
<F374: PID1 set value agreement detection band>
<F388: PID1 output dead band>
<F389: PID1 set value select>

For details of PID control, refer to PID Control Instruction Manual (E6582112).
For parameter setting, refer to [5. 3. 8] "Setting PID control" as well.

6. 22 Retaining the stop position

<Pt: V/f Pattern>
<F381: Simple positioning completion range>
<F359: PID control1>
<F362: PID1 proportional gain>
<F369: PID1 start wait time>
<F375: PG pulses number>
<F376: PG phases number select>

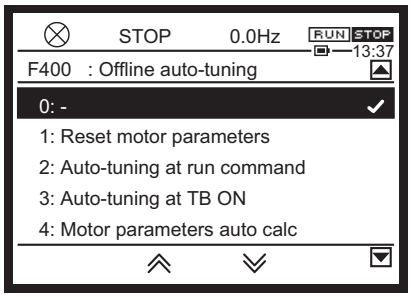
For details of stop position retain function, refer to PID Control Instruction Manual (E6582112).

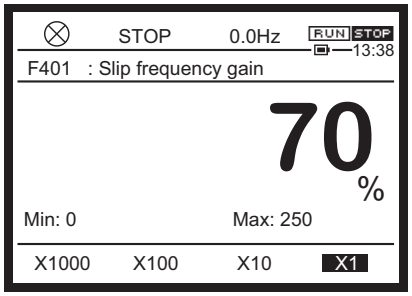
6. 23 Setting of motor parameters

WARNING	
Prohibited	• Do not touch terminals or motor of the inverter while performing auto tuning. Touching the terminals or motor while voltage is applied to the terminals and motor may result in electric shock, even if the motor is stopped. After setting offline auto-tuning (F400 = "2"), execute the auto tuning at first start of the inverter. The auto tuning takes several seconds and the motor is stopped meanwhile, but voltage is applied to the terminals and motor. The motor may also generate a sound during the auto tuning, but this is not malfunction.
Mandatory action	• Install circuit protection such as the mechanical brake in the crane. If there is no sufficient circuit protection installed in the crane, insufficient motor torque while auto tuning will cause the machine stalling/falling.

6. 23. 1 Setting induction motor parameters

<F400: Offline auto-tuning>
<F401: Slip frequency gain>
<F402: Automatic torque boost>
<F403: Online auto-tuning>
<F405: Motor rated capacity>
<F412: Leakage inductance>
<F413: Exciting current coefficient>
<F414: Stall prevention coefficient>
<F415: Motor rated current>
<F416: Motor no load current>
<F417: Motor rated speed>
<F459: Load inertia ratio>
<F462: Speed reference filter coefficient 1>
<F465: Speed reference filter coefficient 2>





■ Function

To select vector control, automatic torque boost, or automatic energy-saving with <Pt: V/f Pattern>, you must set motor parameters (auto-tuning).
There are four setting methods.

- Use <AU2: Torque boost macro> to set both <Pt> and <F400: Offline auto-tuning>.
- Set <Pt> and <F400> individually.
- Set <Pt> and <F400> individually. Perform an auto-tuning after calculating the motor parameter automatically (available with motor not connected).

• Set <Pt> and set the motor parameter manually.

Important

- Check the motor name plate and set the following parameters first.
  The value of 4 pole general purpose motor, with same capacity as the inverter, is set by default setting.
  - <vL: Base frequency 1> (Rated frequency)
  - <vLv: Base frequency voltage 1> (Rated voltage)
  - <F405: Motor rated capacity>
  - <F415: Motor rated current>
  - <F417: Motor rated speed>
- Set other motor parameters as necessary.

■ Setting method 1: Use torque boost macro

This is the simplest setting method. Vector control/automatic torque boost/automatic energy-saving and auto-tuning are all set at once.
Check the motor name plate and set the following parameters first.
- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Next, set <AU2: Torque boost macro>.
1: Automatic torque boost + offline auto-tuning
2: Vector control 1 + offline auto-tuning
3: Energy savings + offline auto-tuning
For details of setting methods, refer to [5. 3. 5].

■ Setting method 2: Set auto-tuning

Set vector control/automatic torque boost/automatic energy-saving and auto-tuning individually.
First, set <Pt: V/f Pattern>. For details of setting methods, refer to [5. 3. 4].
Next, perform offline auto-tuning.

1) Parameter setting

Title	Parameter name	Adjustment range	Default setting
F400	Offline auto-tuning	0: - 1: Reset motor parameters (0 after execution) 2: Auto-tuning at run command (0 after execution) 3: Auto-tuning at TB ON 4: Motor parameters auto calculation (0 after execution) 5: 4+2 (0 after execution) 6: Auto-tuning at run command during TB ON 7: Auto-tuning F402 only at run command during TB ON	0

2) Selecting auto-tuning setting

1: Reset motor parameters (0 after execution)

Set motor parameters <F402: Automatic torque boost>, <F412: Leakage inductance>, and <F416: Motor no load current> to default setting values (same motor parameter values as a 4 pole general purpose motor with same capacity as the inverter).

2: Auto-tuning at run command (0 after execution)

Perform auto-tuning when the motor starts for the first time after settings are made and automatically set <F402: Automatic torque boost> and <F412: Leakage inductance> while considering the motor wiring.

3: Auto-tuning at TB ON

Assign "66: Offline auto-tuning" (67 is the inversion signal) to the digital input terminal.
When the assigned input terminal is ON, make an auto-tuning and automatically set <F402: Automatic torque boost> and <F412: Leakage inductance>.
This setting allows auto-tuning while the motor is stopped; use this function when the motor cannot run following the auto-tuning due to some reason related to the operation of the machinery.
However, if standby signal is OFF, this function will not be enabled.
To make an auto-tuning again, tern input terminal off once, then turn on again.

6: Auto-tuning at run command during TB ON

Assign "66: Offline auto-tuning" (67 is the inversion signal) to the digital input terminal.
When the assigned input terminal is ON, always make an auto-tuning and automatically set <F402: Automatic torque boost> and <F412: Leakage inductance> at startup.

7: Auto-tuning F402 only at run command during TB ON

Assign "66: Offline auto-tuning" (67 is the inversion signal) to the digital input terminal.
Always make an auto-tuning at startup when the motor starts for the first time after the assigned input terminal is ON and set <F402: Automatic torque boost> only.

3) Cautions during offline auto-tuning

- Offline auto-tuning must be performed with the motor connected but in a completely stopped state.
  Due to residual voltage, tuning may not be properly executed immediately after running motor is stopped.
- There would be almost no rotation of the motor during offline auto-tuning, but you must keep in mind that voltage is still applied during this time.
- During auto-offline tuning, "Atn" will be displayed on the LCD screen.
- Offline auto-tuning takes a few seconds. If any failure is found, tripping will occur with auto-tuning error "Etn1" or "Etn2", and motor parameters will not be set.
- Offline auto-tuning cannot be performed on special motors such as a high-speed motor or high-slip motor. Calculate the motor parameters using "Setting method 3".
- If offline auto-tuning cannot be executed or auto-tuning error "Etn1" or "Etn2" occurs, perform manual setting using "Setting method 4".

■ Setting method 3: Make auto-tuning of motor parameter after automatic setting.

Make auto-tuning after setting vector control/automatic torque boost/automatic energy-saving and performing motor parameters auto calculation.

Check the motor name plate and set the following parameters first.
- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Next, set <Pt: V/f Pattern>. For details of setting methods, refer to [5. 3. 4].
Then, select <F400> = "4: Motor parameters auto calculation (0 after execution)" and calculate motor parameters automatically.
Motor parameters <F402: Automatic torque boost>, <F412: Leakage inductance>, and <F416: Motor no load current> will be set automatically.
This setting can be made without connecting the motor since it only calculates.
After automatic setting of motor parameter with <F400> = "4", be sure to set <F400> to "2: Auto-tuning at run command (0 after execution)" and perform an auto-tuning.
You can set <F400> to "4" and "2" collectively by setting <F400> to "5: 4+2 (0 after excecution)".
Since calculation is performed based on general trend, the calculation results may not be correct. In this case, set the parameter manually. In case ETN3 trip occurs after set 4 to F400 , do not set 4 to F400, and set the parameter manually.

■ Setting method 4: Manually setting motor parameter

Set <Pt: V/f Pattern> and set the motor parameter manually.
If tuning error "Etn1" is displayed during auto-tuning setting or when you want to improve vector control characteristics, set motor parameters individually.

4) Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F401	Slip frequency gain	0 - 250	%	70
F402	Automatic torque boost	0.1 - 30.00	%	*1
F405	Motor rated capacity	0.01 - 315.0	kW	*1
F412	Leakage inductance	0.0 - 25.0	%	*1
F413	Exciting current coefficient	100 - 150	%	100
F415	Motor rated current	*1	A *1	*1
F416	Motor no load current	10 - 90	%	*1
F417	Motor rated speed	100 - 64000	min^{-1}	*2
F459	Load inertia ratio	0.1 - 100.0	Times	1.0
F460	Speed control response 1	0.0 - 25.0	-	0.0
F461	Speed control stabilization coefficient 1	0.50 - 2.50	-	1.00
F462	Speed reference filter coefficient 1	0 - 100	-	35

Title	Parameter name	Adjustment range	Unit	Default setting
F463	Speed control response 2	0.0 - 25.0	-	0.0
F464	Speed control stabilization coefficient 2	0.50 - 2.50	-	1.00
F465	Speed reference filter coefficient 2	0 - 100	-	35
F466	Speed control response switching frequency	0.0 - FH	Hz	0.0

*1 Depending on capacity. For details, refer to [11. 6].
*2 Depending on the setup menu. Refer to [5. 3. 10], [11. 10].

5) Motor parameter setting method (Basic)

<F401: Slip frequency gain>

This parameter sets the compensation gain for motor slip.
Increasing the value will reduce motor slip.
Set <F417: Motor rated speed> and then make fine adjustments to <F401>.
Keep in mind that setting a higher value than necessary will cause unstable operation such as hunting.

<F402: Automatic torque boost>

This parameter adjusts the primary resistive component of the motor.
Increasing this value will prevent torque reduction due to voltage drop during low speed.
Adjust the value according to the actual operation.
Keep in mind that setting a higher value than necessary will increase current at low speed and may cause tripping.
If there is a motor test report, check the stator resistance value per phase.
<F402> (%) = (√3 x Rs x <F415> x 0.9) / (Vtype x 100)
where Rs is the stator resistance value per phase (Ω), Vtype is 200, 400 V (depends on voltage class).

<F405: Motor rated capacity>

This parameter sets the motor rated capacity.
Check the motor name plate or test report while setting.

<F412: Leakage inductance>

This parameter sets the leakage inductance component of the motor.
Increasing this value will improve torque in the high-speed region.

<F415: Motor rated current>

This parameter sets the motor rated current.
Check the motor name plate or test report while setting.

<F416: Motor no load current>

This parameter sets the ratio of the motor no-load current to the rated current.
This is equivalent to the exciting inductance of the motor.
Check the no-load current value in the motor test report and divide it by the rated current value.
Set the calculated value in %.

Increasing this value will increase the exciting current.
Keep in mind that setting a value too high will cause hunting in the motor.

<F417: Motor rated speed>
This parameter sets the motor rated speed.
Check the motor name plate or test report while setting.

6) Motor parameter setting method (Advanced)

- **How to adjust the moment of inertia of the load**

<F459: Load inertia ratio>
This parameter adjusts the excess response speed.
Increasing this value will reduce the overshoot at the acceleration/deceleration completion point.
Default setting values are set so that the moment of inertia of the load (including the motor shaft) value is set to be appropriate at 100% of the motor shaft. If the moment of inertia of the load is not 100%, set a value appropriate for the actual inertia of the load.

<F460: Speed control response 1>
<F461: Speed control stabilization coefficient 1>
<F462: Speed reference filter coefficient 1>
<F463: Speed control response 2>
<F464: Speed control stabilization coefficient 2>
<F465: Speed reference filter coefficient 2>
<F466: Speed control response switching frequency>

This parameter adjusts the excess response speed.
Increasing this value will reduce the overshoot at the acceleration/deceleration completion point. Set a value appropriate for the actual inertia of the load.
For details, refer to "Current and Speed Control Gain Adjustment Method" manual (E6582136).

- If the torque needs to be increased in low speed range (10Hz or less as a guide)
  Perform the basic settings for the motor parameters. Then, if the torque needs to be increased even further, increase <F413: Exciting current coefficient> to a maximum of 130%. <F413> is a parameter that increases the magnetic flux of the motor at low speeds, so specifying a higher value for <F413> increases the no-load current. If the no-load current exceeds the rated current, do not adjust this parameter.

- If the motor stalls when operated at frequencies over the base frequency
  Adjust <F414: Stall prevention coefficient>.
  If a heavy load is applied momentarily (transiently), the motor may stall before the load current reaches the stall prevention level (<F601>, etc.). In such a case, a motor stall may be avoided by reducing the value of <F414> gradually.

Memo	• To use vector control, the motor capacity must be the same as the inverter rated capacity, or you can use a general purpose squirrel-cage motor with capacity no less than one rank below. Note that the minimum applicable motor capacity is 0.1 kW.

■ Online auto-tuning setting

<F403: Online auto-tuning> is a function that automatically adjusts motor parameters by predicting the increase in motor temperature.

- Online auto-tuning must be performed along with <F400: Offline auto-tuning>.
- Perform auto-tuning when the motor has cooled down (same temperature as the ambient temperature).

7) Parameter setting

Title	Parameter name	Adjustment range	Default setting
F403	Online auto-tuning	0: Disabled 1: Self-cooling motor auto-tuning 2: Forced air-cooling motor auto-tuning	0

8) Selecting a setting value

1: Self-cooling motor auto-tuning

Set this value when the motor is equipped with a self-cooling fan (a type in which a fan is directly connected to the motor shaft).

2: Forced air-cooling motor auto-tuning

Set this value when the motor is equipped with a fan motor (forced air-cooling).

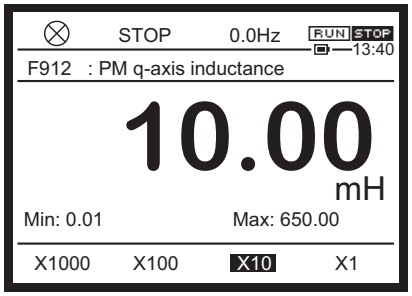
6

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 23. 2 Setting PM motor parameters

<F400: Offline auto-tuning>
<F402: Automatic torque boost>
<F405: Motor rated capacity>
<F415: Motor rated current>
<F417: Motor rated speed>
<F459: Load inertia ratio>
<F462: Speed reference filter coefficient 1>
<F465: Speed reference filter coefficient 2>
<F912: PM q-axis inductance>
<F913: PM d-axis inductance>
<F915: PM control method>



■ Function

To select PM motor control with <Pt: V/f Pattern>, you must set motor parameters (auto-tuning). There are three setting methods.

- Set <Pt> and <F400: Offline auto-tuning> individually.
- Set <Pt> and <F400> individually. Perform an auto-tuning after calculating the motor parameter automatically (available with motor not connected).
- Set <Pt> and set the motor parameter manually.

6

Important

- To set <Pt: V/f Pattern> to "6: PM motor control" or "12: PG feedback PM motor control", check the motor name plate and set the following parameters first.
  - <vL: Base frequency 1> (Rated frequency): calculate from back EMF
  - <vLv: Base frequency voltage 1> (Rated voltage): calculate from back EMF
  - <F405: Motor rated capacity>
  - <F415: Motor rated current>
  - <F417: Motor rated speed>
  - <F912: PM q-axis inductance>
  - <F913: PM d-axis inductance>

■ Setting method 1: Set auto-tuning

Set PM motor control and auto-tuning individually.
First, set <Pt: V/f Pattern> to "6: PM motor control". For details of setting methods, refer to [5. 3. 4].
Next, perform offline auto-tuning.

1) Parameter setting

Title	Parameter name	Adjustment range	Default setting
F400	Offline auto-tuning	0: - 1: Reset motor parameters (0 after execution) 2: Auto-tuning at run command (0 after execution) 3: Auto-tuning at TB ON 4: Motor parameters auto calculation (0 after execution) 5: - 6: Auto-tuning at run command during TB ON 7: Auto-tuning F402 only at run command during TB ON	0

2) How to select a setting value

1: Reset motor parameters (0 after execution)

Motor parameters <F402: Automatic torque boost>, <F912: PM q-axis inductance>, and <F913: PM d-axis inductance> are set with default setting values.

2: Auto-tuning at run command (0 after execution)

Perform tuning when the motor starts for the first time after settings are made and automatically set <F402: Automatic torque boost>, <F912: PM q-axis inductance>, and <F913: PM d-axis inductance> while considering the motor wiring.

3: Auto-tuning at TB ON

Assign "66: Offline auto-tuning" (67 is the inversion signal) to the digital input terminal.
When the assigned input terminal is ON, executed an auto-tuning and automatically set <F402: Automatic torque boost>, <F912: PM q-axis inductance>, and <F913: PM d-axis inductance>.
This setting allows auto-tuning while the motor is stopped; use this function when the motor cannot run following the auto-tuning due to some reason related to the operation of the machinery.
However, if standby signal is OFF, this function will not be enabled.
To make an auto-tuning again, tern input terminal off once, then turn on again.

6: Auto-tuning at run command during TB ON

Assign "66: Offline auto-tuning" (67 is the inversion signal) to the digital input terminal.
When the assigned input terminal is ON, always make an auto-tuning and automatically set <F402: Automatic torque boost>, <F912: PM q-axis inductance>, and <F913: PM d-axis inductance> at startup.

7: Auto-tuning F402 only at run command during TB ON

Assign "66: Offline auto-tuning" (67 is the inversion signal) to the digital input terminal.
Always execute an auto-tuning at startup when the motor starts for the first time after the assigned input terminal is ON and set <F402: Automatic torque boost> only.

3) Cautions during offline auto-tuning

- Offline auto-tuning must be performed with the motor connected but in a completely stopped state.

Due to residual voltage, auto-tuning may not be properly performed immediately after running motor is stopped.

- There would be almost no rotation of the motor during offline auto-tuning, but you must keep in mind that voltage is still applied during this time.
- During auto-offline tuning, "Atn" will be displayed on the LCD screen.
- Offline auto-tuning takes a few seconds. If any failure is found, tripping will occur with auto-tuning error "Etn1" or "Etn2", and motor parameters will not be set.
- Offline auto-tuning cannot be performed on special motors. Calculate the motor parameters using "Setting method 2".
- If offline auto-tuning cannot be performed or auto-tuning error "Etn1" or "Etn2" occurs, set manually using "Setting method 3".

■ Setting method 2: Make auto-tuning of motor parameter after automatic setting.

Set PM motor control and then perform motor parameters auto calculation.
Check the motor name plate and set the following parameters first.

- <vL: Base frequency 1> (Rated frequency)
- <vLv: Base frequency voltage 1> (Rated voltage)
- <F405: Motor rated capacity>
- <F415: Motor rated current>
- <F417: Motor rated speed>

Next, set <Pt: V/f Pattern> to "6: PM motor control". For details of setting methods, refer to [5. 3. 4].
Then, select <F400> = "4: Motor parameters auto calculation (0 after execution)" and perform <vLv: Base frequency voltage> auto calculation.
This setting can be made without connecting the motor since it only calculates.
After automatic setting of motor parameter with <F400> = "4", be sure to set <F400> to "2: Auto-tuning at run command (0 after execution)" and execute an auto-tuning.
Since calculation is performed based on general trend, the calculation results may not be correct. In this case, set the parameter manually.

■ Setting method 3: Manually setting motor parameter

Set <Pt: V/f Pattern> to "6: PM motor control" and set the motor parameter manually.
If tuning error "Etn1" is displayed during auto-tuning setting or when you want to improve PM motor control characteristics, set motor parameters individually. For details of setting methods, refer to [5. 3. 4].

4) Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F402	Automatic torque boost	0.1 - 30.00	%	*1
F405	Motor rated capacity	0.01 - 315.0	kW	*1
F415	Motor rated current	*1	A *1	*1
F417	Motor rated speed	100 - 64000	min^{-1}	*2
F459	Load inertia ratio	0.1 - 100.0	Times	1.0
F460	Speed control response 1	0.0 - 25.0	-	0.0

Title	Parameter name	Adjustment range	Unit	Default setting
F461	Speed control stabilization coefficient 1	0.50 - 2.50	-	1.00
F462	Speed reference filter coefficient 1	0 - 100	-	35
F463	Speed control response 2	0.0 - 25.0	-	0.0
F464	Speed control stabilization coefficient 2	0.50 - 2.50	-	1.00
F465	Speed reference filter coefficient 2	0 - 100	-	35
F466	Speed control response switching frequency	0.0 - FH	Hz	0.0
F912	PM q-axis inductance	0.01 - 650.00	mH	10.00
F913	PM d-axis inductance	0.01 - 650.00	mH	10.00

*1 Depending on capacity. For details, refer to [11. 6].
*2 Depending on the setup menu. Refer to [5. 3. 10], [11. 10].

6

5) Motor parameter setting method

<F402: Automatic torque boost>

This parameter adjusts the primary resistive component of the motor.
Increasing this value will prevent torque reduction due to voltage drop during low speed.
Adjust the value according to the actual operation. Keep in mind that setting a higher value than necessary will increase current at low speed and may cause tripping.
If there is a motor test report, check the stator resistance value per phase.
<F402> (%) = (√3 x Rs x <F415> x 0.9) / (Vtype x 100)
where Rs is the stator resistance value per phase (Ω), Vtype is 200, 400 V (depends on voltage class).

<F405: Motor rated capacity>

This parameter sets the motor rated capacity.
Check the motor name plate or test report while setting.

<F415: Motor rated current>

This parameter sets the motor rated current.
Check the motor name plate or test report while setting.

<F417: Motor rated speed>

This parameter sets the motor rated speed.
Check the motor name plate or test report while setting.

How to adjust the moment of inertia of the load

<F459: Load inertia ratio>

This parameter adjusts the excess response speed.
Increasing this value will reduce the overshoot at the acceleration/deceleration completion point.

Default setting values are set so that the moment of inertia of the load (including the motor shaft) value is set to be appropriate at 100% of the motor shaft. If the moment of inertia of the load is not 100%, set a value appropriate for the actual moment of inertia of the load.

<F460: Speed control response 1>
<F461: Speed control stabilization coefficient 1>
<F462: Speed reference filter coefficient 1>
<F463: Speed control response 2>
<F464: Speed control stabilization coefficient 2>
<F465: Speed reference filter coefficient 2>
<F466: Speed control response switching frequency>

This parameter adjusts the excess response speed.
Increasing this value will reduce the overshoot at the acceleration/deceleration completion point. Set a value appropriate for the actual moment of inertia of the load.
For details, refer to "Current and Speed Control Gain Adjustment Method" manual (E6582136).

<F912: PM q-axis inductance>
<F913: PM d-axis inductance>
Set q-axis inductance and d-axis inductance (mH) of PM motor.
Use <F400: auto-tuning> to set the value.

Memo

- To use PM motor control, the motor capacity must be the same as the inverter rated capacity, or you can use a motor with capacity no less than one rank below.
- If there is a possibility that main power supply is shut down during running, set <F301: Auto-restart> to activate.
  Otherwise, when DC-bus voltage is recovered and inverter start to run again, E-39 or OP trip occurs, because motor is still rotated and back EMF voltage is high.

■ PM motor control and starting torque optimization setting

If the PM motor does not start after auto-tuning due to heavy load, set <F915: PM control method> to "4" for starting torque optimization.

6) Parameter setting

Title	Parameter name	Adjustment range	Default setting
F915	PM control method	0: Method 0 1: Method 1 2: Method 2 3: Method 3 4: Method 4	3

7) How to select setting values

0: Method 0
This value sets no initial position estimation control. Reverse run may occur at startup.
If tripping occurs with PM auto-tuning error "E-39", use this function by setting <F915> to "0".

1: Method 1
This value sets initial position estimation for high saliency motors.

2: Method 2
This value sets initial position estimation and starting torque optimization for high saliency motors.

3: Method 3
This value sets initial position estimation for weak saliency motors.

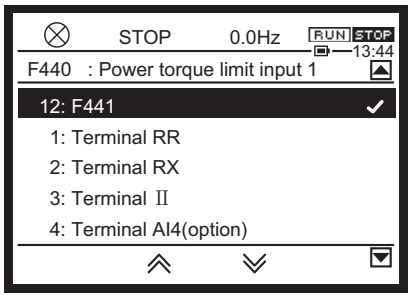
4: Method 4
This value sets initial position estimation and starting torque optimization for weak saliency motors.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 24 Torque limits

6. 24. 1 Switching torque limits

<F440: Power running torque limit input select 1>
<F441: Power running torque limit level 1>
<F442: Regenerative torque limit input select 1>
<F443: Regenerative torque limit level 1>
<F444: Power running torque limit level 2>
<F445: Regenerative torque limit level 2>
<F446: Power running torque limit level 3>
<F447: Regenerative torque limit level 3>
<F448: Power running torque limit level 4>
<F449: Regenerative torque limit level 4>
<F454: Torque limit in field weakening>

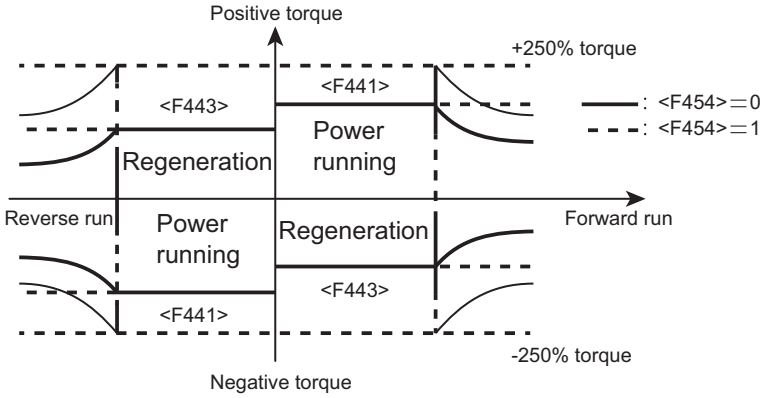


■ Function

When the motor-generated torque reaches a certain level, the inverter reduce the torque by lowering the output frequency.
You can select a constant output limit or a constant torque limit in the constant output zone.

■ Selecting a setting value

1) When torque limits are applied by the parameter setting values



Select from where to input a torque limit value at <F440: Power running torque limit input select 1> and <F442: Regenerative torque limit input select 1>.
As default setting, torque limits are applied by the parameter setting values.

Title	Parameter name	Adjustment range	Default setting
F440	Power running torque limit input select 1	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F441	12
F442	Regenerative torque limit input select 1	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F443	12

Set the torque limit values for the power running and regenerative torques at <F441: Power running torque limit level 1> and <F443: Regenerative torque limit level 1>.
Set limit treatment of the constant output zone (weak magnetic field) at <F454: Torque limit in field weakening>. You can select either constant output limit <F454> = "0" (default setting) or constant torque limit <F454> ="1".

6

Title	Parameter name	Adjustment range	Unit	Default setting
F441	Power running torque limit level 1	0.0-249.9 250.0: Disabled	%	250.0
F443	Regenerative torque limit level 1	0.0-249.9 250.0: Disabled	%	250.0
F454	Torque limit in field weakening	0: Constant power limit 1: Constant torque limit		0

You can set four patterns each for the power running torque limit or the regenerative torque limit at the parameter settings.

Title	Parameter name	Adjustment range	Unit	Default setting
F444	Power running torque limit level 2	0.0-249.9 250.0: Disabled	%	250.0
F445	Regenerative torque limit level 2		%	250.0
F446	Power running torque limit level 3		%	250.0
F447	Regenerative torque limit level 3		%	250.0
F448	Power running torque limit level 4		%	250.0
F449	Regenerative torque limit level 4		%	250.0

Patterns 1 to 4 can be switched by turning the input terminal ON/OFF.

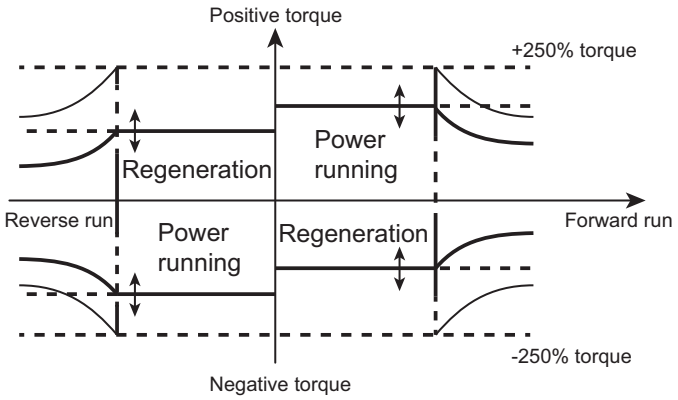
Assign "32: Stall prevention switching/Torque limit switching 1" and "34: Torque limit switching 2" to the two unused input terminals.

	32: Stall prevention switching/ Torque limit switching 1	34: Torque limit switching 2
Torque limit level 1	OFF	OFF
Torque limit level 2	ON	OFF
Torque limit level 3	OFF	ON
Torque limit level 4	ON	ON

Memo

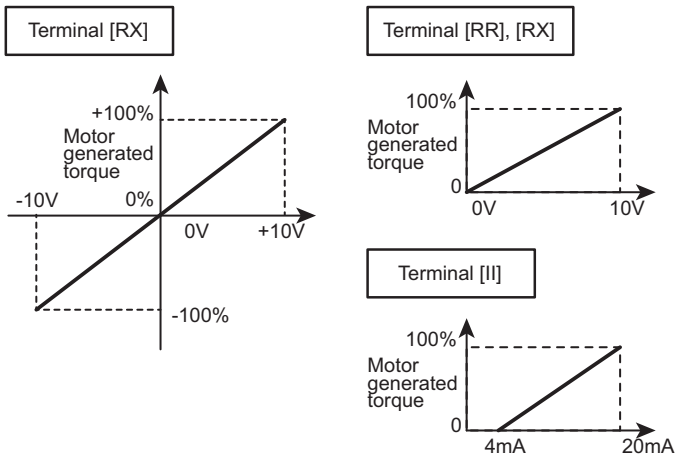
- Set the torque limit level to "250.0" when disabling this function.
- When <Pt: V/f Pattern>="0", "1", or "7", the torque limit will be disabled.
- When the current value is big, or the setting value of <F601: Stall prevention level 1> is small, the stall preventive function may be active before torque limit and lower the frequency.

2) When torque limits are applied by external signals



Torque limit value can be changed by external signals.

- When setting with input of 0 to 10 Vdc to terminal [RR]
  Set "1" for <F440: Power running torque limit input select 1> and <F442: Regenerative torque limit input select 1>.
- When setting with input of -10 to 10 Vdc to terminal [RX]
  Set "2" for <F440: Power running torque limit input select 1> and <F442: Regenerative torque limit input select 1>.
- When setting with input of 4 to 20 mAdc to terminal [II]
  Set "3" for <F440: Power running torque limit input select 1> and <F442: Regenerative torque limit input select 1>.



Memo

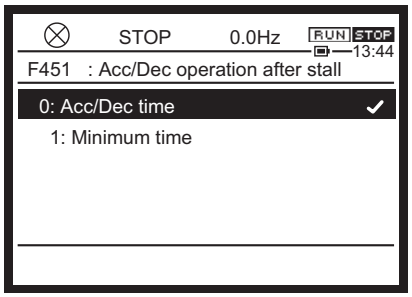
- The torque command values are limited to the torque limit level in torque control.
- When V/f Pattern is "V/f constant", "Variable torque", and "V/f 5-points", the torque limit will be disabled.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 24. 2 Selecting Acc/Dec operation after stall prevention operation

<F451: Acc/Dec operation after stall operation>



■ Function

When you use lifting gear (crane or hoist) in combination with mechanical brakes, and if the output frequency is decreasing due to stall prevention operation before mechanical brake release, accelerate the mechanical brake delay time in the minimum time to prevent load from falling due to torque reduction after mechanical brake release.

This will also improve the response in inching operation, and thus preventing the load from slipping down.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F451	Acc/Dec operation after stall operation	0: Acc/Dec time 1: Minimum time	0

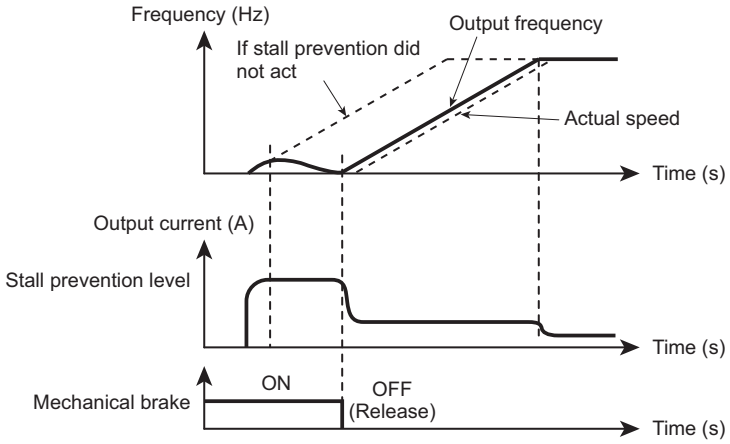
■ Selecting a setting value

0: Acc/Dec time

When stall prevention is active, the output frequency gets low.

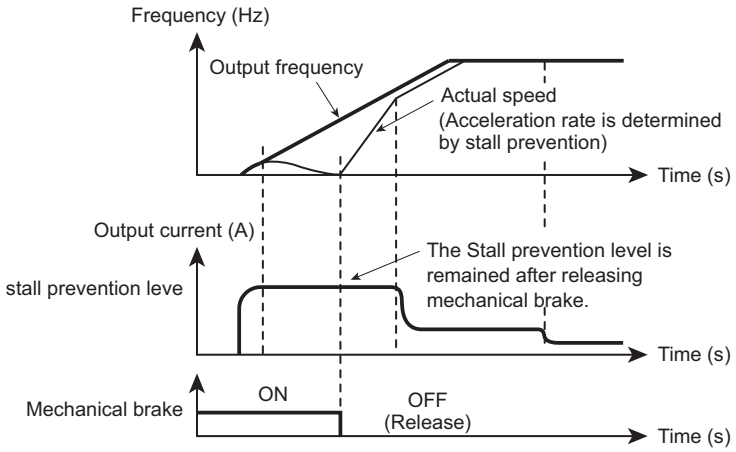
If stall prevention was active and the output frequency is decreasing before releasing the machine, even if the mechanical brake is released, the stall prevention remains active during the delay time of the brake operation . After delay time of the brake operation, the output current value gets low, the stall prevention operation is deactivated and the output frequency increases.

With this setting, the output frequency reaches the frequency command value after brake operation delay time + acceleration time. The actual speed of the machinery changes in sync with the output frequency.



1: Minimum time

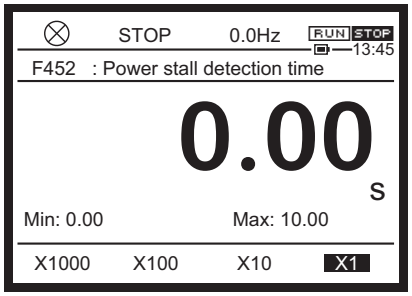
With the same situation as in 0, the output frequency precedes and accelerates in minimum time, even when the stall prevention is active. After release of the mechanical brake, the output current is retained, and the actual speed of the machinery changes in sync with the output frequency.
This setting can prevent the load from falling, thus improving the response of the inching operation.



Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 24. 3 Detecting the stall time during power running to trip

<F452: Stall detection time during power running>
<F441: Power running torque limit level 1>
<F601: Stall prevention level 1>



■ Function

This function is one of the functions to prevent lifting gear from falling. If stall prevention operation occurs in succession, this function judges that the motor has stalled to trip it.

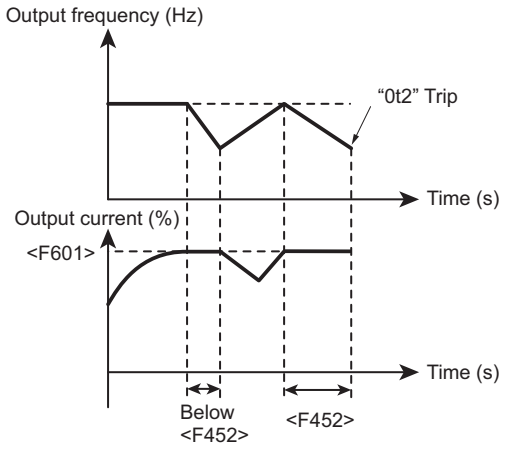
■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F452	Stall detection time during power running	0.00-10.00	s	0.00
F441	Power running torque limit level 1	0.0-249.9 250.0: Disabled	%	250.0
F601	Stall prevention level 1	10-200 (HD) 10-160 (ND)	%	150(HD) 120(ND)

6

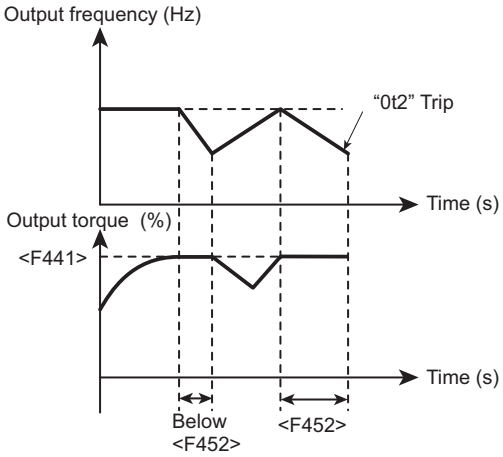
■ Setting method

1) In case of overcurrent stall



If, during power running, the output current reaches the value for <F601: Stall prevention level 1> or more, and continues for the period of time set for <F452: Stall detection time during power running>, the trip "Ot2" will occur.

2) In case of torque limit



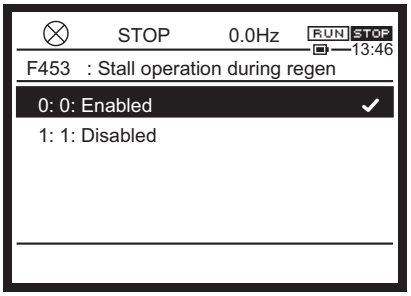
If, during power running, the output torque reaches the value for <F441: Power running torque limit level 1> or more, and continues for the period of time set for <F452: Stall detection time during power running>, the trip "Ot2" will occur. In case F452=0, this function is not activated (Ot2 trip does not occur).

6

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 24. 4 Selecting stall operation during regeneration

<F453: Stall operation during regen>



■ Function

This function is one of the functions to prevent the lifting gear from being displaced at stop. If current stall prevention gets active during regeneration of controlled stop, there may be a mismatch at stop. Set to inhibit only the stall prevention of current.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F453	Stall operation during regen	0: Enabled 1: Disabled	0

■ Selecting a setting value

To inhibit the stall prevention of current during regeneration of controlled stop, set <F453: Stall operation during regen> to "1".

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 25 Torque control

For details of switching to torque control, refer to Torque control (E6582106).

6. 25. 1 Setting external torque commands

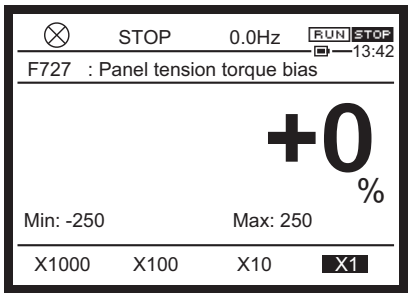
<F420: Torque command select>
<F421: Torque command filter>
<F435: Rotation direction limit during torque control>
<F455: Torque command polarity at Rev>
<F725: Panel torque command>

6. 25. 2 Speed limit during torque control

<F425: Fwd speed limit input>
<F426: Fwd speed limit level>
<F427: Rev speed limit input>
<F428: Rev speed limit level>
<F430: Speed limit center value input select>
<F431: Speed limit center value>
<F432: Speed limit band>

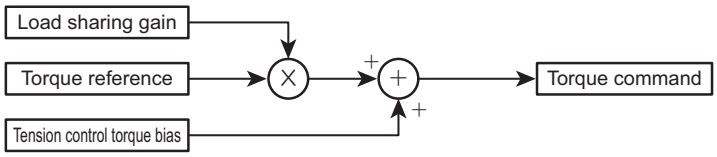
6. 25. 3 Selecting tension control torque bias input and load sharing gain input

<F423: Tension control torque bias input>
<F424: Load sharing gain input>
<F727: Panel tension torque bias>
<F728: Panel load sharing gain>



■ Function

These parameters are used to select tension control torque bias input and load sharing gain input.



■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F423	Tension control torque bias input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F727 13 - 19: - 20: Embedded Ethernet 21: RS485 communication connector 1 22: RS485 communication connector 2 23: Communication option		0
F424	Load sharing gain input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F728 13 - 19: - 20: Embedded Ethernet 21: RS485 communication connector 1 22: RS485 communication connector 2 23: Communication option		0
F727	Panel tension torque bias	-250 to +250	%	0
F728	Panel load sharing gain	0 - 250	%	100

■ Setting example

Select destination of tension control torque bias input and load sharing gain input.

When setting with input of 0 to 10 Vdc to terminal [RR]

Set <F423: Tension control torque bias input> = "1" or <F424: Load sharing gain input> = "1".

When setting with input of -10 to +10 Vdc to terminal [RX]

Set <F423: Tension control torque bias input> = "2" or <F424: Load sharing gain input> = "2".

When setting with input of 4 to 20 mAdc to terminal [II]

Set <F423: Tension control torque bias input> = "3" or <F424: Load sharing gain input> = "3".

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 26 Adjusting current and speed control gain

6. 26. 1 Setting current and speed control gain

<F458: Current control response>
<F459: Load inertia ratio>
<F460: Speed control response 1>
<F461: Speed control stabilization coefficient 1>
<F462: Speed reference filter coefficient 1>
<F463: Speed control response 2>
<F464: Speed control stabilization coefficient 2>
<F465: Speed reference filter coefficient 2>
<F466: Speed control response switching frequency>

For details, refer to "Current and Speed Control Gain Adjustment Method" manual (E6582136).

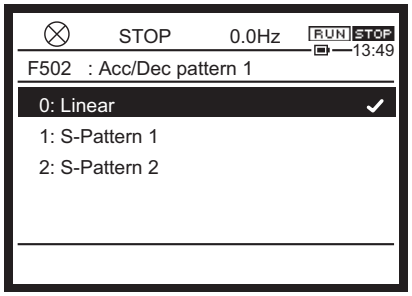
6. 26. 2 Setting the over modulation ratio

<F495: Over modulation ratio>

6. 27 Switching multiple acceleration/ deceleration

6. 27. 1 Setting Acc/Dec patterns

<F502: Acc/Dec pattern 1>
<F506: S-Pattern range at Acc start>
<F507: S-Pattern range at Acc completion>
<F508: S-Pattern range at Dec completion>
<F509: S-Pattern range at Dec start>



■ Function

You can select acceleration/deceleration patterns suitable for the purpose.

6

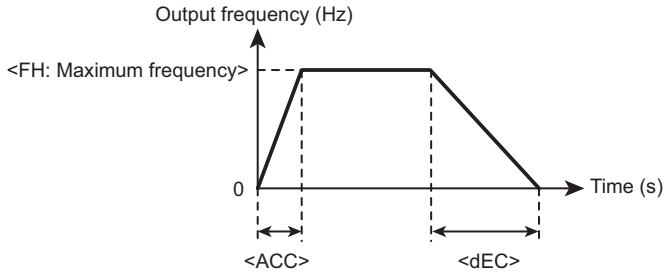
■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F502	Acc/Dec pattern 1	0: Linear 1: S-Pattern 1 2: S-Pattern 2		0
F506	S-Pattern range at Acc start	0-50	%	10
F507	S-Pattern range at Acc completion	0-50	%	10
F508	S-Pattern range at Dec completion	0-50	%	10
F509	S-Pattern range at Dec start	0-50	%	10

■ How to select the setting value for <F502>

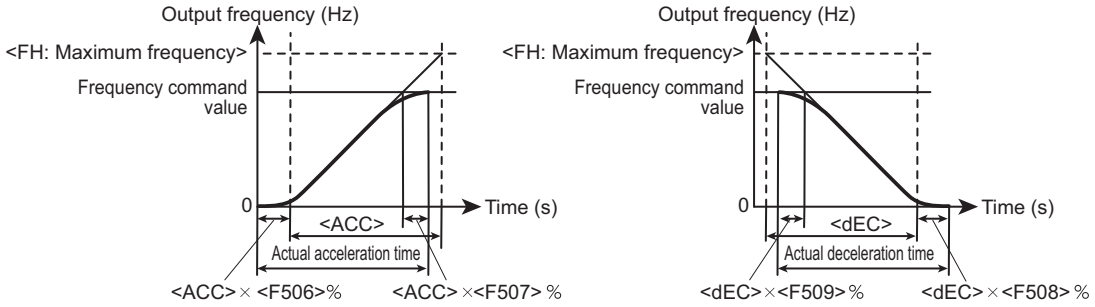
0: Linear pattern

This is linear acceleration and deceleration, and is a normal Acc/Dec pattern.
Normally, you can use this setting for operation.



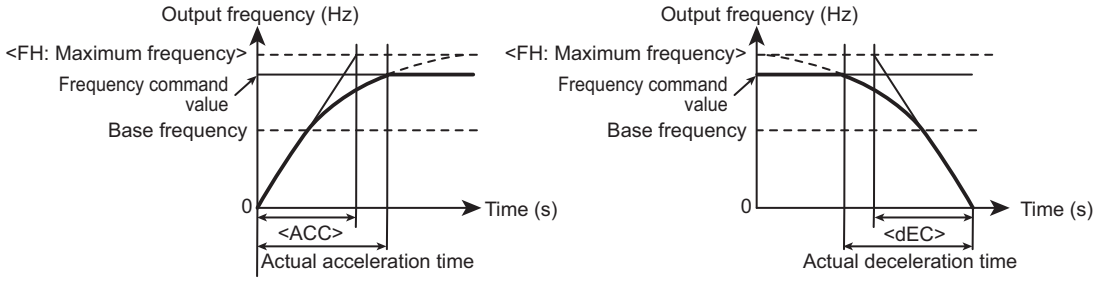
1: S-Pattern 1

The S-Pattern Acc/Dec 1 is selected to minimize the shock at acceleration/deceleration. This is suitable for pneumatic transport machines, etc.



2: S-Pattern 2

For the S-Pattern ACC/DEC 2, the motor accelerating torque accelerates in the small demagnetizing region. This is suitable for high-speed spindle operation, etc.

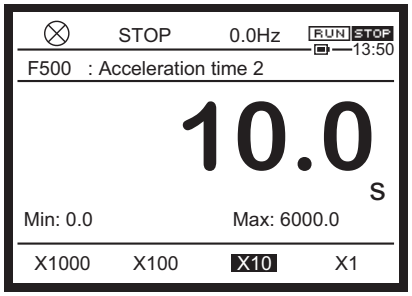


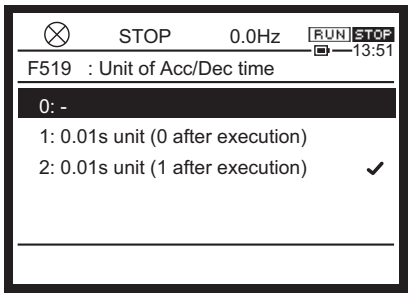
Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 27. 2 Switching four types of acceleration/deceleration

<F500: Acceleration time 2>
<F501: Deceleration time 2>
<F503: Acc/Dec pattern 2>
<F504: Panel Acc/Dec select>
<F505: Acc/Dec switching frequency 1>
<F510: Acceleration time 3>
<F511: Deceleration time 3>
<F512: Acc/Dec pattern 3>
<F513: Acc/Dec switching frequency 2>
<F514: Acceleration time 4>
<F515: Deceleration time 4>
<F516: Acc/Dec pattern 4>
<F517: Acc/Dec switching frequency 3>
<F519: Unit of Acc/Dec time>





6

■ Function

You can set four types of options for each acceleration and deceleration time.
There are three setting methods to choose from four types.

1) **Selection by the parameters**
2) **Switching by frequencies**
3) **Switching by the terminals**

■ Setting of parameters

Title	Parameter name	Adjustment range	Unit	Default setting
ACC	Acceleration time 1	0.0 - 6000 (600.0)	s	*1
dEC	Deceleration time 1	0.0 - 6000 (600.0)	s	*1
F500	Acceleration time 2	0.0 - 6000 (600.0)	s	*1
F501	Deceleration time 2	0.0 - 6000 (600.0)	s	*1
F510	Acceleration time 3	0.0 - 6000 (600.0)	s	*1
F511	Deceleration time 3	0.0 - 6000 (600.0)	s	*1
F514	Acceleration time 4	0.0 - 6000 (600.0)	s	*1
F515	Deceleration time 4	0.0 - 6000 (600.0)	s	*1
F519	Unit of Acc/Dec time	0: - 1: 0.01 s unit (0 after execution) 2: 0.1 s unit (0 after execution)	-	0

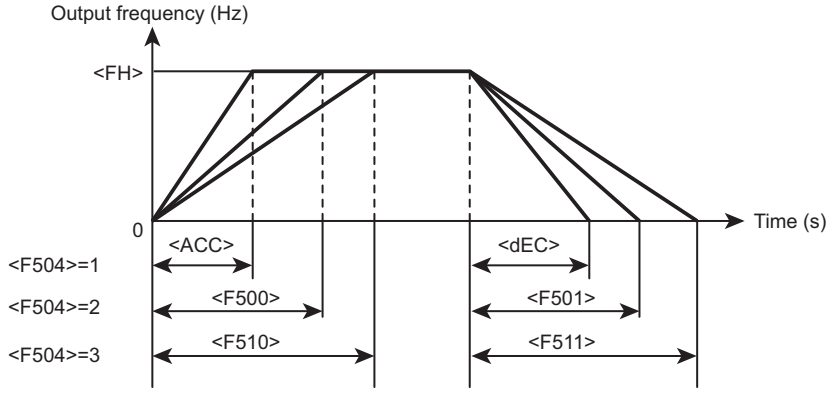
*1 Depending on capacity. For details, refer to [11. 6].

In default setting, the acceleration/deceleration time is set in the increment unit of 0.1 second.
When you set <F519: Unit of Acc/Dec time> to "1", you can change the increment unit for the acceleration/deceleration time to 0.01 second. (After setting <F519>, the unit returns to 0.)

■ How to use the parameters

1) Selection by the parameters

Title	Parameter name	Adjustment range	Unit	Default setting
F504	Panel Acc/Dec select	1: Acc/Dec 1 2: Acc/Dec 2 3: Acc/Dec 3 4: Acc/Dec 4		1

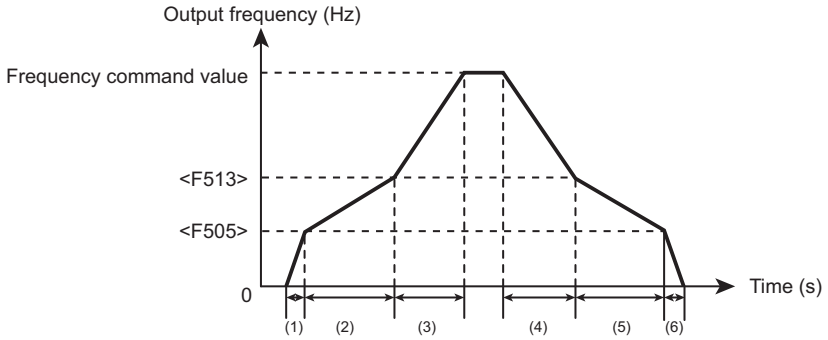


Set run command to panel run. Set <CMOd: Run command select> to "1: Operation panel, Extension panel".
At default setting, "Acc/Dec 1" is set, and <ACC: Acceleration time 1> and <dEC: Deceleration time 1> is enabled.
When using "Acc/Dec 2" to "Acc/Dec 4", set <F504: Panel Acc/Dec select>.

2) Switching by frequencies

Title	Parameter name	Adjustment range	Unit	Default setting
F505	Acc/Dec switching frequency 1	0.0: Disabled 0.1-UL	Hz	0.0
F513	Acc/Dec switching frequency 2	0.0: Disabled 0.1-UL	Hz	0.0
F517	Acc/Dec switching frequency 3	0.0: Disabled 0.1-UL	Hz	0.0

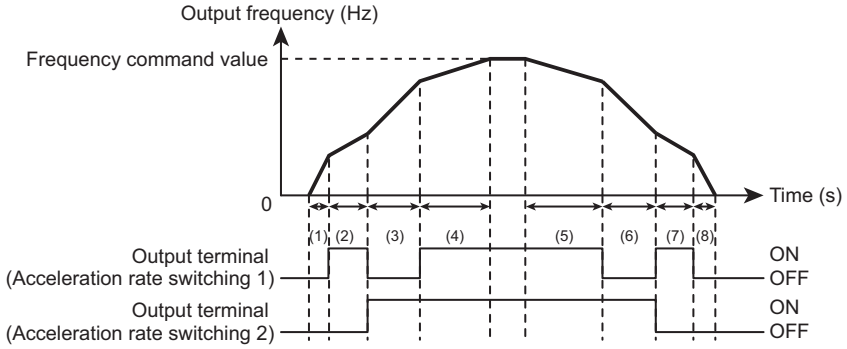
The acceleration/deceleration time is automatically switched according to the set frequency.
Even if the order of the switching frequencies is changed, it will be switched between Acc/Dec 1 and 2, Acc/Dec 2 and 3, and then Acc/Dec 3 and 4 in the order of the increasing frequencies.
For example, if <F505: Acc/Dec switching frequency 1> is higher than <F513: Acc/Dec switching frequency 2>, Acc/Dec 1 is selected to <F513>, and Acc/Dec 2 to <F505>.



(1) Accelerate by the inclination of the acceleration time <ACC>
(2) Accelerate by the inclination of the acceleration time <F500>
(3) Accelerate by the inclination of the acceleration time <F510>
(4) Decelerate by the inclination of the deceleration time <F511>
(5) Decelerate by the inclination of the deceleration time <F501>
(6) Decelerate by the inclination of the deceleration time <dEC>

3) Switching by the terminals

The acceleration/deceleration time is switched by signals to terminals.



(1) Accelerate by the inclination of the acceleration time <ACC>
(2) Accelerate by the inclination of the acceleration time <F500>
(3) Accelerate by the inclination of the acceleration time <F510>
(4) Accelerate by the inclination of the acceleration time <F514>
(5) Decelerate by the inclination of the deceleration time <F515>
(6) Decelerate by the inclination of the deceleration time <F511>
(7) Decelerate by the inclination of the deceleration time <F501>
(8) Decelerate by the inclination of the deceleration time <dEC>

Set run command to terminal run. Set <CMOd: Run command select> to "0: Terminal".
Patterns 1 - 4 can be switched by turning the two input terminals ON/OFF.
Assign "32: Stall prevention switching/Torque limit switching 1" and "34: Torque limit switching 2" to the two unused input terminals.

	24: Acc/Dec switching 1	26: Acc/Dec switching 2
Acc/Dec 1	OFF	OFF
Acc/Dec 2	ON	OFF
Acc/Dec 3	OFF	ON
Acc/Dec 4	ON	ON

■ Acc/Dec patterns

You can individually select Acc/Dec patterns by selecting Acc/Dec 1, 2, 3 or 4.

Title	Parameter name	Adjustment range	Unit	Default setting
F502	Acc/Dec pattern 1	0: Linear 1: S-Pattern 1 2: S-Pattern 2		0
F503	Acc/Dec pattern 2			0
F512	Acc/Dec pattern 3			0
F516	Acc/Dec pattern 4			0
F506	S-Pattern range at Acc start	0-50	%	10
F507	S-Pattern range at Acc completion	0-50	%	10
F508	S-Pattern range at Dec completion	0-50	%	10
F509	S-Pattern range at Dec start	0-50	%	10

For details on the Acc/Dec patterns, refer to [6. 27. 1].
Parameters to determine S-Pattern ranges of "1: S-Pattern 1", <F506><F507><F508><F509>, is common to Acc/Dec patterns 1 - 4.

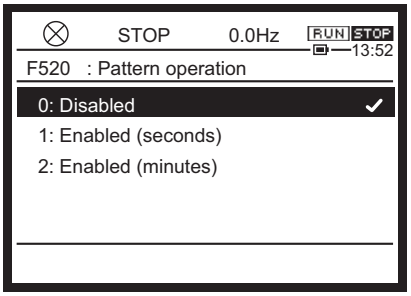
6

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 28 Pattern operation

<F520: Pattern operation>
<F521: Pattern operation continue select>
<F522: Pattern 1 repeat number>
<F523: Pattern 1 select 1> to <F530: Pattern 1 select 8>
<F531: Pattern 2 repeat number>
<F532: Pattern 2 select 1> to <F539: Pattern 2 select 8>
<F540: Operation time (1-speed)> to <F554: Operation time (15-speed)>



■ Function

You can perform terminal run according to up to 30 types (15 types x 2 patterns) of operation frequencies, operation time, and acceleration/deceleration time that were set in advance.
Pattern operation switching, and Run/Stop are all input from the terminals.

■ Parameter setting

6

Title	Parameter name	Adjustment range	Unit	Default setting
F520	Pattern operation	0: Disabled 1: Enabled (seconds) 2: Enabled (minutes)		0
F521	Pattern operation continue select	0: Reset after stop 1: Continue after stop		0
F522	Pattern 1 repeat number	1-254 255: Continuous	Times	1
F523-F530	Pattern 1 select 1-8	0: Skip 1: Sr1 2: Sr2 3: Sr3 4: Sr4 5: Sr5 6: Sr6 7: Sr7 8: F287 9: F288 10: F289 11: F290 12: F291 13: F292 14: F293 15: F294		0
F531	Pattern 2 repeat number	1-254 255: Continuous	Times	1
F532-F539	Pattern 2 select 1-8	Same as <F523>		0
F540-F554	Operation time (1 to 15-speed)	0.1-5999 6000: Continuous	The unit is set at <F 520>.	5.0

Title	Parameter name	Adjustment range	Unit	Default setting
F560	Preset speed operation style	0: Frequency only 1: With function	-	0
F561 - F575	Operation function (1-speed) to Operation function (15-speed)	0: Fwd run +1: Rev run +2: Acc/Dec switching signal 1 +4: Acc/Dec switching signal 2 +8: V/f switching signal 1 +16: V/f switching signal 2 +32: Torque limit switching signal 1 +64: Torque limit switching signal 2		0

When auto-restart after momentary stop is set, time is also added to the pattern operation time during catch on fly. Therefore, the actual operation time may be shorter than the setting time.

■ How to use the parameters

The basic operation method is as follows:

1) Set <F520: Pattern operation> to "1: Enabled (seconds)" or "2: Enabled (minutes)".

This parameter is used to select the time unit (seconds/minutes) for <F540: Operation time (1-speed)> to <F554: Operation time (15-speed)>.

2) Set the frequency to operate.

To set the frequencies to be used for pattern operations, do so at the following parameters related to preset-speed frequencies, not at specific parameters.

- <Sr1: Preset speed 1> to <Sr7: Preset speed 7>
- <F287: Preset speed 8> to <F294: Preset speed 15>

3) To attach function to the frequency to operate, set <F560: Preset speed operation style> to "1: With function".

The function can be set to each frequency to operate. Set required functions, e.g. Fwd, Rev, Acc/Dec switching 1, 2, V/f switching 1, 2, to the following parameters.

- <F561: Operation function (1-speed)> through <F575: Operation function (15-speed)>

For details, refer to [5. 3. 7].

4) Set the required operation time at <F540: Operation time (1-speed)> to <F554: Operation time (15-speed)> for every frequency to operate. Select the unit (seconds/minutes) at <F520: Acc/Dec switching frequency 1>.

5) Set the order of frequency to operate.

Three parameter setting methods are provided.

- Select pattern operation mode at <F521: Pattern operation continue select>.

0: Reset after stop

Operation is resumed after the pattern operations are reset by stop or switching operation.

1: Continue after stop

Pattern operations are started by stop or switching operation. After completion of a routine, operation stops or the next routine is started.

- Select pattern groups to set the order of frequencies to operate.
  - <F522: Pattern 1 repeat number>
  - <F523: Pattern 1 select 1> to <F530: Pattern 1 select 8>
  - <F531: Pattern 2 repeat number>
  - <F532: Pattern 2 select 1> to <F539: Pattern 2 select 8>

- You can set parameter groups to operate by turning the input terminal ON/OFF.
  Assign "38: Pattern operation 1" and "40: Pattern operation 2" to the two unused input terminals.
  Also, assigning "42: Pattern operation continuation" and "44: Pattern operation start" to other input terminals allows you can select operation method by turning them ON/OFF.

6) Display status of pattern operation in [Monitor mode].

The status of the pattern operation can be checked in [Monitor mode]. Set the monitor numbers shown in the following table to <F711: Monitor mode 1 display> to <F718: Monitor mode 8 display>.

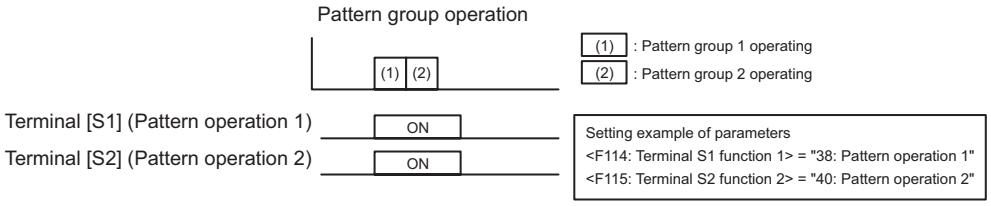
Monitor number	Operation status	Example of display	Example of content
66	Pattern operation group number	P1.0	Indicates Pattern group 1.
67	Pattern operation remaining cycle number	n123	Indicates that the 123rd pattern is being performed.
68	Pattern operation preset speed number	F1	Indicates that 1-speed frequency is used to operate.
69	Pattern operation remaining time	123.4	Indicates that the current pattern will be ended in 123.4 seconds.

■ Pattern operation switching output

Signals can be output when all pattern operations are ended.
Assign "36: Pattern operation switching" to an output terminal.
Output is turned OFF when run command is off and when the pattern operation selection is changed.

■ Notes for pattern operation

- You need to input pattern operation group selection from the terminal.
- When all input terminals with pattern operation assigned are turned OFF, and after pattern operation is ended, normal operation will start.
- When multiple group numbers are simultaneously input, operations will be performed in the order of the increasing group numbers, to automatically change to the next group. In this case, it may take approximately 0.06 second (per pattern) to search the patterns.
- Turn pattern operation 1 or 2 ON, wait for 10 ms or more to elapse, then turn ON the run command. Turning the run command ON early may cause operation with normal output frequency instead of pattern operation.
- <F964: Preset speed 16> to <F979: Preset speed 31> cannot be set to pattern operation.



Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 29 Shock monitoring function

<F590: Shock monitoring>
<F591: Shock monitoring trip>
<F592: Shock monitoring detection>
<F593: Shock monitoring detection level>
<F595: Shock monitoring detection time>
<F596: Shock monitoring detection hysteresis>
<F597: Shock monitoring dtection wait time>
<F598: Shock monitoring detection condition>

For details, refer to Shock Monitoring Function Instruction Manual (E6582098).

6. 30 Setting the protection functions

Set the protection functions against electric thermal, current stall prevention operation, input/output phase failure, short circuit, ground fault, overtorque, undervoltage, analog signal disconnection, etc. for safety operation.

6. 30. 1 Setting the motor electronic thermal protection

<F606: Motor overload reduction frequency threshold>
<F607: Motor overload time>
<F631: Inverter overload detection>
<F632: Electronic thermal memory target>
<F657: Overload alarm level>

For details on the motor electronic thermal functions, refer to [5. 2. 5].

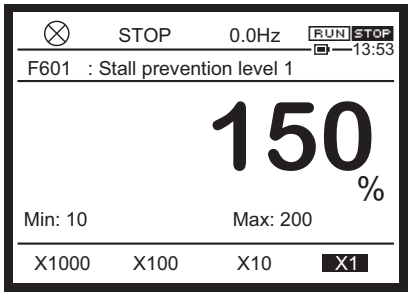
6. 30. 2 Setting overcurrent stall

⚠ CAUTION

Prohibited

- Do not set the stall prevention level parameters (F601 and F185) extremely low.
  If the stall prevention level parameters (F601 and F185) are set at or below the motor no-load current, the stall preventive function will be always enabled and increase the frequency when it judges that regenerative braking is taking place.
  Do not set the stall prevention level parameters (F601 and F185) at 30% or less under normal use conditions.

<F601: Stall prevention level 1>
<F185: Stall prevention level 2>



6

■ Function

If the current exceeding the level set at Stall prevention level 1 or 2 is flowed, stall prevention operation will be enabled to lower the output frequencies.
Setting the output frequency low lowers output current of fans and pumps, which prevents overcurrent trip.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F601	Stall prevention level 1	10-200 (HD) 10-160 (ND)	%	*1
F185	Stall prevention level 2			

*1 Depending on capacity. For details, refer to [11. 6].
In case F601=199, 200(or 159, 160), stall prevention control is not activated.

■ How to set the parameter

100% reference is the inverter rated current.
To switch <F601: Stall prevention level 1> between <F185: Stall prevention level 2>, use signals to input terminal. Assign "32: Stall prevention switching/Torque limit switching 1" to the unused input terminal.
For details, refer to [7. 2. 1].

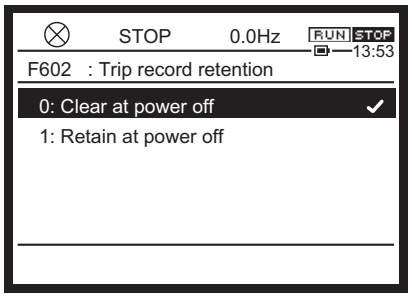
■ Display during the stall prevention operation

If the current exceeding the stall prevention level is about to flow, the output frequency will change. At this time, the letter "C" will blink.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 30. 3 Retaining trip types

<F602: Trip record retention>



■ Function

Trip can be reset by turning power off, but you can set to retain details about trip occurrence even when power is turned off.

After power off, the saved trip type will be displayed after turning power on again. If trip factor is remaining, however, the trip will occur again.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F602	Trip record retention	0: Clear at power off 1: Retain at power off	0

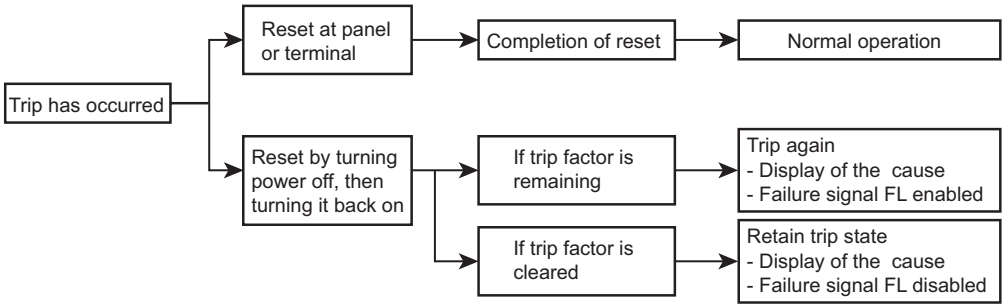
■ Selecting a setting value

0: Clear at power off

Reset the trip at power off. Trip type will not be retained after turning power on again.

1: Retain at power off

The following shows how the inverter operates after power off.

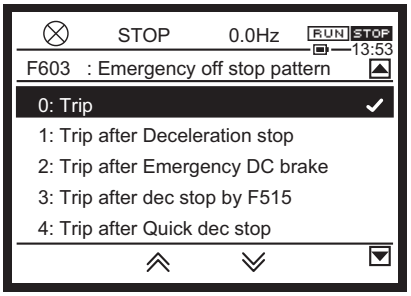


Memo	• The causes of the last eight trips can be displayed in [Monitor mode] even if the trip record retention is set. For details, refer to [8. 1. 1]. • If the power is turned on again, the data at trip in [Monitor mode] will not be retained. Check the data on the details monitor for the past trip history. For details, refer to [8. 1. 2]. • Even if the power is turned ON during retry, a trip record will be retained.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 30. 4 Emergency off

<F603: Emergency off stop pattern>
<F604: Emergency DC braking time>



■ Function

Set the stop pattern for emergency off
At the time of emergency off, a trip occurs. The trip display is "E".

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F603	Emergency off stop pattern	0: Trip 1: Trip after Deceleration stop 2: Trip after Emergency DC braking 3: Trip after deceleration stop by F515 4: Trip after Quick deceleration stop 5: Trip after Dynamic quick deceleration stop		0
F604	Emergency DC braking time	0.0-20.0	s	1.0
F251	DC braking current	0 - 100	%	50
F515	Deceleration time 4	0.0-6000	s	*1

*1 Depending on capacity. For details, refer to [11. 6].

■ Select the setting value for <F603: Emergency off stop pattern>

0: Trip
A trip occurs by emergency off command. The motor performs coast stop.

1: Trip after Deceleration stop
A trip occurs after deceleration stop is performed for the period of time set for <dEC: Deceleration time 1>.

2: Trip after Emergency DC braking
The inverter stops after emergency DC braking, and a trip occurs.
Set <F251: DC braking current> and <F604: Emergency DC braking time>.

3: Trip after deceleration stop by <F515>
A trip occurs after deceleration stop is performed for the period of time set for <F515: Deceleration time 4>.
Set <F515>.

Use this parameter when you want to set deceleration time for normal operation and emergency off in different time.

4: Trip after Quick deceleration stop
After quick deceleration is performed, a trip occurs after stop.
In quick deceleration stop, the motor can decelerate more quickly than normal deceleration by increasing the voltage to the motor (over-excitation control) to increase the energy consumed by the motor when the voltage reaches the overvoltage limit operation level during deceleration.

5: Trip after Dynamic quick deceleration stop
A trip occurs after Dynamic quick deceleration stop.
In Dynamic quick deceleration, the motor may be decelerated more quickly than quick deceleration control by increasing the voltage to the motor (over-excitation control) to increase the energy consumed by the motor as soon as the motor starts decelerating.

■ How to use

1) Emergency off via external signal

Emergency off can be performed via a signal to a terminal. Assign "20: Emergency off" to the input terminal. Select how to stop the operation in <F603>.

Emergency off from the terminals is always given priority even during panel run.

2) Emergency off from the operation panel

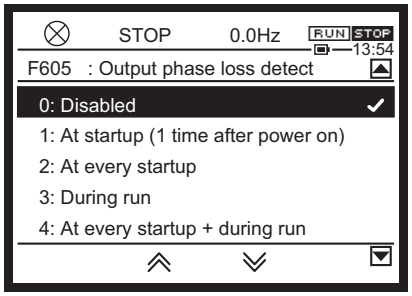
Emergency off can be performed on the operation panel when panel run is not performed.
To perform emergency off, press the [STOP] key on the operation panel twice.
For details on the operation, refer to [3. 2. 3].

The inverter cannot be reset the trip while the emergency off signal is being input to the input terminal. Reset a trip after releasing the signal.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 5 Output phase loss detection

<F605: Output phase loss detection>



■ Function

When the phase loss on the inverter output side is detected, and after a certain period of time passed, a trip occurs. The trip display is "EPHO".

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F605	Output phase loss detection	0: Disabled 1: At startup (only one time after power on) 2: At every startup 3: During run 4: At every startup + during run 5: Output shut off detection	0

■ How to select a setting value

0: Disabled

A trip does not occur. (Failure signal FL disabled)

1: At startup (only one time after power on)

After the power is turned on, output phase loss is detected at the first startup, and a trip occurs after a certain period of time passed. (Failure signal FL enabled)

2: At every startup

At every startup, output phase loss is detected, and a trip occurs after a certain period of time passed. (Failure signal FL enabled)

3: During run

A phase loss is detected during run, and a trip occurs after a certain period of time passed. (Failure signal FL enabled)

4: At every startup + during run

At every startup and during run, a phase loss is detected, and a trip occurs after a certain period of time passed. (Failure signal FL enabled)

5: Output shut off detection

In case you release between the motor and inverter for commercial power supply, restart the operation with low-voltage by controlling impact after the connection at the output side is off and connect it again. (Failure signal FL disabled)

Detection is not performed at auto-restart.

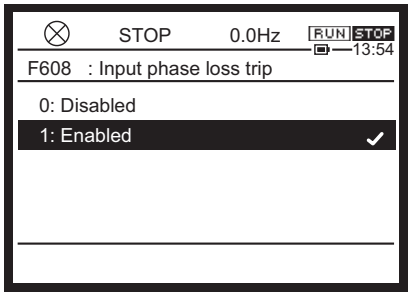
An output phase loss is detected at auto-tuning regardless of the setting for <F605: Output phase loss detection>.

Memo	• If <Pt: V/f Pattern> = "5" and "6" is set, 3-phase loss at <F605>="3", or "4", and <F605>="5" will be disabled. • For special motors such as high-speed motors, detection error may occur.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 6 Input phase loss detection

<F608: Input phase loss trip>



■ Function

If the phase loss on the inverter input side is detected and an abnormal ripple voltage persists in the power circuit capacitor for a certain period of time, a trip occurs. The trip display is "EPHI".

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F608	Input phase loss trip	0: Disabled 1: Enabled	1

6

■ Difference between the settings

0: Disabled

A trip does not occur. (Failure signal FL disabled)

1: Enabled

If the phase loss is detected during run and an abnormal ripple voltage persists in the power circuit capacitor for a certain period of time, a trip occurs. (Failure signal FL enabled)

Important

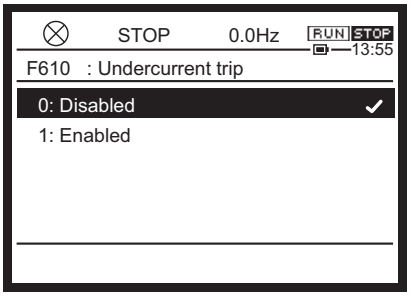
- In case of light-load operation or if the motor capacity is too small for the inverter capacity, input phase loss may not be detected.
- If the power supply capacity is too large for the inverter capacity (500 kVA or more, and 10 times or more), detection error may occur. In this case, install an input reactor.
- When <F608> = "0: Disabled", if heavy-load operation continues in the phase loss status on the input side, the power circuit capacitor of inverter may be damaged.
- To operate the inverter with DC input, set <F608: Input phase loss trip> to "0: Disabled".
- To operate the inverter with DC input with size A4 to A6, set <F640: DC supply input> to "1". In this case input phase loss detection is disabled independent to F608 setting.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 30. 7 Undercurrent detection

<F610: Undercurrent trip>
<F609: Undercurrent detection hysteresis>
<F611: Undercurrent detection level>
<F612: Undercurrent detection time>



■ Function

Trips or outputs an alarm when the output current falls to the value set in <F611: Undercurrent detection level> or less for the time specified in <F612: Undercurrent detection time>.
Hysteresis can be set by <F609: Undercurrent detection hysteresis> The trip display is "UC".

■ Parameter setting

6

Title	Parameter name	Adjustment range	Unit	Default setting
F610	Undercurrent trip	0: Disabled 1: Enabled		0
F609	Undercurrent detection hysteresis	1 - 20	%	10
F611	Undercurrent detection level	0 - 150	%	0
F612	Undercurrent detection time	0 - 255	s	0

■ Difference depending on the setting of <F610: Undercurrent trip>

0: Disabled

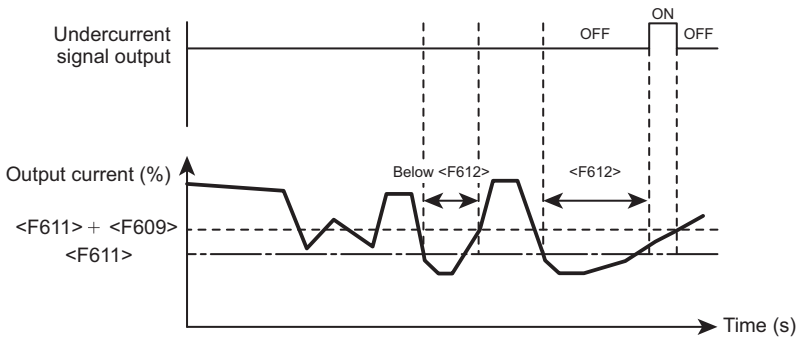
A trip does not occur. (Failure signal FL disabled)
Undercurrent (UC) alarm can be output from the output terminal.
Assign "26: Undercurrent (UC) alarm" to an unused output terminal.

1: Enabled

When a current level set in <F611: Undercurrent detection level> or less is detected for the period of time set in <F612: Undercurrent detection time> or more, the inverter trips and "UC" is displayed. (Failure signal FL enabled)

■ Setting example

Set "26: Undercurrent (UC) alarm" to the unused output terminal.
In the case of <F610: Undercurrent trip> = "0: Disabled", the signal can be output from the output terminal as follows.

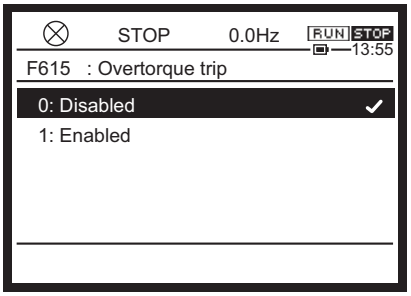


In the case of <F610: Undercurrent trip> = "1: Enabled", when a current is <F611: Undercurrent detection level> or less for the period of time specified by <F612: Undercurrent detection time>, the inverter trips.
After tripping, undercurrent (UC) alarm signal remains ON.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 8 Overtorque detection

<F615: Overtorque trip>
<F616: Overtorque detection level during power running>
<F617: Overtorque detection level during regen>
<F618: Overtorque detection time>
<F619: Overtorque detection hysteresis>



■ Function

The power running torque value is <F616: Overtorque detection level during power running> or more, or the regen torque value is <F617: Overtorque detection level during regen> or more, and remains over for the time specified by <F618: Overtorque detection time>, tripping or alarm can be output. You can enable or disable the trip setting by <F615: Overtorque trip>. The trip display is "Ot".

6

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F615	Overtorque trip	0: Disabled 1: Enabled		0
F616	Overtorque detection level during power running	0: Disabled *1 1 - 320	%	150
F617	Overtorque detection level during regen	0: Disabled *1 1 - 320	%	150
F618	Overtorque detection time	0.0-10.0 *2	s	0.5
F619	Overtorque detection hysteresis	0 - 100	%	10

*1 You can output an alarm set regardless of the <F615> setting. Trip or alarm cannot be output when <F616> or <F617> is set to "0: Disabled".

*2 <F618>= "0.0" seconds is the shortest time detected on control.

■ Difference depending on the setting of <F615: Overtorque trip>

0: Disabled

A trip does not occur. (Failure signal FL disabled)

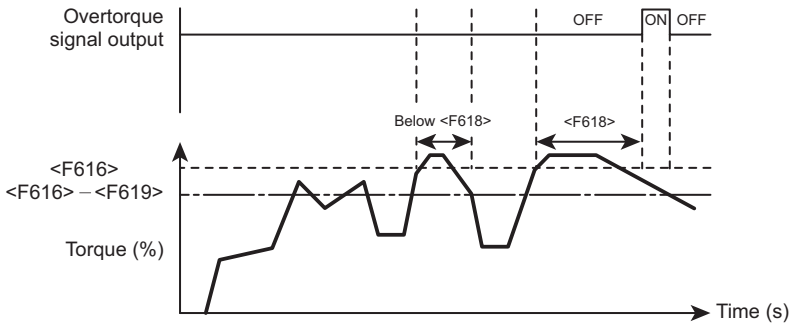
Overtorque (OT) alarm can be output when the power running torque value is <F616> or more, or the regen torque value is <F617> or more, is detected for the period of time specified by <F618>.

1: Enabled

The inverter trips when the power running torque value is <F616> or more, or the regen torque value is <F617> or more, is detected over the period of time specified by <F618> or longer. Overtorque (OT) alarm can also be output from the output terminal. (Failure signal FL enabled)

■ Setting example

Assign "28: Overtorque (OT) alarm" to the unused output terminal.
In the case of <F615: Overtorque trip> = "0: Disabled", the alarm functions as follows.



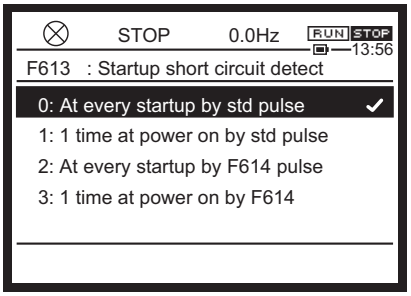
When <F615: Overtorque trip> = "1: Enabled", the inverter trips if overtorque is detected for the period of time specified by <F618: Overtorque detection time>.
After that, overtorque (OT) alarm remains ON.

6

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 9 Short circuit detection at start

<F613: Short circuit detection at start>
<F614: Pulse width of short circuit detection at start>



■ Function

Inverter detects inverter output short-circuit at the start.
Normally, short-circuit can be detected in the length of standard pulse (50 μs). When operating a low-impedance motor, such as a high-speed motor, however, select the short-time pulse by <F614:Pulse width of short circuit detection at start> to prevent an error detection.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F613	Short circuit detection at start	0: At every startup by standard pulse 1: Only one time after power on by standard pulse 2: At every startup by F614 setting pulse 3: Only one time after power on by F614 setting pulse		0
F614	Pulse width of short circuit detection at start	0: No short circuit detection at start in case F613="2", or "3" 1 - 50	 μs	25

■ Setting the <F613: Short circuit detection at start>

0: At every startup by standard pulse
Detection is executed in the length of standard pulse every time at the start of inverter operation.

1: Only one time after power on by standard pulse
Detection is executed in the length of standard pulse only during the first start-up at power on or after resetting.

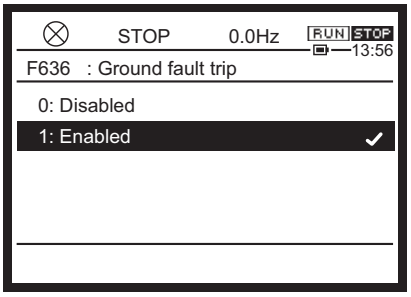
2: At every startup by F614 setting pulse
Detection is executed in the length of short-time pulse specified by <F614: Pulse width of short circuit detection at start> every time at the start of inverter operation.

3: Only one time after power on by F614 setting pulse
Detection is executed in the length of short-time pulse specified by <F614: Pulse width of short circuit detection at start> only one time during the first start-up at power on or after resetting.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 10 Ground fault detection

<F636: Ground fault trip>



■ Function

Inverter detects the ground fault.
If a ground fault occurs in the inverter unit or output side, the inverter will trip. The trip display is "EF2".

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F636	Ground fault trip	0: Disabled 1: Enabled	1

■ How to select a setting value

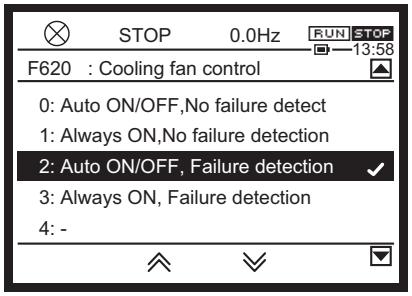
0: Disabled
A trip does not occur. (Failure signal FL disabled)
In this case, installation of a ground detector, such as a ground relay, is recommended.

1: Enabled
Ground fault detection is enabled.
The inverter will trip when ground fault is detected. (Failure signal FL enabled)

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 11 Cooling fan control

<F620: Cooling fan control>



■ Function

The cooling fan run only when the ambient temperature is high and during run. This way, the service life of cooling fan can be extended compared to when keep running the cooling fan while the power is ON. It is also able to trip when the capability of the cooling fan falls below a certain level. The trip display is "E-42".

■ Parameter setting

6

Title	Parameter name	Adjustment range	Default setting
F620	Cooling fan control	0: Auto ON/OFF, No failure detection 1: Always ON, No failure detection 2: Auto ON/OFF, Failure detection 3: Always ON, Failure detection 4 - 7: -	2

*When the motor speed of the cooling fan is lower than a certain level, cooling fan fault alarm can be output from the output terminal regardless of the setting in <F620>.

■ Selecting a setting value

0: Auto ON/OFF, No failure detection

Cooling fan is automatically controlled. Cooling fan operates only when the ambient temperature is high and during run.

Cooling fan operates automatically, if the ambient temperature is high, even when the inverter is in a stop.

1: Always ON, No failure detection

Cooling fan runs all the time when the inverter is on.

Trip does not occur at the time of the cooling fan failure. (Failure signal FL disabled)

2: Auto ON/OFF, Failure detection

Cooling fan is automatically controlled. Cooling fan runs only when the ambient temperature is high and during operation.

When the motor speed of the cooling fan is lower than a certain level, a trip occurs. (Failure signal FL enabled)

3: Always ON, Failure detection

Cooling fan runs all the time when the inverter is on.

When the motor speed of the cooling fan is lower than a certain level, a trip occurs. (Failure signal FL enabled)

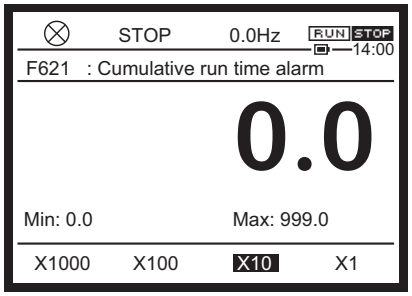
■ Output during cooling fan run

If you assign the function to the unused output terminal, cooling fan fault alarm can be output while the cooling fan is running.
"50: During cooling fan run"
"190: Cooling fan fault alarm"
If you set <F620: Cooling fan control> to "2" or "3", a trip occurs at the time of the cooling fan fault. The trip display is "E-42".

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 12 Cumulative run time alarm setting

<F621: Cumulative run time alarm>



■ Function

This parameter activates the alarm from the output terminal after the inverter's cumulative run time is <F621: Cumulative run time alarm> or more.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F621	Cumulative run time alarm	0.0 - 999.0	100 h	876.0

■ Signal output of cumulative run time alarm

Assign "56: Cumulative run time alarm" to the unused output terminal.

Memo

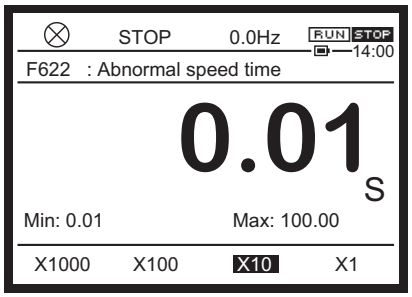
- Cumulative run time up to the present time can be confirmed in the [Monitor mode].
- Monitor value of the cumulative run time can be reset to 0 (zero) by selecting "5: Clear cumulative run time" in the default setting <tyP: Default setting>. For details, refer to [5. 2. 9].

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 13 Speed error (over speed) detection

<F622: Abnormal speed detection time>
<F623: Abnormal speed increase band>
<F624: Abnormal speed decrease band>



■ Function

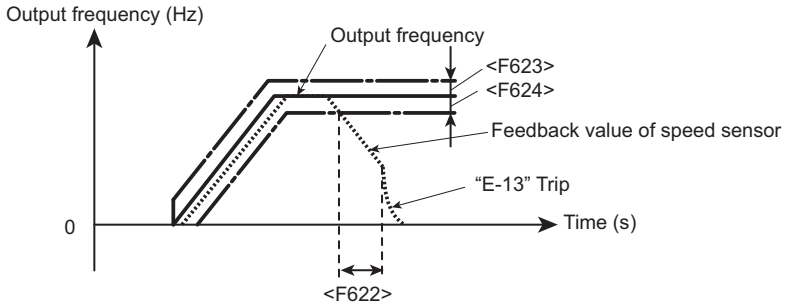
When operating without the PG feedback (<Pt: V/f Pattern> = "0" - "9"), if the rough speed exceeds the speed limit over the setting time, this parameter announces an error and outputs a failure.
When operating with the PG feedback (<Pt: V/f Pattern> = "10" or "11"), the parameter monitors the speed feedback value and a trip occurs when speed exceeds the speed limit over the setting time.
When output frequency > (<FH> +12 Hz) or > (<FH> + <vL>/10) at all <Pt>, a trip occurs.
The trip display is "E-13".

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F622	Abnormal speed detection time	0.01 - 100.0	s	0.01
F623	Abnormal speed increase band	0.00: Disabled 0.01 - 30.0	Hz	0.00
F624	Abnormal speed decrease band	0.00: Disabled 0.01 - 30.0	Hz	0.00

■ Guideline for the setting

If speed feedback (Estimated speed) > (Output frequency + <F623>) or speed feedback (Estimated speed) < (Output frequency - <F624>), and a certain period of time set with <F622: Abnormal speed detection time>, a trip occurs.
You can provide range for a detection level of a trip with a setting of <F623: Abnormal speed increase band> and <F624: Abnormal speed decrease band>
During torque control, if speed feedback (Estimated speed) > (Speed upper limit + <F623>) or > (Speed lower limit - <F624>) a certain period of time set with <F622: Abnormal speed detection time>, "E-13" trip occurs.



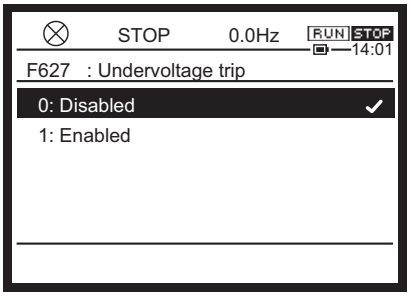
Memo

- When the setting value is 0 (zero), this function may not become activated properly while in the stall protection mode. To maintain this function, use of setting <F451: Acc/Dec operation after stall operation> = "1: Minimum time" is recommended. For details, refer to [6. 24. 2].

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 14 Undervoltage trip setting

<F627: Undervoltage trip>
<F625: Undervoltage detection level>
<F628: Undervoltage detection time>



■ Function

This parameter sets the action when undervoltage of the power circuit is detected.
When undervoltage is detected, it displays "MOFF" and stops. Alarm can be output from the output terminal.
If you want to trip, set by <F627: Undervoltage trip>. The trip display is "UP1".

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F627	Undervoltage trip	0: Disabled 1: Enabled		0
F625	Undervoltage detection level	50 - 79 80: Auto	%	80 *1
F628	Undervoltage detection time	0.01 - 10.00	s	0.03
F629	Regenerative power ride-through level	55 - 100	%	75

*1 100% reference of <F625> is 200 V (240V class), 400 V (480V class).

■ Detection level of undervoltage alarm "MOFF"

Exclude <F625: Undervoltage detection level> = "80: Auto"
The occurrence level of MOFF alarm is the setting value of <F625>. MOFF alarm will be cleared at the setting value of <F629: Regenerative power ride-through level>.

When <F625: Undervoltage detection level> = "80: Auto"
Both occurrence level and clear level of MOFF alarm is followed by the level specified by the internal setting.

■ Setting the <F627: Undervoltage trip>

0: Disabled
The inverter stops but does not trip. (Failure signal FL disabled)

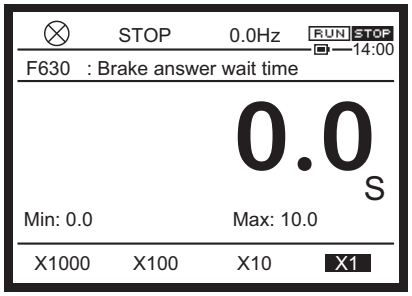
1: Enabled
The inverter trips after undervoltage is detected for the period of time set by <F628: Undervoltage detection time> or longer. The trip display is "UP1". (Failure FL enabled)

Memo	• While the inverter is stopped, undervoltage is not detected.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 30. 15 Brake answer waiting time setting

<F630: Brake answer wait time>



■ Function

This parameter can set the waiting time for the brake answer (reply) from the system. Input brake answer to the input terminal with "130: Brake answerback" is assigned.
After the operation start, when there is no answer after elapse of the setting time, the inverter trips. The trip display is "E-11".

■ Parameter setting

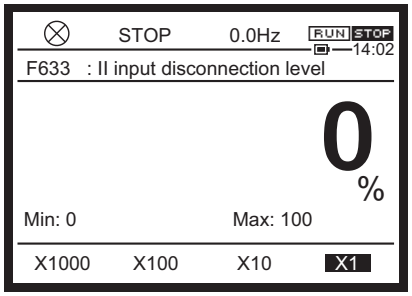
Title	Parameter name	Adjustment range	Unit	Default setting
F630	Brake answer wait time	0.0: Disabled 0.1 - 10.0	s	0.0

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- This function is used with "brake function".
  About "brake function", refer to "E6582104".

6. 30. 16 Analog input disconnection detection

<F633: II analog input disconnection detection level>
<F644: Operation after II analog input disconnection detection>
<F649: Fallback frequency>



■ Function

This parameter sets the action when the analog input level for [II] terminal is the setting value of <F633: II analog input disconnection detection level> or less for approximately 0.3 seconds.
You can trip the inverter or maintain its operation. The trip display is "E-18". If you select other than a trip, alarm "A-18" blinks.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F633	II analog input disconnection detection level	0: Disabled 1 - 100	%	0
F644	Operation after II analog input disconnection detection	1 : Frequency reference keeps just before reference, & Alarm. 2 : Ramp Coast stop, & Alarm 3 : Free wheel, & Alarm 4 : Free wheel, & Fault 5 : Frequency reference becomes F649, & Alarm.	-	4
F649	Fallback frequency	LL-UL	Hz	0.0

■ Setting the <F633: II analog input disconnection detection level>

0: Disabled
No detection.

1 - 100
Action of the inverter is based on the setting of <F644: Operation after II analog input disconnection detection> when the analog input level for [II] terminal is the setting value of <F633> or less for approximately 0.3 seconds.

■ Setting the <F644: Operation after II analog input disconnection detection>

This parameter sets the action when the analog input level for [II] terminal is the setting value of <F633> or less for approximately 0.3 seconds.

1 : Frequency reference keeps just before reference
Continue running.

Alarm "A-18" blinks.

2 : Ramp Coast stop,
Deceleration stop.
Alarm "A-18" blinks.

3 : Free wheel
Coast stop.
Alarm "A-18" blinks.

4 : Free wheel, & Fault
Trip. The trip display is "E-18".

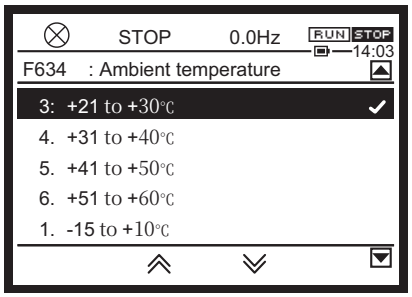
5 : Frequency reference becomes F649
The inverter runs with the frequency setting by <F649: Fallback frequency>.
Alarm "A-18" blinks.

Memo	• Depending on the degree of deviation of the analog data detected, disconnection may be detected too early.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]. • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 17 Setting parts replacement alarm by the ambient temperature

<F634: Annual average ambient temperature>



■ Function

Based on the inverter ON time (cumulative power ON time), motor run time (cumulative run time), cooling fan run time (cumulative cooling fan run time), output current , and <F634: Annual average ambient temperature>, the time of replacement of the cooling fan, power circuit capacitor, and capacitor mounted on a printed circuit board is calculated. When the time of replacement approaches, the alarm can be output on the monitor display and output terminal.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F634	Annual average ambient temperature	1: -15 to +10°C 2: +11 to +20°C 3: +21 to +30°C 4: +31 to +40°C 5: +41 to +50°C 6: +51 to +60°C	3

■ Selecting a setting value

Set the annual average temperature around the inverter. (This is not the annual highest temperature.)

Important

- Set <F634: Annual average ambient temperature> when installing the inverter. After the installation, this setting should not be changed. Otherwise, calculation of parts replacement alarm may have an error.

■ Signal output of parts replacement alarm

Assign the parts replacement alarm to the unused output terminal. For details, refer to [7. 2. 2].
"128: Parts replacement alarm"
"160: Cooling fan replacement alarm"

■ Monitor display of parts replacement alarm

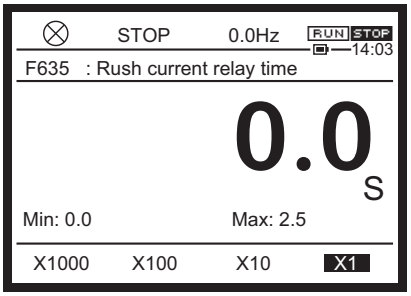
Parts replacement alarm information (refer to [8. 1. 1]) can be checked in the [Monitor mode].

Memo	• Cumulative power ON time, cumulative fan run time, and cumulative run time can be checked in the [Monitor mode]. For details, refer to [8. 1. 1]. • Monitor value of cumulative fan run time and cumulative run time can be reset to 0 (zero) by the setting of <tyP: Default setting>. For details, refer to [5. 2. 9].

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 18 Rush current suspension relay control

<F635: Rush current suppression relay delay time>



■ Function

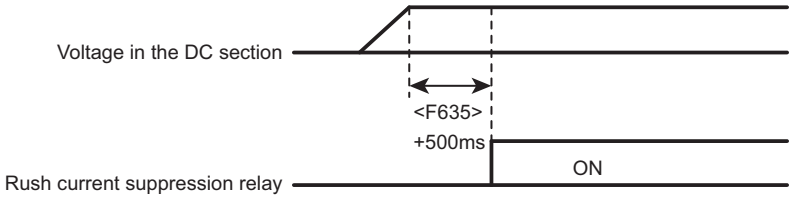
This function is used for DC input or when multiple inverters are connected with DC section and when the rush current suspension resistor relay needs to be controlled.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F635	Rush current suppression relay delay time	0.0 - 2.5	s	0.0

■ Guideline for the setting

When the voltage of DC section in the inverter has reached the specified voltage, after a lapse of setting time by <F635: Rush current suppression relay delay time> +500ms (basic wait time), the rush current suspension relay is turned on.

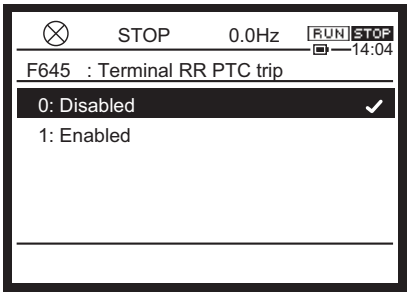


Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 30. 19 Motor PTC thermal protection setting

<F645: Terminal RRPTC trip>
<F646: PTC detection resistance>
<F108: Terminal RR input select>
<F148: Terminal AI4 input select>
<F149: Terminal AI5 input select>
<F637: Terminal AI4 PTC trip>
<F638: Terminal AI5 PTC trip>



■ Function

This function is set to protect the motor from overheating by using PTC, which is integrated in the monitor.
You can trip the motor. The trip display is "E-32".

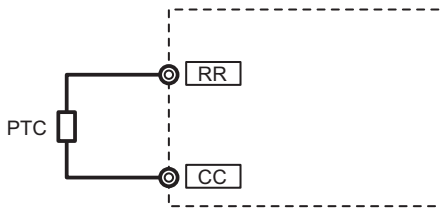
■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F645	Terminal RR PTC trip	0: Disabled 1: Enabled		0
F646	PTC detection resistance	100 - 9999	Ω	3000
F656	PTC detection temperature	0 - 200	°C	90
F108	Terminal RR input	1: Voltage input (0-10V) 2, 3: - 4: PTC input 5: PT100 (2-wire) input 6: - 7: PT100 (2-wire) input 8: - 9: KTY84 input		1
F148	Terminal AI4 input select	1: Voltage input (0-10 V) 2: Voltage input (-10 to +10 V) 3: Current input (0-20 mA) 4: PTC input 5: PT100 (2-wire) input 6: PT100 (3-wire) input 7: PT100 (2-wire) input 8: PT1000 (3-wire) input 9: KTY84 input		0
F149	Terminal AI5 input select			
F637	Terminal AI4 PTC trip	0: Disabled 1: Enabled		0
F638	Terminal AI5 PTC trip			

■ PTC thermal protection using terminal [RR]

Connect PTC between terminals [RR]-[CC].
Set "4", "5", "7", and "9" with <F108: Terminal RR switching>.
In <F645: Terminal RR PTC trip>, when "0: Disabled" is selected, pre-alarm only, and when "1: Enabled" is selected, pre-alarm and trip are enabled.

The trip level is the value which is set by <F646> when <F108>= "4: PTC input", and if <F108>= "5: PT100", "7: PT1000", and "9: KTY84", it is the setting value of <F656>.
Pre-alarm level is 60% of <F646> when <F108>="4".
Pre-alarm level is <F656> - 10 deg.C when <F108>="5", "7", and "9".



■ Signal output of PTC input pre-alarm

Assign "150: PTC input pre-alarm" to the unused output terminal.

Memo

- With optional terminals [AI4] and [AI5], PTC thermal protection is possible in the same manner. For details, refer to "I/O extension 1 installation manual" (E6582128).

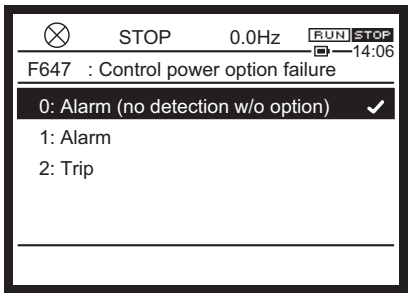
6

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 20 Protecting the control power supply option unit at a time of failure

<F647: Control power option failure detection>



■ Function

When the control power supply option unit (CPS002Z) is used, if the unit does not output the voltage for 15 minutes or more due to some error, this function can activate alarm display or tripping.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F647	Control power option failure detection	0: Alarm (no detection without option) 1: Alarm 2: Trip	0

■ How to select a setting value

0: Alarm (no detection without option)

This is selected when the control power supply backup is not necessary.
When no control power supply is input between terminals [+SU] externally, use this setting.
Also when the control power supply backup is selected, when failure occurs during run, the inverter output is shut off and the alarm "COFF" is displayed. When failure exists already at the time of voltage input, errors are not detected.

1: Alarm

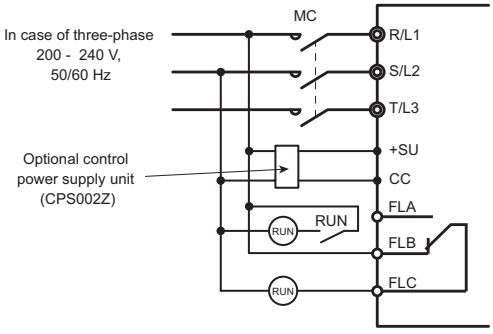
This is selected for the control power supply backup (alarm output).
When voltage of the control power supply which is input to terminal [+SU] drops, the inverter output is shut off, and the alarm "COFF" is displayed.
Once "COFF" has occurred, the alarm is not reset even when the control power supply voltage is recovered to the normal level. The alarm can be reset by turning off the power circuit.

2: Trip

This is set for the control power supply backup (trip output).
This option enables the inverter trip when voltage of the control power drops. The trip display is "E-29".
Different from the normal trip, the trip is maintained regardless of the setting status of <F602: Trip record retention>.
This setting is valid when the standard connection in [2. 3. 2] is used.

When an inverter failure occurs while the control power supply has an failure as follows, the main power supply may turn ON/OFF repeatedly. In such a case, select "1: Retain at power off" in <F602: Trip record retention>.

For details, refer to [6. 30. 3].

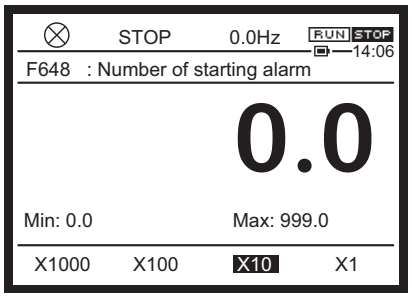


Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6

6. 30. 21 Setting number of starting alarm and alarm occurrence of the specified trip

<F648: Number of starting alarm>
<F658: Number of external equipment starting alarm>
<F664: Specified trip 1>
<F665: Specified trip 2>
<F666: Specified trip 3>



■ Function

This parameter counts the number of starting of the inverter, and when it reaches the value set by <F648: Number of starting alarm>, it outputs the alarm and confirm it in [Monitor mode].
For number of external equipment starting alarm, you can outputs the alarm and confirm it in [Monitor mode]. For number of starting for external equipment, the number of input to the input terminal is counted.
Also, occurrence of the specified trip can be confirmed in [Monitor mode].

6

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F648	Number of starting alarm	0 - 999.0	x10,000 times	999.0
F658	Number of external equipment starting alarm	0 - 999.0	x10,000 times	999.0
F664	Specified trip 1	0 - 1 00	Times	0
F665	Specified trip2	0 - 1 00	Times	0
F666	Specified trip3	0 - 1 00	Times	0

■ Signal output of the number of starting alarm of the inverter

This parameter counts the number of starting of the inverter, and when it reaches the value set by <F648: Number of starting alarm>, it outputs the alarm and confirm it in [Monitor mode].
Output alarm

Assign "162: Number of starting alarm" to the unused output terminal. For details, refer to [7. 2. 2].
[Monitor mode]

Set "100: Number of starting" to <F711: Monitor mode 1 display> through <F718: Monitor mode 8 display>. For details, refer to [8. 1. 1].

■ Signal output of the number of external equipment starting alarm

This parameter counts the number of starting of the external equipment, and when it reaches the values set by <F658: Number of external equipment starting alarm>, it outputs the alarm and can be confirmed in [Monitor mode].
For Number of starting for external equipment, a signal to the input terminal with the function of "114: External equipment counter" is assigned is counted.
Output alarm

Assign "184: Number of external equipment starting alarm" to the unused output terminal. For details, refer to [7. 2. 2].

[Monitor mode]

Set "103: External equipment counter" to <F711: Monitor mode 1 display> through <F718: Monitor mode 8 display>. For details, refer to [8. 1. 1].

■ Signal output of the number of occurrence of the specified trip

You can confirm occurrence of the specified trip in [Monitor mode]. You can set up to three specified trips.

Set the monitor numbers shown in the following table to <F711: Monitor mode 1 display> to <F718: Monitor mode 8 display>. For details, refer to [8. 1. 1].

"113: Number of specified trip 1"

"114: Number of specified trip 2"

"115: Number of specified trip 3"

Memo

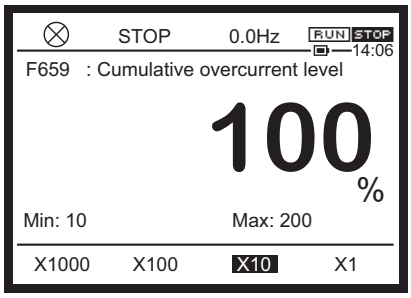
- The number of starting, the number of forward run, and the number of reverse starting up to the present time can be confirmed in [Monitor mode]. You can reset the monitor value to 0 with the setting of "12: Clear number of starting" in <tyP: Default setting>. For details, refer to [5. 2. 9].
- You can reset the monitor value of "external equipment counter" to 0 with the setting of "14: Clear number of external equipment starting" in <tyP: Default setting>. For details, refer to [5. 2. 9].

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 30. 22 Setting cumulative overcurrent level and time

<F659: Cumulative overcurrent level>



■ Function

Inverter cumulates the time when motor current is over this parameter. This cumulative time can be confirmed in [Monitor mode].

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F659	Cumulative overcurrent level	10 - 200	%	100

■ Signal output of the cumulative overcurrent time

You can confirm the cumulative overcurrent time in [Monitor mode].
Set the monitor numbers shown below to <F711: Monitor mode 1 display> to <F718: Monitor mode 8 display>. For details, refer to [8. 1. 1].

"93: Cumulative overcurrent time"

Memo

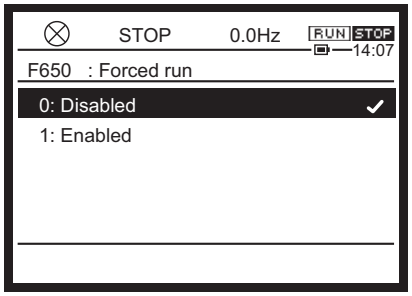
- Cumulative overcurrent time can be confirmed in [Monitor mode]. You can reset the monitor value to 0 with the setting of "15: Clear cumulative overcurrent time " in <tyP: Default setting>. For details, refer to [5. 2. 9].

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 31 Forced run control in emergency

<F650: Forced run>



■ Function

With the forced run control, the motor runs at the specified speed in an emergency.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F650	Forced run	0: Disabled 1: Enabled		0
F294	Preset speed 15 / Forced run speed	LL - UL	Hz	0.0

■ Setting the parameters and input terminal

Set <F650: forced run> = "1: Enabled"
Set any of the function to the unused input terminal. For details, refer to [7. 2. 1].
You can perform the forced run or fire speed run with the setting of <F650> = "1" and an assigned input terminal is ON.

"56: Forced run"
- Once the input signal is ON, it is self-retained. The motor runs at the frequency set by <F294>.
- In case of a slight failure, the motor performs the forced run, in which the operation is continued.

"58: Fire speed run"
- Once the input signal is ON, it is self-retained. The motor performs the fire speed run at the frequency set by <F294>.

In both cases, to stop the running, the power circuit needs to be turned off.
During the forced run and the fire speed run, "FIrE" is displayed.

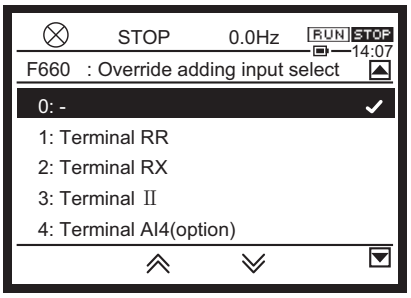
■ Signal output of forced run

Assign any of these to the unused output terminal. For details, refer to [7. 2. 2].
"138: During forced run"
"140: During fire speed run"

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 32 Frequency adjustment using external input (override function)

<F660: Override adding input select>
<F661: Override multiplying input select>
<F729: Panel override multiplication gain>



■ Function

You can make adjustment for adding or multiple to frequency command value by external signal.

■ Parameter setting

6

Title	Parameter name	Adjustment range	Unit	Default setting
F660	Override adding input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 9: - 10: Touch wheel 1 (power off or press OK to save) 11 - 14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18/19: - 20: Embedded Ethernet 21: RS485 communication connector 1 22: RS485 communication connector 2 23: Communication option		0
F661	Override multiplying input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F729 13 - 30: - 31: Terminal RR *1 32: Terminal RX *1 33: Terminal II *1 34: Terminal AI4 (option) *1 35 - 41: - 42: F729 *1		0

Title	Parameter name	Adjustment range	Unit	Default setting
F729	Panel override multiplication gain	-100 to +100	%	0

■ Guideline for the setting

The override functions calculate the frequency command value by means of the following expression:

• Frequency command value × (1+<F661> Input (%)/100) + <F660> Input (Hz)

<F661> is limited to -100 to +100

However, when the setting value of <F661: Override multiplying input select> is *1 in the table, use the following expression.

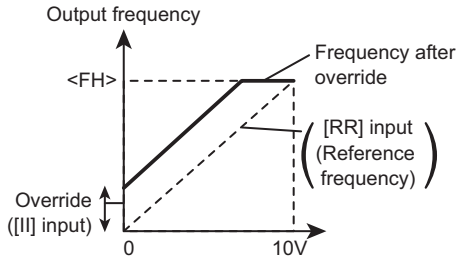
• Frequency command value × (<F661> Input (%)/100) + <F660> Input (Hz)

<F661> is not limited

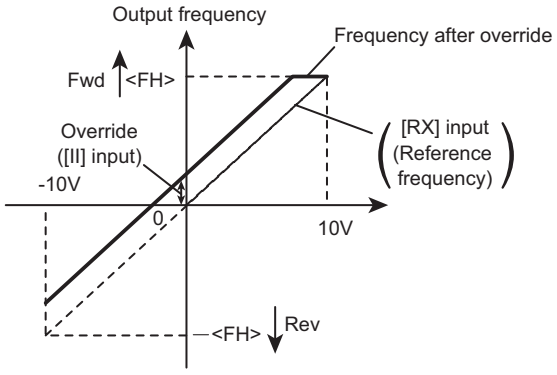
■ Additive override

An input override frequency is added to the frequency command value externally.

Example 1: Terminal [RR] (Reference frequency command) Terminal [II] (override input)



Example 2: Terminal [RX] (Reference frequency command) Terminal [RR] (override input)



Example 1: <F660>= "3: Terminal II", <F661>= "0: Disabled"

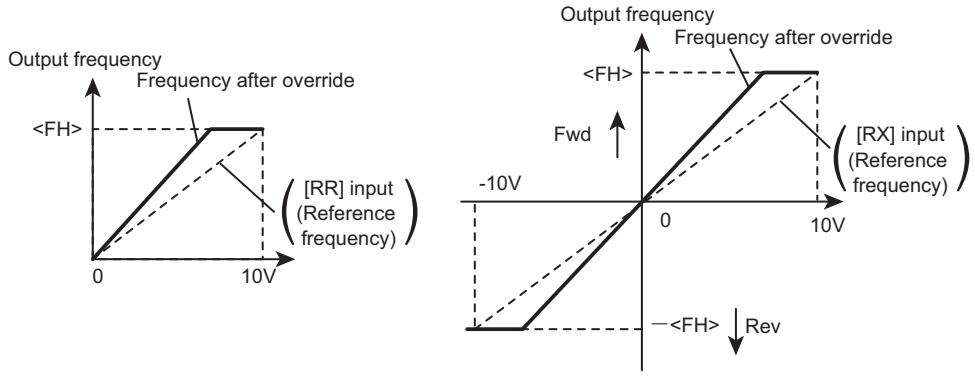
Output frequency = Reference frequency + Override (terminal [II] input (Hz))

Example 2: <F660>= "1: Terminal RR", <F661>= "0: Disabled"

Output frequency = Reference frequency + Override (terminal [RR] input (Hz))

■ Multiple override

An input override frequency is added to the frequency command value externally.



Example 1: <F660>= "0: Disabled", <F661>= "3: Terminal II"
<FMOd>= "1: Terminal RR", <FH>= "80.0", <UL>= "80.0"
terminal [RR] input
<F201>= "0", <F202>= "0.0", <F203>= "100", <F204>= "80.0"
terminal [II] input
<F216>= "0", <F220>= "0", <F218>= "100", <F221>= "100"
Output frequency = Reference frequency x {1 + Override (terminal [II] input (%)/100)}

Example 2: <F660>=0 (disabled), <F661>=1 (terminal [RR])
<FMOd>= "2: Terminal RX", <FH>= "80.0", <UL>= "80.0"
terminal [RX] input
<F210>= "0", <F211>= "0.0", <F212>= "100", <F213>= "80.0"
terminal [RR] input
<F201>= "0", <F205>= "0", <F203>= "100", <F206>= "100"
Output frequency = Reference frequency x {1 + Override (terminal [RR] input (%)/100)}

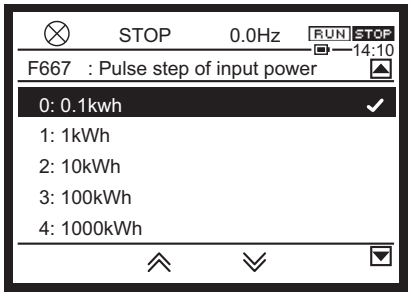
Example 3
Output frequency = Reference frequency x {1 + Override (<F729: Panel override multiplication gain> Setting value (%)/100)}

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 33 Adjustment parameters

6. 33. 1 Pulse output based on input cumulative power by a fixed integral value

<F667: Pulse output step of input cumulative power>
<F668: Pulse output width of input cumulative power>



■ Function

Every time the integral input power reaches the cumulative power unit set by <F667: Pulse output step of input cumulative power>, pulse signal can be output. You can display the power by pulse count without an external power meter.
Pulse output width is set by <F668: Pulse output width of input cumulative power>.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F667	Pulse output step of input cumulative power	0: 1.0=1 kWh 1: 1.0=10 kWh 2: 1.0=100 kWh 3: 1.0=1000 kWh 4: 1.0=10000 kWh 5: 1.0=100000 kWh		1
F668	Pulse output width of input cumulative power	0.1 - 1.0	s	0.1

■ Setting the parameters

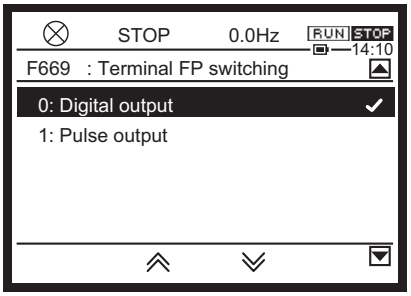
This is a setting for pulse output from terminal [FP].
Set <F130: Terminal FP function 1> = "180: For input cumulative power"
Set the integral power unit with <F667: Pulse output step of input cumulative power>, and set the pulse output width with <F668: Pulse output step of input cumulative power>.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 33. 2 Pulse train output

<F669: Terminal FP switching>
<F676: Terminal FP pulse train output function>
<F677: Maximum pulse number of pulse train output>
<F678: Pulse train output filter>



■ Function

Pulse trains can be output from terminal [FP]. Set the pulse output function and the number of pulses.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F669	Terminal FP switching	0: Digital output 1: Pulse output		0
F676	Terminal FP pulse train output function	0-149 *1		0
F677	Maximum pulse number of pulse train output	0.50 - 30.00	kpps	8.00
F678	Pulse train output filter	1 - 1000	ms	64

*1 For details, refer to [11. 7].

■ Setting method

For example, to output frequency (0 - 60Hz) at 0 - 600 pulse, set as follows.
<FH>= "60.0", <F669>= "1", <F676>= "0", <F677>= "0.60"

When the item selected by <F676> has reached the value of the reference of maximum value, the number of pulse set by <F677: maximum pulse number of pulse train output> is output.

ON pulse width is a fixed width. When outputting the maximum number of pulses set by <F677>, the width is fixed at a value, where the duty ratio is 50%.
Therefore, the duty ratio varies according to the output pulse.
For example,

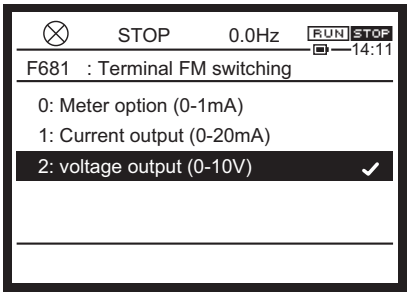
- <F677>="0.80" (kpps), ON pulse width = approx. 0.6 (ms)
- <F677>="1.00" (kpps), ON pulse width = approx. 0.5 (ms)
- <F677>="1.60" (kpps), ON pulse width = approx. 0.3 (ms)

Pulses below 15pps cannot be output.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 33. 3 Analog output adjustment

<F681: Terminal FM switching>
<F682: Terminal FM inclination polarity>
<F683: Terminal FM bias>
<F684: Terminal FM filter>
<F685: Terminal FM upper-limit level>
<F686: Terminal AM switching>
<F687: Terminal AM inclination polarity>
<F688: Terminal AM bias>
<F689: Terminal AM filter>
<F690: Terminal AM upper-limit level>



■ Function

With the setting of <F681>, you can switch the output signal from terminal [FM] to 0 - 1mAdc output, 0 - 20mAdc output, and 0 - 10 Vdc output. Default setting is 0 - 10Vdc output.
Similarly, the output signal from the terminal [AM] can be also switched.

■ Parameter setting

6

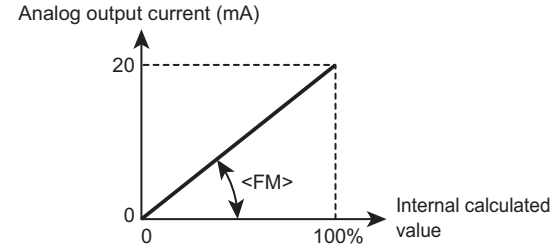
Title	Parameter name	Adjustment range	Unit	Default setting
F681	Terminal FM switching	0: Meter option (0-1mA) 1: Current output (0-20mA) 2: Voltage output (0-10V)		2
F682	Terminal FM inclination polarity	0: Negative inclination (downward slope) 1: Positive inclination (upward slope)		1
F683	Terminal FM bias	-100.0 to +100.0	%	0.0
F684	Terminal FM filter	1 - 1000	ms	1
F685	Terminal FM upper-limit level	0.0 - 100.0	%	100.0
F686	Terminal AM switching	0: Meter option (0-1mA) 1: Current output (0-20mA) 2: Voltage output (0-10V)		2
F687	Terminal AM inclination polarity	0: Negative inclination (downward slope) 1: Positive inclination (upward slope)		1
F688	Terminal AM bias	-100.0 to 100.0	%	0.0
F689	Terminal AM filter	1 - 1000	ms	1
F690	Terminal AM upper-limit level	0.0 - 100.0	%	100.0

■ Setting methods

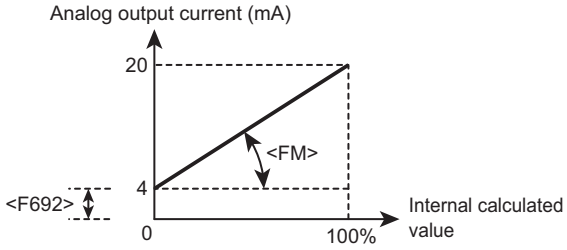
To obtain 4 - 20 mAdc output, adjust <F683: Terminal FM bias> and <F688: Terminal AM bias>.
When using the optional frequency meter (QS60T), set <F681> to "0" or F686 to "0".

■ Setting example

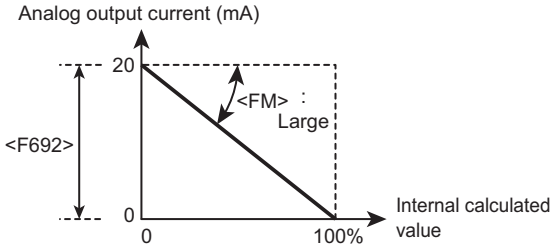
<F681>="1", <F691>="1", <F692>= "0" (%)



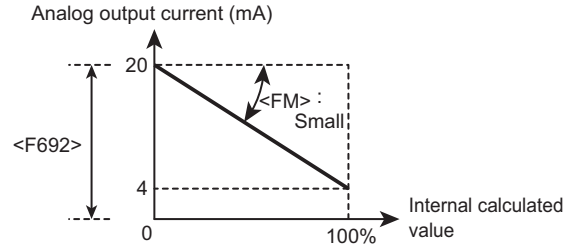
<F681>="1", <F691>="1", <F692>= "20" (%)



<F681>="1", <F691>="1", <F692>= "100" (%)



<F681>="1", <F691>="0", <F692>= "100" (%)



Set the inclination of analog output with <FM: Terminal FM adjustment> and <F671: Terminal AM adjustment>. For details of how to adjust, refer to [5. 2. 6].

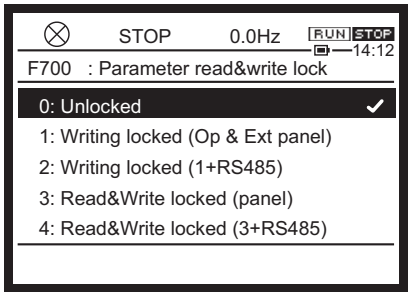
Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 34 Setting functions of operation panel

Lock or unlock the key operation of the operation panel and parameter setting.
Also, set the display functions of the operation panel.

6. 34. 1 Lockout key operation and parameter setting

<F700: Parameter reading&writing access lockout>
<F730: Panel frequency setting lockout>
<F731: Operation after disconnection detection during panel run>
<F732: Panel Hand/Auto function lockout>
<F733: Panel Run lockout>
<F734: Panel emergency off lockout>
<F735: Panel reset lockout>
<F736: CMOd/FMOd change lockout during run>
<F737: Panel keys lockout>
<F738: Password setting>
<F739: Password verification>



6

■ Function

These parameters allow you to locked or unlocked operation on the operation panel and the change of parameters. Using these parameters, you can also lock various key operations to prevent malfunction.
Lock parameters with a password to prevent configuration.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F700	Parameter reading&writing access lockout *1	0: Unlocked 1: Writing locked (Operation panel, Extension panel) 2: Writing locked (1+RS485) 3: Reading&Writing locked (Operation panel, Extension panel) 4: Reading&Writing locked (3+RS485)	0
F730	Panel frequency setting lockout	0: Unlocked 1: Locked 2: Unlocked after press OK	2
F731	Operation after disconnection detection during panel run*2	1: Continue running 2, 3: - 4: Trip	4
F732	Panel Hand/Auto function lockout*3	0: Unlocked 1: Locked	1
F733	Panel Run lockout	0: Unlocked 1: Locked	0
F734	Panel emergency off lockout	0: Unlocked 1: Locked	0

Title	Parameter name	Adjustment range	Default setting
F735	Panel reset lockout	0: Unlocked 1: Locked	0
F736	CMOd/FMOd change lockout during run	0: Unlocked 1: Locked	1
F737	Panel keys lockout *4	0: Unlocked 1: Locked 2: Locked only extension panel 3: Locked only operation panel	0
F738	Password setting *5	0: Disabled 1 - 9998 9999: Password was set	0
F739	Password verification	0: non-setting 1 - 9998 9999: Password was set	0

*1 The setting of <F700>="2" and "4" is valid after reset (turning off power).
*2 Enabled when run command is input from the operation panel.
*3 <F732> is only for extended LED panel. <F750> is for LCD panel.
*4 After setting <F737>. turn on the power again. The setting is valid after the power is turned on again.
*5 The setting of <738>="9999" is valid after reset (turning off power).

■ Selecting a setting value

In [Standard mode], if you lock the frequency setting on the operation panel (<FC>, <FPId>, Preset speed), set <F730: Panel frequency setting lockout> to "1".
You cannot lock the setting with <F700>.

■ Setting/clearing method of password when it is required for protection

1) Password setting method

Parameters other than <F700>, <F738>, and <F739> cannot be changed when <F700> is set to "1" to "4".
When <F738> or <F739> is "0", a password has not been set. You can set a new password.
When <F738> or <F739> is "9999", a password has already been set.
If not set, select and register a number from "1" to "9998" for <F738> as a password. Do not forget your password as it is required to release the lock.

Important

- The lock cannot be released if you forget the password. Do not forget this password as we cannot retrieve it.

Memo	• The password cannot be set when <F700> = "0". Select a number other then 0 and then set the password. • The password can be read out to parameter writer (optional device) until the power is off after setting <F738>. Please note that password will not be able to read out due to password protection after the power is off.

2) Password clearing method

When <F738> or <F739> is read out and the value is "9999", a password has already been set.
The password has to be cleared in order to change parameters.
To <F739>, input the number registered to <F738> when the password was set.
If the password matches, "PASS" is displayed and the password is cleared.
If the password is incorrect, "FAIL" is displayed and the screen returns to <F739>.
The setting of <F700> can be changed after the password is cleared.
By setting <F700> to "0", settings of all the parameters are enabled.

Important	• You cannot try inputting <F739> for more than three times. If a wrong password has been input three times, setting is no longer possible. However, the number of times is reset after power is off.

■ Cancellation method of <F700> and <F737> lockout setting

3) Cancellation of <F700> lockout setting

The setting of <F700> can be changed at any time, regardless of its setting value.

4) Cancellation of <F737> lockout setting

When the key operation lockout is set, press and hold down the [OK] key for 5 seconds or more.
The message "Undo" appears and this setting is canceled temporarily for the key operation.
To cancel this setting permanently, change the setting of <F737> directly.

■ Parameter setting unlocked with digital input

When "110: Parameter writing unlocked" is assigned to the unused input terminal, setting of parameters is possible regardless of the setting of <F700: Parameter reading&writing access lockout>.

■ Parameter setting lockout with digital input

If the following functions are assigned to the unused input terminal, parameter writing or reading is locked.
"200: Parameter writing locked"
"202: Parameter reading locked"

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 34. 2 Changing current/voltage display from percentage to unit (A/V)

<F701: Current, voltage units select>

For details, refer to [5. 2. 7].

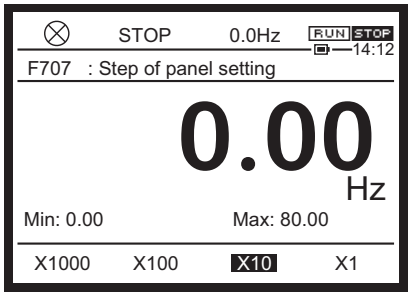
6. 34. 3 Displaying motor or line speed

<F702: Free unit multiplication factor>
<F703: Target of free unit>
<F705: Free unit inclination polarity>
<F706: Free unit bias>

For details, refer to [5. 4. 3].

6. 34. 4 Changing variation steps of panel display

<F707: Step of panel setting>
<F708: Step of panel display>



■ Function

The changeable step width can be changed at panel frequency setting.
This function is useful when only running with frequencies of intervals of 1 Hz, 5 Hz, and 10 Hz units.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F707	Step of panel setting	0.00: Disabled 0.01 - FH	Hz	0.00
F708	Step of panel display	0: Disabled 1 - 255		0

■ Caution when used

The settings of these parameters do not work when <F702: Free unit multiplication factor> is set.
When you set other than "0" to <F707> and increase the frequency by turning the touch wheel to the right, frequency will not be increased beyond this point and the "HI" message is displayed if the frequency is over <UL: Upper limit frequency> with just one more step rotation.
Similarly, when you decrease the frequency by turning the touch wheel to the left and if the frequency falls under <LL: Lower limit frequency> with just one more step rotation, the "LO" message is displayed in advance and the frequency cannot be lowered beyond this point.

■ Setting example

1) <F707> = not "0.00", <F708> = "0: Disabled"

Under normal conditions, the frequency command value on the operation panel increases by 0.1 Hz when you turn the touch wheel to the right. If <F707> is not "0.00", the frequency command value will increase by the value with <F707> each time you turn the touch wheel to the right by 1 step. Similarly, the frequency command value on the operation panel will decrease by the value set with <F707> when you turn the touch wheel to the left by 1 step.
When the second decimal place of <F707> is 0, the second decimal place of the frequency command value is not displayed.

2) When <F707> is not "0.00", and <F708> is not "0"

The value displayed on the panel can also be changed in steps.
Output frequency displayed on LCD screen = Internal output frequency x <F708>/<F707>

■ **Operation example**

<F707> = "0.00: Disabled"

By rotating the touch wheel by 1 step, the panel run frequency command value changes only by 0.1 Hz.

<F707> = "10.00"

Rotating the touch wheel by 1 step changes the panel run frequency command value in 10.00 Hz increments, from 0.00 up to 60.00 (Hz).

<F707> = "1.00", <F708> = "1"

By rotating the touch wheel by 1 step, the frequency command value changes in steps of 1Hz: 0→ 1 → 2 → ... → 60 (Hz) and also the value displayed on the LCD panel changes in steps of 1.

Use these settings to hide decimal fractions.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 34. 5 Selecting data displayed in [Standard mode]

<F710: Standard mode display>
<F720: Standard mode display of extension panel>
<F723: Status area display of operation panel>

Different contents can be displayed on the operation panel of the inverter unit and the extension panel (optional).
You can set the content displayed on Status area on the operation panel.

For details, refer to [5. 4. 3].

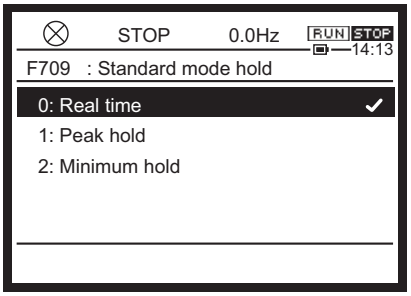
6. 34. 6 Changing display in [Monitor model]

<F711: Monitor mode 1 display> to <F718: Monitor mode 8 display>

Change the display items in [Monitor mode].
For details, refer to [8. 1. 1].

6. 34. 7 Holding display in [Standard mode]

<F709: Hold function of standard mode>



■ Function

The display in [Standard mode] can be held.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F709	Hold function of standard mode	0: Real time 1: Peak hold 2: Minimum hold	0

■ Selecting a setting value

0: Real time

The contents selected with <F710: Standard mode display> are displayed.

1: Peak hold

2: Minimum hold

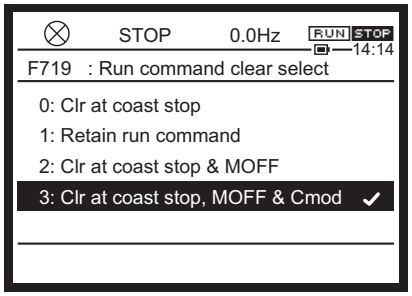
For peak hold values and minimum hold values, the maximum/minimum values in each operation cycle are displayed.

- When the motor is at a standstill, the values monitored last are held as they were until the motor is started the next time.
- The maximum and minimum values monitored after power is on are always displayed whether the motor is running or at a standstill.

Reference	
	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 34. 8 Clearing run command

<F719: Run command clear select>



■ Function

This parameter is used to select whether the run command is retained or cleared when the following events occur during panel run or RS485 communication run.

- Coast stop with standby function (ST) is off (OFF display)
- Coast stop with coast command function (FRR) is on (OFF display)
- Power circuit undervoltage (MOFF) alarm

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F719	Run command clear select	0: Clear at coast stop. Retain when MOFF occurs and CMOd is changed. 1: Retain run command. 2: Clear at coast stop and at MOFF. Retain when CMOd is changed. 3: Clear at coast stop, at MOFF and when CMOd is changed.	2

■ Difference between the settings

<F719> setting value	Coast stop	When power circuit undervoltage (MOFF) alarm occurred	When <CMOd> is changed
0	Run command clear	Retain run command	
1	Retain run command		
2	Run command clear		Retain run command
3	Run command clear		

Important

- If "PrA" alarm occurs when STO activated, run command is cleared regardless of the <F719> setting.

Retain run command.
Inverter restarts when coast stop is cleared after its occurrence.
Inverter restarts when power is supplied again when the power circuit undervoltage (MOFF) alarm occurs.

Run command clear
Inverter does not restart after coast stop or occurrence of the power circuit undervoltage (MOFF) alarm.
Press the [RUN] key to operate it again in panel run. Turn on the run command in RS485 communication run.

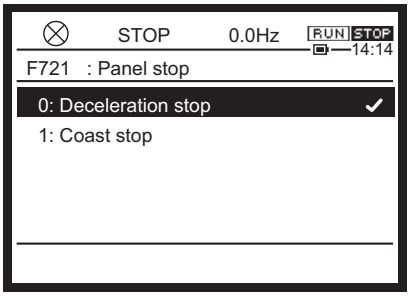
■ Setting example of parameters of input terminals

Set necessary function to the unused input terminal. For details, refer to [7. 2. 1].
"6: Standby"
"96: Coast stop"

Reference	
	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • <CMod: Run command select> -> Refer to [5. 2. 1] • Details of operation by external signals -> Refer to Chapter 7

6. 34. 9 Selecting panel stop pattern

<F721: Panel stop>



■ Function

This parameter is used to select a panel stop pattern by pressing the [STOP] key on the operation panel from Deceleration stop or Coast stop.

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F721	Panel stop	0: Deceleration stop 1: Coast stop	0

■ Selecting a setting value

0: Deceleration stop

The motor decelerate to a stop in the deceleration time set with <dEC: Deceleration time 1>.

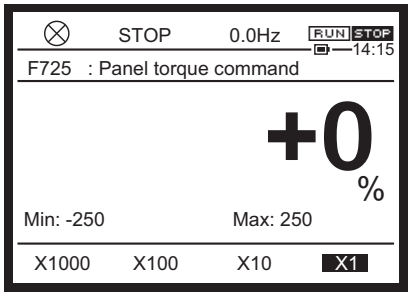
1: Coast stop

The inverter cuts off power supply to the motor. The motor comes to a stop after coasting for a while. Depending on the load, the motor may keep running for a longer time.

Reference	
	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • <dEC: Deceleration time 1> -> Refer to [5. 2. 4]

6. 34. 10 Setting torque command value in panel run

<F725: Panel torque command>



■ Function

This parameter is used to set a torque command value when torque control is performed in panel run.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F725	Panel torque command	-250 to +250	%	0

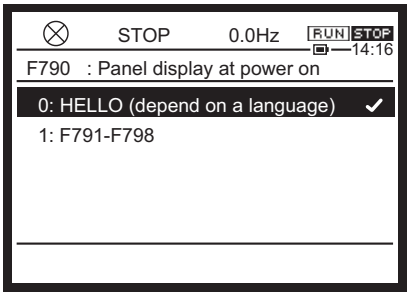
■ Guideline for the setting

<F725: Panel torque command> is enabled only when <F420: Torque command select> is "12" and acts as command value(%).
For details, refer to torque control (E6582106).

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3] • Details on operation by external signals -> Refer to [Chapter 7].

6. 34. 11 Selecting panel display at power on

<F790: Panel display at power on>
<F791: 1st and 2nd characters of F790>
<F792: 3rd and 4th characters of F790>
<F793: 5th and 6th characters of F790>
<F794: 7th and 8th characters of F790>
<F795: 9th and 10th characters of F790>
<F796: 11th and 12th characters of F790>
<F797: 13th and 14th characters of F790>
<F798: 15th and 16th characters of F790>



■ Function

These parameters allow you to change the characters on panel display at power on.
By default setting, "HELLO" is displayed, but the word changes depending on the language selection. (The word equivalent of "Hello" for each language is displayed.)

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F790	Panel display at power on	0: HELLO (depending on language selection) 1: F791 - F798 2, 3: -	0
F791	1st and 2nd characters of F790	0-FFFF	2d2d
F792	3rd and 4th characters of F790	0-FFFF	2d2d
F793	5th and 6th characters of F790	0-FFFF	2d2d
F794	7th and 8th characters of F790	0-FFFF	2d2d
F795	9th and 10th characters of F790	0-FFFF	2d2d
F796	11th and 12th characters of F790	0-FFFF	2d2d
F797	13th and 14th characters of F790	0-FFFF	2d2d
F798	15th and 16th characters of F790	0-FFFF	2d2d

■ Guideline for the setting

To display characters other than "HELLO", set <F790> to "1" and set the characters Changing variation steps of panel display displayed with <F791> to <F798>.
Refer to "ASCII LED" of RS485 Communication Function Instruction Manual (E6582143) for setting of characters and set by hex number.

Reference	• How to operate the operation panel -> Refer to [3. 1. 1]. • How to switch display mode on the operation panel -> Refer to [3. 1. 2]. • Procedure to change parameter setting -> Refer to [4. 2. 3]

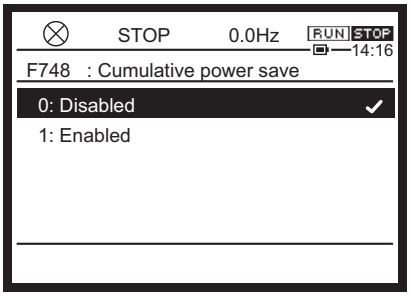
6. 35 Trace function

<F740: Trace>
<F741: Trace cycle>
<F742: Trace data 1>
<F743: Trace data 2>
<F744: Trace data 3>
<F745: Trace data 4>

For details, refer to Trace Function Instruction Manual (E6582134).

6. 36 Store cumulative power

<F748: Cumulative power save>
<F749: Cumulative power unit>



■ Function

At the main power off, the cumulative power can be stored, or the unit of the cumulative power can be selected.
Cumulative power can be monitored as monitor number 20 (input), 21 (output).
The parameter setting in detail is referred to section 8. 1. 1.

6

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F748	Cumulative power save	0: Disabled 1: Enabled	0
F749	Cumulative power unit	0: 1.0=1 kWh 1: 1.0=10 kWh 2: 1.0=100 kWh 3: 1.0=1000 kWh 4: 1.0=10000 kWh 5: 1.0=100000 kWh	*1

*1 Depending on capacity. For details, refer to [11. 6].

Memo

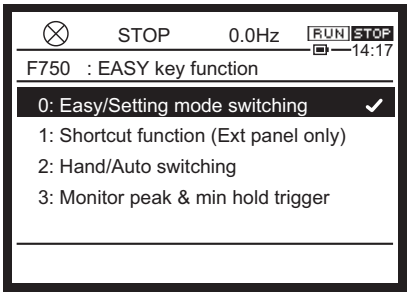
- Cumulative power monitor can be cleared by the signal to the input terminal. Assign "74: Cumulative power monitor clear" to the unused input terminal. For details, refer to [7. 2. 1].
- When monitor of cumulative power is saturated, change the value of F749.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- Details on operation by external signals -> Refer to [Chapter 7].

6. 37 Select EASY key function

<F750: EASY key function>
LED extension panel option



■ Function

This parameter is valid when the [EASY] key exists (extension panel, etc.)
Since the operation panel of this inverter has no [EASY] key, values other than "0", "2" are invalid even if they are set with <F750>.
When the [EASY] key exists, the following four functions can be selected.

- [Easy mode]/[Setting mode] switching
- Shortcut key function
- Hand/Auto switching
- Monitor peak and minimum hold trigger

For options such as the extension panel, refer to [10. 3].

■ Parameter setting

Title	Parameter name	Adjustment range	Default setting
F750	EASY key function	0: Easy/Setting mode switching 1: Shortcut function (Extension panel only) 2: Hand/Auto switching 3: Monitor peak and minimum hold trigger	0

■ Difference between the settings

0: Easy/Setting mode switching
When you press the [EASY] key while the inverter is stopped, the [Setting mode] and [Easy mode] can be switched.
In the default setting, the [Setting mode] is set at the time of power on.
The display of parameter setting varies depending on the mode. For details, refer to [4. 2. 1].

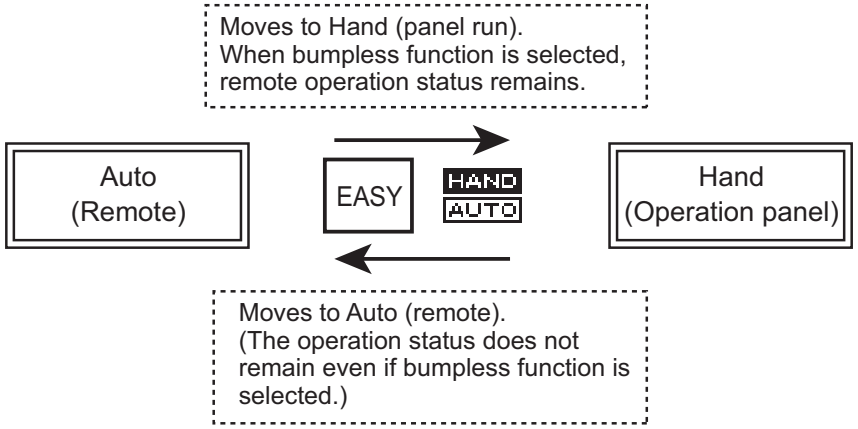
1: Shortcut function (Extension panel only)
Parameters whose settings are frequently changed can be registered as shortcuts so that they can be read out easily with one operation.
Shortcuts are valid only in [Standard mode]
After setting <F750: EASY key function> to "1", read the setting value of the parameter to be stored and press the [EASY] key for two seconds or more. Now shortcut registration is complete.
To read out the parameter, press the [EASY] key.

2: Hand/Auto switching
You can switch manual (operation panel) and automatic (remote) easily.
After setting <F750: EASY key function> to "2", switch the mode with the [EASY] key.

When <F295: Bumpless> is set to "1: Enabled", the mode can be switched even during run.

In manual, the [EASY] key lamp or HAND/AUTO is lit .

In automatic, the inverter is operated with the operation method selected with <CMOd: Run command select>, <FMOd: Frequency command select 1>, etc.



6

Memo

- Note that when you set <F750> to "0" in manual, the panel operation status remains and the setting is different from the one with <CMOd: Run command select>.

3: Monitor peak and minimum hold trigger

Set the peak hold and minimum hold triggers of <F709: Hold function of standard mode> with the [EASY] key.

The measurement of the minimum and maximum values set for <F709> starts at the instant when you press the [EASY] key after setting <F750: EASY key function> to "3".

The peak hold and minimum hold values are displayed in absolute values.

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]
- <F295: Bumpless> of parameter -> Refer to [6. 13]
- <F709: Hold function of standard mode> of parameter -> Refer to [6. 34. 7]

6. 38 Communication functions

Use the communication and monitor functions in communication run using RS485 communication and various optional open networks.

6. 38. 1 Setting communication functions

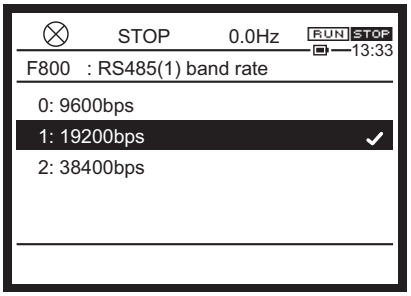
⚠ WARNING

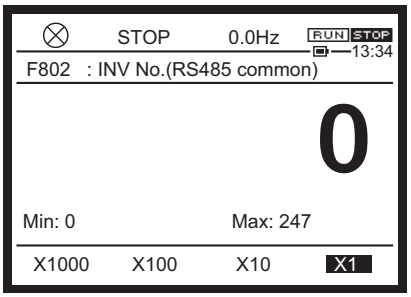
Mandatory action

- Set the parameter Communication time-out.
  If the parameter is not properly set, the inverter cannot be stopped immediately and this will result in injury and accidents.
- Install an emergency stop device and an interlock that are configured in accordance with the system specifications.
  If the inverter cannot be stopped immediately via communication or the extension panel, this will result in injury and accidents.

For details, refer to RS485 Communication Function Instruction Manual (E6582143).

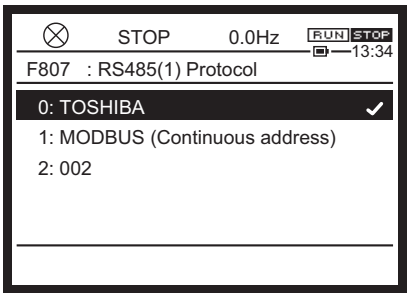
<F800: RS485 (1) baud rate>
<F801: RS485 (1) parity>
<F802: Inverter number (RS485 common)>
<F803: RS485 (1) time-out time>
<F804: RS485 (1) time-out operation>
<F805: RS485 (1) transmission wait time>
<F806: RS485 (1) inverter to inverter communication>
<F807: RS485 (1) protocol>
<F808: RS485 (1) time-out detection>
<F809: Operation panel connection priority>
<F810: Communication frequency point select>
<F811: Communication point 1 input value>
<F812: Communication point 1 frequency>
<F813: Communication point 2 input value>
<F814: Communication point 2 frequency>
<F820: RS485 (2) baud rate>
<F821: RS485 (2) parity>
<F823: RS485 (2) time-out time>
<F824: RS485 (2) time-out operation>
<F825: RS485 (2) transmission wait time>
<F826: RS485 (2) inverter to inverter communication>





6

<F827: RS485 (2) protocol>
<F828: RS485 (2) time-out detection>
<F829: RS485 (2) wiring type>
<F830: MODBUS continuous address>
<F856: Motor pole number for communication>
<F870: Block write data 1>
<F871: Block write data 2>
<F875: Block read data 1>
<F876: Block read data 2>
<F877: Block read data 3>
<F878: Block read data 4>
<F879: Block read data 5>
<F899: Communication option reset>



■ Function

RS485 communication is built-in as standard.
It can be connected to the host to create a network for transmitting data between multiple inverters.
An inverter-to-inverter communication function is also available.

6

Communication function

1) Computer-linking functions

The following functions are enabled by data communication between the computer and inverter.

- Monitoring inverter status (such as the output frequency, current, and voltage)
- Sending Run/Stop and other control commands to the inverter
- Reading, editing and writing inverter parameter settings

2) Inverter-to-inverter communication function

This function allows you to set up a network that makes it possible to carry out proportional operation of multiple inverters. A host computer is not required.
One inverter serves as a leader and sends data selected with the parameter to other inverters that are followers in the same network. By using this function, you can configure a network for easy synchronized operation and proportional operation (setting of point frequency).

Time-out

This is a function to detect cable disconnection during communication.
When data is not sent even once to the inverter during a user-defined period of time, an inverter trip ("Err5" is displayed on the panel) or an alarm("t" is blinking) is output.

Broadcast communication

This is a function used to send a command (data write) to multiple inverters with single communication.

Communication protocol

Toshiba inverter protocol and a part of Modbus RTU protocol are supported.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F800	RS485 (1) baud rate *1	0: 9600 bps 1: 19200 bps 2: 38400 bps		1
F801	RS485 (1) parity *1	0: Disabled 1: Even parity 2: Odd parity		1
F802	Inverter number (RS485 common)	0 - 247		0
F803	RS485 (1) time-out time *2	0.0: Disabled 0.1 - 100.0	s	0.0
F804	RS485 (1) time-out operation *2	1: Continue running 2, 3: - 4: Trip 5: - 6: Trip after deceleration stop		0
F805	RS485 (1) transmission wait time	0.00 - 2.00	s	0.00
F806	RS485 (1) inverter to inverter communication*1	0: Follower (0Hz command when Leader fails) 1: Follower (continue running when Leader fails) 2: Follower (emergency off when Leader fails) 3: Leader (transmit frequency command) 4: Leader (transmit output frequency signal) 5: Leader (transmit torque command) 6: Leader (transmit output torque command)		0
F807	RS485 (1) protocol	0: TOSHIBA 1: MODBUS		0
F808	RS485 (1) time-out detection	0: Always 1: Run command and frequency command by communication are enabled. 2: During run by communication		1
F809	Operation panel connection priority *3	0: By the parameter setting 1: Connect to connector 1 2: Connect to connector 2		1
F810	Communication frequency point select	0: Disabled 1: RS485 (1) 2: RS485 (2) 3: Communication option 4: Embedded Ethernet		0
F811	Communication point 1 input value	0-100	%	0
F812	Communication point 1 frequency	0.0-FH	Hz	0.0
F813	Communication point 2 input value	0-100	%	100

Title	Parameter name	Adjustment range	Unit	Default setting
F814	Communication point 2 frequency	0.0-FH	Hz	50.0/60.0 *4
F820	RS485 (2) baud rate *1	0: 9600 bps 1: 19200 bps 2: 38400 bps		1
F821	RS485 (2) parity *1	0: Disabled 1: Even parity 2: Odd parity		1
F823	RS485 (2) time-out time *2	0.0: Disabled 0.1 - 100.0	s	0.0
F824	RS485 (2) time-out operation *2	1: Continue running 2, 3: - 4: Trip 5: - 6: Trip after Deceleration stop		0
F825	RS485 (2) transmission wait time	0.00 - 2.00	s	0.00
F826	RS485 (2) inverter to inverter communication*1	0: Follower (0Hz command when Leader fails) 1: Follower (continue running when Leader fails) 2: Follower (emergency off when Leader fails) 3: Leader (transmit frequency command) 4: Leader (transmit output frequency signal) 5: Leader (transmit torque command) 6: Leader (transmit output torque command)		0
F827	RS485 (2) protocol	0: TOSHIBA 1: MODBUS		0
F828	RS485 (2) time-out detection	0: Always 1: Run command and frequency command by communication are enabled. 2: During run by communication		1
F829	RS485 (2) wiring type	0: 2-wire 1: 4-wire		0
F830	MODBUS continuous address	0: Disabled 1: Enabled		0
F856	Motor pole number for communication	1: 2 pole 2: 4 pole 3: 6 pole 4: 8 pole 5: 10 pole 6: 12 pole 7: 14 pole 8: 16 pole		2
F870	Block write data 1	0: Disabled 1: Communication command 1 2: Communication command 2 3: Frequency command 4: TB output 5: Analog output 6: Speed command by communication		0
F871	Block write data 2			0

Title	Parameter name	Adjustment range	Unit	Default setting
F875	Block read data 1	0: Disabled 1: Status information 2: Output frequency 3: Output current 4: Output voltage 5: Alarm information 6: PID feedback value 7: Input terminal monitor 8: Output terminal monitor 9: Terminal RR monitor 10: Terminal RX monitor 11: Terminal II monitor 12: Input voltage (DC detection) 13: Speed feedback frequency 14: Torque 15: My function output monitor 1 16: My function output monitor 2 17: My function output monitor 3 18: My function output monitor 4 19: Free memorandum 20: Motor speed 21: Input power 22: Output power 23: Trip information		0
F876	Block read data 2			0
F877	Block read data 3			0
F878	Block read data 4			0
F879	Block read data 5			0
F899	Communication option reset	0: - 1: Reset option and inverter		0

*1 Valid after the setting is changed and the power is turned off and on again.

*2 The setting contents are as follows.

- Disabled: The inverter does not trip even if a communication error occurs.
- Trip: The inverter trips when communication time-over occurs, and "Err5" is displayed.
- Alarm: When communication time-over occurs, an alarm can be output from the output terminal. Assign the output terminal function "78" (RS485 communication time-out) (79 is inversion output) to the output terminal.

*3 When using RS485 communication, set <F809>="0".

*4 Depending on the setup menu. Refer to [11. 10].

■ Communication option

Refer to [10. 3. 5] and [10. 3. 6] for options connected to RS485 communication connectors.
To use these options, set <F805: RS485 (1) transmission wait time > to "0.00".

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 38. 2 Using RS485 communication

■ Operation by RS485 communication

To run/stop the inverter by RS485 communication, select "3: RS485 communication (connector 1)" or "4: RS485 communication (connector 2)" with <CMOd: Run command select>.

To issue frequency commands by RS485 communication, select "21: RS485 communication (connector 1)" or "22: RS485 communication (connector 2)" with <FMOd: Frequency command select 1>.

Run commands and frequency commands by communication have priority over those from the operation panel and terminals. Therefore, run commands and frequency commands from communication can be enabled regardless of the settings of <CMOd> and <FMOd>.

However, when "48" (Communication priority cancel) of input terminal function selection is assigned to the input terminal and a signal is input externally, perform panel run with the setting of <CMOd> and <FMOd>.

When "2: Hand/Auto switching " is selected with <F750: EASY key function>, you can switch the operation panel run and communication run with the [HAND/AUTO] key of the operation panel.

■ Transmission specifications

6

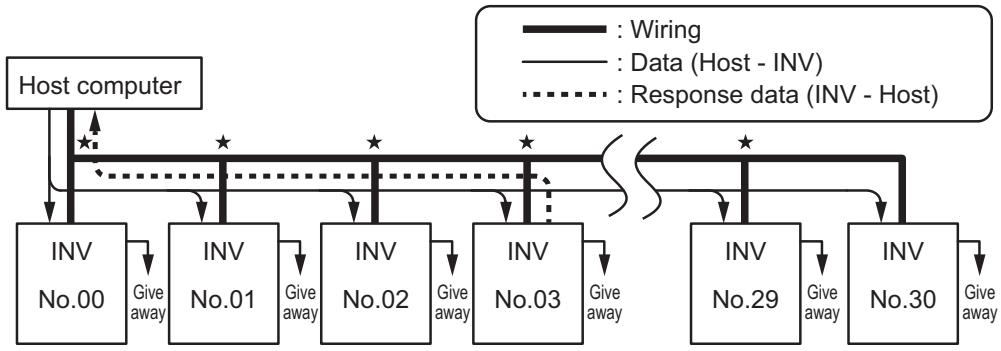
Item	Specifications	
Communication protocol	TOSHIBA inverter protocol	MODBUS-RTU protocol
Interface	RS485 compliant	
Transmission scheme	Half duplex [Serial bus type (Line terminations resistor necessary at both ends of system)]	
Wiring	2-wire	
Transmission distance	500 m max. (total length)	
Connection terminals	32 max. (including upper host computer) Inverters connected in the system: 32 max.	
Synchronization scheme	Start-stop synchronization	
Communication baud rate	9600 bps - 38.4 kbps	
Character transmission	ASCII mode: JIS X0201 8-bit (ASCII) Binary mode: Binary codes fixed to 8 bits	Binary codes fixed to 8 bits
Error detecting scheme 1	Parity: Even/Odd/Non parity (selectable using a parameter)	
Error detecting scheme 2	Checksum	CRC
Stop bit length	Received by inverter: 1bit/Sent by inverter: 2 bits	
Order of bit transmission format	Least significant bit transmitted first	
Character transmission format	11-bit characters (Stop bit =1, with parity)	
Inverter Number	ASCII mode: 0 - 99 Binary mode: 0 - 63 (3Fh)	1 - 247

Item	Specifications	
Broadcast communication	Inverter Number should be set to ASCII mode: ** (*? or ?* (?=0-9) is available) Binary mode: 255 (0FFh)	Inverter Number should be set to 0
Frame length	Variable	
Error correction	Disabled	
Response monitoring	Disabled	
Other	Inverter operation at communication time-over: Select from trip/alarm/none - When alarm is selected, an alarm is output from the output terminal. - When trip is selected, "Err5" blinks on the panel.	

■ Connection example when using computer link function

1) Independent communication

Here is a case where an operation frequency command is sent from the host computer to inverter No.3.



INV: Inverter

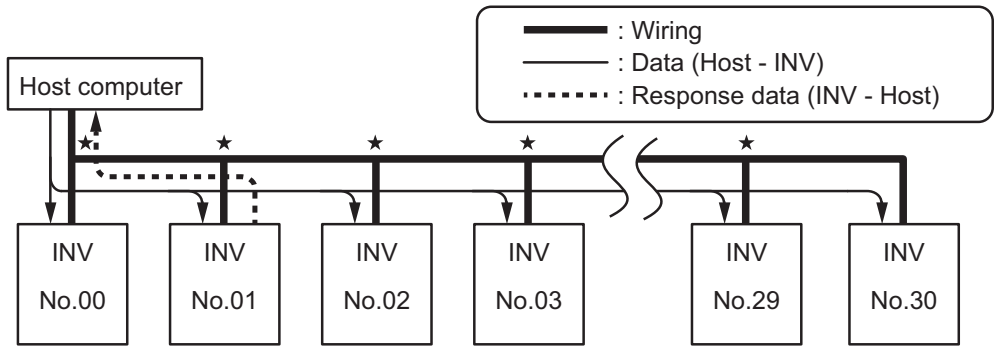
Give away: Only the inverter with the selected inverter number conducts data processing. All other inverters, even if they have received the data, give it away and stand by to receive the next data.

★ : Use the terminal block, etc. to branch the cable.

1. Data is sent from the host computer.
2. Data from the computer is received at each inverter, and the inverter numbers are checked.
3. The command is decoded and processed only by the inverter with the selected inverter number.
4. The selected inverter responds by sending the processing results, together with its own inverter number, to the host computer.
5. As a result, only the selected inverter starts operating in accordance with the operation frequency command sent by the host computer.

2) Broadcast communication

Here is a case where a frequency command is sent via a broadcast from the host computer.



INV: Inverter

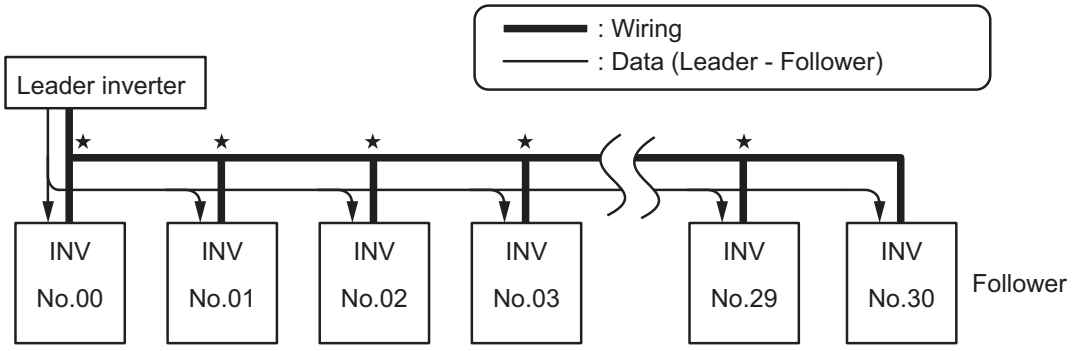
★ : Use the terminal block, etc. to branch the cable.

1. Data is sent from the host computer.
2. Data from the computer is received at each inverter and the inverter numbers are checked.
3. When "*" is added to the position of an inverter number, it is judged a broadcast. The command is decoded and processed.
4. To prevent data conflicts, only inverters where "*" is overwritten to "0" can reply with data to the host computer.
5. As a result, all inverters are operating with the broadcast operation frequency command.

Specify inverter numbers by group for group broadcasts.
This is a function only for ASCII mode. For parity mode, refer to RS485 Communications Function Instruction Manual (E6582143).
For example, when "*1" is set, inverters "01", "02", "03", "04", ..., "09" can be broadcast to.
In this case, the inverter specified as "01" can reply.

■ Connection example of inverter-to-inverter communication

One inverter is a leader and the other inverters are followers.
Here is a case where all follower inverters connected operate at the same frequency as the leader inverter.
No frequency point is set.



INV: Inverter

★ : Use the terminal block, etc. to branch the cable.

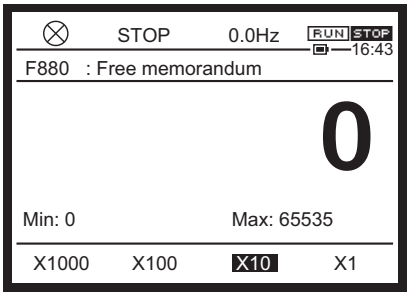
1. The leader inverter transmits frequency command data to its follower inverters.

2. The follower inverters calculate a frequency reference from the data received and save the frequency calculated.
3. As a result, all follower inverters operate at the same frequency as the leader inverter.

The leader inverter always sends frequency command data to its follower inverters.
The follower inverters are always on standby so that they can receive an frequency command from the leader inverter at any time.

6. 38. 3 Input numbers as memorandum

<F880: Free memorandum>



■ Function

You can enter the identification number, etc. for easier management and maintenance of the inverter.

■ Parameter setting

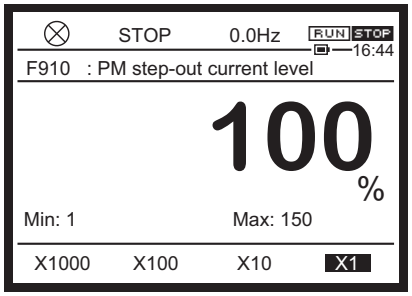
Title	Parameter name	Adjustment range	Default setting
F880	Free memorandum	0 - 65535	0

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3].

6. 39 Step-out detection of PM motor

<F910: PM step-out detection current level>
<F911: PM step-out detection time>



■ Function

If the PM motor steps out and if the exciting current increases (it increases in such a case) and remains over the value set by <F910: PM step-out detection current level > for the period of time set by <F911: PM step-out detection time>, the inverter will judge the motor to be stepping out and trip it.

At that time, the trip message "SOUT" is displayed.

■ Parameter setting

Title	Parameter name	Adjustment range	Unit	Default setting
F910	PM step-out detection current level	1 - 150	%	100
F911	PM step-out detection time	0.00: Disabled 0.01 - 2.55	s	0.00

Important

- When using an PM motor, consult your Toshiba distributor, since the inverter is not compatible with all types of PM motors.
- The inverter may fail to detect step-out in some cases, because it uses an electrical method to detect step-out. To avoid detection failures, you are recommended to install a mechanical step-out detector.

Memo

- For setting of PM motor parameter, refer to [6. 23. 2].

Reference

- How to operate the operation panel -> Refer to [3. 1. 1].
- How to switch display mode on the operation panel -> Refer to [3. 1. 2].
- Procedure to change parameter setting -> Refer to [4. 2. 3]

6. 40 Traverse function

<F980: Traverse operation>
<F981: Traverse Acc time>
<F982: Traverse Dec time>
<F983: Traverse step>
<F984: Traverse jump step>

For details, refer to Traverse Function Instruction Manual (E6582100).

6. 41 My function

My function <A800> - <A847>, <A900> - <A982>

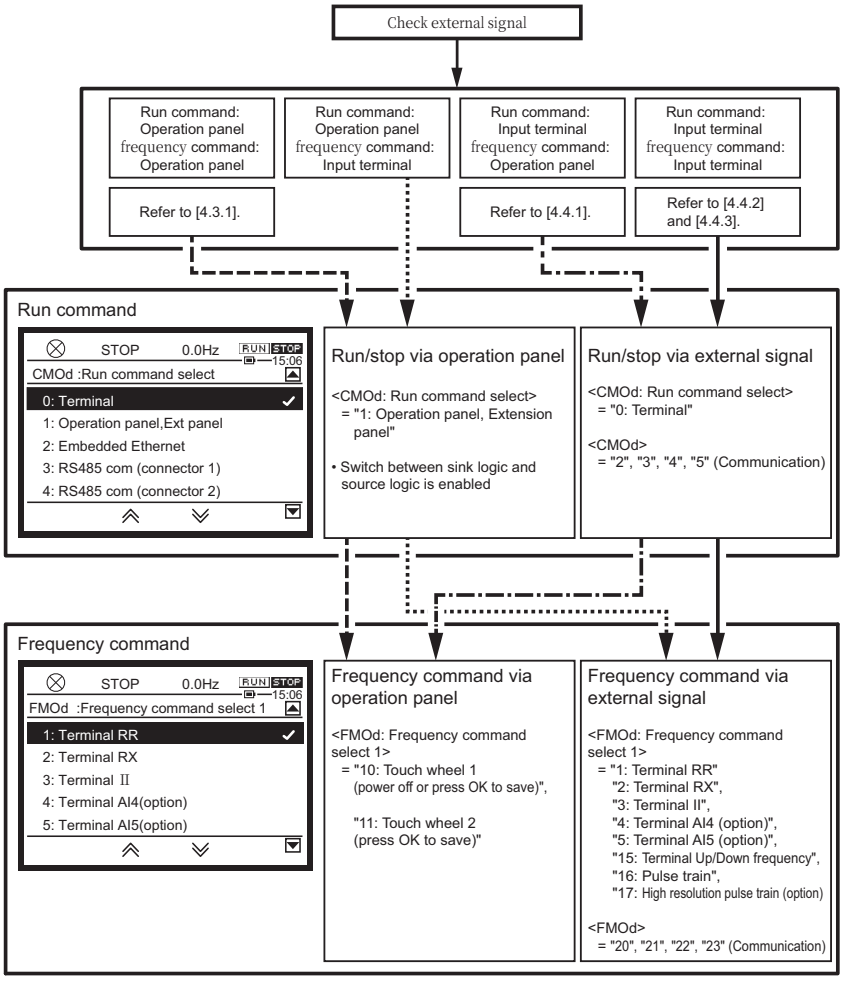
For details, refer to My Function Instruction Manual (E6582114).

7 Operating using external signals

You can operate the inverter by inputting external signals to the control terminals.
The run commands are input to the digital input terminals by the ON/OFF signals.
The frequency commands are input to the analog input terminals by the voltage signals (potentiometer, etc.), or the current signals. This chapter explains how to set the parameters required to operate the inverter using external signals and how to assign the functions to the terminals.

7. 1 How to externally operate the inverter

You can operate the inverter by external signals.
The parameter setting items vary depending on the operation method. Before setting the parameters, be sure to check the operation method (how to input run commands and frequency commands).



For operation by communication, refer to "Communication Function Instruction Manual" (E6582143) and [6. 38].

7. 2 Applied operation by I/O signals

You can assign the functions to the digital input terminals. The assigned functions can be switched for operation.
Also, you can assign the functions to the digital output terminals and the relay logic output terminals to output signals to external equipment.
For the digital terminals, sink logic and source logic can be switched with the slide switch [SW1]. For details, refer to [2. 3. 5].

7. 2. 1 Setting the functions to the input terminals (for sink logic)

Signals are input to the digital input terminals from an external programmable controller. The signals are used for operating the inverter and switching the functions.
The digital input terminal functions can be selected from a variety of functions, thus allowing flexible compatibility with system design.

■ Configuration of the control terminal block



■ Function setting for the digital input terminals

Terminal symbol	Title	Parameter name	Adjustment range	Default setting
F	F111	Terminal F function 1	0 - 203 *1	2
	F151	Terminal F function 2		0
	F155	Terminal F function 3		0
R	F112	Terminal R function 1	0 - 203 *1	4
	F152	Terminal R function 2		0
	F156	Terminal R function 3		0

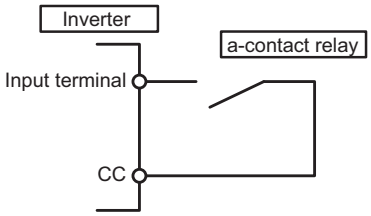
Terminal symbol	Title	Parameter name	Adjustment range	Default setting
RES	F113	Terminal RES function 1	0 - 203 *1	8
	F153	Terminal RES function 2		0
	F157	Terminal RES function 3		0
S1	F114	Terminal S1 function 1	0 - 203 *1	10
	F154	Terminal S1 function 2		0
	F158	Terminal S1 function 3		0
S2	F115	Terminal S2 function	0 - 203	12
S3	F116	Terminal S3 function	0 - 203	14
S4	F117	Terminal S4 function *2	0 - 203	16
	F146	Terminal S4 input select	0: Digital input 1: Pulse train input 2: PG input	0
S5	F118	Terminal S5 function *3	0 - 203	118
	F147	Terminal S5 input select	0: Digital input 1: Pulse train input 2: PG input	0
DI11	F119	Terminal DI11 function *4	0 - 203	0
DI12	F120	Terminal DI12 function *4	0 - 203	0
DI13	F121	Terminal DI13 function *4	0 - 203	0
DI14	F122	Terminal DI14 function *4	0 - 203	0
DI15	F123	Terminal DI15 function *4	0 - 203	0
DI16	F124	Terminal DI16 function *4	0 - 203	0
F	F140	Terminal F response time	1 - 1000 (ms)	1 *5
R	F141	Terminal R response time	1 - 1000 (ms)	1 *5
RES	F142	Terminal RES response time	1 - 1000 (ms)	1 *5
S1	F143	Terminal S1 response time	1 - 1000 (ms)	1 *5
S2 - S5	F144	Terminal S2-S5 response time	1 - 1000 (ms)	1 *5
DI11-DI16	F145	Terminal DI11-DI16 response time *4	1 - 1000 (ms)	1 *5

*1 If a variety of functions are assigned to a terminal, the assigned functions will be simultaneously enabled.
*2 When you use the terminal [S4] as digital input, set <F146: Terminal S4 input select> = "0: Digital input".
*3 When you use the terminal [S5] as digital input, set <F147: Terminal S5 input select> = "0: Digital input".
*4 Indicated optional terminals on IO extension 1 (ETB013Z), refer to E6582128.
*5 If stable operation cannot be achieved because of noise of the frequency setting circuit, etc., increase the values for <F140: Terminal F response time> to <F145: Terminal DI11-DI16 response time>.

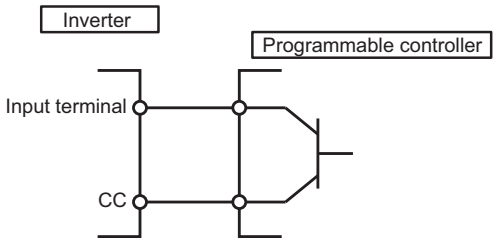
Memo	• To always enable the functions, assign the functions to <F110: Always active function 1>, <F127: Always active function 2>, and <F128: Always active function 3>.

■ Connecting methods

1) A contact input (for sink logic)



2) Transistor output connection (for sink logic)



You can connect the input terminal and the terminal [CC] (common) to the programmable controller output (non-logic switch) for control purposes. Use this connecting method for forward/reverse run, or preset speed operation, etc.

■ Usage example: 3-wire operation (one-push operation)

The use of the 3-wire operation function allows the one-push signal (reset logic signal) to be self-held during operation. No external sequence circuit is needed.

To perform 3-wire operation, make setting as shown below:

<F110: Always active function 1> = "6: Standby"

<CMOd: Run command select> = "0: Terminal"

<F111: Terminal F function 1> = "2: Fwd run" (default setting)

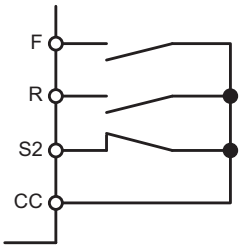
<F112: Terminal R function 1> = "4: Rev run"(default setting)

Also, assign "50: 3-wire operation hold/stop" ("51" for inversion input) to the input terminal.

The following shows an example for assignment to the terminal [S2].

<F115: Terminal S2 function > = "50"

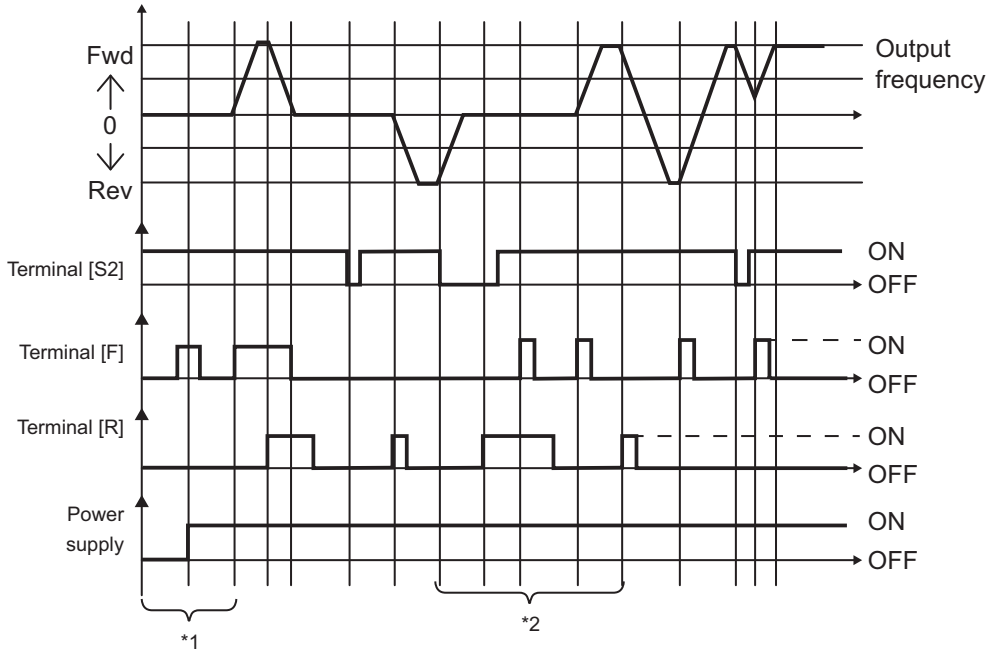
For sink logic



Fwd run

Rev run

3-wire operation hold/stop … Comes to deceleration stop with the terminal [S2] ON.



*1 -> If each terminal is turned ON before the power is turned ON, it is very dangerous because sudden movement occurs. Therefore, the input terminal ON signal is ignored at power on. After power on, turn ON the input terminal again.

*2 -> Turn ON 3-wire operation hold/stop(HD), and then Fwd run (F) or Rev run (R).
Even if Fwd run or Rev run is turned ON while 3-wire operation hold/stop is OFF, the signal will be ignored. Even if 3-wire operation hold/stop is turned ON while Rev run is ON, operation will not occur. Even If Fwd run is turned ON in that state, operation will not occur. Turn OFF Fwd run and Rev run, and then turn ON Fwd run or Rev run.

The input terminal function of 3-wire operation hold/stop is held only for Fwd run (F) and Rev run (R). Keep in mind that the other functions are not held when Fwd run or Rev run is used in combination of any other function. For example, when Fwd run and Preset speed switching 1 (SS1) are assigned, Fwd run is held, but not Preset speed switching 1.

Memo	• If the jog run command is input during 3-wire operation, operation will stop. • Keep in mind that DC braking continues even if a run command is input during DC braking.

■ List of the digital input terminal functions

Setting value		Input terminal function	Setting value		Input terminal function
Positive logic	Negative logic (Inverse)		Positive logic	Negative logic (Inverse)	
0	1	No function	84	85	Terminal R2 output hold
2	3	Fwd run	88	89	Terminal Up frequency *1
4	5	Rev run	90	91	Terminal Down frequency *1
6	7	Standby	92	93	Terminal Up, Down frequency clear *1
8	9	Reset 1	94	95	Dancer correction OFF
10	11	Preset speed switching 1	96	97	Coast stop
12	13	Preset speed switching 2	98	99	Fwd/Rev
14	15	Preset speed switching 3	100	101	Run/Stop
16	17	Preset speed switching 4	102	103	Commercial power run switching
18	19	Jog run	104	105	FMOd/F207 priority switching
20	21	Emergency off	106	107	Terminal II priority
22	23	DC braking	108	109	Terminal operation priority
24	25	Acc/Dec switching 1	110	111	Parameter writing unlocked
26	27	Acc/Dec switching 2	112	113	Speed control/Torque control switching
28	29	V/f switching 1	114	115	External equipment counter
30	31	V/f switching 2	116	117	PID 1, 2 switching
32	33	Stall prevention switching/Torque limit switching 1	118	119	Preset speed switching 5
34	35	Torque limit switching 2	120	121	Quick deceleration 1
36	37	PID control OFF	122	123	Quick deceleration 2
38	39	Pattern operation 1	124	125	Preliminary excitation
40	41	Pattern operation 2	126	127	Brake
42	43	Pattern operation continuation	130	131	Brake answerback
44	45	Pattern operation start	134	135	Traverse operation
46	47	External thermal trip	136	137	Rescue operation
48	49	Communication priority cancel	138	139	Pump control switching
50	51	3-wire operation hold/stop	140	141	Fwd slowdown
52	53	PID differential/integral reset	142	143	Fwd stop
54	55	PID plus/minus switching	144	145	Rev slowdown
56	57	Forced run	146	147	Rev stop

Setting value		Input terminal function	Setting value		Input terminal function
Positive logic	Negative logic (Inverse)		Positive logic	Negative logic (Inverse)	
58	59	Fire speed run	148	149	Fwd/Rev slowdown
60	61	Dwell operation	150	151	Hit and stop clear
62	63	Synchronized Acc/Dec	152	153	No.2 motor switching
64	65	My function start	154	155	External PID3 enabled
66	67	Offline auto-tuning	156	157	External PID4 enabled
68	69	Speed control gain switching	158	159	Reset 2
70	71	Servo lock	162	163	External PID3 differential/integral reset
72	73	Simple positioning	164	165	External PID3 plus/minus switching
74	75	Cumulative power monitor clear	170	171	External PID4 differential/integral reset
76	77	Trace trigger	172	173	External PID4 plus/minus switching
78	79	Light-load high-speed operation inhibited	176	177	Pump control release
80	81	Terminal FP output hold	200	201	Parameter writing locked
82	83	Terminal R1 output hold	202	203	Parameter reading locked

*1 Enabled only for <FMOd: Frequency command select 1> = "15: Terminal Up/Down frequency".
The frequency command range is 0.0 to <FH: Maximum frequency>. The acceleration/deceleration time is the time set for <ACC: Acceleration time 1> and <dEC: Deceleration time 1> unless acceleration/deceleration switching is performed.

For details on the input terminal functions, refer to [11. 5].

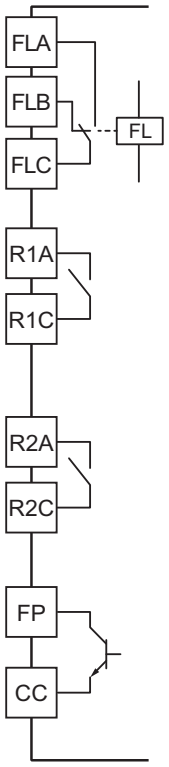
7. 2. 2 Setting the functions to the output terminals (for sink logic)

Signals are output to external equipment from the inverter.
You can select the functions for the digital output terminals and the relay logic output terminals from a variety of output terminal functions.
Two types of functions can be set for the terminals [FP] and [R1A]-[R1C]. In this case, output is possible when the two functions are simultaneously turned ON or either of the functions is turned ON.

■ Configuration of the control terminal block



■ Use conditions



Functions of the terminals [FLA]-[FLB]-[FLC]:
Set in parameter <F132> *1

Functions of the terminals [R1A]-[R1C], [R2A]-[R2C]:
Set in parameter <F130>, <F137> *1

Functions of the terminal [FP]:
Set in parameter <F131>, <F138> *1

*1 With relay contact output, chattering (momentary ON/OFF of contact) is generated by external factors of the vibration and the impact, etc. In particular, please set a filter of 10 ms or more, or timer for measures when connecting it directly to the input unit of the programmable controller. When connecting the programmable controller, use the terminal [FP] if possible.

■ Function setting for the output terminals

Terminal symbol	Title	Parameter name	Adjustment range	Default setting
FP	F130	Terminal FP function 1 *1	0 - 255	6
	F137	Terminal FP function 2 *1		255
	F669	Terminal FP switching	0: Digital output 1: Pulse train output	0
FLA-FLB-FLC	F132	Terminal FL function	0 - 255	10
R1A-R1C	F133	Terminal R1 function 1	0 - 255	4
	F138	Terminal R1 function 2		255
R2A-R2C	F134	Terminal R2 function	0 - 255	254
DQ11	F159	Terminal DQ11 function *2	0 - 255	254
DQ12	F160	Terminal DQ12 function *2	0 - 255	254
R4	F161	Terminal R4 function *2	0 - 255	254
R5	F162	Terminal R5 function *2	0 - 255	254
R6	F163	Terminal R6 function *2	0 - 255	254
R1	F135	Terminal R1 delay time	0.0 - 60.0 (s)	0.0
R2	F136	Terminal R2 delay time	0.0 - 60.0 (s)	0.0
FP R1A-R1C	F139	Terminal FP, R1 logic select	0: F130 and F137, F133 and F138 1: F130 and F137, F133 or F138 2: F130 or F137, F133 and F138 3: F130 or F137, F133 or F138	0

*1 When you use the terminal [FP] as digital input, set <F669: Terminal FP switching> = "0: Digital output".

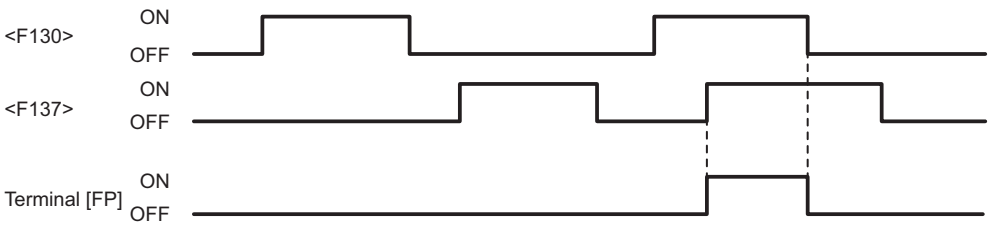
*2 Indicated optional terminals on IO extension 1 (ETB013Z) or IO extension 2 (ETB014Z), refer to E6582128 or E6582129.

■ Assigning two types of functions to a terminal

For the output terminals, you can assign two types of functions to the terminals [FP] and [R1A]-[R1C].

1) Logical product (AND): Signals are output when two types of functions are simultaneously turned ON.

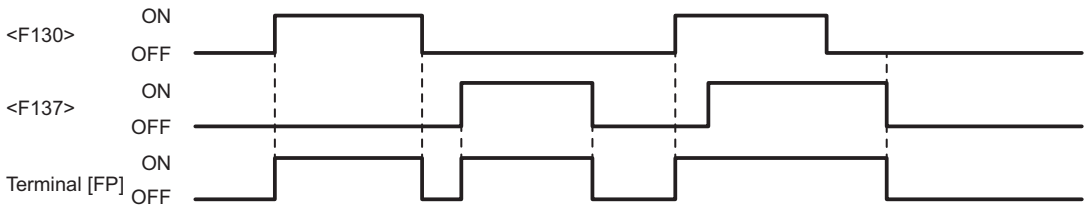
In case of the terminal [FP], when you set <F139: Terminal FP, R1 logic select> = "0" or "1", signals are output when the functions set for <F130: Terminal FP function 1> and <F137: Terminal FP function 2> are simultaneously turned ON.



In case of the terminals [R1A]-[R1C], when you set <F139> = "0" or "2", signals are output when the functions set for <F133: Terminal R1 function 1> and <F138: Terminal R1 function 2> are simultaneously turned ON.

2) Logical sum (OR): Signals are output when either of two functions is turned ON.

In case of the terminal [FP], when you set <F139: Terminal FP, R1 logic select> = "2" or "3", signals are output when either of the functions set for <F130: Terminal FP function 1> and <F137: Terminal FP function 2> is turned ON.



7

In case of the terminals [R1A]-[R1C], when you set <F139> = "1" or "3", signals are output when either of the functions set for <F133: Terminal R1 function 1> and <F138: Terminal R1 function 2> is turned ON.

■ Holding the signal output ON state (output hold function)

You can set the terminals [FP], [R1A]-[R1C], and [R2A]-[R2C] so that the ON state is held even after the condition is changed when a signal is once turned ON.

When a corresponding output terminal is turned ON while the input terminal where the output hold function is assigned is ON, the ON state is held.

Assign the following function numbers to any open input terminals.

For holding the output of the terminal [FP]: "80: Terminal FP output hold"

For holding the output of the terminal [R1A]: "82: Terminal R1 output hold"

For holding the output of the terminal [R2A]: "84: Terminal R2 output hold"

■ Usage example 1: Outputting running signals

The following shows examples for outputting running signals.

Running signals can be output from the terminals [R1A]-[R1C] as default setting.

- <F133: Terminal R1 function 1> = "4: Low-speed signal" (default setting)
- <F100: Low-speed signal output frequency> = "0.0" (Hz) (default setting)

For the output terminal function of "4: Low-speed signal", signals are output when the output frequency becomes the frequency set for <F100: Low-speed signal output frequency> or more. In case of <F100> = "0.0" (Hz), the signal is turned ON when the frequency is output. Therefore, you can use it as a running signal.

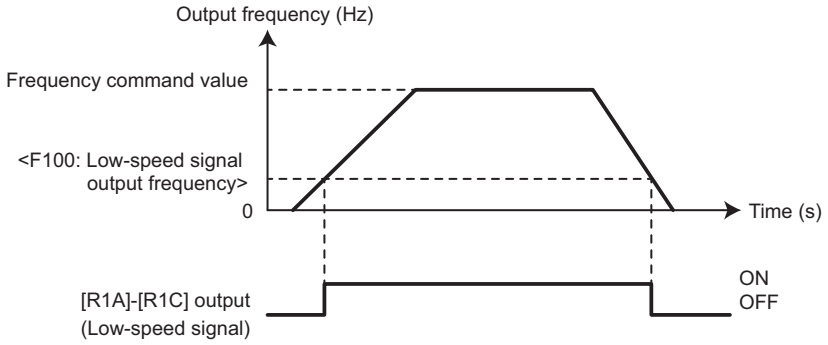
■ Usage example 2: Outputting braking signals

The following shows an example for outputting the excitation/release signals for the electromagnetic brake.

To output the braking signals from the terminals [R1A]-[R1C], make setting as follows:

- <F133: Terminal R1 function 1> = "4: Low-speed signal" (default setting)
- <F100: Low-speed signal output frequency> = "2.5" (Hz) (setting example)

Set <F100> to the value for the motor rated slip.



■ List of the digital output terminal functions

Setting value		Output terminal function	Setting value		Output terminal function
Positive logic	Negative logic (Inverse)		Positive logic	Negative logic (Inverse)	
0	1	Lower limit frequency (LL)	116	117	Failure signal 4
2	3	Upper limit frequency (UL)	118	119	Stop positioning completion
4	5	Low-speed signal	120	121	During sleep
6	7	Acc/Dec completed	122	123	During synchronized Acc/Dec
8	9	Specified frequency attainment	124	125	During traverse operation
10	11	Failure signal 1	126	127	During traverse Dec
12	13	Failure signal 2	128	129	Parts replacement alarm
14	15	Overcurrent (OC) pre-alarm	130	131	Overtorque (OT) pre-alarm
16	17	Inverter overload (OL1) pre-alarm	132	133	Frequency command 1/ Frequency command 2
18	19	Motor overload (OL2) pre-alarm	134	135	Failure signal 3
20	21	Overheat (OH) pre-alarm	136	137	Hand/Auto
22	23	Overvoltage (OP) pre-alarm	138	139	During forced run
24	25	Main circuit undervoltage (MOFF) alarm	140	141	During fire speed run
26	27	Undercurrent (UC) alarm	142	143	Undertorque alarm
28	29	Overtorque (OT) alarm	144	145	PID1, 2 frequency command agreement

Setting value		Output terminal function	Setting value		Output terminal function
Positive logic	Negative logic (Inverse)		Positive logic	Negative logic (Inverse)	
30	31	Braking resistor overload (OLr) pre-alarm	150	151	PTC input pre-alarm
32	33	Emergency off trip	152	153	During Safe Torque Off (STO)
34	35	During retry	154	155	Analog input disconnecting alarm
36	37	Pattern operation end	156	157	Terminal F ON/OFF
38	39	PID deviation limit	158	159	Terminal R ON/OFF
40	41	Run/Stop	160	161	Cooling fan replacement alarm
42	43	Serious failure	162	163	Number of starting alarm
44	45	Slight failure	164	165	Light load detection 2
46	47	Commercial power/Inverter Switching 1	166	167	During Acc
48	49	Commercial power/Inverter Switching 2	168	169	During Dec
50	51	During cooling fan run	170	171	During constant speed run
52	53	During jog run	172	173	During DC braking
54	55	During terminal run	174	175	During hit and stop
56	57	Cumulative run time alarm	176	177	During run including servo lock
58	59	Communication option communication time-out	178	179	During servo lock
60	61	Fwd/Rev run	180	181	For input cumulative power
62	63	Ready for run 1	182	183	Shock monitoring alarm
64	65	Ready for run 2	184	185	Number of external equipment starting alarm
68	69	During brake	186	187	V/f switching status 1
70	71	During alarm or pre-alarm	188	189	V/f switching status 2
72	73	During Fwd speed limit	190	191	Cooling fan fault alarm
74	75	During Rev speed limit	192	193	Embedded Ethernet communication time-out
76	77	Inverter healthy output	194 - 201		Calendar 1 - 4
78	79	RS485 communication time-out	202	203	During PID2 control
92	93	Designated data bit 0	204	205	During External PID3 control
94	95	Designated data bit 1	206	207	External PID3 deviation limit
106	107	Light load detection 1	208	209	During External PID4 control
108	109	Heavy load detection	210	211	External PID4 deviation limit
110	111	During positive torque limit	212	213	Pump control

Setting value		Output terminal function	Setting value		Output terminal function
Positive logic	Negative logic (Inverse)		Positive logic	Negative logic (Inverse)	
112	113	During negative torque limit	222 - 253		My function output 1 - 16
114	115	For external relay of rush current suppression	254	255	254: Always OFF 255: Always ON

The setting items in the table are as follows:

- Alarm: Indicates an alarm output where the inverter or external equipment may be damaged if it continues.
- Pre-alarm: Indicates an alarm output almost at the trip level.

For positive logic

- "ON": Indicates that the digital output transistor or the relay is ON.
- "OFF": Indicates that the digital output transistor or the relay is OFF.

For negative logic

- "ON": Indicates that the digital output transistor or the relay is OFF.
- "OFF": Indicates that the digital output transistor or the relay is ON.

For details on the output terminal functions and the levels, refer to [11. 6].

7. 3 Frequency commands by the analog signals

You can input voltage signals and current signals to the analog input terminals as a frequency command.

7. 3. 1 Inputting frequency commands by analog signals

You can select four types of analog signals as a frequency command signal.

- Potentiometer
- 0 - 10 Vdc
- 4(0) - 20 mAdc
- -10 to +10 Vdc

For how to fine adjust the analog signals and output frequencies, refer to [6. 6. 3].

■ Configuration of the control terminal block



■ Analog input terminal function settings

Terminal symbol	Title	Parameter name	Adjustment range	Default setting
RR	F201	RR point 1 input value	0 - 100 (%)	0
	F202	RR point 1 frequency	0.0 - 590.0 (Hz)	0.0
	F203	RR point 2 input value	0 - 100 (%)	100
	F204	RR point 2 frequency	0.0 - 590.0 (Hz)	50.0/60.0 *1

Terminal symbol	Title	Parameter name	Adjustment range	Default setting
RX	F210	RX point 1 input value	-100 to 100 (%)	0
	F211	RX point 1 frequency	0.0 - 590.0 (Hz)	0.0
	F212	RX point 2 input value	-100 to 100 (%)	100
	F213	RX point 2 frequency	0.0 - 590.0 (Hz)	50.0/60.0 *1
	F107	Terminal RX input voltage select	0: 0 to +10 V 1: -10 to +10 V	0
II	F216	II point 1 input value	0 - 100 (%)	20
	F217	II point 1 frequency	0.0 - 590.0 (Hz)	0.0
	F218	II point 2 input value	0 - 100 (%)	100
	F219	II point 2 frequency	0.0 - 590.0 (Hz)	50.0/60.0 *1
AI4	F222	AI4 point 1 input value *2	-100 to 100 (%)	0
	F223	AI4 point 1 frequency *2	0.0 - 590.0 (Hz)	0.0
	F224	AI4 point 2 input value *2	-100 to 100 (%)	100
	F225	AI4 point 2 frequency *2	0.0 - 590.0 (Hz)	50.0/60.0 *1
	F148	Terminal AI4 input select *2	1: Voltage input (0 - 10 V) 2: Voltage input (-10 to +10 V) 3: Current input (0 - 20 mA) 4: PTC input 5: PT100 (2-wire) input 6: PT100 (3-wire) input 7: PT1000 (2-wire) input 8: PT1000 (3-wire) input 9: KTY84 input	1
AI5	F228	AI5 point 1 input value *2	-100 to 100 (%)	0
	F229	AI5 point 1 frequency *2	0.0 - 590.0 (Hz)	0.0
	F230	AI5 point 2 input value *2	-100 to 100 (%)	100
	F231	AI5 point 2 frequency *2	0.0 - 590.0 (Hz)	50.0/60.0 *1
	F149	Terminal AI5 input select *2	1: Voltage input (0 to 10V) 2: Voltage input (-10 to +10 V) 3: Current input (0 - 20 mA) 4: PTC input 5: PT100 (2-wire) input 6: PT100 (3-wire) input 7: PT1000 (2-wire) input 8: PT1000 (3-wire) input 9: KTY84 input	1

Terminal symbol	Title	Parameter name	Adjustment range	Default setting
Common	F209	Analog input filter	1: Disabled 2 - 1000 (ms)	1 *3
	A959	Analog input function target 11	0: Disabled 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 5: Terminal AI5	
	A961	Analog function setting destination 11	0: Disabled 1: Acc/Dec rate (ACC.dEC etc.) 2: Upper limit frequency (UL) 3: Acc multiplication factor (FH/ ACC etc.) 4: Dec multiplication factor (FH/ dEC etc.) 5: Manual torque boost (vb etc.) 6: Stall prevention level (F601 etc.) 7: Motor OL protection current (tHrA) 8: Speed control response (F460 etc.) 9: Droop gain (F320 etc.) 10: PID proportional gain (F362 etc.) 11: Base frequency voltage (VL etc.) 12 - 20: -	
	A962	Analog input function target 21	Same as A959	
	A964	Analog function setting destination 21	Same as A961	

*1 The default setting value is depending on the setup menu. Refer to [5. 3. 10].
*2 Indicated optional terminals on IO extension 1 (ETB013Z), refer to E6582128.
*3 If stable operation cannot be achieved because of noise of the frequency command circuit, etc., increase the value for <F209: Analog input filter>.

For details on switching two types of analog signals for operation, refer to [5. 4. 1].

7. 3. 2 Inputting the frequency commands by potentiometer/voltage (0 - 10 Vdc)

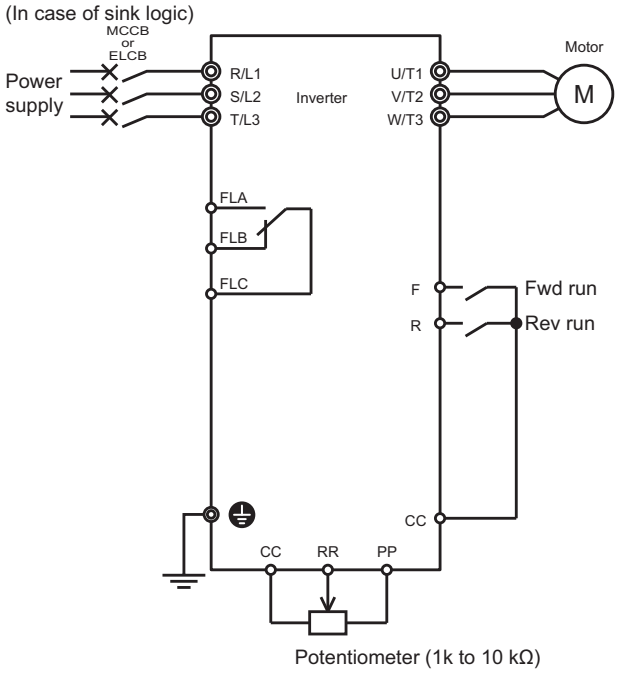
Connect a potentiometer (1 k - 10 kΩ) between the terminals [PP]-[RR]-[CC] to input frequency commands.
Divide the reference voltage (10 Vdc) of the terminal [PP] using a potentiometer to input the voltage of 0 - 10 Vdc between the terminals [RR]-[CC].
You can also directly input a voltage signal of 0 - 10 Vdc between the terminals [RR]-[CC] without using a potentiometer.

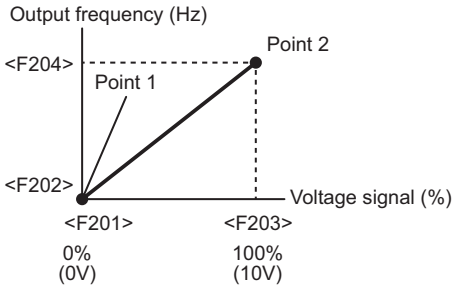
■ Setting example

The following shows an example of how to externally input the run commands to the digital input terminals, and how to input the frequency commands using a potentiometer.
The frequency shall be 0 Hz at the minimum setting of a potentiometer, and 60 Hz at the maximum setting of a potentiometer.

- <CMOd: Run command select> = "0: Terminal"
- <FMOd: Frequency command select 1> = "1: Terminal RR"
- <F201: RR point 1 input value> = "0" (%) (default setting)
- <F202: RR point 1 frequency> = "0" (Hz) (default setting)
- <F203: RR point 2 input value> = "100" (%) (default setting)
- <F204: RR point 2 frequency> = "60" (Hz) (default setting)

For the characteristics of input voltages and output frequencies, set at two points of <F201> and <F202>, and <F203> and <F204>. The reference for 100% of the input value is 10 V.





7. 3. 3 Inputting the frequency commands by current (4 - 20 mAdc)

Input the current signal of 4(0) - 20 mAdc between the terminals [II]-[CC].

■ Setting example

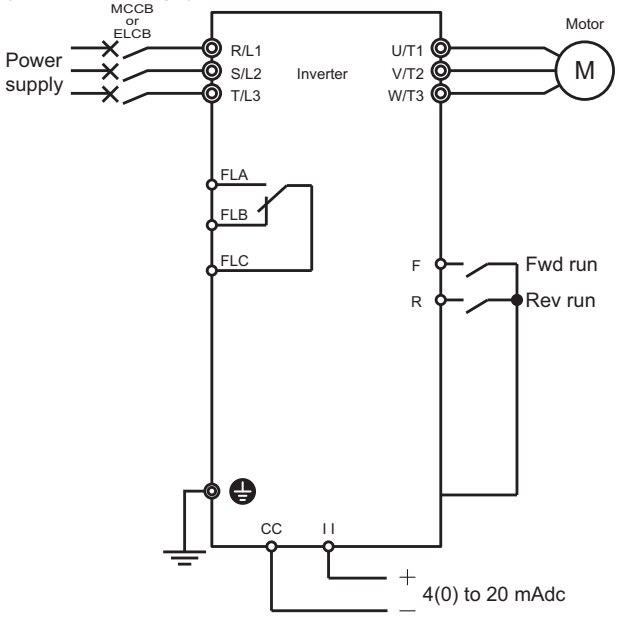
The following shows an example of how to externally input the run commands to the digital input terminals with a current input of 4 - 20 mAdc.

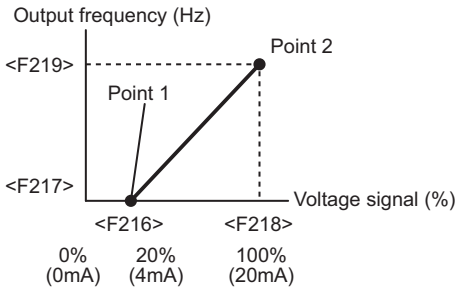
The frequency shall be 0 Hz for the minimum input of 4 mA, and 60 Hz for the maximum input of 20 mA.

- <CMOd: Run command select> = "0: Terminal"
- <FMOd: Frequency command select 1> = "3: Terminal II"
- <F216: II point 1 input value> = "20" (%) (default setting)
- <F217: II point 1 frequency> = "0" (Hz) (default setting)
- <F218: II point 2 input value> = "100" (%) (default setting)
- <F219: II point 2 frequency> = "60" (Hz) (default setting)

For the characteristics of input currents and output frequencies, set at two points of <F216> and <F217>, and <F218> and <F219>. The reference for 100% of the input value is 20mA.

(In case of sink logic)





7. 3. 4 Inputting frequency commands by voltage (-10 to +10 Vdc)

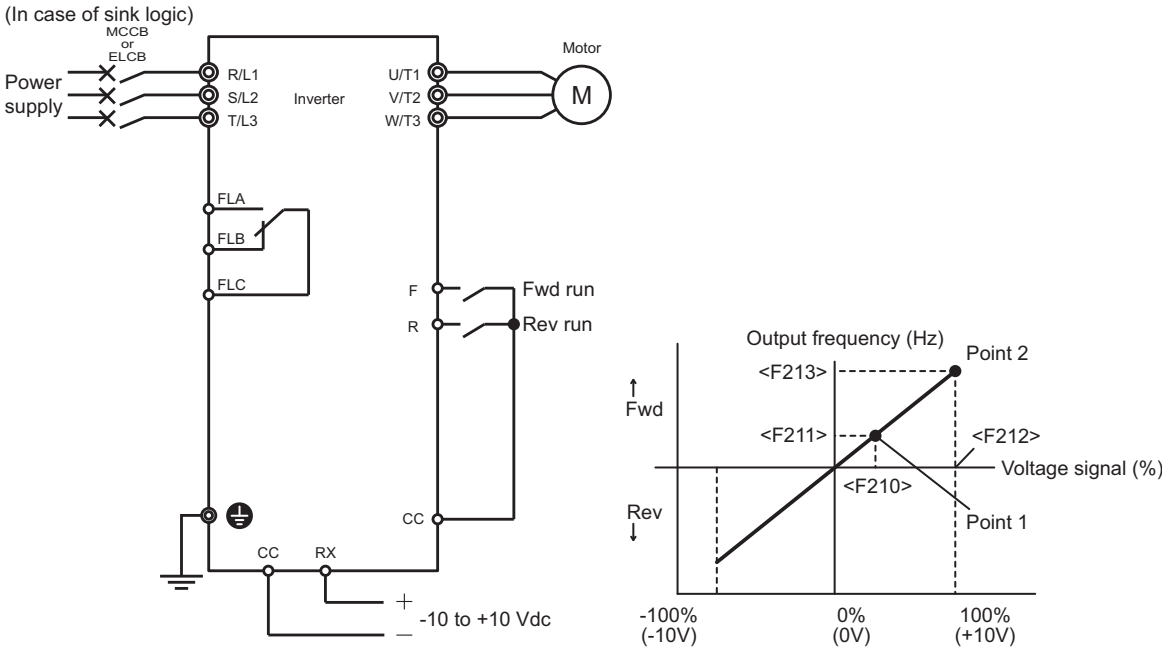
Input the voltage signal of -10 to +10 Vdc between the terminals [RX]-[CC].
You can also input a voltage of 0 - 10 Vdc. Set <F107: Terminal RX input voltage select> = "0: 0 to +10 V".

■ Setting example

The following shows an example of how to externally input the run commands to the digital input terminals with a voltage input of -10 to +10 V.
The frequency shall be 0 Hz at 0 V, and 60 Hz at +10 V. At this time, the frequency becomes 60 Hz in reverse run at -10 V.

- <CMOd: Run command select> = "0: Terminal"
- <FMOd: Frequency command select 1> = "2: Terminal RX"
- Set <F107: Terminal RX input voltage select> = "1: -10 to +10 V".
- <F210: RX point 1 input value> = "0" (%) (default setting)
- <F211: RX point 1 frequency> = "0" (Hz) (default setting)
- <F212: RX point 2 input value> = "100" (%) (default setting)
- <F213: RX point 2 frequency> = "60" (Hz) (default setting)

For the characteristics of input currents and output frequencies, set at two points of <F210> and <F211>, and <F212> and <F213>. The reference for 100% of the input value is 10 V.



7

8 Monitoring operation status

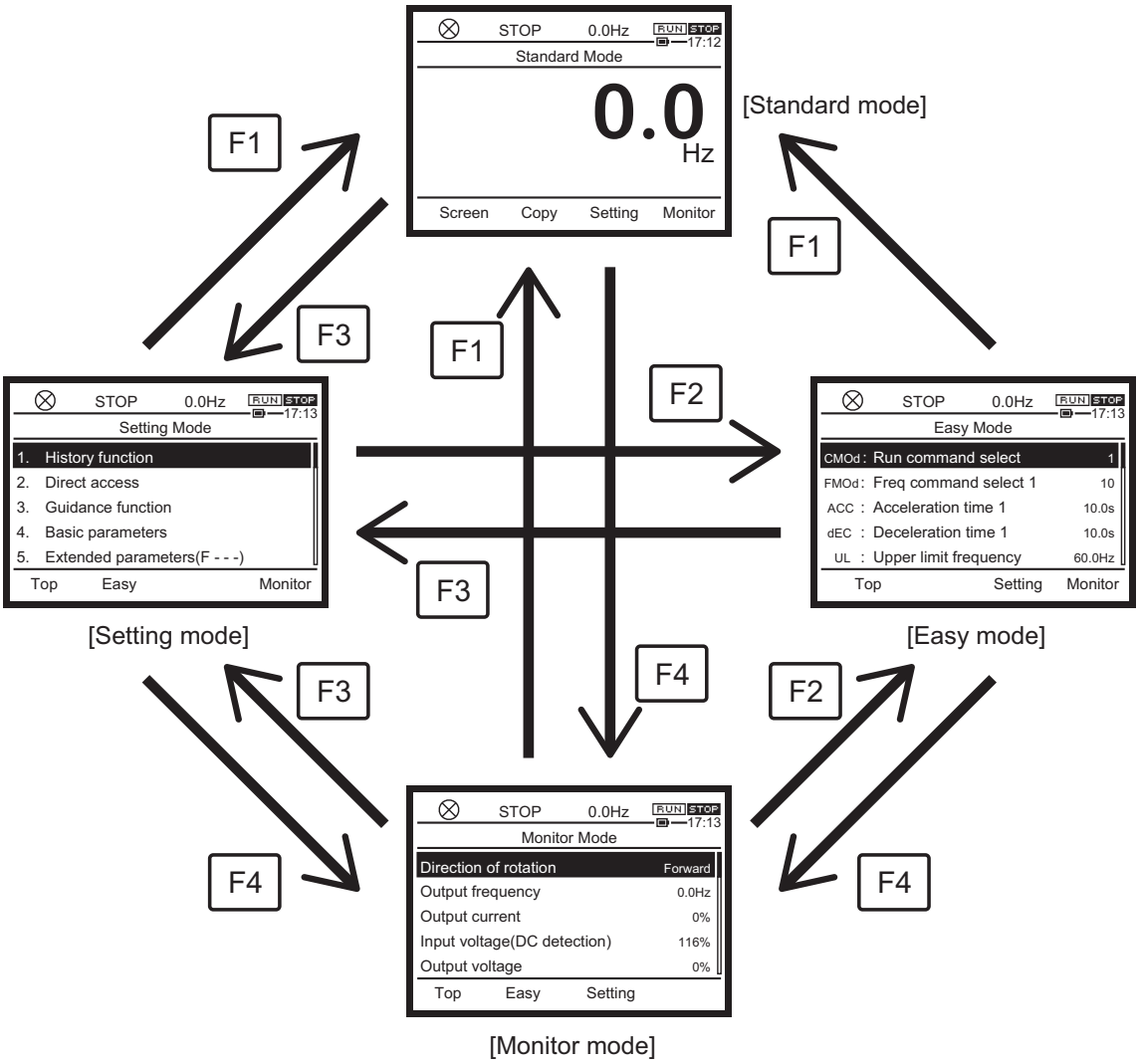
In [Monitor mode], the operation status of the inverter, ON/OFF information of input/output terminals, trip record, etc. are displayed.
This chapter explains the display contents of [Monitor mode].
Furthermore, display at the time of occurrence of a trip and causes and remedies are also introduced.

8. 1 Screen display of [Monitor mode]

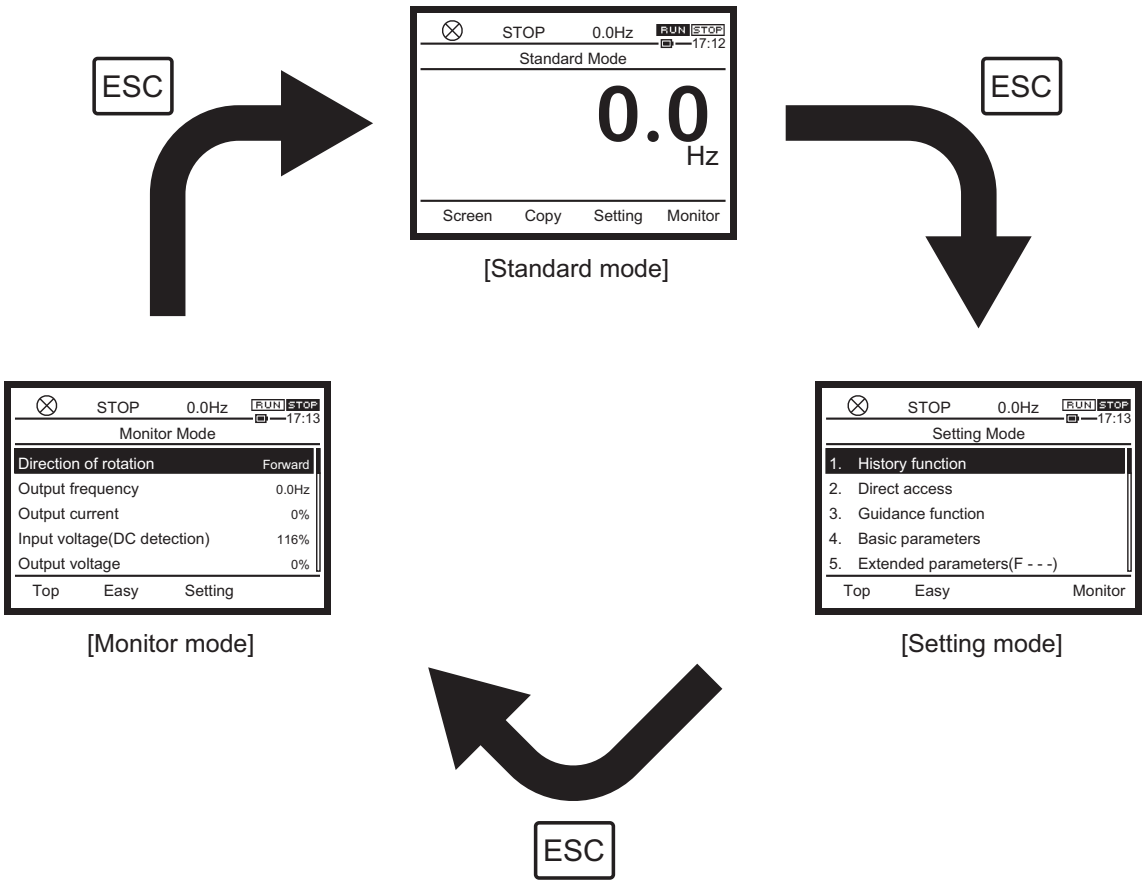
For the outline of screen display of [Monitor mode], refer to [3. 1. 2] "■Screen display of [Monitor mode]".

8. 1. 1 Operation Status monitor

When [Standard mode] is displayed on the LCD screen during run, press the [F4] key or press [ESC] key twice to switch to [Monitor mode].


STOP 0.0Hz RUN STOP 17:12
Standard Mode
0.0 Hz
Screen Copy Setting Monitor
[Standard mode]
F1
F3
F2
F4
STOP 0.0Hz RUN STOP 17:13
Setting Mode
1. History function
2. Direct access
3. Guidance function
4. Basic parameters
5. Extended parameters(F - - -)
Top Easy Monitor
[Setting mode]
STOP 0.0Hz RUN STOP 17:13
Easy Mode
CMOd : Run command select 1
FMOd : Freq command select 1 10
ACC : Acceleration time 1 10.0s
dEC : Deceleration time 1 10.0s
UL : Upper limit frequency 60.0Hz
Top Setting Monitor
[Easy mode]
STOP 0.0Hz RUN STOP 17:13
Monitor Mode
Direction of rotation Forward
Output frequency 0.0Hz
Output current 0%
Input voltage(DC detection) 116%
Output voltage 0%
Top Easy Setting
[Monitor mode]

8

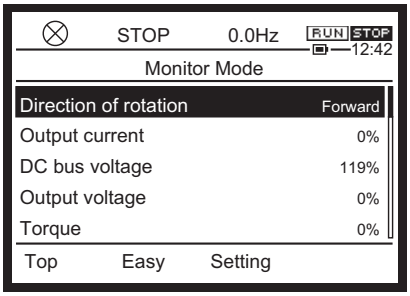

ESC
STOP 0.0Hz RUN STOP 17:12
Standard Mode
0.0
Hz
Screen Copy Setting Monitor
[Standard mode]
ESC
STOP 0.0Hz RUN STOP 17:13
Monitor Mode
Direction of rotation Forward
Output frequency 0.0Hz
Output current 0%
Input voltage(DC detection) 116%
Output voltage 0%
Top Easy Setting
[Monitor mode]
STOP 0.0Hz RUN STOP 17:13
Setting Mode
1. History function
2. Direct access
3. Guidance function
4. Basic parameters
5. Extended parameters(F - - -)
Top Easy Monitor
[Setting mode]
ESC

■ Screen configuration of [Monitor mode]

If an "OK" mark is displayed on the [F4] key when you select any of the displayed items, a details monitor is available. When you press the [F4] key or [OK] key, you can go to the details monitor. When you press the [i] key, you can check the inverter rating and the CPU version.

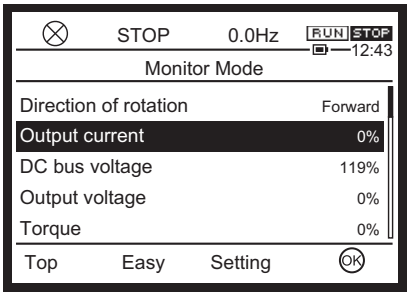
1) Direction of rotation

"Forward" or "Reverse" is displayed.
The direction of rotation of the monitor output by the inverter is displayed whether the motor is run or stopped.



2) Selected monitor 1 to 8

The monitor items selected with <F711: Monitor mode 1 display> to <F718: Monitor mode 8 display> are displayed. In the default setting, the following monitor items are displayed.



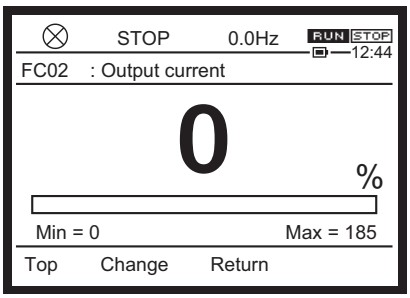
- Output current
- Input voltage (DC detection)
- Output voltage
- Torque
- Input power
- Output power
- Inverter load factor
- Motor load factor

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Memo

- Output current: The current monitored is displayed in percentage. The value indicated on the nameplate is 100%. The unit can be switched to A (amperes). Set <F701: Current, voltage units select> to "1: A (ampere), V (volt)."
- Input voltage: The reference values (100% values) are 200 V (240 V class) and 400 V (480 V class). The voltage displayed is the voltage determined by converting the voltage measured in the DC section into an AC voltage. The unit can be switched to V (volts). Set <F701: Current, voltage units select> to "1: A (ampere), V (volt)."
- Output voltage: The reference values (100% values) are 200 V (240 V class) and 400 V (480 V class). The voltage displayed is the output command voltage. The unit can be switched to V (volts). Set <F701: Current, voltage units select> to "1: A (ampere), V (volt)."
- Load factor of inverter: Depending on <F300: Carrier frequency> setting and so on, the actual rated current may become smaller than the rated output current indicated on the nameplate. With the actual rated current at that time (after reduction) as 100%, the proportion of the load current to the rated current is indicated in percent. The load factor is also used to calculate the conditions for overload trip "OL1".

In the details monitor, it is indicated with a graphic bar.
When you press the [F2] key ("Change"), you can go to <F711: Monitor mode 1 display> to <F718: Monitor mode 8 display> to change settings.



Title	Parameter name	Adjustment range	Default setting
F711	Monitor mode 1 display	0 - 162 *1	2
F712	Monitor mode 2 display	0 - 162*1	3
F713	Monitor mode 3 display	0 - 162*1	4
F714	Monitor mode 4 display	0 - 162*1	8
F715	Monitor mode 5 display	0 - 162*1	18
F716	Monitor mode 6 display	0 - 162*1	19
F717	Monitor mode 7 display	0 - 162*1	35
F718	Monitor mode 8 display	0 - 162*1	34

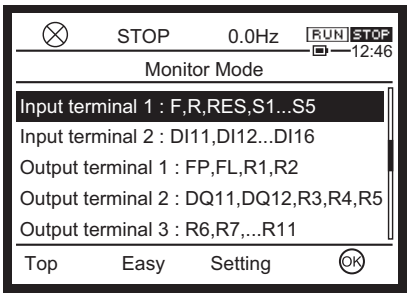
*1 For details, refer to the table at the end of this subsection.

8

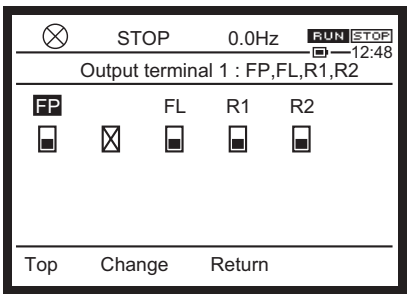
3) Input/output terminals

The details monitor displays the ON/OFF status of the following input/output terminals.

- Input terminal 1 (F, R, RES, S1...S4, S5)
- Input terminal 2 (DI11, DI12...DI16)
- Output terminal 1 (FP, FL,R1, R2)
- Output terminal 2 (DQ11, DQ12, R3, R4, R5)
- Output terminal 3 (R6, R7...R11)

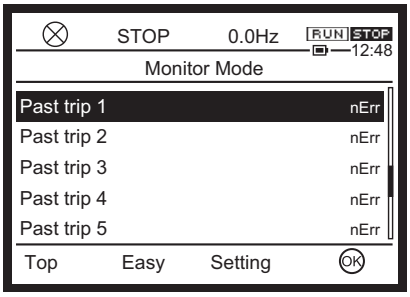


If the terminal you have selected has a related parameter, the [F2] key ("Change") is displayed. When you press the [F2] key ("Change"), you can go to the screen of the related parameter to change the setting.



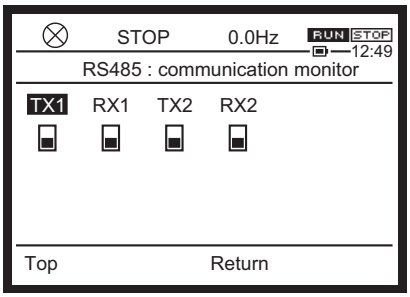
4) Past trip 1 to 8

The trip records are displayed. Past trip 1 is the record of the latest trip, and Past trip 8 is the record of the oldest trip.
If no trip information exists, "nErr" is displayed.
On the details monitor, you can check the details of trips. Refer to [8.1.2].



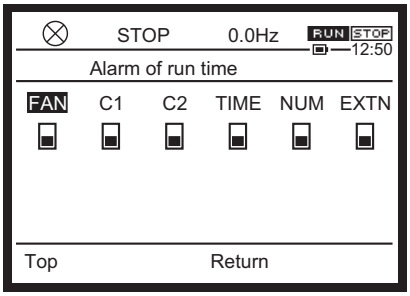
5) Communication status

The details monitor displays the transmitting/receiving status of RS485 communication connector 1, 2. The connector 1 signal transmitting "TX1", connector 1 signal receiving "RX1", connector 2 signal transmitting "TX2", and connector 2 signal receiving "RX2" are displayed.



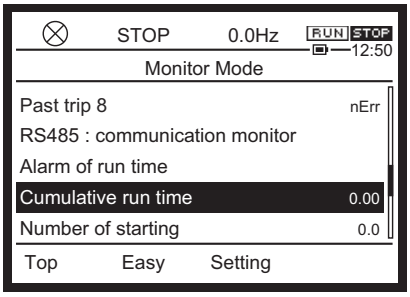
6) Parts replacement alarm information

The details monitor displays replacement alarms of the cooling fan, capacitor, etc.



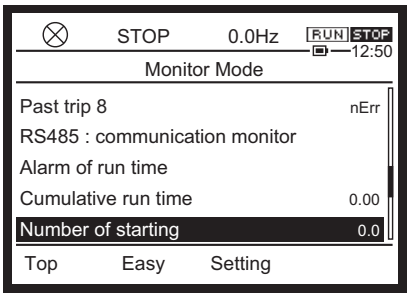
7) Cumulative run time

The cumulative run time of the inverter is displayed. The display unit is 100 hours, and the minimum value 0.01 is equal to 1 hour.
To clear the value, set <tyP: Default setting> to "5: Clear cumulative run time."



8) Number of starting

The number of starting of the inverter is displayed. The display unit is one time, and the maximum value is 9.99 million times.
(In the case of an LED display extension panel, the display unit is 10000 times, and the minimum value 0.1 is equal to 1000 times.)
To clear the value, set <tyP: Default setting> to "12: Clear cumulative run time."



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■ Settings for <F711: Monitor mode 1 display> to <F718: Monitor mode 8 display>

Setting value	Function name	Display unit	Setting value	Function name	Display unit
0	Output frequency	0.1 Hz	71	Motor speed (estimated value, Max. 32700 min^{-1})	min^{-1}
1	Frequency command value	0.1 Hz	72	Communication option Receiving counter	1
2	Output current	1%/<F701> setting *1	73	Communication option Abnormal counter	1
3	Input voltage (DC detection)	1%/<F701> setting *1	76	Terminal S4/S5 pulse train input value	0.10%
4	Output voltage	1%/<F701> setting *1	77	My function COUNT1	1
5	Stator frequency	0.1 Hz	78	My function COUNT2	1
6	Speed feedback frequency (real time)	0.1 Hz	79	Dancer control PID result frequency	0.1 Hz
7	Speed feedback frequency (1-second filter)	0.1 Hz	80	Embedded Ethernet Transmission counter	1
8	Torque	1% *1	81	Embedded Ethernet Receiving counter	1
9	Torque command	1% *1	82	Embedded Ethernet Abnormal counter	1
10	Output frequency during run. / Frequency command value during stop.	Hz/free unit	83	Connected option number	1
			84	My function COUNT3	1
11	Torque current	1% *1	85	My function COUNT4	1
12	Exciting current	1%	86	My function COUNT5	1
13	PID feedback value	0.1 Hz	90	Cumulative power ON time	100 hours
14	Motor overload factor (OL2 data)	1%	91	Cumulative cooling fan run time	100 hours
15	Inverter overload factor (OL1 data)	1%	92	Cumulative run time	100 hours
16	Braking resistor overload factor (OLr data)	1%	93	Cumulative overcurrent time	100 hours
17	Braking resistor load factor (%ED)	1%	95	Pump 0 run time	100 hours
18	Input power	0.1 kW *1	96	Pump 1 run time	100 hours
19	Output power	0.1 kW *1	97	Pump 2 run time	100 hours
20	Input cumulative power	<F749> setting	98	Pump 3 run time	100 hours
21	Output cumulative power	<F749> setting	99	Pump 4 run time	100 hours

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Setting value	Function name	Display unit	Setting value	Function name	Display unit
22	-	-	100	Number of starting	10000 times
23	-	-	101	Number of Fwd starting	10000 times
24	Terminal RR input value	1%	102	Number of Rev starting	10000 times
25	Terminal RX input value	1%	103	External equipment counter	Time
26	Terminal II input value	1%	105	Pump 5 run time	100 hours
27	Motor speed command (max 32700 min^{-1})	min^{-1}	106	Pump 6 run time	100 hours
28	Terminal FM output value	1	107	Pump 7 run time	100 hours
29	Terminal AM output value	1	108	Pump 8 run time	100 hours
30	-	-	109	Pump 9 run time	100 hours
31	Communication data output	*2	110	Number of trip	Time
32	Slot A option CPU version	-	111	Number of serious failure trip	1
33	Slot B option CPU version	-	112	Number of slight failure trip	1
34	Motor load factor	%	113	Number of specified trip 1	1
35	Inverter load factor	%	114	Number of specified trip 2	1
36	Inverter rated current	A	115	Number of specified trip 3	1
37	Inverter rated current (with carrier frequency correction)	A	120	Internal temperature 1	°C
38	Actual carrier frequency	kHz	124	Main circuit board temperature	°C
39	Slot C option CPU version	-	130	External PID3 set value	0.1 Hz
40	Embedded Ethernet CPU version	-	131	External PID3 feedback value	0.1 Hz
41	Terminal FP pulse train output value	pps	132	External PID3 result value	0.1 Hz
43	Terminal FM/AM gain setting value	-	133	External PID4 set value	0.1 Hz
44	Terminal AI4 input value	1%	134	External PID4 feedback value	0.1 Hz
45	Terminal AI5 input value	1%	135	External PID4 result value	0.1 Hz
46	My function monitor output 1	-	150	Signed output frequency	0.1 Hz
47	My function monitor output 2	-	151	Signed frequency command value	0.1 Hz
48	My function monitor output 3	-	152	Signed stator frequency	0.1 Hz
49	My function monitor output 4	-	153	Signed speed feedback frequency (real time)	0.1 Hz

Setting value	Function name	Display unit	Setting value	Function name	Display unit
62	PID result frequency	0.1 Hz	154	Signed speed feedback frequency (1-second filter)	0.1 Hz
63	PID set value	0.1 Hz	155	Signed torque	1%
64	Light-load high-speed switching load torque	1%	156	Signed torque command	1%
65	Light-load high-speed torque during constant speed run	1%	158	Signed torque current	1%
66	Pattern operation group number	0.1	159	Signed PID feedback value	0.1 Hz
67	Pattern operation remaining cycle number	1	160	Signed terminal RX input value	1%
68	Pattern operation preset speed number	1	161	Signed terminal AI4 input value	1%
69	Pattern operation remaining time	0.1	162	Signed terminal AI5 input value	1%
70	Inverter rated voltage	1 V			

*1 Filtered value.
Filter time constant can be set by <F722>.

*2 For details, refer to “RS485 Communication Function Instruction Manual” (E6582143).

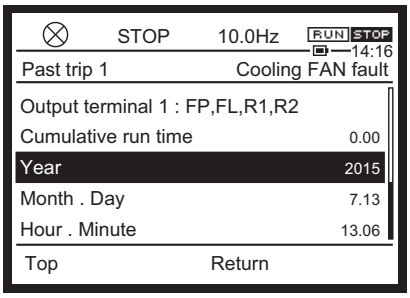
8

8. 1. 2 Detailed display of past trip

When you press the [OK] key while Past trip 1 to 8 are displayed in [Monitor mode], more detailed information can be displayed as follows.
Unlike "Display at the time of trip" in [3. 2. 2], it can be displayed after the inverter is turned off or reset. However, the monitor value of a trip is not always recorded as the maximum value because of the time required for detection.

■Details of the past
On the detail screen of the past trip show the information of the 13 items.
The trip history number and trip name are displayed in the mode name area.

- Number of occurrences
- Output frequency
- Direction of rotation
- Frequency command value
- Output current
- Input voltage (DC detection)
- Output voltage
- Input terminal 1 (F, R, RES, S1...S4, S5)
- Output terminal 1 (FP, FL,R1, R2)
- Cumulative operation time
- Year
- Month, Date
- Hour, Minutes



At following circumstance, the trip date (year, month, …) are not correct.
1. LCD keypad is not attached.
2. date (year, month, …) are not set correctly.
3. the battery of LCD keypad is empty.

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8. 2 Screen display at trip occurrence

If an alarm occurs, text is displayed on the LCD screen according to the contents of the alarm.
If a trip occurs, text is displayed on the LCD screen, and the backlight turns red to indicate an error.

8. 2. 1 Display of trip information and alarm information

If the inverter trips, the contents of the trip are displayed. You can also check the status at the time of trip in [Monitor mode].
If the inverter issues an alarm, the contents of the alarm are displayed.
Refer to "Chap 13" for trip and alarm display.

8. 2. 2 Monitor display at trip

Data at the time of occurrence of the trip are retained.
Before the inverter is turned off or reset, information equivalent to "Operation Status monitor" in [8. 1. 1] can be displayed in [Monitor mode].
After power off or reset, information is stored in Past trip 1 to 8 in [Monitor mode]. For details, refer to [8. 1. 2].

9 Measures to satisfy standards

This chapter explains the measures to comply with the EMC Directive, UL/CSA Standards, etc. by introducing examples.

9. 1 How to deal with CE marking

CE mark is put on all products of VF-AS3 to declare that they are in conformity with the requirements of Low Voltage Directive and EMC Directive, also the products integrating the safety function are in conformity with the requirements of machine directive as safety component.

The CE mark must be put on all machines and systems with built-in inverters because such machines and systems are subject to the above directives. If they are final products, they might also be subject to the Machinery Directive.
It is the responsibility of the manufacturers of such final products to put the CE mark on each final product. In order to make machines and systems with built-in inverters comply with the EMC Directive and the Low Voltage Directive, we recommend the installation method of inverters and measures for EMC Directive described in this instruction manual.

We have tested representative models with them installed under the environment described later in this manual to check for conformity with the EMC Directive. However, we cannot check the inverters under your operating environment. EMC varies depending on the composition of the control panel with a built-in inverter(s), the relationship with other built-in electrical components, the wiring condition, the layout condition, and so on. Therefore, you need to verify yourself whether your machine and system conforms to the EMC Directive.

9. 1. 1 Compliance with EMC Directive

The CE mark must be put on every final product that includes an inverter(s) and a motor(s). 480V class inverters of VF-AS3 series are equipped with an EMC filter and comply with the EMC Directive if wiring is carried out correctly.

The EMC standards are broadly divided into two categories; Emission and Immunity, each of which is further categorized according to the operating environment of each individual machine as shown in the table below. We consider that the tests required for machines and systems as final products are almost the same as those required for inverters.

Category	Subcategory	Product standards	Test standard
Emission	Radiated noise	IEC61800-3	CISPR11 (EN55011)
	Conducted noise		CISPR11 (EN55011)
Immunity	Electrostatic discharge		IEC61000-4-2
	Radio-frequency electromagnetic field		IEC61000-4-3
	Electrical fast transient/burst		IEC61000-4-4
	Surge		IEC61000-4-5
	Conducted radio-frequency common mode		IEC61000-4-6
	Voltage dips, short interruptions and voltage variations		IEC61000-4-11

(1) EMC Directive compliance of this inverter

The built-in EMC filter on the input side of this inverter (480 V class) reduces conducted noise and radiated noise from input cables. The compliance with the EMC Directive is as shown in the table below.

Inverter type	Carrier frequency <F300>	Conducted noise IEC61800-3 category C2 (EN55011 classB Group1)	Conducted noise IEC61800-3 category C3 (EN55011 classB Group1)
		Length of motor connecting cable	Length of motor connecting cable
	(kHz)	(m)	(m)
VFAS3-4004PC	4	50	150
VFAS3-4007PC	4	50	150
VFAS3-4015PC	4	50	150
VFAS3-4022PC	4	50	150
VFAS3-4037PC	4	50	150
VFAS3-4055PC	4	50	150
VFAS3-4075PC	4	50	150
VFAS3-4110PC	4	50	150
VFAS3-4150PC	4	50	150
VFAS3-4185PC	4	50	150
VFAS3-4220PC	4	50	150
VFAS3-4300PC	4	50	150
VFAS3-4370PC	4	50	150
VFAS3-4450PC	2.5	-	150
VFAS3-4550PC	2.5	-	150
VFAS3-4750PC	2.5	-	150
VFAS3-4900PC	2.5	-	150

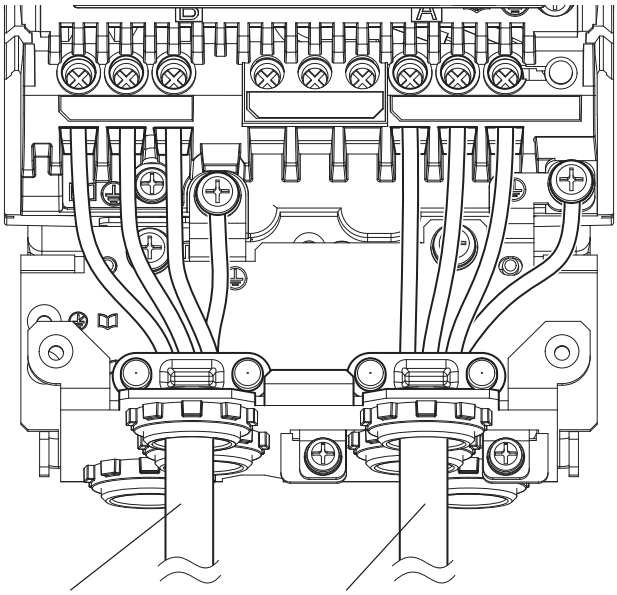
Inverter type	Carrier frequency <F300>	Conducted noise IEC61800-3 category C2 (EN55011 classB Group1)	Conducted noise IEC61800-3 category C3 (EN55011 classB Group1)
		Length of motor connecting cable	Length of motor connecting cable
	(kHz)	(m)	(m)
VFAS3-4110KPC	2.5	-	150
VFAS3-4132KPC	2.5	-	150
VFAS3-4160KPC	2.5	-	50
VFAS3-4200KPC	2.5	-	50
VFAS3-4220KPC	2.5	-	50
VFAS3-4280KPC	2.5	-	50

(2) Examples of measures to comply with EMC Directive

The following are measures to comply with the EMC Directive when you use 480V class products of VF-AS3 by installing it in other machines and systems.

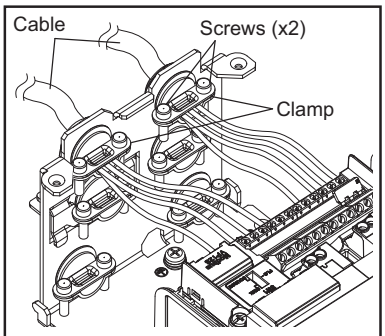
- Examples of general measures
- When adding an EMC filter for further reduction of noise
- Measures for operation with external signals

The following are general EMC measures explained concretely.

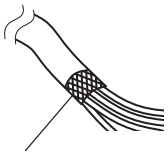


Power supply wiring
(No shielded grounding needed)
[R/L1], [S/L2], [T/L3]

Motor wiring
(Shielded grounding needed)
[U/T1], [V/T2], [W/T3]



When the shielded wires need grounding, modify before installing as shown in the figure below.



Peel off the outer sheath of the cable and fix the shielded part with a clamp.

9

Using shielded power wires and shielded control wires

- Use shielded power wires, such as inverter input/output wires, and shielded control wires.
- Route the wires and wires so as to minimize their lengths.
- Keep a distance between the power cable and the control wire and between the input and output wires of the power cable. Do not route them in parallel or bind them together. Instead, if necessary, cross at right angle.

Installing inverter in steel cabinet

- Install the inverter in a sealed steel cabinet.
- Using wires as thick and short as possible, ground the metal plate and the control panel securely with a distance kept between the grounding wire and the power wire.

Routing input and output wires apart

- Route the input and output wires apart as far as possible from each other.

Grounding of shielded wires

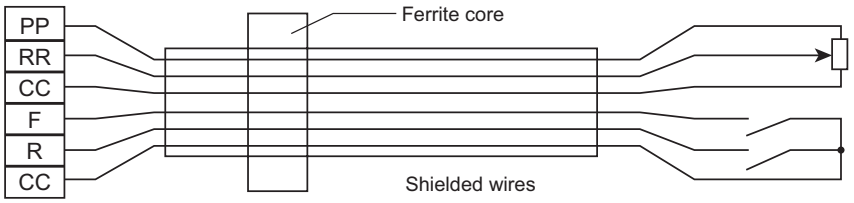
- To ground shielded wires through a metal conduit.
- To ground the shielded control wires by fixing the metal saddle of the body.
- Inserting a ferrite core in a shielded wire is even more effective in limiting the radiated noise.

Inserting zero-phase reactor and ferrite cores

- Insert a zero-phase reactor in the inverter output line.
- Insert ferrite cores in the grounding wires of the metal plate and cabinet.

(3) Measures for operation with external signals

To operate with external signals, take measures as shown in the figure below (e.g.: using a potentiometer and Fwd/Rev terminals).



9. 1. 2 Compliance with Low Voltage Directive

The Low Voltage Directive provides for the safety of machines and systems.

(1) Low Voltage Directive Compliance of this inverter

Inverters are CE-marked in accordance with the requirement of Low Voltage Directive, and can therefore be installed in machines or systems and exported without problem to European countries.

- Applicable standard: IEC61800-5-1
- Pollution degree: 2
- Overvoltage category: 3

(2) Example of measures to comply with Low Voltage Directive

When incorporating the inverter into a machine and system, it is necessary to take the following measures so that the inverter satisfies the Low Voltage Directive.

Installing in cabinet

- Install the inverter in a cabinet and ground the inverter enclosure.
- When doing maintenance, be extremely careful not to put your fingers into the inverter through a wiring hole and touch a charged part, which may occur depending on the model of the inverter used.

Paying attention to how to ground

- To ground shielded wires through a metal conduit.
- Connect grounding wires other than the shielded wires to the grounding terminals on the inverter.
- However, do not connect two or more grounding wires to the grounding terminals (screws) for the inverter main circuit.
- Refer to the table in [10. 1] to select a grounding wire size.

Installing protection device

- Install a fuse, an earth leakage circuit breaker (ELCB) or a molded-case circuit breaker (MCCB) on the input side of the inverter. For details, refer to [9. 2. 3] [10. 2. 2].

9. 2 Compliance with UL/CSA Standards

The VF-AS3 models, that conform to the UL Standard and CSA Standard have the UL/CSA mark on the nameplate.

9. 2. 1 Compliance with Installation

The VF-AS3 inverter must be mounted on a wall, and used within the ambient temperature specification.
For frame size A6, A7 and A8, a UL certificate was granted on the assumption that the inverter would be installed in a cabinet. Therefore, install the inverter in a cabinet and if necessary, take measures to maintain the ambient temperature (temperature in the cabinet) within the specified temperature range.

Maximum Surrounding Air Temperature is 50°C.	
240V	0.4 - 55kW (HD), 0.75 - 75kW (ND)
480V	0.4 - 280kW (HD), 0.75 - 160kW (ND)

Maximum Surrounding Air Temperature is 45°C.
220 - 315kW (ND)

* Refer to [1. 2] for (HD) and (ND).

9. 2. 2 Compliance with Connection

Use the UL conformed cables (Rating 75°C or more, Use the copper conductors only.) to the main circuit terminals (R/L1, S/L2, T/L3, U/T1, V/T2, W/T3), UL-certified electric wire for FLA, FLB, FLC, R1A, R1C, R2A and R2C terminals.
For instruction in the United States, Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.
For instruction in the Canada, Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Canadian Electrical Code and any additional local codes.
=> For recommended tightening torque, see [2. 3. 3]
=> For recommended electric wire sizes, see [9. 2. 3]
=> Use the electric wire of Class1 for the control circuits.

For details of wiring, terminals and the functions, refer to [2. 3. 2], [2. 3. 3], [2. 3. 4], [2. 3. 5].

9. 2. 3 Cautions for peripheral devices

Install a UL conformed fuse on the input side of the inverter.

For this inverter, a UL test has been conducted under the interrupting current (current that runs when interruption of power occurs) conditions in the table below. Note that the interrupting current varies depending on the applicable motor output.

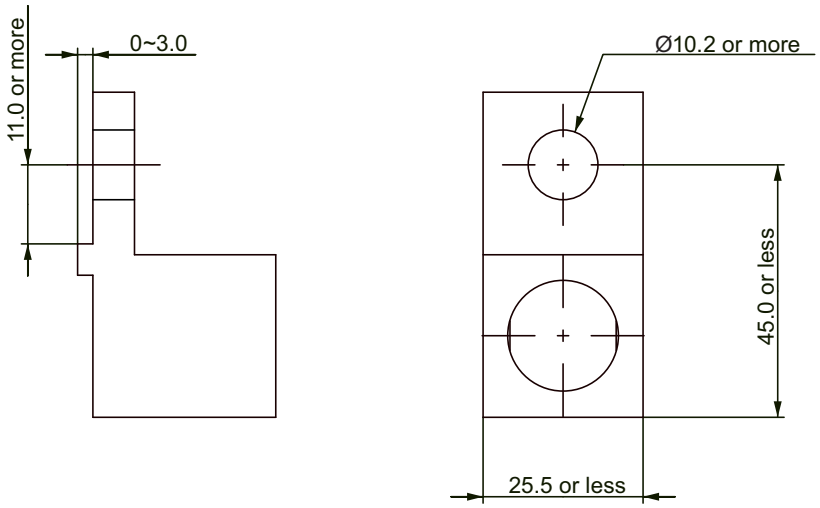
Max input voltage (V)	Applicable motor output (kW @ND)	Power supply short-circuit current (A)
3-phase 240 V	0.7 - 37	Suitable For Use On A Circuit Capable Of Delivering Not More Than 5,000A rms Symmetrical Amperes, 240 Volts Maximum When Protected by J Class Fuses
	45	Suitable For Use On A Circuit Capable Of Delivering Not More Than 10,000A rms Symmetrical Amperes, 240 Volts Maximum When Protected by J Class Fuses
	55 - 75	Suitable For Use On A Circuit Capable Of Delivering Not More Than 10,000A rms Symmetrical Amperes, 240 Volts Maximum When Protected by AR Class Fuses
3-phase 480 V	0.7 - 37	Suitable For Use On A Circuit Capable Of Delivering Not More Than 5,000A rms Symmetrical Amperes, 480 Volts Maximum When Protected by J Class Fuses
	45 - 90	Suitable For Use On A Circuit Capable Of Delivering Not More Than 10,000A rms Symmetrical Amperes, 480 Volts Maximum When Protected by J Class Fuses
	110 - 132	Suitable For Use On A Circuit Capable Of Delivering Not More Than 10,000A rms Symmetrical Amperes, 480 Volts Maximum When Protected by AR Class Fuses
	160	Suitable For Use On A Circuit Capable Of Delivering Not More Than 18,000A rms Symmetrical Amperes, 480 Volts Maximum When Protected by AR Class Fuses
	220	Suitable For Use On A Circuit Capable Of Delivering Not More Than 18,000A rms Symmetrical Amperes, 480 Volts Maximum When Protected by J Class Fuses
	250 - 280	Suitable For Use On A Circuit Capable Of Delivering Not More Than 18,000A rms Symmetrical Amperes, 480 Volts Maximum When Protected by T Class Fuses
	315	Suitable For Use On A Circuit Capable Of Delivering Not More Than 30,000A rms Symmetrical Amperes, 480 Volts Maximum When Protected by T Class Fuses

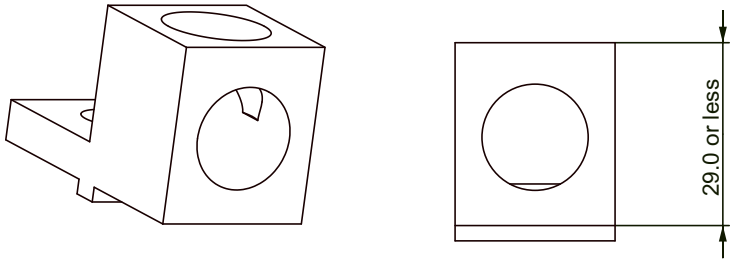
For the classes, current values, and the wire sizes of fuses, refer to the following table.

Voltage class	Applicable motor [kW]	Inverter type	Output current *1	AIC (A) (Interrupting capacity)	Fuse class and current (A)	Power wire sizes *2	Grounding wire sizes *2
3-phase 240 V	0.75	VFAS3-2004P	4.6 <F300>="4"	AIC 5000A	J 6Amax.	AWG 14	AWG 14
	1.5	VFAS3-2007P	8.0 <F300>="4"	AIC 5000A	J 10Amax.	AWG 14	AWG 14
	2.2	VFAS3-2015P	11.2 <F300>="4"	AIC 5000A	J 15Amax.	AWG 14	AWG 14
	4.0	VFAS3-2022P	18.7 <F300>="4"	AIC 5000A	J 25A max.	AWG 10	AWG 12
	5.5	VFAS3-2037P	25.4 <F300>="4"	AIC 5000A	J 35Amax.	AWG 8	AWG 10
	7.5	VFAS3-2055P	32.7 <F300>="4"	AIC 5000A	J 45Amax.	AWG 8	AWG 10
	11	VFAS3-2075P	46.8 <F300>="4"	AIC 5000A	J 60Amax.	AWG 6	AWG 10
	15	VFAS3-2110P	63.4 <F300>="4"	AIC 5000A	J 90Amax.	AWG 4	AWG 10
	18.5	VFAS3-2150P	78.4 <F300>="4"	AIC 5000A	J 110Amax.	AWG 2	AWG 8
	22	VFAS3-2185P	92.6 <F300>="4"	AIC 5000A	J 125Amax.	AWG 1	AWG 8
	30	VFAS3-2220P	123.0 <F300>="2.5"	AIC 5000A	J 150Amax.	AWG 2/0	AWG 6
	37	VFAS3-2300P	149.0 <F300>="2.5"	AIC 5000A	J 175Amax.	AWG 3/0	AWG 6
	45	VFAS3-2370P	176.0 <F300>="2.5"	AIC 10000A	J 225Amax.	250MCM	AWG 6
	55	VFAS3-2450P	211.0 <F300>="2.5"	AIC 10000A	AR 315Amax.	AWG 2/0 × 2 *3 *4	AWG 6 *3 *4
	75	VFAS3-2550P	282.0 <F300>="2.5"	AIC 10000A	AR 350Amax.	AWG 3/0 × 2 *3 *4	AWG 4 *3 *4
3-phase 480 V	0.75	VFAS3-4004PC	2.2 <F300>="4"	AIC 5000A	J 3Amax.	AWG 14	AWG 14
	1.5	VFAS3-4007PC	4.0 <F300>="4"	AIC 5000A	J 6Amax.	AWG 14	AWG 14
	2.2	VFAS3-4015PC	5.6 <F300>="4"	AIC 5000A	J 10Amax.	AWG 14	AWG 14
	4.0	VFAS3-4022PC	9.3 <F300>="4"	AIC 5000A	J 15Amax.	AWG 14	AWG 14
	5.5	VFAS3-4037PC	12.7 <F300>="4"	AIC 5000A	J 15Amax.	AWG 12	AWG 14
	7.5	VFAS3-4055PC	16.5 <F300>="4"	AIC 5000A	J 20Amax.	AWG 10	AWG 14

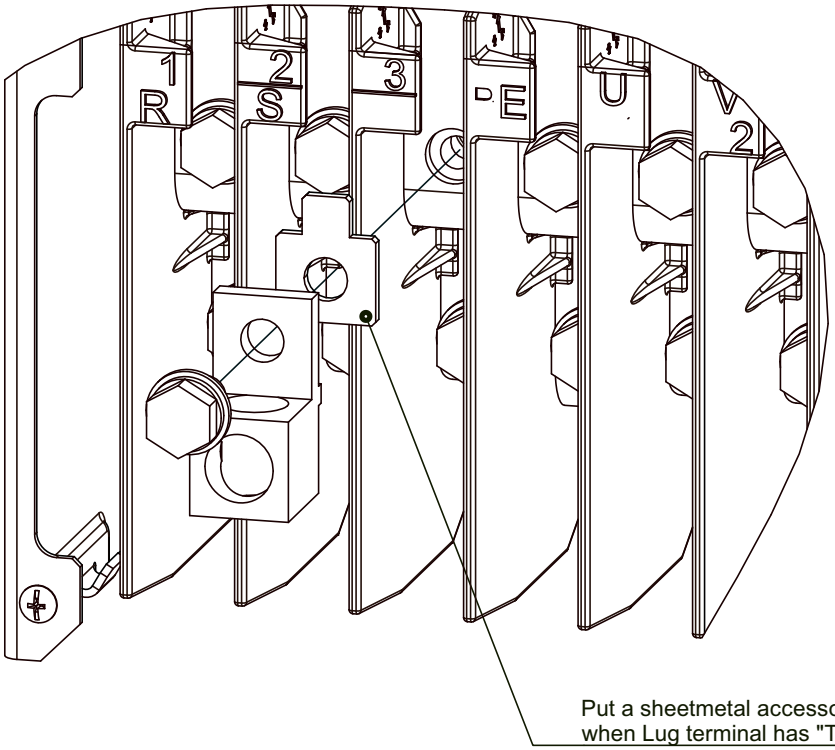
Voltage class	Applicable motor [kW]	Inverter type	Output current *1	AIC (A) (Interrupting capacity)	Fuse class and current (A)	Power wire sizes *2	Grounding wire sizes *2
3-phase 480 V	11	VFAS3-4075PC	23.5 <F300>="4"	AIC 5000A	J 30Amax.	AWG 10	AWG 10
	15	VFAS3-4110PC	31.7 <F300>="4"	AIC 5000A	J 40Amax.	AWG 8	AWG 10
	18.5	VFAS3-4150PC	39.2 <F300>="4"	AIC 5000A	J 50Amax.	AWG 8	AWG 10
	22	VFAS3-4185PC	46.3 <F300>="4"	AIC 5000A	J 60Amax.	AWG 6	AWG 10
	30	VFAS3-4220PC	61.5 <F300>="4"	AIC 5000A	J 80Amax.	AWG 4	AWG 10
	37	VFAS3-4300PC	74.5 <F300>="4"	AIC 5000A	J 100Amax.	AWG 3	AWG 8
	45	VFAS3-4370PC	88.0 <F300>="4"	AIC 10000A	J 110Amax.	AWG 1	AWG 8
	55	VFAS3-4450PC	106.0 <F300>="2.5"	AIC 10000A	J 150Amax.	AWG 1/0	AWG 6
	75	VFAS3-4550PC	145.0 <F300>="2.5"	AIC 10000A	J 200Amax.	AWG 3/0	AWG 6
	90	VFAS3-4750PC	173.0 <F300>="2.5"	AIC 10000A	J 225Amax.	250MCM	AWG 6
	110	VFAS3-4900PC	211.0 <F300>="2.5"	AIC 10000A	AR 250Amax.	AWG 1/0 × 2 *3 *4	AWG 4 *3 *4
	132	VFAS3-4110KPC	250.0 <F300>="2.5"	AIC 10000A	AR 315Amax.	AWG 2/0 × 2 *3 *4	AWG 4 *3 *4
	160	VFAS3-4132KPC	302.0 <F300>="2.5"	AIC 18000A	AR 350Amax.	AWG 4/0 × 2 *3 *4	AWG 4 *3 *4
	220	VFAS3-4160KPC	427.0 <F300>="2.5"	AIC 18000A	J 500Amax.	350MCM × 2	AWG 2/0
	250	VFAS3-4200KPC	481.0 <F300>="2.5"	AIC 18000A	J 600Amax.	250MCM × 3	AWG 2/0
	280	VFAS3-4220KPC	550.0 <F300>="2.5"	AIC 18000A	J 600Amax.	300MCM × 3	AWG 3/0
	315	VFAS3-4280KPC	616.0 <F300>="2.5"	AIC 30000A	T 800Amax.	350MCM × 3	AWG 3/0

*1 The UL rated output current is the one when the carrier frequency <F300> is the value in the table or less.
*2 The wire size is the one when 75°C is continuously allowed (ambient temperature of 40°C or less).
*3 This part shows the wiring size with using the Lug terminal.
*4 Lug terminal for Frame size A6 has some constraints. Refer to page 9-10.


11.0 or more
0~3.0
Ø10.2 or more
45.0 or less
25.5 or less


29.0 or less

9


R
S
E
U
V
1
2
3
2
Put a sheetmetal accessory
when Lug terminal has "Turn prevent" shape

- The input withstand rating is obtained with heat calculation. If the fuse is installed to a circuit with larger input withstand rating, a reactor should be installed so that the input withstand rating should be reduced below this level.
- Output interrupt rating varies depending on the type of integral solid state short circuit. Install the fuse according to the NEC standard, local standard and type of installation.
- Use a fuse of Cooper Bussmann or Mersen.
- Be sure to use rod crimp-style terminals for the grounding terminals of the heat sink and metal plate of the inverter.

9. 2. 4 Overload protection

The overload protection levels are below,
HD rating: 150%-1minute, 180%-2s (Frame size A1~A6)
150%-1minute, 165%-2s (Frame size A7, A8)
ND rating: 120%-1minute, 135%-2s (All frame sizes)

For the rated current, refer to the name plate.

9. 2. 5 Motor thermal protection

To use the electronic thermal function of this inverter for motor thermal protection, set parameters according to the motor specifications applied. For details, refer to [5. 2. 5].
When operating multiple motors with one inverter, install overload relay for each motor.

9. 2. 6 Motor integrated PTC thermal protection

For details, refer to [6. 30. 19].

9. 2. 7 Other

Contact your Toshiba distributer or Toshiba sales representative (see the back cover of this manual), if you need the hard copy (paper) of CD-ROM.

9. 3 Compliance with safety standards

For details, refer to “VF-AS3 Safety function manual" (E6582068).

10 Selection and installation of peripheral devices

In this chapter, the selection and installation methods of peripheral devices for this inverter are described.

⚠ WARNING	
Mandatory action	• All options to be used must be those specified by Toshiba. The use of options other than those specified by Toshiba will result in an accident. • In using a power distribution device and options for the inverter, they must be installed in a cabinet. When they are not installed in the cabinet, this will result in electric shock.
Be sure to connect the grounding wire.	• The grounding wire must be connected securely. If the grounding wire is not securely connected, when the inverter has failure or earth leakage, this will result in electric shock or fire.

10. 1 Selection of wire size

According to the voltage class and capacity of the inverter, perform wiring using appropriate wires as shown in the table below. When connecting peripheral devices to the inverter also, perform wiring according to the wire size for a wire location shown in the table below.

- The wire size is a value when using a 600 V HIV insulation wire (copper wire with the maximum allowable temperature 75 °C of an insulator) with 50 °C ambient temperature and 30 m or less the length of each wire.
- For the wire of the control circuit, use a shielded wire with 0.75 mm^2 or more.

■**Wire size for HD rating**

Voltage class	Applicable motor (kW)	Inverter type-form		Wire size (mm^2)				
				Power circuit		DC wire	Braking resistor (Optional)	Grounding wire
				Input	Output			
3-phase 240 V	0.4	VFAS3-	2004P	1.5	1.5	2.5	1.5	2.5
	0.75		2007P	1.5	1.5	2.5	1.5	2.5
	1.5		2015P	1.5	1.5	2.5	1.5	2.5
	2.2		2022P	1.5	1.5	2.5	1.5	2.5
	4.0		2037P	2.5	4	2.5	1.5	4
	5.5		2055P	4	6	4	1.5	6
	7.5		2075P	6	10	6	2.5	10
	11		2110P	10	16	10	4	16
	15		2150P	16	25	16	6	16
	18.5		2185P	25	35	25	10	16
	22		2220P	35	50	35	16	25
	30		2300P	50	70	50	25	35
	37		2370P	70	95	70	35	50
	45		2450P	95	120	95	50	70
	55		2550P	120	70x2	120	50	95
3-phase 480 V	0.4	VFAS3-	4004PC	1.5	1.5	2.5	1.5	2.5
	0.75		4007PC	1.5	1.5	2.5	1.5	2.5
	1.5		4015PC	1.5	1.5	2.5	1.5	2.5
	2.2		4022PC	1.5	1.5	2.5	1.5	2.5
	4.0		4037PC	1.5	1.5	2.5	1.5	2.5
	5.5		4055PC	1.5	2.5	2.5	1.5	2.5
	7.5		4075PC	2.5	4	2.5	1.5	2.5
	11		4110PC	4	6	4	1.5	4
	15		4150PC	6	10	6	2.5	10
	18.5		4185PC	10	10	10	2.5	10
	22		4220PC	16	16	10	4	16
	30		4300PC	25	25	16	6	16
	37		4370PC	25	35	25	10	16
	45		4450PC	35	35	35	16	16
	55		4550PC	50	50	50	16	25
	75		4750PC	95	95	70	35	50
	90		4900PC	120	120	95	35	70
	110		4110KPC	70x2	70x2	70x2	50	95
	132		4132KPC	70x2	70x2	70x2	70	95
	160		4160KPC	120x2	95x2	150x2	95	120
	200		4200KPC	150x2	120x2	150x3	150	150
	220		4220KPC	150x3	120x2	150x3	150	150
	280		4280KPC	150x3	185x2	150x4	150	120x2

■**Wire size for ND rating**

Voltage class	Applicable motor (kW)	Inverter type-form		Wire size (mm^2)				
				Power circuit		DC wire	Braking resistor (Optional)	Grounding wire
				Input	Output			
3-phase 240 V	0.75	VFAS3-	2004P	1.5	1.5	2.5	1.5	2.5
	1.5		2007P	1.5	1.5	2.5	1.5	2.5
	2.2		2015P	1.5	1.5	2.5	1.5	2.5
	4.0		2022P	2.5	4	2.5	1.5	4
	5.5		2037P	4	6	4	1.5	6
	7.5		2055P	6	10	6	2.5	10
	11		2075P	10	16	10	4	16
	15		2110P	16	25	16	6	16
	18.5		2150P	25	35	25	10	16
	22		2185P	35	50	35	16	25
	30		2220P	50	70	50	25	35
	37		2300P	70	95	70	35	50
	45		2370P	95	120	95	50	70
	55		2450P	70x2	70x2	50x2	50	95
	75		2550P	95x2	95x2	70x2	70	120
3-phase 480 V	0.75	VFAS3-	4004PC	1.5	1.5	2.5	1.5	2.5
	1.5		4007PC	1.5	1.5	2.5	1.5	2.5
	2.2		4015PC	1.5	1.5	2.5	1.5	2.5
	4.0		4022PC	1.5	1.5	2.5	1.5	2.5
	5.5		4037PC	1.5	2.5	2.5	1.5	2.5
	7.5		4055PC	2.5	4	2.5	1.5	2.5
	11		4075PC	4	6	4	1.5	4
	15		4110PC	6	10	6	2.5	10
	18.5		4150PC	10	10	10	2.5	10
	22		4185PC	10	16	10	4	16
	30		4220PC	16	25	16	6	16
	37		4300PC	25	35	25	10	16
	45		4370PC	35	35	35	16	16
	55		4450PC	50	50	50	16	25
	75		4550PC	70	95	70	35	50
	90		4750PC	95	120	95	35	70
	110		4900PC	50x2	50x2	70x2	35	95
	132		4110KPC	70x2	70x2	70x2	50	95
	160		4132KPC	95x2	95x2	95x2	70	120
	220		4160KPC	150x2	150x2	150x2	95	150
	250		4200KPC	150x2	150x2	185x2	150	150
	280		4220KPC	150x3	120x3	150x3	150	120x2
	315		4280KPC	150x3	150x3	150x3	150	120x2

Memo

- The wire size of this chapter comply with IEC60364-5-52 (Grounding wire: IEC60364-5-54). It does not comply with UL Standard.
- For the wire size to comply with UL Standard, refer to [9. 2. 3].

10

10. 2 Selection of a wiring device

According to the table [10. 2. 1], select an appropriate wiring device depending on the voltage class and capacity of the inverter.

10. 2. 1 Selection table of a wiring device

Select a wiring device depending on the inverter type and input current in the table next.

■ Wiring devices for HD rating

Voltage class	Applicable motor (kW)	Inverter type-form		Input current (A)	Rated current (A)	
					Molded-case circuit breaker (MCCB) Earth leakage circuit breaker (ELCB)	Magnetic contactor (MC)
3-phase 240 V	0.4	VFAS3-	2004P	1.7	3	20
	0.75		2007P	3.3	5	20
	1.5		2015P	6.0	10	20
	2.2		2022P	9.0	15	20
	4.0		2037P	15.1	20	20
	5.5		2055P	20.1	30	32
	7.5		2075P	27.3	40	32
	11		2110P	40.0	50	50
	15		2150P	53.2	75	60
	18.5		2185P	64.8	100	80
	22		2220P	78.3	100	80
	30		2300P	104.7	150	150
	37		2370P	128.4	175	200
	45		2450P	157.6	200	260
	55		2550P	189.0	250	260

Voltage class	Applicable motor (kW)	Inverter type-form		Input current (A)	Rated current (A)	
					Molded-case circuit breaker (MCCB) Earth leakage circuit breaker (ELCB)	Magnetic contactor (MC)
3-phase 480 V	0.4	VFAS3-	4004PC	0.9	3	20
	0.75		4007PC	1.8	3	20
	1.5		4015PC	3.2	5	20
	2.2		4022PC	4.9	10	20
	4.0		4037PC	8.3	10	20
	5.5		4055PC	10.9	15	20
	7.5		4075PC	14.7	20	20
	11		4110PC	21.4	30	32
	15		4150PC	28.9	40	32
	18.5		4185PC	35.4	50	50
	22		4220PC	42.1	60	50
	30		4300PC	57.1	75	60
	37		4370PC	69.9	100	80
	45		4450PC	84.8	125	100
	55		4550PC	103.3	125	135
	75		4750PC	139.8	175	200
	90		4900PC	170.2	225	260
	110		4110KPC	203.5	250	260
	132		4132KPC	240.3	300	260
	160		4160KPC	290.0	350	350
	200		4200KPC	360.0	500	450
	220		4220KPC	395.0	500	450
	280		4280KPC	495.0	700	660

■**Wiring devices for ND rating**

Voltage class	Applicable motor (kW)	Inverter type-form		Input current (A)	Rated current (A)	
					Molded-case circuit breaker (MCCB) Earth leakage circuit breaker (ELCB)	Magnetic contactor (MC)
3-phase 240 V	0.75	VFAS3-	2004P	3.0	5	20
	1.5		2007P	5.9	10	20
	2.2		2015P	8.5	15	20
	4.0		2022P	15.1	20	20
	5.5		2037P	20.2	30	32
	7.5		2055P	27.1	40	32
	11		2075P	39.3	50	50
	15		2110P	53.0	75	60
	18.5		2150P	65.1	100	80
	22		2185P	76.0	100	80
	30		2220P	104.7	150	150
	37		2300P	128.0	175	200
	45		2370P	154.7	200	260
	55		2450P	191.9	250	260
	75		2550P	256.0	350	350
3-phase 480 V	0.75	VFAS3-	4004PC	1.6	3	20
	1.5		4007PC	3.1	5	20
	2.2		4015PC	4.5	10	20
	4.0		4022PC	8.0	10	20
	5.5		4037PC	10.8	15	20
	7.5		4055PC	14.4	20	20
	11		4075PC	20.8	30	32
	15		4110PC	28.3	40	32
	18.5		4150PC	34.9	50	50
	22		4185PC	41.4	50	50
	30		4220PC	55.9	75	60
	37		4300PC	69.0	100	80
	45		4370PC	83.4	125	100
	55		4450PC	101.9	125	135
	75		4550PC	138.0	175	200
	90		4750PC	165.1	200	260
	110		4900PC	203.5	250	260
	132		4110KPC	240.3	300	260
	160		4132KPC	284.2	350	350
	220		4160KPC	395.0	500	450
	250		4200KPC	444.0	500	450
	280		4220KPC	495.0	700	660
	315		4280KPC	555.0	1000	660

- Install a surge absorber on the exciting coil of a magnetic contactor (MC) and relays.
- When using an auxiliary contacts 2a type magnetic contactor (MC), use the 2a contacts in parallel to increase the liability of the contacts.
- Selection is for assuming a normal power supply capacity and using a Toshiba 4-pole standard motor with input power 200 V/400 V-50 Hz.
- For the influence of the leakage current, refer to [2. 4. 3].

10. 2. 2 Installation of a molded-case circuit breaker (MCCB) and earth leakage circuit breaker (ELCB)

For protection of the wiring system, install a molded-case circuit breaker (MCCB) between the power supply and the inverter (primary side).
An earth leakage circuit breaker (ELCB) that is equipped with a function to shut off by detecting leakage current can be also installed. However, be cautious that an ELCB may operate improperly, because the leakage current becomes large due to the influence of a wiring method, a built-in noise filter, etc.
Because the short-circuit current is different with power supply capacity and wiring system conditions, select MCCB or ELCB depending on the inverter type and input current in the table [10. 2. 1].

Memo	• When complying with UL Standard and CSA Standard, a fuse needs to be installed on the primary side of the inverter. For details, refer to [9. 2. 3].

10. 2. 3 Installation of a magnetic contactor (MC)

When installing a magnetic contactor (MC) on the primary or secondary side of the inverter, select following the below.

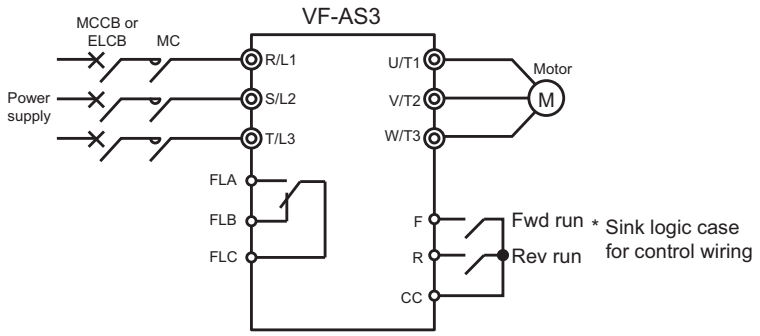
■ Installation on the primary side

When the power side and the inverter need to be detached in the following cases, install a magnetic contactor (MC) between the power supply and the inverter (primary side).
Select a magnetic contactor (MC) depending on the inverter type and input current in the table [10. 2. 1].

- Thermal relay on the motor is activated
- Protection detection relay (FL) inside the inverter is activated
- Not to automatically restart at restoration of power after power failure
- When using the braking resistor (option), the thermal relay of the braking resistor is activated

To open the power circuit (primary side) when the protective function detection relay inside the inverter is activated, the molded-case circuit breaker (MCCB) with a power cutoff device can be installed instead of magnetic contactors (MC). Make sure the molded-case circuit breaker (MCCB) trips at the contact of protection detection relay. If earth leakage detector is not installed, earth leakage circuit breaker (ELCB) should be installed instead of MCCB.

A connection example for installing the primary-side magnetic contactor (MC) is shown next.



Important

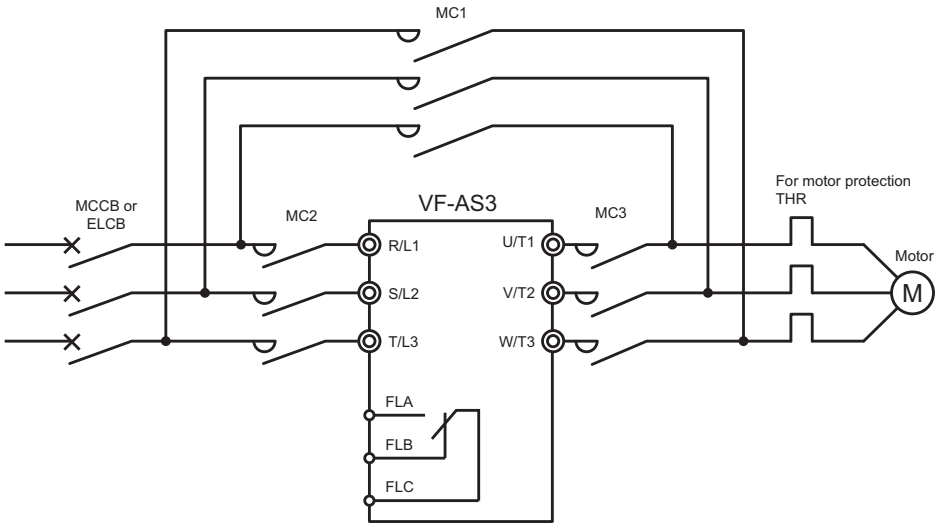
- Do not run/stop the inverter by turning the magnetic contactor (MC) installed on the primary side ON/OFF. When run/stop the inverter, set the terminal [F] (forward) or terminal [R] (reverse) of the control terminal ON/OFF.
- Install a surge absorber on the exciting coil of a magnetic contactor (MC).

■ Installation on the secondary side

To switch the motor during the inverter is stopped, and change the motor power, a magnetic contactor (MC) can be installed between the inverter and motor (secondary side).
When operating the motor with commercial power supply by switching the circuit and not through the inverter, select a magnetic contactor (MC) with AC-3 Class and confirming to the motor rated current.

A connection example for installing the secondary-side magnetic contactor (MC) is shown next.

10



Important

- Be sure to have interlock for the commercial power supply is applied to the inverter output terminal.
- Do not turn the magnetic contactor (MC) in the secondary circuit ON/OFF during run. It can cause failure due to rush current flowing to the inverter.
- Install a surge absorber on the exciting coil of a magnetic contactor (MC).

10. 2. 4 Installation of a thermal relay (THR)

Use an electronic thermal protector of the inverter for motor overload protection. Set a motor overload protection level with a parameter according to the motor rating.
However, in the following cases, install a thermal relay (THR) between the inverter and motor (secondary side).

- Running multiple motors simultaneously with one inverter.
  In this case, install a thermal relay on each motor.
- Running a motor with smaller output than applicable motor output of the standard specification
  (When the motor capacity is too small to set with a parameter of the motor overload protection level).

For details on motor overload protection level, refer to [5. 3. 5].

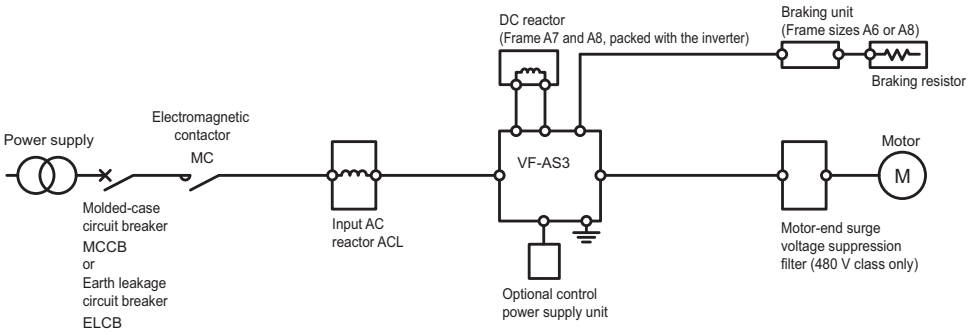
To give sufficient protection for the motor running in a low-speed range, the use of a motor with motor winding embedded type thermal relay is recommended.

Important

- "Thermal overload relay" is recommended, install it for each motor to be protected. "Thermal relay with CT" is not available.

10. 3 External options

This inverter provides external options shown in the next figure.



Functions, purposes, notes, etc. of individual external option are explained next.
External options are shown in [10. 3. 9].

10. 3. 1 Input AC reactor, (DC reactor)

Input AC reactor is used for improving input power factor on the inverter power side (primary side), reducing harmonics or restriction of surge voltage.
It is also installed when the power supply capacity is 500 kVA or more and is 10 times or more of the inverter capacity, and when devices that cause distorted waves (a device with thyristor, etc.) and a large capacity inverter is connected on the same power distribution line. Install an input AC reactor between the power supply and the inverter (primary side).

10

A DC reactor is a reactor to connect with the DC terminal, and used for improving input power factor and reducing harmonics. It has better power factor improvement effect than an input AC reactor. When a facility applying the inverter requires high reliability, it is recommended to use with an input AC reactor that has surge voltage restriction effect.
However, the frame size A1 to A6 of the inverter has a built-in DC reactor as standard, and the frame size A7 and A8 attached with a DC reactor, no option is available.

Type	Effect		
	Power factor improvement	Harmonics reduction	Surge voltage restriction
Input AC reactor	Enabled	Enabled	Enabled
DC reactor	Enabled (large)	Enabled (large)	Disabled

10. 3. 2 Braking resistor, Braking unit

It is a resistor to consume regenerative energy from a motor.
When making frequent rapid deceleration and stop, it is used to shorten deceleration time with load in large inertia.
A braking unit is necessary in addition to a braking resistor for the frame size A6 and A8.

For details on using a braking resistor, refer to [6. 15. 4].

10. 3. 3 Motor-end surge voltage suppression filter

When operating a 480 V class general purpose motor with a voltage type PWM control inverter that uses high speed switching element (IGBT, etc.), surge voltage exceeding the insulation level of motor winding is generated depending on power supply voltage, motor wire length and its laying method, and type. When the condition is repeatedly applied for a long time, it may cause deterioration of insulation on the motor.
Such measures as installation of an AC reactor, surge voltage suppression filter on the inverter output side (secondary side), and use of a high insulation strength motor are necessity.

- To be installed floor horizontal mounting.
- To be used that carrier frequency is 15kHz or less, and output frequency is 60Hz or less.

For details of carrier frequency, refer to [6. 14].

10. 3. 4 Optional control power supply

This inverter supplies control power supply from the power supply inside the inverter. When control power supply is backed up with this option, display and output signal can be maintained in case of power supply shut off.

- It is common with 240 V/480 V class.
- Type-form: CPS002Z

10. 3. 5 LED extension panel option

It is an extension panel for LED display. A specific cable is used to connect between the inverter and LED panel.
When using this panel, remove the standard operation panel, and connect to the RS485 communication connector 1.

- Panel type-form: RKP002Z
  Specific cable type-form: CAB0011 (1 m), CAB0013 (3 m), CAB0015 (5 m)
- Panel type-form: RKP007Z
  Specific calbe type-form: CAB0071 (1 m), CAB0073 (3 m), CAB0075 (5 m)

10. 3. 6 USB communication conversion unit

It enables to set and manage parameters on a personal computer.
Connect between the RS485 communication connector 1 of the inverter and a personal computer. Use the specific cable for the inverter side, and a commercial USB cable (USB 1.1/2.0 compatible A-B connection type) for a personal computer side. Software PCM002Z for parameter management is required.

- Type-form: USB001Z
- Specific cable type-form: CAB0011 (1 m), CAB0013 (3 m), CAB0015 (5 m)

10. 3. 7 Flange mounting kit

It reduces heat rising up inside the cabinet.

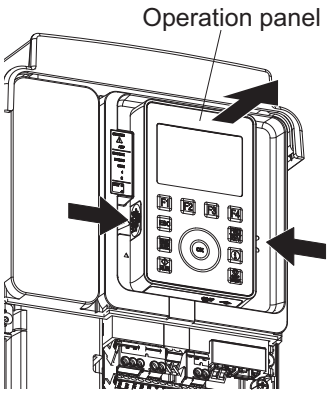
10. 3. 8 Door mounting kit

It enables to mount operation panel on the cabinet door. Use the exclusive cable for interconnection between this kit and the inverter. For detail, refer to “Door mounting kit instruction manual” (E6582159).

- Type-form: SBP010Z
- Specific cable type-form: CAB0071 (1 m), CAB0073 (3 m), CAB0075 (5 m) , CAB00710 (10 m)

How to remove operation panel
While pressing the PUSH part located on both right and left sides of the operation panel, pull the operation panel straight upward.

How to mount operation panel again
Push the operation panel with fixing the connector back side on RS485 communication connector 1 on control block.



10. 3. 9 External option list

External options are shown in the next table.

Category	Product name	Specification / Ranges	Type-form	Remarks
Control option	Door mounting kit	Door mounting kit for operation panel	SBP010Z	Coming soon
	Option adapter	For Safety option & For using case of 3 options	SBP011Z	Coming soon

Category	Product name	Specification / Ranges	Type-form	Remarks
Power option	Flange mounting kit	For Frame size A1 to A5	FOT018Z to FOT022Z	
	Flange mounting kit	For Frame size A6	FOT023Z	Coming soon
	Flange mounting kit	For Frame size A7	FOT013Z	
	Flange mounting kit	For Frame size A8	FOT014Z	
	Braking unit	For Frame size A6	PB7-4132K	Coming soon
	Braking unit	For Frame size A8	PB7-4200K	
	Braking resistor	All ranges	PBR-xxxx*1	
	Input reactor	All ranges	PFL-xxxxS*1	
	Motor end surge suppression filter	480 V all ranges	MSF-4xxxZ*1	
Others	LED extension panel	Big LED keypad	RKP002Z	
	LED extension panel	Small LED keypad	RKP007Z	
	Control power supply unit	DC24V backup option	CPS002Z	
	USB communication conversion unit	Converter between RS485 (Inverter) and USB (PC)	USB001Z	

*1 xxx (number) varies depending on capacity.

10. 4 Insert type options

This inverter is equipped with two option slots (A, B) as standard. The option adapter (option) can be mounted for an extended slot.

10. 4. 1 Insert type options and functions

Cassette options are available as shown in the next table.

■ **Cassette options**

Name	Specification	Type-form	Slot availability	Remarks
I/O extension 1	6x digital input 2x digital output 2x analog input	ETB013Z	A, B, C	Refer to E6582128
I/O extension 2	3x 1a relay	ETB014Z	A, B ,C	Refer to E6582129
Digital encoder	RS422 Line receiver	VEC008Z	B	Refer to E6582140 and E6582148
Resolver	Resolver	VEC010Z	B	Coming soon
Safety module	SS1, SS2, SOS, SBC, SMS, SLS, SDI, SSM	SFT001Z	C	Coming soon
PROFINET	PROFINET interface	PNE001Z	A	
EtherCAT	EtherCAT interface	IPE003Z	A	Coming soon
PROFIBUS-DP	PROFIBUS-DP interface	PDP003Z	A	
DeveceNet	DeviceNet interface	DEV003Z	A	
CANopen	CANopen interface RJ45 D-sub Open style	CAN001Z CAN002Z CAN003Z	A	Coming soon

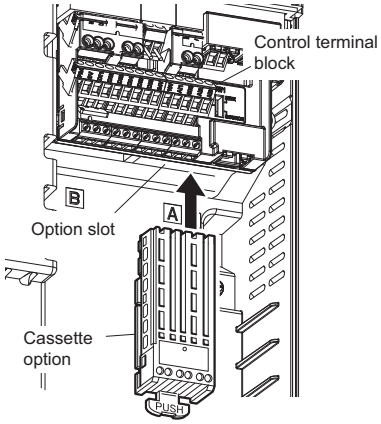
10. 4. 2 Mounting/removing insert type options

⚠ WARNING	
Prohibited	• Do not connect any communication options other than supported by option slots. It can cause failure and accident.
Mandatory action	• Mounting/removing options should be performed 15 minutes or more after the power is shut off, and checking the charge lamp of the inverter is OFF. The inverter and options may be damaged. • Do not use tools for mounting/removing options. The inverter and options may be damaged.

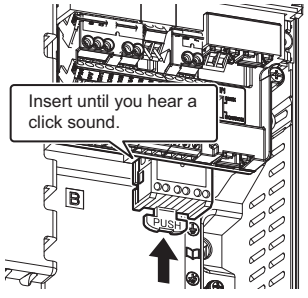
Mounting/removing methods of a cassette option to the option slot A, B are as follows.
When using the option slot 3, refer to [10. 4. 3].

■ Mounting (Option slot A, B)

1 Remove the front cover and other parts.
Covers to be removed at the time of wiring vary depending on the frame size.
For how to remove, refer to [2. 2].



2 Insert a cassette option to the option slot A, B until you hear a click sound.



3 Perform wiring to the cassette option.

4 When wiring is complete, mount the removed cover.
For how to mount them, refer to [2. 2].

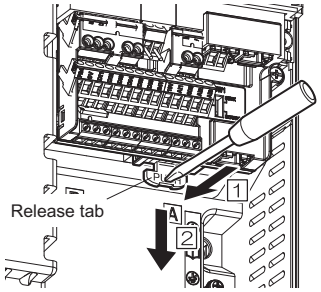
■ Removing (Option slot A, B)

1 Remove the front cover and other parts.
Covers to be removed vary depending on the frame size.
For how to remove, refer to [2. 2].

2 Remove wiring to the cassette option.

10

3 While pressing the release tab down, pull the cassette option to remove from the option slot.



4 Mount the removed covers.
For how to mount them, refer to [2. 2].

Important

- Do not use excessive force to press a cassette option to the option slot, or the connector pin may be damaged. Along the guide, insert straight slowly.
- Depending on a cassette option, insertion to the option slot A, B may not be possible. Refer to [10. 4. 1].
- In the case of frame size A7 or A8, remove the wire-holding fitting mounted at the lower part of the option slot A, B before inserting/removing the cassette option.

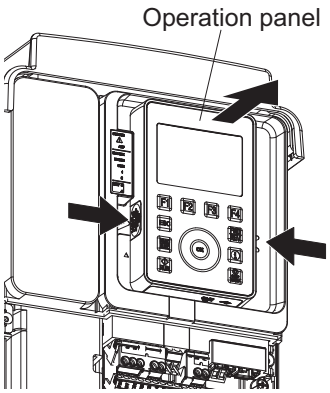
10. 4. 3 Mounting/removing the option adapter

Mounting/removing methods of the option 3 slot adapter are as follows.
Mounting and removing methods of a cassette option is the same with option slot A, B. For details, refer to [10. 4. 2].

■ Mounting of option

1 Remove the front covers and other parts in advance. Covers to be removed at the time of wiring vary depending on the frame size of inverter.

2 While pressing the PUSH part located on both right and left sides of the operation panel, pull the operation panel straight upward.
The operation panel is connected to the unit with the connector on the center of back side.

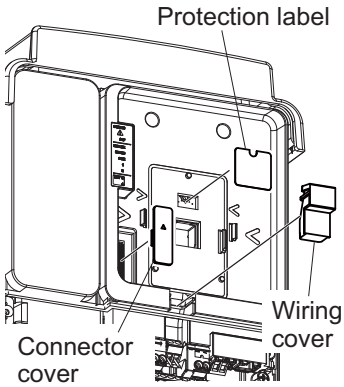


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3 Remove the protection label.

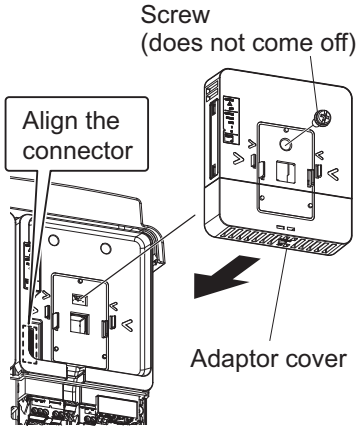
4 Remove the connector cover.
Store the removed parts so as not to be lost.

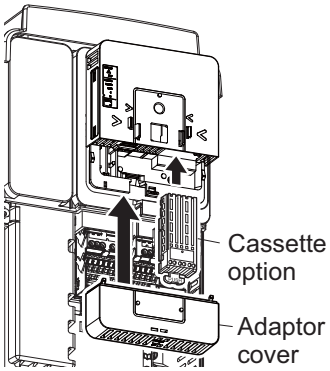
5 Remove the option wiring cover.
The option wiring cover can be removed by fingers.
Store the removed parts so as not to be lost.



6 Match the position of the Option adaptor connector with the inverter, and mount the Option adaptor.
Store the removed parts so as not to be lost.

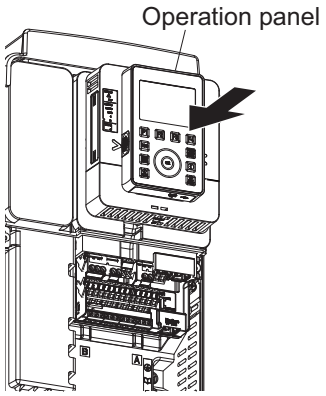
7 Tighten the screw.
This screw is used to connect ground for option.





8 Insert a screwdriver, etc. to the lock removal hole of the adaptor cover to push and unlock, and remove the adaptor cover upward. In this state, a cassette option can be inserted to slot C.
Using the groove of removed wiring cover, perform wiring of the cassette option before inserting the option, and fix the wiring by the attached cable tie.

9 After wiring is complete, mount the adaptor cover on the Option adaptor.
Be cautious that the wiring of the cassette option does not get pinched by the adaptor cover.
The removed operation panel can be installed on top surface of the Option adaptor.

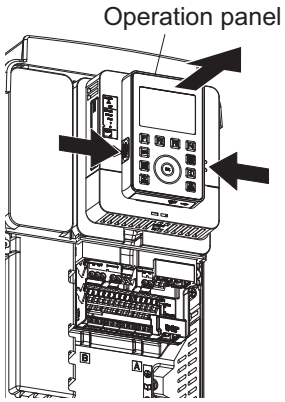


10 Mount the removed front covers.

■ Removing of option

1 Remove the front covers and other parts in advance. Covers to be removed at the time of wiring vary depending on the frame size of inverter.

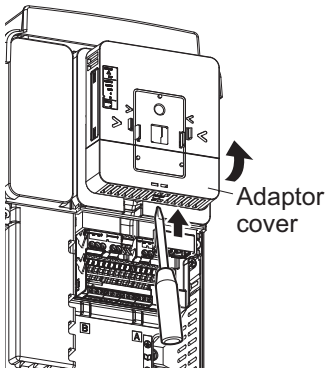
2 While pressing the PUSH part located on both right and left sides of the operation panel, pull the operation panel straight upward.
The operation panel is connected to the unit with the connector on the center of back side.



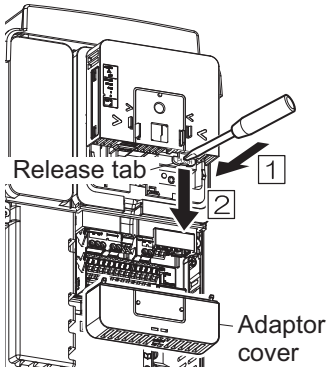
10

3 Insert a screwdriver, etc. to the lock removal hole of the Option adaptor cover to push and unlock, and remove the adaptor cover of the Option adaptor.

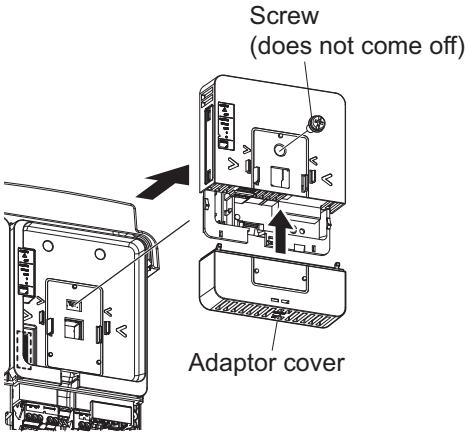
4 Remove wiring to the cassette option.



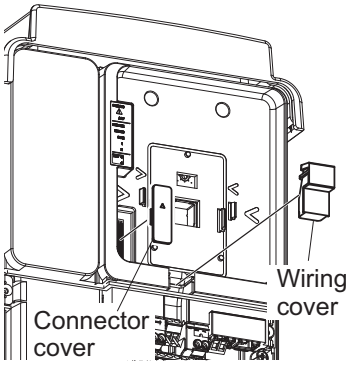
5 While pressing the release tab down, pull the cassette option to remove from slot C.



6 Remove the Option adaptor.
Mount the adaptor cover removed before.



7 While pressing the PUSH part located on both right and left sides of the operation panel, pull the operation panel straight upward.
The operation panel is connected to the unit with the connector on the center of back side.



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11 Table of parameters

11. 1 Frequency setting parameter

Title	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/Communication)	Default setting	Write during running*6	User setting	Reference
FC	Panel run frequency	LL - UL	Hz	0.1/0.01	0.0	Y		[4. 3. 1]

*1 Parameter values vary depending on the capacity. For details, refer to [11. 6].
*2 Depending on the setup menu. Refer to [11. 10].
*3 For details on the analog output and monitor output function, refer to [11. 7].
*4 Refer to section [11. 8] for details about the input terminal function.
*5 Refer to section [11. 9] for details about the output terminal function.
*6 Y: Writable N: Not writable

11. 2 Basic parameter

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
AUH	-	History function	-	-	-	0	-		[4. 2. 1]
AUF	0093	Guidance function	0: - 1: Embedded Ethernet setting 2: Preset speed operation 3: Analog frequency command 4: Motor 1, 2 switching 5: Motor parameter 6: PM motor parameter	-	-	0	N		[4. 2. 1]
AUA	0090	Application easy setting	0: - 1: Initial easy setting 2: Conveyor 3: Material handling 4: Hoisting 5: Fan 6: Pump 7: Compressor	-	-	0	N		-
AUE	0032	Eco-standby power setting	0: - +1: Embedded Ethernet OFF	-	-	0	N		[5. 3. 1]
AUL	0094	Multi-rating select	0: - 1: - 2: ND rating (120%-60s) (0 after execution) 3: HD rating (150%-60s) (0 after execution) 4 - 8: -	-	-	0	N		[1. 2] [5. 3. 2]
AU1	0000	Automatic Acc/Dec	0: Disabled 1: Automatic Acc/Dec 2: Automatic Acc only	-	-	0	N		[5. 3. 3]
AU2	0001	Torque boost macro	0: Disabled 1: Automatic torque boost + offline auto-tuning 2: Vector control 1 + offline auto-tuning 3: Energy savings + offline auto-tuning	-	-	0	N		[5. 3. 4] [5. 3. 5] [6. 23. 1]
CMOd	0003	Run command select	0: Terminal 1: Operation panel, Extension panel 2: Embedded Ethernet 3: RS485 communication (connector 1) 4: RS485 communication (connector 2) 5: Communication option	-	-	0	N		[4. 3. 1] [4. 4. 1] [5. 2. 1]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
FMOd	0004	Frequency command select 1	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 9: - 10: Touch wheel 1 (power off or press OK to save) 11: Touch wheel 2 (press OK to save) 12: Sr0 13,14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18,19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	-	-	1	N		[4. 3. 1] [4. 4. 1] [5. 2. 1] [5. 4. 1] [7. 3. 2] [7. 3. 3] [7. 3. 4]
Pt	0015	V/f Pattern	0: V/f constant 1: Variable torque 2: Automatic torque boost 3: Vector control 1 4: Energy savings 5: Dynamic energy savings (for fan and pump) 6: PM motor control 7: V/f 5-point setting 8: - 9: Vector control 2 (speed / torque) 10: PG feedback control 11: PG feedback vector control (speed / torque) 12: -	-	-	0	N		[5. 3. 4] [5. 3. 5] [6. 23. 1] [6. 23. 2]
vb	0016	Manual torque boost 1	0.00 - 30.00	%		*1	Y		[5. 3. 6]
vL	0014	Base frequency 1	15.0 - 590.0	Hz		50.0 / 60.0 *2	Y		[5. 2. 2]
vLv	0409	Base frequency voltage 1	240V class: 50-330V 480V class: 50-660V	V		*2	Y		[5. 2. 2]
FH	0011	Maximum frequency	30.0 - 590.0	Hz		*2	N		[5. 2. 3]
UL	0012	Upper limit frequency	0.0 - FH	Hz		50.0 / 60.0 *2	Y		[5. 2. 3]
LL	0013	Lower limit frequency	0.0 - UL	Hz		0.0	Y		[5. 2. 3] [6. 9]
ACC	0009	Acceleration time 1	0.0 - 6000 (600.0)	s		*1	Y		[5. 2. 4] [5. 3. 3] [6. 27. 2]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
dEC	0010	Deceleration time 1	0.0 - 6000 (600.0)	s		*1	Y		[5. 2. 4] [5. 3. 3] [6. 27. 2]
Sr0	0030	Preset speed 0	LL - UL	Hz		0.0	Y		[5. 3. 7]
Sr1	0018	Preset speed 1	LL - UL	Hz		0.0	Y		[4. 4. 3] [5. 3. 7] [6. 28]
Sr2	0019	Preset speed 2	LL - UL	Hz		0.0	Y		
Sr3	0020	Preset speed 3	LL - UL	Hz		0.0	Y		
Sr4	0021	Preset speed 4	LL - UL	Hz		0.0	Y		[5. 3. 7] [6. 28]
Sr5	0022	Preset speed 5	LL - UL	Hz		0.0	Y		
Sr6	0023	Preset speed 6	LL - UL	Hz		0.0	Y		
Sr7	0024	Preset speed 7	LL - UL	Hz		0.0	Y		
FPId	0025	PID1 set value	F368 - F367	Hz		0.0	Y		[5. 3. 8] [6. 21]
Fr	0008	Panel Fwd/ Rev run select	0: Fwd run 1: Rev run 2: Fwd run (switchable F/R by panel) 3: Rev run (switchable F/R by panel)	-	-	0	Y		[4. 3. 2] [5. 3. 9]
tHrA	0031	Motor overload protection current 1	Depending on capacity *1	A		*1	Y		[5. 2. 5]
OLM	0017	Motor overload protection characteristic	0: Standard motor, OL2, No stall 1: Standard motor, OL2, Stall 2: Standard motor, No OL2 trip, No stall 3: Standard motor, No OL2 trip, Stall 4: Constant torque motor, OL2, No stall 5: Constant torque motor, OL2, Stall 6: Constant torque motor, No OL2 trip, No stall 7: Constant torque motor, No OL2 trip, Stall	-	-	0	Y		[5. 2. 5]
FMSL	0005	Terminal FM function	0 - 162 *3	-	-	0	Y		[5. 2. 6]
FM	0006	Terminal FM adjustment	-	-	-	-	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
tyP	0007	Default setting	0: - 1: 50Hz setting 2: 60Hz setting 3: Default setting 1 4: Clear past trips 5: Clear cumulative run time 6: Initialize type form 7: Store user settings 8: Rewrite user settings 9: Clear cumulative fan run time 10,11: - 12: Clear number of starting 13: Default setting 2 (complete initialization) 14: Clear number of external equipment starting 15: Clear cumulative overcurrent time	-	-	0	N		[5. 2. 9]
SEt	0099	Region setting check	0: Setup menu starting 1: Japan (read only) 2: Mainly North America (read only) 3: Mainly Asia (read only) 4: Mainly Europe (read only) 5: Mainly China (read only)	-	-	0	N		[5. 3. 10]
PSEL	0050	Parameter mode select	0: Setting mode at power on 1: Easy mode at power on 2: Easy mode only	-	-	0	Y		[5. 2. 8]
F1--	-	Head of F100	-	-	-	-	-		[11. 3]
F2--	-	Head of F200	-	-	-	-	-		
F3--	-	Head of F300	-	-	-	-	-		
F4--	-	Head of F400	-	-	-	-	-		
F5--	-	Head of F500	-	-	-	-	-		
F6--	-	Head of F600	-	-	-	-	-		
F7--	-	Head of F700	-	-	-	-	-		
F8--	-	Head of F800	-	-	-	-	-		
F9--	-	Head of F900	-	-	-	-	-		
A---	-	Start of A	-	-	-	-	-		[11. 4]
C---	-	Start of C	-	-	-	-	-		[11. 5]
GrU	-	Changed parameters search & edit	-	-	-	-	-		-

*1 Parameter values vary depending on the capacity. For details, refer to [11.6].
*2 Depending on the setup menu. Refer to [11.10].
*3 For details on the analog output and monitor output function, refer to [11.7].
*4 Refer to section [11.8] for details about the input terminal function.
*5 Refer to section [11.9] for details about the output terminal function.
*6 Y: writable N: Not writable

11. 3 Extended parameter

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F100	0100	Low-speed signal output frequency	0.0 - FH	Hz		0.0	Y		[2. 4. 1] [6. 1. 1]
F101	0101	Reach signal specified frequency	0.0 - FH	Hz		0.0	Y		[6. 1. 3]
F102	0102	Reach signal detection band	0.0 - FH	Hz		2.5	Y		[6. 1. 2] [6. 1. 3]
F105	0105	Fwd/Rev priority of both close	0: Reverse 1: Stop	-	-	1	N		[6. 2. 1]
F107	0107	Terminal RX input voltage select	0: 0 to +10 V 1: -10 to +10 V	-	-	0	N		[6. 2. 2] [6. 6. 2] [7. 3. 1] [7. 3. 4]
F108	0108	Terminal RR input select	1: Voltage input (0-10 V) 2: - 3: - 4: PTC input 5: PT100 (2-wire) input 6: - 7: PT1000 (2-wire) input 8: - 9: KTY84 input	-	-	1	N		[6. 2. 3] [6. 6. 2] [6. 30. 19]
F110	0110	Always active function 1	0 - 177*4	-	-	6	N		[6. 3. 1] [7. 2. 1]

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F111	0111	Terminal F function 1	0 - 203*4	-	-	2	N		[7. 2. 1]
F112	0112	Terminal R function 1		-	-	4	N		
F113	0113	Terminal RES function 1		-	-	8	N		
F114	0114	Terminal S1 function 1		-	-	10	N		
F115	0115	Terminal S2 function		-	-	12	N		
F116	0116	Terminal S3 function		-	-	14	N		
F117	0117	Terminal S4 function		-	-	16	N		
F118	0118	Terminal S5 function		-	-	118	N		
F119	0119	Terminal DI11 function		-	-	0	N		
F120	0120	Terminal DI12 function		-	-	0	N		
F121	0121	Terminal DI13 function		-	-	0	N		
F122	0122	Terminal DI14 function		-	-	0	N		
F123	0123	Terminal DI15 function		-	-	0	N		
F124	0124	Terminal DI16 function	0 - 203*4	-	-	0	N		
F127	0127	Always active function 2	0 - 177*4	-	-	0	N		[6. 3. 1] [7. 2. 1]
F128	0128	Always active function 3		-	-	0	N		
F130	0130	Terminal FP function 1	0 - 255*5	-	-	6	N		[7. 2. 2]
F132	0132	Terminal FL function		-	-	10	N		
F133	0133	Terminal R1 function 1		-	-	4	N		
F134	0134	Terminal R2 function		-	-	254	N		

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F135	0135	Terminal R1 delay time	0.0 - 60.0	s		0.0	N		[7. 2. 2]
F136	0136	Terminal R2 delay time	0.0 - 60.0	s		0.0	N		
F137	0137	Terminal FP function 2	0 - 255*5	-	-	255	N		
F138	0138	Terminal R1 function 2		-	-	255	N		
F139	0139	Terminal FP, R1 logic select	0: F130 and F137, F133 and F138 1: F130 and F137, F133 or F138 2: F130 or F137, F133 and F138 3: F130 or F137, F133 or F138	-	-	0	N		
F140	0140	Terminal F response time	1 - 1000	ms		1	N		[7. 2. 1]
F141	0141	Terminal R response time	1 - 1000	ms		1	N		
F142	0142	Terminal RES response time	1 - 1000	ms		1	N		
F143	0143	Terminal S1 response time	1 - 1000	ms		1	N		
F144	0144	Terminal S2-S5 response time	1 - 1000	ms		1	N		
F145	0145	Terminal DI11-DI16 response time	1 - 1000	ms		1	N		
F146	0146	Terminal S4 input select	0: Digital input. 1: Pulse train input 2: PG input	-	-	0	N		[6. 6. 4] [7. 2. 1]
F147	0147	Terminal S5 input select	0: Digital input. 1: Pulse train input 2: PG input	-	-	0	N		
F148	0148	Terminal AI4 input select	1: Voltage input (0-10 V) 2: Voltage input (-10 to +10V) 3: Current input (0-20 mA) 4: PTC input 5: PT100 (2-wire) input 6: PT100 (3-wire) input 7: PT1000 (2-wire) input 8: PT1000 (3-wire) input 9: KTY84 input	-	-	1	N		[6. 2. 4] [6. 6. 2]
F149	0149	Terminal AI5 input select	1: Voltage input (0-10 V) 2: Voltage input (-10 to +10V) 3: Current input (0-20 mA) 4: PTC input 5: PT100 (2-wire) input 6: PT100 (3-wire) input 7: PT1000 (2-wire) input 8: PT1000 (3-wire) input 9: KTY84 input	-	-	1	N		[6. 30. 19] [7. 2. 1]

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F151	0151	Terminal F function 2	0 - 203*4	-	-	0	N		[7. 2. 1]
F152	0152	Terminal R function 2		-	-	0	N		
F153	0153	Terminal RES function 2		-	-	0	N		
F154	0154	Terminal S1 function 2		-	-	0	N		
F155	0155	Terminal F function 3		-	-	0	N		
F156	0156	Terminal R function 3		-	-	0	N		
F157	0157	Terminal RES function 3		-	-	0	N		
F158	0158	Terminal S1 function 3		-	-	0	N		
F159	0159	Terminal DQ11 function	0 - 255*5	-	-	254	N		[7. 2. 2]
F160	0160	Terminal DQ12 function		-	-	254	N		
F161	0161	Terminal R4 function		-	-	254	N		
F162	0162	Terminal R5 function		-	-	254	N		
F163	0163	Terminal R6 function		-	-	254	N		
F170	0170	Base frequency 2	15.0 - 590.0	Hz		50.0 / 60.0 *2	Y		[6. 4]
F171	0171	Base frequency voltage 2	240V class: 50-330V 480V class: 50-660V	V		*2	Y		
F172	0172	Manual torque boost 2	0.00 - 30.00	%		*1	Y		
F173	0173	Parameter for manufacturer	-	-	-	-	-		-
F174	0174	Base frequency 3	15.0 - 590.0	Hz		50.0/ 60.0 *2	Y		[6. 4]
F175	0175	Base frequency voltage 3	240V class: 50-330V 480V class: 50-660V	V		*2	Y		
F176	0176	Manual torque boost 3	0.00 - 30.00	%		*1	Y		
F177	0177	Parameter for manufacturer	-	-	-	-	-		-
F178	0178	Base frequency 4	15.0 - 590.0	Hz		50.0/ 60.0 *2	Y		[6. 4]
F179	0179	Base frequency voltage 4	240V class: 50-330V 480V class: 50-660V	V		*2	Y		
F180	0180	Manual torque boost 4	0.00 - 30.00	%		*1	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F181	0181	Parameter for manufacturer	-	-	-	-	-		-
F182	0182	Motor overload protection current 2	Depending on capacity *1	A		*1	Y		[6. 4]
F183	0183	Motor overload protection current 3		A		*1	Y		
F184	0184	Motor overload protection current 4		A		*1	Y		
F185	0185	Stall prevention level 2	10-200 (HD) 10-160 (ND)	% (A)		150 (HD) 120 (ND)	Y		[6. 30. 2]
F190	0190	V/f 5-point VF1 frequency	0.0 - FH	Hz		0.0	N		[5. 3. 4]
F191	0191	V/f 5-point VF1 voltage	0.0 - 125.0	% (V)		0.0	N		
F192	0192	V/f 5-point VF2 frequency	0.0 - FH	Hz		0.0	N		
F193	0193	V/f 5-point VF2 voltage	0.0 - 125.0	% (V)		0.0	N		
F194	0194	V/f 5-point VF3 frequency	0.0 - FH	Hz		0.0	N		
F195	0195	V/f 5-point VF3 voltage	0.0 - 125.0	% (V)		0.0	N		
F196	0196	V/f 5-point VF4 frequency	0.0 - FH	Hz		0.0	N		
F197	0197	V/f 5-point VF4 voltage	0.0 - 125.0	% (V)		0.0	N		
F198	0198	V/f 5-point VF5 frequency	0.0 - FH	Hz		0.0	N		
F199	0199	V/f 5-point VF5 voltage	0.0 - 125.0	% (V)		0.0	N		
F200	0200	Frequency command priority select	0: FMOd/F207 (switched by TB) 1: FMOd/F207 (switched by F208)	-	-	0	Y		[5. 4. 1] [6. 6. 1]
F201	0201	RR point 1 input value	0 - 100	%		0	Y		[6. 6. 2] [7. 3. 1] [7. 3. 2]
F202	0202	RR point 1 frequency	0.0 - 590.0	Hz		0.0	Y		
F203	0203	RR point 2 input value	0 - 100	%		100	Y		
F204	0204	RR point 2 frequency	0.0 - 590.0	Hz		50.0/ 60.0 *2	Y		
F205	0205	RR point 1 rate	0 - 250	%		0	Y		[6. 6. 2]
F206	0206	RR point 2 rate	0 - 250	%		100	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F207	0207	Frequency command select 2	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 9: - 10: Touch wheel 1 (power off or press OK to save) 11: Touch wheel 2 (press OK to save) 12: Sr0 13,14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18,19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	-	-	3	N		[5. 4. 1] [6. 6. 1]
F208	0208	Frequency command switching frequency	0.1 - FH	Hz		0.1	Y		
F209	0209	Analog input filter	1: Disabled 2 - 1000	ms		1	Y		[6. 6. 2] [7. 3. 1] [7. 3. 4]
F210	0210	RX point 1 input value	-100 to +100	%		0	Y		
F211	0211	RX point 1 frequency	0.0 - 590.0	Hz		0.0	Y		
F212	0212	RX point 2 input value	-100 to +100	%		100	Y		
F213	0213	RX point 2 frequency	0.0 - 590.0	Hz		50.0/ 60.0 *2	Y		
F214	0214	RX point 1 rate	-250 to +250	%		0	Y		[6. 6. 2]
F215	0215	RX point 2 rate	-250 to +250	%		100	Y		
F216	0216	II point 1 input value	0 - 100	%		20	Y		[6. 6. 2] [7. 3. 1] [7. 3. 3]
F217	0217	II point 1 frequency	0.0 - 590.0	Hz		0.0	Y		
F218	0218	II point 2 input value	0 - 100	%		100	Y		
F219	0219	II point 2 frequency	0.0 - 590.0	Hz		50.0/ 60.0 *2	Y		
F220	0220	II point 1 rate	0 - 250	%		0	Y		[6. 6. 2]
F221	0221	II point 2 rate	0 - 250	%		100	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F222	0222	AI4 point 1 input value	-100 to +100	%		0	Y		[6. 6. 2] [7. 3. 1]
F223	0223	AI4 point 1 frequency	0.0 - 590.0	Hz		0.0	Y		
F224	0224	AI4 point 2 input value	-100 to +100	%		100	Y		
F225	0225	AI4 point 2 frequency	0.0 - 590.0	Hz		50.0/ 60.0 *2	Y		
F226	0226	AI4 point 1 rate	-250 to +250	%		0	Y		[6. 6. 2]
F227	0227	AI4 point 2 rate	-250 to +250	%		100	Y		
F228	0228	AI5 point 1 input value	-100 to +100	%		0	Y		[6. 6. 2] [7. 3. 1]
F229	0229	AI5 point 1 frequency	0.0 - 590.0	Hz		0.0	Y		
F230	0230	AI5 point 2 input value	-100 to +100	%		100	Y		
F231	0231	AI5 point 2 frequency	0.0 - 590.0	Hz		50.0/ 60.0 *2	Y		
F234	0234	Pulse train input point 1 input value	0 - 100	%		0	Y		[6. 6. 4]
F235	0235	Pulse train input point 1 frequency	0.0 - 590.0	Hz		0.0	Y		
F236	0236	Pulse train input point 2 input value	0 - 100	%		100	Y		
F237	0237	Pulse train input point 2 frequency	0.0 - 590.0	Hz		50.0/ 60.0 *2	Y		
F239	0239	Parameter for manufacturer	-	-	-	-	-		-
F240	0240	Start frequency	0.0 - 10.0	Hz		0.1	Y		[6. 7. 1]
F241	0241	Run frequency	0.0 - FH	Hz		0.0	Y		[6. 7. 2]
F242	0242	Run frequency hysteresis	0.0 - FH	Hz		0.0	Y		
F243	0243	End frequency	0.0 - 30.0	Hz		0.0	Y		[6. 7. 1]
F244	0244	0 Hz dead band	0.0 - 5.0	Hz		0.0	Y		[6. 7. 3]
F249	0249	DC braking carrier frequency	1.0 - 16.0	kHz		*1	Y		[6. 8. 1]
F250	0250	DC braking frequency	0.0 - FH	Hz		0.0	Y		[6. 8. 1] [6. 8. 3]
F251	0251	DC braking current	0 - 100	%		50	Y		[6. 8. 1] [6. 30. 4]
F252	0252	DC braking time	0.0 - 25.5	s		1.0	Y		[6. 8. 1] [6. 8. 3]
F253	0253	Fwd/Rev DC braking priority	0: Disabled 1: Enabled	-	-	0	Y		[6. 8. 1]
F254	0254	Motor shaft fixing control	0: Disabled 1: Enabled	-	-	0	Y		[6. 8. 2]
F255	0255	0Hz command select at stop	0: DC braking 1: 0 Hz command	-	-	0	N		[6. 8. 3]

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F256	0256	Run sleep detection time	0.0: Disabled 0.1 - 600.0	s		0.0	Y		[6. 9]
F257	0257	Parameter for manufacturer	-	-	-	-	-		-
F258	0258	Parameter for manufacturer	-	-	-	-	-		-
F259	0259	Run sleep detection time at startup	0.0: Disabled 0.1 - 600.0	s		0.0	Y		[6. 9]
F260	0260	Jog frequency	F240 - 20.0	Hz		5.0	Y		[6. 10]
F261	0261	Jog stop select	0: Deceleration stop 1: Coast stop 2: DC braking stop	-	-	0	N		
F262	0262	Panel jog run	0: Disabled 1: Enabled	-	-	0	Y		
F264	0264	Terminal Up response time	0.0 - 10.0	s		0.1	Y		[6. 6. 5]
F265	0265	Terminal Up frequency step	0.0 - FH	Hz		0.1	Y		
F266	0266	Terminal Down response time	0.0 - 10.0	s		0.1	Y		
F267	0267	Terminal Down frequency step	0.0 - FH	Hz		0.1	Y		
F268	0268	Initial Up/Down frequency	LL - UL	Hz		0.0	Y		
F269	0269	Up/Down frequency rewrite	0: F268 is not changed. 1: F268 is changed after power off.	-	-	1	Y		
F270	0270	Jump frequency 1	0.0 - FH	Hz		0.0	Y		[6. 11]
F271	0271	Jump frequency 1 band	0.0 - 30.0	Hz		0.0	Y		
F272	0272	Jump frequency 2	0.0 - FH	Hz		0.0	Y		
F273	0273	Jump frequency 2 band	0.0 - 30.0	Hz		0.0	Y		
F274	0274	Jump frequency 3	0.0 - FH	Hz		0.0	Y		
F275	0275	Jump frequency 3 band	0.0 - 30.0	Hz		0.0	Y		
F287	0287	Preset speed 8	LL - UL	Hz		0.0	Y		[5. 3. 7] [6. 28]
F288	0288	Preset speed 9	LL - UL	Hz		0.0	Y		
F289	0289	Preset speed 10	LL - UL	Hz		0.0	Y		
F290	0290	Preset speed 11	LL - UL	Hz		0.0	Y		
F291	0291	Preset speed 12	LL - UL	Hz		0.0	Y		
F292	0292	Preset speed 13	LL - UL	Hz		0.0	Y		
F293	0293	Preset speed 14	LL - UL	Hz		0.0	Y		
F294	0294	Preset speed 15 / Forced run speed	LL - UL	Hz		0.0	Y		[5. 3. 7] [6. 12. 2] [6. 28] [6. 31]

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F295	0295	Bumpless	0: Disabled 1: Enabled	-	-	0	Y		[6. 13]
F297	0297	Parameter for manufacturer	-	-	-	-	-		-
F298	0298	Parameter for manufacturer	-	-	-	-	-		-
F300	0300	Carrier frequency	Depending on capacity *1	kHz		*1	Y		[2. 4. 1] [2. 4. 3] [6. 14]
F301	0301	Auto-restart	0: Disabled 1: Power failure 2: Terminal ST On/Off 3: Terminal ST On/Off or power failure 4: At startup	-	-	0	N		[5. 4. 2]
F302	0302	Regenerative power ride-through	0: Disabled 1: Regenerative power ride-through 2: Deceleration stop at power failure 3: Synchronized Acc/ Dec (TB) 4: Synchronized Acc/ Dec (TB + power failure)	-	-	0	N		[6. 15. 2]
F303	0303	Retry	0: Disabled 1 - 10	Times		0	Y		[6. 15. 3]
F304	0304	Dynamic braking, OLr trip	0: Disabled 1: Enabled, OLr trip 2: Enabled, No OLr trip 3: Enabled (except during ST OFF), OLr trip 4: Enabled (except during ST OFF), No OLr trip 5: Enabled (except during trip), OLr trip 6: Enabled (except during trip), No OLr trip 7: Enabled (except during trip & ST OFF), OLr trip 8: Enabled (except during trip & ST OFF), No OLr trip	-	-	0	N		[6. 15. 4]
F305	0305	Overvoltage limit operation	0: Enabled 1: Disabled 2: Enabled (quick deceleration) 3: Enabled (dynamic quick deceleration)	-	-	2	N		[6. 15. 5]
F306	0306	Parameter for manufacturer	-	-	-	-	-		-

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F307	0307	Supply voltage compensation, Output voltage limitation	0: Without supply voltage compensation, Limited output voltage 1: With supply voltage compensation, Limited output voltage 2: Without supply voltage compensation, Unlimited output voltage 3: With supply voltage compensation, Unlimited output voltage	-	-	*2	N		[6. 15. 6]
F308	0308	Braking resistance	0.5 - 1000	Ω		*1	N		[6. 15. 4]
F309	0309	Braking resistor capacity	0.01 - 600.0	kW		*1	N		
F310	0310	Dec time at power failure	0.0 - 320.0	s		2.0	N		[6. 15. 2]
F311	0311	Reverse inhibited	0: Allowed 1: Rev inhibited 2: Fwd inhibited 3: - 4: -	-	-	0	N		[6. 15. 7]
F312	0312	Random switching	0: Disabled 1: Random switching 1 2: Random switching 2 3: Random switching 3	-	-	0	N		[6. 14]
F313	0313	Ridethrough time	0.0: Continuous 0.1 - 320.0	s		2.0	N		[6. 15. 2]
F314	0314	Parameter for manufacturer	-	-	-	-	-		-
F315	0315	Parameter for manufacturer	-	-	-	-	-		-
F316	0316	Carrier frequency control	0: No decrease 1: Valid decrease 2: No decrease, 480V class 3: Valid decrease, 480V class 4: No decrease with sinusoidal filter 5: Valid decrease with sinusoidal filter	-	-	*1	N		[2. 4. 1] [6. 14]
F317	0317	Synchronized stop time	0.0 - 6000	s		2.0	Y		[6. 15. 2]
F318	0318	Synchronized reach time	0.0 - 6000	s		2.0	Y		
F319	0319	Regenerative over-flux upper limit	100 - 160	%		*2	N		[6. 15. 5]

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F320	0320	Droop gain	0.0 - 100.0	%		0.0	Y		[6. 16]
F321	0321	Frequency at 0% droop gain	0.0 - 320.0	Hz		0.0	Y		
F322	0322	Frequency at F320 droop gain	0.0 - 320.0	Hz		0.0	Y		
F323	0323	Droop deadband torque	0 - 100	%		10	Y		
F324	0324	Droop output filter	0.1 - 200.0	rad/s		100.0	Y		
F325	0325	Brake release wait time	0.00 - 2.50	s		0.00	N		[6. 18. 1]
F326	0326	Brake release undercurrent threshold	0 - 100	% (A)		0	Y		
F327	0327	Parameter for manufacturer	-	-	-	-	-		-
F328	0328	Light-load high-speed operation	0: Disabled 1: Auto speed (Fwd: up) 2: Auto speed (Rev: up) 3: Speed F330 (Fwd: up) 4: Speed F330 (Rev: up)	-	-	0	N		[6. 17]
F329	0329	Light-load high-speed learning function	0: - 1: Fwd run only 2: Rev run only	-	-	0	N		
F330	0330	Light-load high-speed automatic operation frequency	30.0 - UL	Hz		50.0/ 60.0*2	N		
F331	0331	Light-load high-speed operation switching lower-limit frequnecy	5.0 - UL	HZ		40.0	Y		
F332	0332	Light-load high-speed operation load detection wait time	0.0 - 10.0	s		0.5	Y		
F333	0333	Light-load high-speed operation load detection time	0.0 - 10.0	s		1.0	Y		
F334	0334	Light-load high-speed operation heavy load detection time	0.0 - 10.0	s		0.5	Y		
F335	0335	Switching load torque during power running	-250 to +250	%		50	Y		
F336	0336	Heavy-load torque during power running	-250 to +250	%		100	Y		
F337	0337	Heavy-load torque during constant speed power running	-250 to +250	%		50	Y		
F338	0338	Switching load torque during regen	-250 to +250	%		50	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F339	0339	Parameter for manufacturer	-	-	-	-	-		-
F340	0340	Creep time 1	0.00 - 10.00	s		0.00	N		[6. 18. 1]
F341	0341	Brake function	0: Disabled 1: Fwd hoisting 2: Rev hoisting 3: Horizontal operation	-	-	0	N		
F342	0342	Load torque input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F343 13 - 19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	-	-	12	Y		[6. 18. 1]
F343	0343	Hoisting torque bias	-250 to +250 (F342 = "12" only)	%		100	Y		
F344	0344	Lowering torque bias rate	0 - 100	%		100	Y		
F345	0345	Brake releasing time	0.00 - 10.00	s		0.05	Y		
F346	0346	Creep frequency	F240 - 20.0	Hz		3.0	N		
F347	0347	Creep time 2	0.00 - 10.00	s		0.10	Y		
F348	0348	Brake learning	0: - 1: Enabled (0 after execution)	-	-	0	N		
F349	0349	Dwell operation	0: Disabled 1: F350-F353 setting 2: Terminal input	-	-	0	N		[6. 19]
F350	0350	Acc suspended frequency	0.0 - FH	Hz		0.0	Y		
F351	0351	Acc suspended time	0.0 - 10.0	s		0.0	Y		
F352	0352	Dec suspended frequency	0.0 - FH	Hz		0.0	Y		
F353	0353	Dec suspended time	0.0 - 10.0	s		0.0	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F354	0354	Commercial power/ Inverter switching	0: Disabled 1: Switch at trip 2: Switch at F355 3: Switch at trip and at F355	-	-	0	N		[6. 20]
F355	0355	Commercial power switching frequency	0.0 - UL	Hz		50.0/ 60.0*2	Y		
F356	0356	Inverter switching wait time	0.10 - 10.00	s		*1	Y		
F357	0357	Commercial power switching wait time	0.10 - 10.00	s		0.62	Y		
F358	0358	Commercial power switching frequency continuous time	0.10 - 10.00	s		2.00	Y		
F359	0359	PID control1	0: Disabled 1: Process PID control 2: Speed PID control 3: Easy positioning PID control 4: Dancer control 5 - 10: - 11: Minus Process PID control 12: Minus Speed PID control 13: Minus Easy positioning PID control 14: Minus Dancer control	-	-	0	N		[5. 3. 8] [6. 21] [6. 22]
F360	0360	PID1 feedback input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 16: - 17: High resolution pulse train (option)	-	-	0	N		[5. 3. 8]
F361	0361	PID1 filter	0.0 - 25.0	s		0.0	Y		[6. 21]
F362	0362	PID1 proportional gain	0.01 - 100.0	-		0.30	Y		[5. 3. 8] [6. 21] [6. 22]
F363	0363	PID1 integral gain	0.01 - 100.0	s^{-1}		0.20	Y		[5. 3. 8] [6. 21]
F364	0364	PID1 deviation upper-limit	LL - UL	Hz		50.0/ 60.0*2	Y		[6. 21]
F365	0365	PID1 deviation lower-limit	LL - UL	Hz		50.0/ 60.0*2	Y		
F366	0366	PID1 differential gain	0.00 - 2.55	s		0.00	Y		[5. 3. 8] [6. 21]
F367	0367	PID1 set value upper-limit	0.0 - FH	Hz		50.0/ 60.0*2	Y		
F368	0368	PID1 set value lower-limit	0.0 - F367	Hz		0.0	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F369	0369	PID control start wait time	0 - 2400	s		0	Y		[5. 3. 8] [6. 21] [6. 22]
F370	0370	PID1 output upper-limit	LL - UL	Hz		50.0/ 60.0*2	Y		[6. 21]
F371	0371	PID1 output lower-limit	LL - UL	Hz		0.0	Y		
F372	0372	PID1 set value increase time	0.1-600.0 (Speed PID)	s		10.0	Y		
F373	0373	PID1 set value decrease time	0.1-600.0 (Speed PID)	s		10.0	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F374	0374	PID1 set value agreement detection band	0.0 - FH	Hz		2.5	Y		[6. 21]
F375	0375	PG pulses number	1 - 9999	pulse		1000	N		[6. 22]
F376	0376	PG select	0: PTI (Command) - PTI (FB) 1: PTI (Command) - Digital option (FB) 2 - 5: - 6: Digital option (Command) - Non FB 7 - 9: - 10: PTI (Command) - PTI (FB inversion) 11: PTI (Command) - Digital option (FB inversion) 12 - 15: - 16: Digital option (Command inversion) - Non FB	-	-	0	N		[6. 6. 4] [6. 22]
F377	0377	PG option disconnection detection	0: Disabled 1: Enabled	-	-	0	N		-
F378	0378	Pulse train input pulses number	1 - 9999	pps		1000	N		[6. 6. 4]
F379	0379	PG option voltage	0: 5V 1: 12V 2: 24V	-	-	0	N		-
F381	0381	Simple positioning completion range	1 - 4000	pulse		100	Y		[6. 22]
F382	0382	Hit and stop control	0: Disabled 1: Enabled 2: -	-	-	0	Y		[6. 18. 2]
F383	0383	Hit and stop frequency	0.1 - 30.0	Hz		5.0	Y		
F384	0384	Hit and stop torque limit	0 - 100	%		100	Y		-
F385	0385	Hit and stop detection time	0.0 - 25.0	s		0.3	Y		-
F386	0386	Hit and stop continuation torque limit	0 - 100	%		50	Y		-
F388	0388	PID1 output dead band	0 - 100	%		0	Y		[6. 21]

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F389	0389	PID1 set value select	0: selected by FMOd/ F207 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 11: - 12: FPId 13,14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18,19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	-	-	0	N		[5. 3. 8] [6. 21]
F390	0390	Parameter for manufacturer	-	-	-	-	-		-
F391	0391	Sleep detection hysteresis	0.0 - UL	Hz		0.0	Y		[6. 9]
F392	0392	Wakeup deviation	0.0 - UL	Hz		0.0	Y		
F393	0393	Wakeup feedback	0.0 - UL	Hz		0.2	Y		
F394	0394	Parameter for manufacturer	-	-	-	-	-		-
F395	0395	Parameter for manufacturer	-	-	-	-	-		-
F399	0399	Parameter for manufacturer	-	-	-	-	-		-
F400	0400	Offline auto-tuning	0: - 1: Reset motor parameters (0 after execution) 2: Auto-tuning at run command (0 after execution) 3: Auto-tuning at TB ON 4: Motor parameters auto calculation (0 after execution) 5: 4+2 (0 after execution) 6: Auto-tuning at run command during TB ON 7: Auto-tuning F402 only at run command during TB ON	-	-	0	N		[6. 23. 1] [6. 23. 2]
F401	0401	Slip frequency gain	0 - 250	%		70	Y		[6. 23. 1]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F402	0402	Automatic torque boost	0.1 - 30.00	%		*1	Y		[6. 23. 1] [6. 23. 2]
F403	0403	Online auto-tuning	0: Disabled 1: Self-cooling motor auto-tuning 2: Forced air-cooling motor auto-tuning	-	-	0	N		[6. 23. 1]
F405	0405	Motor rated capacity	0.10 - 315.0	kW		*1	N		[6. 23. 1] [6. 23. 2]
F412	0412	Leakage inductance	0.0 - 25.0	%		*1	N		[6. 23. 1]
F413	0413	Exciting current coefficient	100 - 150	%		100	N		
F414	0414	Stall prevention coefficient	10 - 250	-		100	N		-
F415	0415	Motor rated current	Depending on capacity *1	A		*1	N		[6. 23. 1] [6. 23. 2]
F416	0416	Motor no load current	10 - 90	%		*1	N		[6. 23. 1]
F417	0417	Motor rated speed	100 - 64000	min^{-1}		*2	N		[6. 23. 1] [6. 23. 2]
F418	0418	Parameter for manufacturer	-	-	-	-	-		-
F419	0419	Parameter for manufacturer	-	-	-	-	-		-
F420	0420	Torque command select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F725 13 - 19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	-	-	2	Y		[6. 25. 1]
F421	0421	Torque command filter	0 - 1000	ms		0	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F423	0423	Tension control torque bias input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F725 13 - 19: - 20: Embedded Ethernet 21: RS485 communication connector 1 22: RS485 communication connector 2 23: Communication option	-	-	0	Y		[6. 25. 3]
F424	0424	Load sharing gain input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F725 13 - 19: - 20: Embedded Ethernet 21: RS485 communication connector 1 22: RS485 communication connector 2 23: Communication option	-	-	0	Y		[6. 25. 3]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F425	0425	Fwd speed limit input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F426	-	-	0	Y		[6. 25. 2]
F426	0426	Fwd speed limit level	0.0 - UL	Hz		50.0/ 60.0*2	Y		
F427	0427	Rev speed limit input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F428	-	-	0	Y		
F428	0428	Rev speed limit level	0.0 - UL	Hz		50.0/ 60.0*2	Y		
F430	0430	Speed limit center value input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F431	-	-	0	Y		
F431	0431	Speed limit center value	0.0 - FH	Hz		0.0	Y		
F432	0432	Speed limit band	0.0 - FH	Hz		0.0	Y		
F435	0435	Rotation direction limit during torque control	0: Fwd/Rev permit 1: Command direction permit	-	-	0	Y		[6. 25. 1]
F440	0440	Power running torque limit input select 1	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F441	-	-	12	Y		[6. 24. 1]
F441	0441	Power running torque limit level 1	0.0-249.9 250.0: Disabled	%		250.0	Y		[6. 24. 1] [6. 24. 3]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F442	0442	Regenerative torque limit input select 1	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F443	-	-	12	Y		[6. 24. 1]
F443	0443	Regenerative torque limit level 1	0.0-249.9 250.0: Disabled	%		250.0	Y		
F444	0444	Power running torque limit level 2	0.0-249.9 250.0: Disabled	%		250.0	Y		
F445	0445	Regenerative torque limit level 2	0.0-249.9 250.0: Disabled	%		250.0	Y		
F446	0446	Power running torque limit level 3	0.0-249.9 250.0: Disabled	%		250.0	Y		
F447	0447	Regenerative torque limit level 3	0.0-249.9 250.0: Disabled	%		250.0	Y		
F448	0448	Power running torque limit level 4	0.0-249.9 250.0: Disabled	%		250.0	Y		
F449	0449	Regenerative torque limit level 4	0.0-249.9 250.0: Disabled	%		250.0	Y		
F451	0451	Acc/Dec operation after stall operation	0: Acc/Dec time 1: Minimum time	-	-	0	N		[6. 24. 2]
F452	0452	Stall detection time during power running	0.00 - 10.00	s		0.00	Y		[6. 24. 3]
F453	0453	Stall operation during regen	0: Enabled 1: Disabled	-	-	0	Y		[6. 24. 4]
F454	0454	Torque limit in field weakening	0: Constant power limit 1: Constant torque limit	-	-	0	N		[6. 24. 1]
F455	0455	Torque command polarity at Rev	0: Regeneration at positive torque command 1: Power running at positive torque command	-	-	0	N		[6. 25. 1]
F456	0456	Exciting forcing level	20 - 150	%		*1	N		-
F457	0457	Exciting forcing control gain	5 - 75	Hz		50	N		-
F458	0458	Current control response	0 - 100	-		0	N		[6. 26. 1]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F459	0459	Load inertia ratio	0.1 - 100.0	Times		1.0	Y		[6. 23. 1] [6. 23. 2] [6. 26. 1]
F460	0460	Speed control response 1	0.0 - 25.0	-		0.0	Y		
F461	0461	Speed control stabilization coefficient 1	0.50 - 2.50	-		1.00	Y		
F462	0462	Speed reference filter coefficient 1	0 - 100	-		35	Y		
F463	0463	Speed control response 2	0.0 - 25.0	-		0.0	Y		
F464	0464	Speed control stabilization coefficient 2	0.50 - 2.50	-		1.00	Y		
F465	0465	Speed reference filter coefficient 2	0 - 100	-		35	Y		
F466	0466	Speed control response switching frequency	0.0 - FH	Hz		0.0	Y		
F467	0467	Parameter for manufacturer	-	-	-	-	-		-
F468	0468	Parameter for manufacturer	-	-	-	-	-		-
F469	0469	Parameter for manufacturer	-	-	-	-	-		-
F470	0470	RR input bias	0 - 255	-	1/1	128	Y		[6. 6. 3]
F471	0471	RR input gain	0 - 255	-	1/1	128	Y		
F472	0472	RX input bias	0 - 255	-	1/1	128	Y		
F473	0473	RX input gain	0 - 255	-	1/1	128	Y		
F474	0474	II input bias	0 - 255	-	1/1	128	Y		
F475	0475	II input gain	0 - 255	-	1/1	128	Y		
F476	0476	AI4 input bias	0 - 255	-	1/1	128	Y		
F477	0477	AI4 input gain	0 - 255	-	1/1	128	Y		
F478	0478	AI5 input bias	0 - 255	-	1/1	128	Y		
F479	0479	AI5 input gain	0 - 255	-	1/1	128	Y		
F480	0480	Inertia auto-tuning	0 - 1	-		0	N		-
F481	0481	Speed command at inertia auto-tuning	10 - 100	%		25	N		-
F482	0482	Speed variation width at inertia auto-tuning	0.1 - 25.0	%		5.0	N		-
F483	0483	Number of speed variation at inertia auto-tuning	5 - 50	Times		10	N		-
F490	0490	Parameter for manufacturer	-	-	-	-	-		-
F491	0491	Parameter for manufacturer	-	-	-	-	-		-

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F495	0495	Over modulation ratio	90 - 120	%		104	N		[6. 26. 2]
F498	0498	Parameter for manufacturer	-	-	-	-	-		-
F499	0499	Parameter for manufacturer	-	-	-	-	-		-
F500	0500	Acceleration time 2	0.0 - 6000 (600.0)	s		*1	Y		[6. 27. 2]
F501	0501	Deceleration time 2	0.0 - 6000 (600.0)	s		*1	Y		
F502	0502	Acc/Dec pattern 1	0: Linear 1: S-Pattern 1 2: S-Pattern 2	-	-	0	Y		[6. 27. 1] [6. 27. 2]
F503	0503	Acc/Dec pattern 2	0: Linear 1: S-Pattern 1 2: S-Pattern 2	-	-	0	Y		[6. 27. 2]
F504	0504	Panel Acc/Dec select	1: Acc/Dec 1 2: Acc/Dec 2 3: Acc/Dec 3 4: Acc/Dec 4	-	-	1	Y		
F505	0505	Acc/Dec switching frequency 1	0.0: Disabled 0.1 - UL	Hz		0.0	Y		
F506	0506	S-Pattern range at Acc start	0 - 50	%		10	Y		[6. 27. 1] [6. 27. 2]
F507	0507	S-Pattern range at Acc completion	0 - 50	%		10	Y		
F508	0508	S-Pattern range at Dec completion	0 - 50	%		10	Y		
F509	0509	S-Pattern range at Dec start	0 - 50	%		10	Y		
F510	0510	Acceleration time 3	0.0 - 6000 (600.0)	s		*1	Y		[6. 27. 2]
F511	0511	Deceleration time 3	0.0 - 6000 (600.0)	s		*1	Y		
F512	0512	Acc/Dec pattern 3	0: Linear 1: S-Pattern 1 2: S-Pattern 2	-	-	0	Y		
F513	0513	Acc/Dec switching frequency 2	0.0: Disabled 0.1 - UL	Hz		0.0	Y		
F514	0514	Acceleration time 4	0.0 - 6000 (600.0)	s		*1	Y		
F515	0515	Deceleration time 4	0.0 - 6000 (600.0)	s		*1	Y		
F516	0516	Acc/Dec pattern 4	0: Linear 1: S-Pattern 1 2: S-Pattern 2	-	-	0	Y		
F517	0517	Acc/Dec switching frequency 3	0.0: Disabled 0.1 - UL	Hz		0.0	Y		
F519	0519	Unit of Acc/Dec time	0: - 1: 0.01 s unit (0 after execution) 2: 0.1 s unit (0 after execution)	-	-	0	N		[5. 2. 4] [6. 27. 2]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F520	0520	Pattern operation	0: Disabled 1: Enabled (seconds) 2: Enabled (minutes)	-	-	0	N		[6. 28]
F521	0521	Pattern operation continue select	0: Reset after stop 1: Continue after stop	-	-	0	N		
F522	0522	Pattern 1 repeat number	1 - 254 255: Continuous	Times	1/1	1	N		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F523	0523	Pattern 1 select 1	0: Skip 1: Sr1 2: Sr2 3: Sr3 4: Sr4 5: Sr5 6: Sr6 7: Sr7 8: F287 9: F288 10: F289 11: F290 12: F291 13: F292 14: F293 15: F294	-	-	0	N		[6. 28]
F524	0524	Pattern 1 select 2		-	-	0	N		
F525	0525	Pattern 1 select 3		-	-	0	N		
F526	0526	Pattern 1 select 4		-	-	0	N		
F527	0527	Pattern 1 select 5		-	-	0	N		
F528	0528	Pattern 1 select 6		-	-	0	N		
F529	0529	Pattern 1 select 7		-	-	0	N		
F530	0530	Pattern 1 select 8		-	-	0	N		
F531	0531	Pattern 2 repeat number	1 - 254 255: Continuous	Times		1	N		
F532	0532	Pattern 2 select 1	0: Skip 1: Sr1 2: Sr2 3: Sr3 4: Sr4 5: Sr5 6: Sr6 7: Sr7 8: F287 9: F288 10: F289 11: F290 12: F291 13: F292 14: F293 15: F294	-	-	0	N		
F533	0533	Pattern 2 select 2		-	-	0	N		
F534	0534	Pattern 2 select 3		-	-	0	N		
F535	0535	Pattern 2 select 4		-	-	0	N		
F536	0536	Pattern 2 select 5		-	-	0	N		
F537	0537	Pattern 2 select 6		-	-	0	N		
F538	0538	Pattern 2 select 7		-	-	0	N		
F539	0539	Pattern 2 select 8		-	-	0	N		
F540	0540	Operation time (1-speed)	0.1 - 5999 (Unit by F520) 6000: Continuous	s/min	0.1/0.1	5.0	Y		
F541	0541	Operation time (2-speed)		s/min	0.1/0.1	5.0	Y		
F542	0542	Operation time (3-speed)		s/min	0.1/0.1	5.0	Y		
F543	0543	Operation time (4-speed)		s/min	0.1/0.1	5.0	Y		
F544	0544	Operation time (5-speed)		s/min	0.1/0.1	5.0	Y		
F545	0545	Operation time (6-speed)		s/min	0.1/0.1	5.0	Y		
F546	0546	Operation time (7-speed)		s/min	0.1/0.1	5.0	Y		
F547	0547	Operation time (8-speed)		s/min	0.1/0.1	5.0	Y		
F548	0548	Operation time (9-speed)		s/min	0.1/0.1	5.0	Y		
F549	0549	Operation time (10-speed)		s/min	0.1/0.1	5.0	Y		
F550	0550	Operation time (11-speed)		s/min	0.1/0.1	5.0	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F551	0551	Operation time (12-speed)	0.1 - 5999 (Unit by F520) 6000: Continuous	s/min	0.1/0.1	5.0	Y		[6. 28]
F552	0552	Operation time (13-speed)		s/min	0.1/0.1	5.0	Y		
F553	0553	Operation time (14-speed)		s/min	0.1/0.1	5.0	Y		
F554	0554	Operation time (15-speed)		s/min	0.1/0.1	5.0	Y		
F560	0560	Preset speed operation style	0: Frequency only 1: With function	-	-	0	N		[5. 3. 7] [6. 12. 1]
F561	0561	Operation function (1-speed)	0: Fwd run +1: Rev run +2: Acc/Dec switching signal 1 +4: Acc/Dec switching signal 2 +8: V/f switching signal 1 +16: V/f switching signal 2 +32: Torque limit switching signal 1 +64: Torque limit switching signal 2	-	1/1	0	N		[5. 3. 7] [6. 12. 1] [6. 28]
F562	0562	Operation function (2-speed)		-	1/1	0	N		
F563	0563	Operation function (3-speed)		-	1/1	0	N		
F564	0564	Operation function (4-speed)		-	1/1	0	N		
F565	0565	Operation function (5-speed)		-	1/1	0	N		
F566	0566	Operation function (6-speed)		-	1/1	0	N		
F567	0567	Operation function (7-speed)		-	1/1	0	N		
F568	0568	Operation function (8-speed)		-	1/1	0	N		
F569	0569	Operation function (9-speed)		-	1/1	0	N		
F570	0570	Operation function (10-speed)		-	1/1	0	N		
F571	0571	Operation function (11-speed)		-	1/1	0	N		
F572	0572	Operation function (12-speed)		-	1/1	0	N		
F573	0573	Operation function (13-speed)		-	1/1	0	N		
F574	0574	Operation function (14-speed)		-	1/1	0	N		
F575	0575	Operation function (15-speed)		-	1/1	0	N		
F576	0576	Operation function (0-speed)		-	1/1	0	N		[5. 3. 7] [6. 12. 1]
F590	0590	Shock monitoring	0: Disabled 1: Current detection 2: Torque detection 3: -	-	-	0	N		[6. 29]
F591	0591	Shock monitoring trip	0: Disabled 1: Enabled	-	-	0	Y		

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F592	0592	Shock monitoring detection	0: Overcurrent/ Overtorque detection 1: Undercurrent/ Undertorque detection	-	-	0	Y		[6. 29]
F593	0593	Shock monitoring detection level	0 - 250	%		150	Y		
F595	0595	Shock monitoring detection time	0.0 - 10.0	s		0.5	Y		
F596	0596	Shock monitoring detection hysteresis	0 - 100	%		10	Y		
F597	0597	Shock monitoring detection wait time	0.0 - 300.0	s		0.0	Y		
F598	0598	Shock monitoring detection condition	0: During run 1: During run (except Acc/Dec)	-	-	0	Y		
F600	0600	Parameter for manufacturer	-	-	-	-	-		-
F601	0601	Stall prevention level 1	10 - 200 (HD) 10 - 160 (ND)	%		150 (HD) 120 (ND)	Y		[6. 24. 3] [6. 30. 2]
F602	0602	Trip record retention	0: Clear at power off 1: Retain at power off	-	-	0	Y		[6. 30. 3]
F603	0603	Emergency off stop pattern	0: Trip 1: Trip after Deceleration stop 2: Trip after Emergency DC braking 3: Trip after deceleration stop by F515 4: Trip after Quick deceleration stop 5: Trip after Dynamic quick deceleration stop	-	-	0	N		[6. 30. 4]
F604	0604	Emergency DC braking time	0.0 - 20.0	s		1.0	Y		
F605	0605	Output phase loss detection	0: Disabled 1: At startup (only one time after power on) 2: At every startup 3: During run 4: At every startup + during run 5: Output shut off detection	-	-	0	N		[6. 30. 5]
F606	0606	Motor overload reduction frequency threshold	0.0 - 60.0	Hz		6.0	Y		[5. 2. 5] [6. 30. 1]
F607	0607	Motor overload time	10 - 2400	s		300	Y		
F608	0608	Input phase loss trip	0: Disabled 1: Enabled	-	-	1	N		[6. 30. 6]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F609	0609	Undercurrent detection hysteresis	1 - 20	%		10	Y		[6. 30. 7]
F610	0610	Undercurrent trip	0: Disabled 1: Enabled	-	-	0	Y		
F611	0611	Undercurrent detection level	0 - 150	%		0	Y		
F612	0612	Undercurrent detection time	0 - 255	s		0	Y		
F613	0613	Short circuit detection at start	0: At every startup by standard pulse 1: Only one time after power on by standard pulse 2: At every startup by F614 setting pulse 3: Only one time after power on by F614 setting pulse	-	-	0	N		[6. 30. 9]
F614	0614	Pulse width of short circuit detection at start	0: No short circuit detection at start 1 - 50	μs		25	N		
F615	0615	Overtorque trip	0: Disabled 1: Enabled	-	-	0	Y		[6. 30. 8]
F616	0616	Overtorque detection level during power running	0: Disabled 1 - 320	%		150	Y		
F617	0617	Overtorque detection level during regen	0: Disabled 1 - 320	%		150	Y		
F618	0618	Overtorque detection time	0.0 - 10.0	s		0.5	Y		
F619	0619	Overtorque detection hysteresis	0 - 100	%		10	Y		
F620	0620	Cooling fan control	0: Auto ON/OFF, No failure detection 1: Always ON, No failure detection 2: Auto ON/OFF, Failure detection 3: Always ON, Failure detection 4 - 7: -	-	-	2	Y		[6. 30. 11]
F621	0621	Cumulative run time alarm	0.0 - 999.0	100 h		876.0	Y		[6. 30. 12]
F622	0622	Abnormal speed detection time	0.01 - 100.0	s		0.01	Y		[6. 30. 13]
F623	0623	Abnormal speed increase band	0.00: Disabled 0.01 - 30.0	Hz		0.00	Y		
F624	0624	Abnormal speed decrease band	0.00: Disabled 0.01 - 30.0	Hz		0.00	Y		
F625	0625	Undervoltage detection level	50 - 79 80: Auto	%		80	N		[6. 15. 2] [6. 30. 14]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F626	0626	Overvoltage limit operation level	100 - 150	%		134	N		[6. 15. 4] [6. 15. 5]
F627	0627	Undervoltage trip	0: Disabled 1: Enabled	-	-	0	N		[6. 30. 14]
F628	0628	Undervoltage detection time	0.01 - 10.00	s		0.03	N		
F629	0629	Regenerative power ride-through level	55 - 100	%		75	N		[6. 15. 2] [6. 30. 14]
F630	0630	Brake answer wait time	0.0: Disabled 0.1 - 10.0	s		0.0	Y		[6. 18. 1] [6. 30. 15]
F631	0631	Inverter overload detection	0: 150% - 60s (HD) 120% - 60s (ND) 1: Temperature estimation	-	-	0	N		[5. 3. 5] [6. 30. 1]
F632	0632	Motor overload memory target	0: No.1 to 4 motor, memory disabled 1: No.1 to 4 motor, memory enabled 2: No.1 motor, memory disabled 3: No.1 motor, memory enabled	-	-	0	Y		
F633	0633	II analog input disconnection detection level	0: Disabled 1 - 100	%		0	Y		[6. 30. 16]
F634	0634	Annual average ambient temperature	1: -15 to +10°C 2: +11 to +20°C 3: +21 to +30°C 4: +31 to +40°C 5: +41 to +50°C 6: +51 to +60°C	-	-	3	Y		[6. 30. 17]
F635	0635	Rush current suppression relay delay time	0.0 - 2.5	s		0.0	N		[6. 30. 18]
F636	0636	Ground fault trip	0: Disabled 1: Enabled	-	-	1	N		[6. 30. 10]
F637	0637	Terminal AI4 PTC trip	0: Disabled 1: Enabled	-	-	0	N		[6. 30. 19]
F638	0638	Terminal AI5 PTC trip	0: Disabled 1: Enabled	-	-	0	N		
F639	0639	Braking resistor overload time	0.1 - 600.0	s		5.0	N		[6. 15. 4]
F640	0640	DC supply input	0: Disabled 1: Enabled	-	-	0	N		-
F643	0643	Residual voltage waiting control frequency threshold	0.0 - 60.0	Hz		10.0	N		-
F644	0644	Operation after II analog input disconnection detection	1: Continue running 2: Deceleration stop 3: Coast stop 4: Trip 5: Run by F649	-	-	4	N		[6. 30. 16]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F645	0645	Terminal RR PTC trip	0: Disabled 1: Enabled	-	-	0	Y		[6. 30. 19]
F646	0646	PTC detection resistance	100 - 9999	Ω		3000	Y		
F647	0647	Control power option failure detection	0: Alarm (no detection without option) 1: Alarm 2: Trip	-	-	0	Y		[6. 30. 20]
F648	0648	Number of starting alarm	0.0 - 999.0	10000 times		999.0	Y		[6. 30. 21]
F649	0649	Fallback frequency	LL - UL	Hz		0.0	Y		[6. 30. 16]
F650	0650	Forced run	0: Disabled 1: Enabled	-	-	0	Y		[6. 31]
F651	0651	Undertorque trip	0: Disabled 1: Enabled	-	-	0	Y		-
F652	0652	Undertorque detection level during power running	0 - 250	%		0	Y		-
F653	0653	Undertorque detection level during regen	0 - 250	%		0	Y		-
F654	0654	Undertorque detection time	0.00 - 10.00	s		0.50	Y		-
F655	0655	Undertorque detection hysteresis	0 - 100	%		10	Y		-
F656	0656	PTC detection temperature	0 - 200	°C		90	Y		[6. 30. 19]
F657	0657	Overload alarm level	10 - 100	%		50	Y		[5. 2. 5] [6. 30. 1]
F658	0658	Number of external equipment starting alarm	0.0 - 999.0	10000 times		999.0	Y		[6. 30. 21]
F659	0659	Cumulative overcurrent level	10 - 200	%		100	Y		[6. 30. 22]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F660	0660	Override adding input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5: Terminal AI5 (option) 6 - 9: - 10: Touch wheel 1 (power off or press OK to save) 11 - 14: - 15: Terminal Up/Down frequency 16: Pulse train 17: High resolution pulse train (option) 18,19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	-	-	0	Y		[6. 32]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F661	0661	Override multiplying input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F729 13 - 23: -	-	-	0	Y		[6. 32]
F664	0664	Specified trip 1	0 - 100	Times	1/1	0	N		[6. 30. 21]
F665	0665	Specified trip 2	0 - 100	Times	1/1	0	N		
F666	0666	Specified trip 3	0 - 100	Times	1/1	0	N		
F667	0667	Pulse output step of input cumulative power	0: 0.1kWh 1: 1kWh 2: 10kWh 3: 100kWh 4: 1000kWh 5: 10000kWh	-	-	1	Y		[6. 33. 1]
F668	0668	Pulse output width of input cumulative power	0.1 - 1.0	s		0.1	Y		
F669	0669	Terminal FP switching	0: Digital output 1: Pulse output	-	-	0	N		[6. 33. 2] [7. 2. 2]
F670	0670	Terminal AM function	0 - 162 *3	-	-	2	Y		[5. 2. 6]
F671	0671	Terminal AM adjustment	-	-	-	-	Y		
F676	0676	Terminal FP pulse train output function	0 - 149 *3	-	-	0	Y		[6. 33. 2]
F677	0677	Maximum pulse number of pulse train output	0.50 - 43.20	kpps		8.00	Y		
F678	0678	Pulse train output filter	1 - 1000	ms		64	Y		
F679	0679	Pulse train input filter	1 - 1000	ms		1	Y		[6. 6. 4]
F681	0681	Terminal FM switching	0: Meter option (0-1mA) 1: Current output (0-20mA) 2: Voltage output (0-10V)	-	-	2	N		[6. 33. 3]
F682	0682	Terminal FM inclination polarity	0: Negative inclination (downward slope) 1: Positive inclination (upward slope)	-	-	1	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F683	0683	Terminal FM bias	-100.0 to +100.0	%		0.0	Y		[6. 33. 3]
F684	0684	Terminal FM filter	1 - 1000	ms		1	Y		
F685	0685	Terminal FM upper-limit level	0.0 - 100.0	%		100.0	Y		
F686	0686	Terminal AM switching	0: Meter option (0-1mA) 1: Current output (0-20mA) 2: Voltage output (0-10V)	-	-	2	N		
F687	0687	Terminal AM inclination polarity	0: Negative inclination (downward slope) 1: Positive inclination (upward slope)	-	-	1	Y		
F688	0688	Terminal AM bias	-100.0 to +100.0	%		0.0	Y		
F689	0689	Terminal AM filter	1 - 1000	ms		1	Y		
F690	0690	Terminal AM upper-limit level	0.0 - 100.0	%		100.0	Y		
F699	0699	Trip for test	0 - 100			0	Y		-
F700	0700	Parameter reading & writing access lockout	0: Unlocked 1: Writing locked (Operation panel, Extension panel) 2: Writing locked (1+RS485) 3: Reading & Writing locked (Operation panel, Extension panel) 4: Reading & Writing locked (3+RS485)	-	-	0	Y		[6. 34. 1]
F701	0701	Current, voltage units select	0: % 1: A (ampere), V (volt)	-	-	0	Y		[5. 2. 7] [6. 34. 2]
F702	0702	Free unit multiplicaton factor	0.00: Disabled 0.01 - 200.0	Times		0.00	Y		[5. 4. 3] [6. 34. 3]
F703	0703	Target of free unit	0: All frequencies 1: PID frequencies	-	-	0	Y		
F704	0704	Reference Website	0: English (USA website) 1: English (Japan website)	-	-	*2	Y		
F705	0705	Free unit inclination polarity	0: Negative inclination (downward slope) 1: Positive inclination (upward slope)	-	-	1	Y		
F706	0706	Free unit bias	0.00 - FH	Hz		0.00	Y		
F707	0707	Step of panel setting	0.00: Disabled 0.01 - FH	Hz		0.00	Y		[6. 34. 4]
F708	0708	Step of panel display	0: Disabled 1 - 255	-	-	0	Y		
F709	0709	Hold function of standard mode	0: Real time 1: Peak hold 2: Minimum hold	-	-	0	Y		[6. 34. 7]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F710	0710	Standard mode display	0 - 162 *3	-	-	0	Y		[4. 2. 3] [5. 4. 3] [6. 34. 5]
F711	0711	Monitor mode 1 display		-	-	2	Y		[6. 34. 6] [8. 1. 1]
F712	0712	Monitor mode 2 display		-	-	3	Y		
F713	0713	Monitor mode 3 display		-	-	4	Y		
F714	0714	Monitor mode 4 display		-	-	8	Y		
F715	0715	Monitor mode 5 display		-	-	18	Y		
F716	0716	Monitor mode 6 display		-	-	19	Y		
F717	0717	Monitor mode 7 display		-	-	35	Y		
F718	0718	Monitor mode 8 display		-	-	34	Y		
F719	0719	Run command clear select	0: Clear at coast stop. Retain at MOFF and when CMOd is changed. 1: Retain run command. 2: Clear at coast stop and at MOFF. Retain when CMOd is changed. 3: Clear at coast stop, at MOFF and when CMOd is changed.	-	-	2	Y		[6. 34. 8]
F720	0720	Standard mode display of extension panel	0 - 162 *4	-	-	0	Y		[5. 4. 3] [6. 34. 5]
F721	0721	Panel stop	0: Deceleration stop 1: Coast stop	-	-	0	Y		[6. 34. 9]
F722	0722	Monitor mode filter	8 - 1000	ms		200	Y		-
F723	0723	Status area display of operation panel	0 - 162 *4	-	-	1	Y		[5. 4. 3] [6. 34. 5]
F724	0724	Frequency setting target by touch wheel	0: Panel run frequency command (FC) 1: FC + Preset speed	-	-	0	Y		[5. 3. 7]
F725	0725	Panel torque command	-250 to +250	%		0	Y		[6. 25. 1] [6. 34. 10]
F727	0727	Panel tension torque bias	-250 to +250	%		0	Y		[6. 25. 3]
F728	0728	Panel load sharing gain	0 - 250	%		100	Y		
F729	0729	Panel override multiplication gain	-100 to +100	%		0	Y		[6. 32]

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F730	0730	Panel frequency setting lockout	0: Unlocked without press OK 1: Locked 2: Unlocked after press OK	-	-	2	Y		[6. 34. 1]
F731	0731	Operation after disconnection detection during panel run	1: Continue running 2 - 3: - 4: Trip	-	-	4	Y		
F732	0732	Panel Hand/Auto function lockout	0: Unlocked 1: Locked	-	-	1	Y		
F733	0733	Panel Run lockout	0: Unlocked 1: Locked	-	-	0	Y		
F734	0734	Panel emergency off lockout	0: Unlocked 1: Locked	-	-	0	Y		
F735	0735	Panel reset lockout	0: Unlocked 1: Locked	-	-	0	Y		
F736	0736	CMOd/FMOd change lockout during run	0: Unlocked 1: Locked	-	-	1	Y		
F737	0737	Panel keys lockout	0: Unlocked 1: Locked 2: Locked only extension panel 3: Locked only operation panel	-	-	0	Y		
F738	0738	Password setting	0: Disabled 1 - 9998 9999: Password was set	-	-	0	Y		
F739	0739	Password verification	0: non-setting 1 - 9998 9999: Password was set	-	-	0	Y		
F740	0740	Trace	0: Disabled 1: At trip 2: At trigger input 3: At trip & at trigger input	-	-	1	Y		[6. 35]
F741	0741	Trace cycle	0: 4ms 1: 20ms 2: 100ms 3: 1s 4: 10s	-	-	2	Y		
F742	0742	Trace data 1	0 - 162 *3	-	-	0	Y		
F743	0743	Trace data 2		-	-	1	Y		
F744	0744	Trace data 3		-	-	2	Y		
F745	0745	Trace data 4		-	-	3	Y		
F748	0748	Cumulative power save	0: Disabled 1: Enabled	-	-	0	Y		[6. 36]
F749	0749	Cumulative power unit	0: 1.0=1 kWh 1: 1.0=10 kWh 2: 1.0=100 kWh 3: 1.0=1000 kWh 4: 1.0=10000 kWh 5: 1.0=100000 kWh	-	-	*1	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F750	0750	EASY key function	0: Easy/Setting mode switching 1: Shortcut function (Extension panel only) 2: Hand/Auto switching 3: Monitor peak and minimum hold trigger	-	-	0	N		[6. 37]
F751	0751	Easy setting 1	0-2999 Set easy setting parameters by the communication number 0000-0998: Basic, F100-F998 1000-1999: A000-A999 2000-2999: C000-C999	-	-	3	Y		[5. 2. 8]
F752	0752	Easy setting 2		-	-	4	Y		
F753	0753	Easy setting 3		-	-	9	Y		
F754	0754	Easy setting 4		-	-	10	Y		
F755	0755	Easy setting 5		-	-	12	Y		
F756	0756	Easy setting 6		-	-	13	Y		
F757	0757	Easy setting 7		-	-	31	Y		
F758	0758	Easy setting 8		-	-	6	Y		
F759	0759	Easy setting 9		-	-	999	Y		
F760	0760	Easy setting 10		-	-	999	Y		
F761	0761	Easy setting 11		-	-	999	Y		
F762	0762	Easy setting 12		-	-	999	Y		
F763	0763	Easy setting 13		-	-	999	Y		
F764	0764	Easy setting 14		-	-	999	Y		
F765	0765	Easy setting 15		-	-	999	Y		
F766	0766	Easy setting 16		-	-	999	Y		
F767	0767	Easy setting 17		-	-	999	Y		
F768	0768	Easy setting 18		-	-	999	Y		
F769	0769	Easy setting 19		-	-	999	Y		
F770	0770	Easy setting 20		-	-	999	Y		
F771	0771	Easy setting 21		-	-	999	Y		
F772	0772	Easy setting 22		-	-	999	Y		
F773	0773	Easy setting 23		-	-	999	Y		
F774	0774	Easy setting 24		-	-	999	Y		
F775	0775	Easy setting 25		-	-	999	Y		
F776	0776	Easy setting 26		-	-	999	Y		
F777	0777	Easy setting 27		-	-	999	Y		
F778	0778	Easy setting 28		-	-	999	Y		
F779	0779	Easy setting 29		-	-	999	Y		
F780	0780	Easy setting 30		-	-	999	Y		
F781	0781	Easy setting 31		-	-	701	Y		
F782	0782	Easy setting 32		-	-	50	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F790	0790	Panel display at power on	0: HELLO (Depending on language setting) 1: F791 - F798 2, 3: -	-	-	0	Y		[6. 34. 11]
F791	0791	1st and 2nd characters of F790	0-FFFF	Hex	-	2d2d	Y		
F792	0792	3rd and 4th characters of F790	0-FFFF	Hex	-	2d2d	Y		
F793	0793	5th and 6th characters of F790	0-FFFF	Hex	-	2d2d	Y		
F794	0794	7th and 8th characters of F790	0-FFFF	Hex	-	2d2d	Y		
F795	0795	9th and 10th characters of F790	0-FFFF	Hex	-	2d2d	Y		
F796	0796	11th and 12th characters of F790	0-FFFF	Hex	-	2d2d	Y		
F797	0797	13th and 14th characters of F790	0-FFFF	Hex	-	2d2d	Y		
F798	0798	15th and 16th characters of F790	0-FFFF	Hex	-	2d2d	Y		
F799	0799	Parameter for manufacturer	-	-	-	-	-		-

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F800	0800	RS485 (1) baud rate	0: 9600 bps 1: 19200 bps 2: 38400 bps 3: -	-	-	1	Y		
F801	0801	RS485 (1) parity	0: Disabled 1: Even parity 2: Odd parity	-	-	1	Y		
F802	0802	Inverter number (RS485 common)	0 - 247	-	-	0	Y		
F803	0803	RS485 (1) time-out time	0.0: Disabled 0.1 - 100.0	s		0.0	Y		
F804	0804	RS485 (1) time-out operation	1: Continue running 2, 3: - 4: Trip 5: - 6: Trip after deceleration stop	-	-	1	Y		
F805	0805	RS485 (1) transmission wait time	0.00 - 2.00	s		0.00	Y		
F806	0806	RS485 (1) inverter to inverter communication	0: Follower (0Hz command when Leader fails) 1: Follower (continue running when Leader fails) 2: Follower (emergency off when Leader fails) 3: Leader (transmit frequency command) 4: Leader (transmit output frequency signal) 5: Leader (transmit torque command) 6: Leader (transmit output torque)	-	-	0	Y		[6. 38. 1]
F807	0807	RS485 (1) protocol	0: TOSHIBA 1: MODBUS	-	-	0	Y		
F808	0808	RS485 (1) time-out detection	0: Always 1: Run command and frequency command by communication are enabled. 2: During run by communication	-	-	1	Y		
F809	0809	Operation panel connection priority	0: By the parameter setting 1: Connect to conector 1 2: Connect to conector 2	-	-	1	Y		-

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F810	0810	Communication frequency point select	0: Disabled 1: RS485 (1) 2: RS485 (2) 3: Communication option 4: Embedded Ethernet	-	-	0	Y		[6. 6. 2] [6. 38. 1]
F811	0811	Communication point 1 input value	0 - 100	%		0	Y		
F812	0812	Communication point 1 frequency	0.0 - FH	Hz		0.0	Y		
F813	0813	Communication point 2 input value	0 - 100	%		100	Y		
F814	0814	Communication point 2 frequency	0.0 - FH	Hz		50.0/ 60.0*2	Y		
F820	0820	RS485 (2) baud rate	0: 9600 bps 1: 19200 bps 2: 38400 bps 3: -	-	-	1	Y		[6. 38. 1]
F821	0821	RS485 (2) parity	0: Disabled 1: Even parity 2: Odd parity	-	-	1	Y		
F823	0823	RS485 (2) time-out time	0.0: Disabled 0.1 - 100.0	s		0.0	Y		
F824	0824	RS485 (2) time-out operation	1: Continue running 2, 3: - 4: Trip 5: - 6: Trip after deceleration stop	-	-	1	Y		
F825	0825	RS485 (2) transmission wait time	0.00 - 2.00	s		0.00	Y		
F826	0826	RS485 (2) inverter to inverter communication	0: Follower (0Hz command when Leader fails) 1: Follower (continue running when Leader fails) 2: Follower (emergency off when Leader fails) 3: Leader (transmit frequency command) 4: Leader (transmit output frequency signal) 5: Leader (transmit torque command) 6: Leader (transmit output torque command)	-	-	0	Y		
F827	0827	RS485 (2) protocol	0: TOSHIBA 1: MODBUS	-	-	0	Y		

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F828	0828	RS485 (2) time-out detection	0: Always 1: Run command and frequency command by communication are enabled. 2: During run by communication	-	-	1	Y		[6. 38. 1]
F829	0829	RS485 (2) wiring type	0: 2-wire 1: 4-wire	-	-	0	Y		
F830	0830	MODBUS continuous address	0: Disabled 1: Enabled	-	-	1	Y		
F856	0856	Motor pole number for communication	1: 2 pole 2: 4 pole 3: 6 pole 4: 8 pole 5: 10 pole 6: 12 pole 7: 14 pole 8: 16 pole	-	-	2	Y		
F870	0870	Block write data 1	0: Disabled 1: FA00 (Communication command 1) 2: FA20 (Communication command 2) 3: FA01 (Frequency command) 4: FA50 (TB output) 5: FA51 (Analog output) 6: FA13 (Speed command by communication)	-	-	0	Y		
F871	0871	Block write data 2		-	-	0	Y		

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F875	0875	Block read data 1	0: Disabled 1: FD01 (Status information) 2: FD00 (Output frequency) 3: FD03 (Output current) 4: FD05 (Output voltage) 5: FC91 (Alarm information) 6: FD22 (PID feedback value) 7: FD06 (Input terminal monitor) 8: FD07 (Output terminal monitor) 9: FE35 (Terminal RR monitor) 10: FE36 (Terminal RX monitor) 11: FE37 (Terminal II monitor) 12: FD04 (Input voltage (DC detection)) 13: FD16 (Speed feedback frequency) 14: FD18 (Torque) 15: FE60 (My function output monitor 1) 16: FE61 (My function output monitor 2) 17: FE62 (My function output monitor 3) 18: FE63 (My function output monitor 4) 19: 0880 (Free memorandum) 20: FD90 (Motor speed) 21: FD29 (Input power) 22: FD30 (Output power) 23: FC90 (Trip information)	-	-	0	Y		[6. 38. 1]
F876	0876	Block read data 2		-	-	0	Y		
F877	0877	Block read data 3		-	-	0	Y		
F878	0878	Block read data 4		-	-	0	Y		
F879	0879	Block read data 5		-	-	0	Y		
F880	0880	Free memorandum	0-65535	-	1/1	0	Y		[6. 38. 3]
F896	0896	Parameter for manufacturer	-	-	-	-	-		-
F897	0897	Parameter writing	0: Storage to memory device 1: Storage to memory device except by communication	-	-	0	Y		-
F898	0898	Trip reset	0: Clear trip by request from communication option. Reset by request except from communication option. 1: Reset 2: Trip clear 3 - 5: -	-	-	0	N		-

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Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F899	0899	Communication option reset	0: - 1: Reset option and inverter	-	-	0	N		[6. 38. 1]
F907	0907	PM regenerative over-flux upper limit	0 - 150	%		50	N		-
F908	0908	PM no load current	0 - 100	%		0	N		-
F909	0909	PM step-out detection frequency rate	0 - 100	%		0	N		-
F910	0910	PM step-out detection current level	1 - 150	%		100	N		[6. 39]
F911	0911	PM step-out detection time	0.00: Disabled 0.01 - 2.55	s		0.00	N		
F912	0912	PM q-axis inductance	0.01 - 650.0	mH		10.00	N		[6. 23. 2]
F913	0913	PM d-axis inductance	0.01 - 650.0	mH		10.00	N		
F914	0914	Parameter for manufacturer	-	-	-	-	-		-
F915	0915	PM control method	0: Method 0 1: Method 1 2: Method 2 3: Method 3 4: Method 4	-	-	3	N		[6. 23. 2]
F916	0916	PM starting current	0 - 100	%		25	N		-
F917	0917	IPM maximum torque control	0: Disabled 1: Enabled	-		0	Y		-
F918	0918	IPM current phase adjustment	-45.0 to +45.0	°C		0.0	Y		-
F919	0919	Parameter for manufacturer	-	-	-	-	-		-
F920	0920	Parameter for manufacturer	-	-	-	-	-		-
F921	0921	SPM initial position estimation current	10 - 150	%		100	N		-
F922	0922	PM HF control speed estimation response	5 - 80	Hz		15	N		-
F923	0923	PM control switching speed	5 - 100	%		25	N		-
F924	0924	PM speed estimation filter cutoff frequency	1 - 80	Hz		30	N		-
F925	0925	PM HF control speed estimation stabilization coefficient	0.50 - 2.50			1.00	N		-
F926	0926	PM HF control harmonic frequency	100 - 1000	Hz		500	N		-

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit (Panel/ Communication)	Default setting	Write during running *6	User setting	Reference
F927	0927	PM HF control current level	5 - 100	%		25	N		-
F928	0928	PM initial position estimation time	0 - 1000	ms		125	N		-
F929	0929	PM dead time compensation time	-1 to +32767	ns		0	N		-
F930	0930	Parameter for manufacturer	-	-	-	-	-		-
F964	0964	Preset speed 16	LL - UL	Hz		0.0	Y		[5. 3. 7]
F965	0965	Preset speed 17	LL - UL	Hz		0.0	Y		
F966	0966	Preset speed 18	LL - UL	Hz		0.0	Y		
F967	0967	Preset speed 19	LL - UL	Hz		0.0	Y		
F968	0968	Preset speed 20	LL - UL	Hz		0.0	Y		
F969	0969	Preset speed 21	LL - UL	Hz		0.0	Y		
F970	0970	Preset speed 22	LL - UL	Hz		0.0	Y		
F971	0971	Preset speed 23	LL - UL	Hz		0.0	Y		
F972	0972	Preset speed 24	LL - UL	Hz		0.0	Y		
F973	0973	Preset speed 25	LL - UL	Hz		0.0	Y		
F974	0974	Preset speed 26	LL - UL	Hz		0.0	Y		
F975	0975	Preset speed 27	LL - UL	Hz		0.0	Y		
F976	0976	Preset speed 28	LL - UL	Hz		0.0	Y		
F977	0977	Preset speed 29	LL - UL	Hz		0.0	Y		
F978	0978	Preset speed 30	LL - UL	Hz		0.0	Y		
F979	0979	Preset speed 31	LL - UL	Hz		0.0	Y		
F980	0980	Traverse operation	0: Disabled 1: Enabled	-	-	0	N		[6. 40]
F981	0981	Traverse Acc time	0.1 - 120.0	s		25.0	Y		
F982	0982	Traverse Dec time	0.1 - 120.0	s		25.0	Y		
F983	0983	Traverse step	0.0 - 25.0	%		10.0	Y		
F984	0984	Traverse jump step	0.0 - 50.0	%		10.0	Y	F	

*1 Parameter values vary depending on the capacity. For details, refer to [11. 6].
*2 Depending on the setup menu. Refer to [11. 10].
*3 For details on the analog output and monitor output function, refer to [11. 7].
*4 Refer to section [11. 8] for details about the input terminal function.
*5 Refer to section [11. 9] for details about the output terminal function.
*6 Y: Writable N: Not writable

11. 4 Advanced parameter

Title	Function	Reference
Starting at A000	Calendar function	E6582110
Starting at A200	Pump control	E6582124
Starting at A300	Multi PID	E6582112
Starting at A800 Starting at A900	My function	E6582114

11. 5 Communication parameter

Title	Function	Reference
C001 - C111	Common to communication options	*1
C152 - C157 C500 - C556	For PROFINET option	E6582051
C606 - C699	For embedded Ethernet	E6582125

*1 Refer to each Instruction Manual for option about detail specifications and common parameters.

11. 6 Parameter setting range and default setting depending on capacity

■ **HD rating**

Voltage class	Applicable motor (kW)	Inverter type-form		vb,F172, F176,F180 (%)	ACC,dEC, F500, F501, F510, F511, F514, F515 (s)	tHrA,F182,F183, F184		F249 (kHz)	F298 (V)
						Adjustment range	(A)		
3-phase 240 V	0.4	VFAS3-	2004P	4.80	10.0	0.33-3.30	3.30	4.0	120.0
	0.75		2007P	4.80	10.0	0.46-4.60	4.60	4.0	120.0
	1.5		2015P	4.80	10.0	0.80-8.00	8.00	4.0	120.0
	2.2		2022P	3.10	10.0	1.12-11.20	11.20	4.0	120.0
	4.0		2037P	3.10	10.0	1.87-18.70	18.70	4.0	120.0
	5.5		2055P	2.50	10.0	2.54-25.40	25.40	4.0	120.0
	7.5		2075P	2.30	10.0	3.27-32.70	32.70	4.0	120.0
	11		2110P	1.80	10.0	4.68-46.80	46.80	4.0	120.0
	15		2150P	1.60	10.0	6.34-63.40	63.40	4.0	120.0
	18.5		2185P	1.50	30.0	7.84-78.40	78.40	4.0	120.0
	22		2220P	1.70	30.0	9.3-92.6	92.6	4.0	120.0
	30		2300P	1.40	30.0	12.3-123.0	123.0	4.0	120.0
	37		2370P	0.90	30.0	14.9-149.0	149.0	4.0	120.0
	45		2450P	0.80	30.0	17.6-176.0	176.0	2.5	120.0
	55		2550P	0.80	30.0	21.1-211.0	211.0	2.5	120.0
3-phase 480 V	0.4	VFAS3-	4004PC	4.80	10.0	0.15-1.50	1.50	4.0	240.0
	0.75		4007PC	4.80	10.0	0.22-2.20	2.20	4.0	240.0
	1.5		4015PC	4.80	10.0	0.40-4.00	4.00	4.0	240.0
	2.2		4022PC	3.10	10.0	0.56-5.60	5.60	4.0	240.0
	4.0		4037PC	3.10	10.0	0.93-9.30	9.30	4.0	240.0
	5.5		4055PC	2.50	10.0	1.27-12.70	12.70	4.0	240.0
	7.5		4075PC	2.30	10.0	1.65-16.50	16.50	4.0	240.0
	11		4110PC	1.80	10.0	2.35-23.50	23.50	4.0	240.0
	15		4150PC	1.60	10.0	3.17-31.70	31.70	4.0	240.0
	18.5		4185PC	1.50	30.0	3.92-39.20	39.20	4.0	240.0
	22		4220PC	1.70	30.0	4.63-46.30	46.30	4.0	264.0
	30		4300PC	1.40	30.0	6.15-61.50	61.50	4.0	264.0
	37		4370PC	0.90	30.0	7.45-74.50	74.50	4.0	264.0
	45		4450PC	0.80	30.0	8.8-88.0	88.0	4.0	264.0
	55		4550PC	0.80	30.0	10.6-106.0	106.0	4.0	264.0
	75		4750PC	1.40	60.0	14.5-145.0	145.0	4.0	264.0
	90		4900PC	1.30	60.0	17.3-173.0	173.0	2.5	240.0
	110		4110KPC	1.00	60.0	21.1-211.0	211.0	2.5	240.0
	132		4132KPC	0.80	60.0	25.0-250.0	250.0	2.5	240.0
	160		4160KPC	0.80	60.0	31.4-314.0	314.0	2.5	240.0
	220		4200KPC	0.80	60.0	38.7-387.0	387.0	2.5	240.0
	250		4220KPC	0.80	60.0	42.7-427.0	427.0	2.5	240.0
	280		4280KPC	0.80	60.0	55.0-550.0	550.0	2.5	240.0

Voltage class	Applicable motor (kW)	Inverter type-form		F300		F308 (Ohm)	F309 (kW)	F316	F356 (s)	F402 (%)	F405	
				Adjustment range	(kHz)						<Set> = "JP" (kW)	other (kW)
3-phase 240 V	0.4	VFAS3-	2004P	1.0-16.0	4.0	200.0	0.12	1	0.57	4.30	0.40	0.40
	0.75		2007P	1.0-16.0	4.0	200.0	0.12	1	0.57	4.30	0.75	0.75
	1.5		2015P	1.0-16.0	4.0	75.0	0.12	1	0.57	4.40	1.50	1.50
	2.2		2022P	1.0-16.0	4.0	75.0	0.12	1	0.57	2.90	2.20	2.20
	4.0		2037P	1.0-16.0	4.0	40.0	0.12	1	0.67	2.80	3.70	4.00
	5.5		2055P	1.0-16.0	4.0	20.0	0.24	1	0.87	2.30	5.50	5.50
	7.5		2075P	1.0-16.0	4.0	15.0	0.44	1	0.87	2.00	7.50	7.50
	11		2110P	1.0-16.0	4.0	10.0	0.66	1	1.07	1.60	11.00	11.00
	15		2150P	1.0-16.0	4.0	7.5	0.88	1	1.07	1.50	15.00	15.00
	18.5		2185P	1.0-16.0	4.0	7.5	0.88	1	1.37	1.40	18.50	18.50
	22		2220P	1.0-8.0	4.0	3.3	1.76	1	1.37	1.60	22.00	22.00
	30		2300P	1.0-8.0	4.0	3.3	1.76	1	1.37	1.20	30.00	30.00
	37		2370P	1.0-8.0	4.0	2.0	2.20	1	1.37	0.80	37.00	37.00
	45		2450P	1.0-8.0	2.5	2.0	2.20	1	1.37	0.70	45.00	45.00
	55		2550P	1.0-8.0	2.5	2.0	2.20	1	1.37	0.80	55.00	55.00
3-phase 480 V	0.4	VFAS3-	4004PC	1.0-16.0	4.0	200.0	0.12	3	0.57	4.30	0.40	0.40
	0.75		4007PC	1.0-16.0	4.0	200.0	0.12	3	0.57	4.30	0.75	0.75
	1.5		4015PC	1.0-16.0	4.0	200.0	0.12	3	0.57	4.40	1.50	1.50
	2.2		4022PC	1.0-16.0	4.0	200.0	0.12	3	0.57	2.90	2.20	2.20
	4.0		4037PC	1.0-16.0	4.0	160.0	0.12	3	0.67	2.80	3.70	4.00
	5.5		4055PC	1.0-16.0	4.0	80.0	0.24	3	0.87	2.30	5.50	5.50
	7.5		4075PC	1.0-16.0	4.0	60.0	0.44	3	0.87	2.00	7.50	7.50
	11		4110PC	1.0-16.0	4.0	40.0	0.66	3	1.07	1.60	11.00	11.00
	15		4150PC	1.0-16.0	4.0	30.0	0.88	3	1.07	1.50	15.00	15.00
	18.5		4185PC	1.0-16.0	4.0	30.0	0.88	3	1.37	1.40	18.50	18.50
	22		4220PC	1.0-16.0	4.0	15.0	1.76	3	1.37	1.60	22.00	22.00
	30		4300PC	1.0-16.0	4.0	15.0	1.76	3	1.37	1.20	30.00	30.00
	37		4370PC	1.0-16.0	4.0	8.0	1.76	3	1.37	0.80	37.00	37.00
	45		4450PC	1.0-8.0	4.0	8.0	1.76	3	1.37	0.70	45.00	45.00
	55		4550PC	1.0-8.0	4.0	8.0	1.76	3	1.37	0.80	55.00	55.00
	75		4750PC	1.0-8.0	4.0	8.0	1.76	3	1.37	1.30	75.00	75.00
	90		4900PC	1.0-8.0	2.5	3.7	7.40	3	1.37	1.20	90.00	90.00
	110		4110KPC	1.0-8.0	2.5	3.7	7.40	3	1.37	0.90	110.00	110.00
	132		4132KPC	1.0-8.0	2.5	3.7	7.40	3	1.37	0.80	132.00	132.00
	160		4160KPC	1.0-8.0	2.5	3.7	7.40	3	1.37	0.80	160.00	160.00
	220		4200KPC	1.0-8.0	2.5	1.9	8.70	3	1.37	0.80	200.00	200.00
	250		4220KPC	1.0-8.0	2.5	1.9	8.70	3	1.37	0.80	220.00	220.00
	280		4280KPC	1.0-8.0	2.5	1.4	14.00	3	1.37	0.80	280.00	280.00

Voltage class	Applicable motor (kW)	Inverter type-form		F412 (%)	F415		F416 (%)	F417		F456	F749
					Adjustment range	(A)		50Hz setting (min-1)	60Hz setting (min-1)		
3-phase 240 V	0.4	VFAS3-	2004P	7.0	0.01-99.99	1.70	55	1440	1730	100	0
	0.75		2007P	7.0	0.01-99.99	3.40	55	1440	1730	100	0
	1.5		2015P	5.0	0.01-99.99	6.40	42	1445	1740	100	0
	2.2		2022P	5.0	0.01-99.99	9.40	50	1460	1755	100	0
	4.0		2037P	5.0	0.01-99.99	14.60	38	1460	1755	100	1
	5.5		2055P	5.0	0.01-99.99	21.40	41	1465	1760	100	1
	7.5		2075P	5.0	0.01-99.99	28.60	38	1460	1755	100	1
	11		2110P	4.0	0.01-99.99	42.00	38	1475	1770	100	1
	15		2150P	4.0	0.01-99.99	55.60	33	1470	1760	100	1
	18.5		2185P	4.0	0.01-99.99	69.00	37	1475	1770	100	1
	22		2220P	4.0	0.1-999.9	80.0	32	1470	1760	100	1
	30		2300P	4.0	0.1-999.9	108.0	33	1470	1765	100	1
	37		2370P	4.0	0.1-999.9	132.0	32	1480	1775	100	2
	45		2450P	3.0	0.1-999.9	159.0	31	1480	1775	100	2
	55		2550P	3.0	0.1-999.9	192.0	28	1480	1775	100	2
3-phase 480 V	0.4	VFAS3-	4004PC	7.0	0.01-99.99	0.85	55	1440	1730	100	0
	0.75		4007PC	7.0	0.01-99.99	1.70	55	1440	1730	100	0
	1.5		4015PC	5.0	0.01-99.99	3.20	42	1445	1740	100	0
	2.2		4022PC	5.0	0.01-99.99	4.70	50	1460	1755	100	0
	4.0		4037PC	5.0	0.01-99.99	7.30	38	1460	1755	100	1
	5.5		4055PC	5.0	0.01-99.99	10.70	41	1465	1760	100	1
	7.5		4075PC	5.0	0.01-99.99	14.30	38	1460	1755	100	1
	11		4110PC	4.0	0.01-99.99	21.00	38	1475	1770	100	1
	15		4150PC	4.0	0.01-99.99	27.80	33	1470	1760	100	1
	18.5		4185PC	4.0	0.01-99.99	34.50	37	1475	1770	100	1
	22		4220PC	4.0	0.01-99.99	40.00	32	1470	1760	100	1
	30		4300PC	4.0	0.01-99.99	54.00	33	1470	1765	95	1
	37		4370PC	4.0	0.01-99.99	66.00	32	1480	1775	100	2
	45		4450PC	3.0	0.1-999.9	79.5	31	1480	1775	100	2
	55		4550PC	3.0	0.1-999.9	96.0	28	1480	1775	100	2
	75		4750PC	3.0	0.1-999.9	129.0	28	1480	1775	95	2
	90		4900PC	3.0	0.1-999.9	154.0	26	1480	1775	100	2
	110		4110KPC	3.0	0.1-999.9	190.0	21	1480	1780	100	2
	132		4132KPC	3.0	0.1-999.9	230.0	20	1485	1780	100	2
	160		4160KPC	3.0	0.1-999.9	252.0	20	1485	1785	100	2
	220		4200KPC	3.0	0.1-999.9	315.0	20	1485	1785	100	2
	250		4220KPC	3.0	0.1-999.9	345.0	20	1485	1785	100	2
	280		4280KPC	3.0	0.1-999.9	445.0	20	1485	1785	100	2

■ ND rating

Voltage class	Applicable motor (kW)	Inverter type-form		vb,F172,F176,F180 (%)	ACC,dEC,F500,F501,F510,F511,F514,F515 (s)	tHrA,F182,F183,F184		F249 (kHz)	F298 (V)
						Adjustment range	(A)		
3-phase 240 V	0.75	VFAS3-	2004P	4.80	10.0	0.46-4.60	4.60	4.0	120.0
	1.5		2007P	4.80	10.0	0.80-8.00	8.00	4.0	120.0
	2.2		2015P	3.10	10.0	1.12-11.20	11.20	4.0	120.0
	4.0		2022P	3.10	10.0	1.87-18.70	18.70	4.0	120.0
	5.5		2037P	2.50	10.0	2.54-25.40	25.40	4.0	120.0
	7.5		2055P	2.30	10.0	3.27-32.70	32.70	4.0	120.0
	11		2075P	1.80	10.0	4.68-46.80	46.80	4.0	120.0
	15		2110P	1.60	10.0	6.34-63.40	63.40	4.0	120.0
	18.5		2150P	1.50	30.0	7.84-78.40	78.40	4.0	120.0
	22		2185P	1.70	30.0	9.3-92.6	92.6	4.0	120.0
	30		2220P	1.40	30.0	12.3-123.0	123.0	4.0	120.0
	37		2300P	0.90	30.0	14.9-149.0	149.0	4.0	120.0
	45		2370P	0.80	30.0	17.6-176.0	176.0	4.0	120.0
	55		2450P	0.80	30.0	21.1-211.0	211.0	2.5	120.0
	75		2550P	1.40	60.0	28.2-282.0	282.0	2.5	120.0
3-phase 480 V	0.75	VFAS3-	4004PC	4.80	10.0	0.22-2.20	2.20	4.0	240.0
	1.5		4007PC	4.80	10.0	0.40-4.00	4.00	4.0	240.0
	2.2		4015PC	3.10	10.0	0.56-5.60	5.60	4.0	240.0
	4.0		4022PC	3.10	10.0	0.93-9.30	9.30	4.0	240.0
	5.5		4037PC	2.50	10.0	1.27-12.70	12.70	4.0	240.0
	7.5		4055PC	2.30	10.0	1.65-16.50	16.50	4.0	240.0
	11		4075PC	1.80	10.0	2.35-23.50	23.50	4.0	240.0
	15		4110PC	1.60	10.0	3.17-31.70	31.70	4.0	240.0
	18.5		4150PC	1.50	30.0	3.92-39.20	39.20	4.0	240.0
	22		4185PC	1.70	30.0	4.63-46.30	46.30	4.0	240.0
	30		4220PC	1.40	30.0	6.15-61.50	61.50	4.0	264.0
	37		4300PC	0.90	30.0	7.45-74.50	74.50	4.0	264.0
	45		4370PC	0.80	30.0	8.8-88.0	88.0	4.0	264.0
	55		4450PC	0.80	30.0	10.6-106.0	106.0	4.0	264.0
	75		4550PC	1.40	60.0	14.5-145.0	145.0	4.0	264.0
	90		4750PC	1.30	60.0	17.3-173.0	173.0	4.0	264.0
	110		4900PC	1.00	60.0	21.1-211.0	211.0	2.5	240.0
	132		4110KPC	0.80	60.0	25.0-250.0	250.0	2.5	240.0
	160		4132KPC	0.80	60.0	31.4-302.0	302.0	2.5	240.0
	220		4160KPC	0.80	60.0	38.7-427.0	427.0	2.5	240.0
	250		4200KPC	0.80	60.0	42.7-481.0	481.0	2.5	240.0
	280		4220KPC	0.80	60.0	55.0-550.0	550.0	2.5	240.0
	315		4280KPC	0.60	60.0	61.6-616.0	616.0	2.5	240.0

Voltage class	Applicable motor (kW)	Inverter type-form		F300		F308 (Ohm)	F309 (kW)	F316	F356 (s)	F402 (%)	F405	
				Adjustment range	(kHz)						<Set> =" JP" (kW)	other (kW)
3-phase 240 V	0.75	VFAS3-	2004P	1.0-16.0	4.0	200.0	0.12	1	0.57	4.30	0.75	0.75
	1.5		2007P	1.0-16.0	4.0	75.0	0.12	1	0.57	4.40	1.50	1.50
	2.2		2015P	1.0-16.0	4.0	75.0	0.12	1	0.57	2.90	2.20	2.20
	4.0		2022P	1.0-16.0	4.0	40.0	0.12	1	0.67	2.80	3.70	4.00
	5.5		2037P	1.0-16.0	4.0	20.0	0.24	1	0.87	2.30	5.50	5.50
	7.5		2055P	1.0-16.0	4.0	15.0	0.44	1	0.87	2.00	7.50	7.50
	11		2075P	1.0-16.0	4.0	10.0	0.66	1	1.07	1.60	11.00	11.00
	15		2110P	1.0-16.0	4.0	7.5	0.88	1	1.07	1.50	15.00	15.00
	18.5		2150P	1.0-16.0	4.0	7.5	0.88	1	1.37	1.40	18.50	18.50
	22		2185P	1.0-16.0	4.0	3.3	1.76	1	1.37	1.60	22.00	22.00
	30		2220P	1.0-8.0	4.0	3.3	1.76	1	1.37	1.20	30.00	30.00
	37		2300P	1.0-8.0	4.0	2.0	2.20	1	1.37	0.80	37.00	37.00
	45		2370P	1.0-8.0	4.0	2.0	2.20	1	1.37	0.70	45.00	45.00
	55		2450P	1.0-8.0	2.5	2.0	2.20	1	1.37	0.80	55.00	55.00
	75		2550P	1.0-8.0	2.5	1.7	3.40	1	1.37	1.30	75.00	75.00
3-phase 480 V	0.75	VFAS3-	4004PC	1.0-16.0	4.0	200.0	0.12	3	0.57	4.30	0.75	0.75
	1.5		4007PC	1.0-16.0	4.0	200.0	0.12	3	0.57	4.40	1.50	1.50
	2.2		4015PC	1.0-16.0	4.0	200.0	0.12	3	0.57	2.90	2.20	2.20
	4.0		4022PC	1.0-16.0	4.0	160.0	0.12	3	0.67	2.80	3.70	4.00
	5.5		4037PC	1.0-16.0	4.0	80.0	0.24	3	0.87	2.30	5.50	5.50
	7.5		4055PC	1.0-16.0	4.0	60.0	0.44	3	0.87	2.00	7.50	7.50
	11		4075PC	1.0-16.0	4.0	40.0	0.66	3	1.07	1.60	11.00	11.00
	15		4110PC	1.0-16.0	4.0	30.0	0.88	3	1.07	1.50	15.00	15.00
	18.5		4150PC	1.0-16.0	4.0	30.0	0.88	3	1.37	1.40	18.50	18.50
	22		4185PC	1.0-16.0	4.0	15.0	1.76	3	1.37	1.60	22.00	22.00
	30		4220PC	1.0-16.0	4.0	15.0	1.76	3	1.37	1.20	30.00	30.00
	37		4300PC	1.0-16.0	4.0	8.0	1.76	3	1.37	0.80	37.00	37.00
	45		4370PC	1.0-16.0	4.0	8.0	1.76	3	1.37	0.70	45.00	45.00
	55		4450PC	1.0-8.0	4.0	8.0	1.76	3	1.37	0.80	55.00	55.00
	75		4550PC	1.0-8.0	4.0	8.0	1.76	3	1.37	1.30	75.00	75.00
	90		4750PC	1.0-8.0	4.0	3.7	7.40	3	1.37	1.20	90.00	90.00
	110		4900PC	1.0-8.0	2.5	3.7	7.40	3	1.37	0.90	110.0	110.0
	132		4110KPC	1.0-8.0	2.5	3.7	7.40	3	1.37	0.80	132.0	132.0
	160		4132KPC	1.0-8.0	2.5	3.7	7.40	3	1.37	0.80	160.0	160.0
	220		4160KPC	1.0-8.0	2.5	1.9	8.70	3	1.37	0.80	220.0	220.0
	250		4200KPC	1.0-8.0	2.5	1.9	8.70	3	1.37	0.80	250.0	250.0
	280		4220KPC	1.0-8.0	2.5	1.4	14.00	3	1.37	0.80	280.0	280.0
	315		4280KPC	1.0-8.0	2.5	1.4	14.00	3	1.37	0.60	315.0	315.0

Voltage class	Applicable motor (kW)	Inverter type-form		F412 (%)	F415		F416 (%)	F417		F456	F749
					Adjustment range	(A)		50Hz setting (min-1)	60Hz setting (min-1)		
3-phase 240 V	0.75	VFAS3-	2004P	7.0	0.01-99.99	3.40	55	1440	1730	100	0
	1.5		2007P	5.0	0.01-99.99	6.40	42	1445	1740	100	0
	2.2		2015P	5.0	0.01-99.99	9.40	50	1460	1755	100	0
	4.0		2022P	5.0	0.01-99.99	14.60	38	1460	1755	100	0
	5.5		2037P	5.0	0.01-99.99	21.40	41	1465	1760	100	1
	7.5		2055P	5.0	0.01-99.99	28.60	38	1460	1755	100	1
	11		2075P	4.0	0.01-99.99	42.00	38	1475	1770	100	1
	15		2110P	4.0	0.01-99.99	55.60	33	1470	1760	100	1
	18.5		2150P	4.0	0.01-99.99	69.00	37	1475	1770	100	1
	22		2185P	4.0	0.1-999.9	80.0	32	1470	1760	100	1
	30		2220P	4.0	0.1-999.9	108.0	33	1470	1765	100	1
	37		2300P	4.0	0.1-999.9	132.0	32	1480	1775	100	1
	45		2370P	3.0	0.1-999.9	159.0	31	1480	1775	100	2
	55		2450P	3.0	0.1-999.9	192.0	28	1480	1775	100	2
	75		2550P	3.0	0.1-999.9	264.0	28	1480	1775	100	2
3-phase 480 V	0.75	VFAS3-	4004PC	7.0	0.01-99.99	1.70	55	1440	1730	100	0
	1.5		4007PC	5.0	0.01-99.99	3.20	42	1445	1740	100	0
	2.2		4015PC	5.0	0.01-99.99	4.70	50	1460	1755	100	0
	4.0		4022PC	5.0	0.01-99.99	7.30	38	1460	1755	100	0
	5.5		4037PC	5.0	0.01-99.99	10.70	41	1465	1760	100	1
	7.5		4055PC	5.0	0.01-99.99	14.30	38	1460	1755	100	1
	11		4075PC	4.0	0.01-99.99	21.00	38	1475	1770	100	1
	15		4110PC	4.0	0.01-99.99	27.80	33	1470	1760	100	1
	18.5		4150PC	4.0	0.01-99.99	34.50	37	1475	1770	100	1
	22		4185PC	4.0	0.01-99.99	40.00	32	1470	1760	100	1
	30		4220PC	4.0	0.01-99.99	54.00	33	1470	1765	85	1
	37		4300PC	4.0	0.01-99.99	66.00	32	1480	1775	80	1
	45		4370PC	3.0	0.1-999.9	79.5	31	1480	1775	100	2
	55		4450PC	3.0	0.1-999.9	96.0	28	1480	1775	100	2
	75		4550PC	3.0	0.1-999.9	129.0	28	1480	1775	100	2
	90		4750PC	3.0	0.1-999.9	154.0	26	1480	1775	80	2
	110		4900PC	3.0	0.1-999.9	190.0	21	1480	1780	100	2
	132		4110KPC	3.0	0.1-999.9	230.0	20	1485	1780	100	2
	160		4132KPC	3.0	0.1-999.9	252.0	20	1485	1785	100	2
	220		4160KPC	3.0	0.1-999.9	315.0	20	1485	1785	100	2
	250		4200KPC	3.0	0.1-999.9	345.0	20	1485	1785	100	2
	280		4220KPC	3.0	0.1-999.9	445.0	20	1485	1785	100	2
	315		4280KPC	3.0	0.1-999.9	544.0	20	1485	1785	100	2

11. 7 Analog output/Monitor output function

Option No.	Communication No.		Function	Display unit	Unit (Communication)
	Analog output	Monitor output			
0	FD00	FE00	Output frequency	0.1Hz	0.01Hz
1	FD02	FE02	Frequency command value	0.1Hz	0.01Hz
2	FD03	FE03	Output current	1%/<F701> setting	0.01%
3	FD04	FE04	Input voltage (DC detection)	1%/<F701> setting	0.01%
4	FD05	FE05	Output voltage	1%/<F701> setting	0.01%
5	FD15	FE15	Stator frequency	0.1Hz	0.01Hz
6	FD16	FE16	Speed feedback frequency (real time)	0.1Hz	0.01Hz
7	FD17	FE17	Speed feedback frequency (1-second filter)	0.1Hz	0.01Hz
8	FD18	FE18	Torque	1%	0.01%
9	FD19	FE19	Torque command	1%	0.01%
10	FD99	FE99	Output frequency during run. Frequency command value during stop.	Hz/free unit	-
11	FD20	FE20	Torque current	1%	0.01%
12	FD21	FE21	Exciting current	1%	0.01%
13	FD22	FE22	PID feedback value	0.1Hz	0.01Hz
14	FD23	FE23	Motor overload factor (OL2 data)	1%	0.01%
15	FD24	FE24	Inverter overload factor (OL1 data)	1%	0.01%
16	FD25	FE25	Braking resistor overload factor (OLr data)	1%	1%
17	FD28	FE28	Braking resistor load factor (%ED)	1%	1%
18	DF29	FE29	Input power	0.1kW	0.01kW
19	FD30	FE30	Output power	0.1kW	0.01kW
20	FE76	FE76	Input cumulative power	<F749> setting	<F749> setting
21	FE77	FE77	Output cumulative power	<F749> setting	<F749> setting
22			Fixed output 1	-	-
23			Fixed output 2	-	-
24	FE35	FE35	Terminal RR input value	1%	0.01%
25	FE36	FE36	Terminal RX input value	1%	0.01%
26	FE37	FE37	Terminal II input value	1%	0.01%
27	FD94	FE94	Motor speed command *4	1	1
28	FE40	FE40	Terminal FM output value *1	1	0.01
29	FE41	FE41	Terminal AM output value *2	1	0.01
31	FA51	FA51	Communication data output	*3	*3
32		FE66	Slot A option CPU version	-	-
33		FE67	Slot B option CPU version	-	-
34	FD26	FE26	Motor load factor	%	-
35	FD27	FE27	Inverter load factor	%	-
36		FE70	Inverter rated current	A	-
37		FD70	Inverter rated current (with carrier frequency correction)	A	-

Option No.	Communication No.		Function	Display unit	Unit (Communication)
	Analog output	Monitor output			
38		FD81	Actual carrier frequency	kHz	-
39		FE68	Slot C option CPU version	-	-
40		FE91	Embedded Ethernet CPU version	-	-
41	FD43	FD43	Terminal FP pulse train output value	pps	-
43		FM/F671	Terminal FM/AM gain setting value	-	-
44	FE38	FE38	Terminal AI4 input value	1%	0.01%
45	FE39	FE39	Terminal AI5 input value	1%	0.01%
46	FE60	FE60	My function monitor output 1	-	-
47	FE61	FE61	My function monitor output 2	-	-
48	FE62	FE62	My function monitor output 3	-	-
49	FE63	FE63	My function monitor output 4	-	-
62	FD48	FE48	PID result frequency	0.1Hz	0.01Hz
63	FD58	FE58	PID set value	0.1Hz	0.01Hz
64	FD50	FD50	Light-load high-speed switching load torque	1%	0.01%
65	FD51	FD51	Light-load high-speed torque during constant speed run	1%	0.01%
66		FE31	Pattern operation group number	0.1	0.1
67		FE32	Pattern operation remaining cycle number	1	1
68		FE33	Pattern operation preset speed number	1	1
69		FE34	Pattern operation remaining time	0.1	0.1
70		FE71	Inverter rated voltage	1	0.1
71	FD90	FE90	Motor speed (estimated value) *4	1	1
72		FA15	Communication option Receiving counter	1	1
73		FA16	Communication option Abnormal counter	1	1
76	FE56	FE56	Terminal S4/S5 pulse train input value	0.001	0.0001
77		FD85	My function COUNT1	1	1
78		FD86	My function COUNT2	1	1
79	FD87	FD87	Dancer control PID result frequency	0.1Hz	0.01Hz
80		FA25	Embedded Ethernet Transmission counter	1	1
81		FA17	Embedded Ethernet Receiving counter	1	1
82		FA18	Embedded Ethernet Abnormal counter	1	1
83		FE81	Connected option number	1	1
84		FD91	My function COUNT3	1	1
85		FD92	My function COUNT4	1	1
86		FD93	My function COUNT5	1	1
90		FE80	Cumulative power ON time	100 hours	-
91		FD41	Cumulative cooling fan run time	100 hours	-
92		FD14	Cumulative run time	100 hours	-
93		FD31	Cumulative overcurrent time	-	-
95		E960	Pump 0 run time	100 hours	-
96		E961	Pump 1 run time	100 hours	-
97		E962	Pump 2 run time	100 hours	-

Option No.	Communication No.		Function	Display unit	Unit (Communication)
	Analog output	Monitor output			
98		E963	Pump 3 run time	100 hours	-
99		E964	Pump 4 run time	100 hours	-
100		FD32	Number of starting	10000 times	-
101		FD33	Number of Fwd starting	10000 times	-
102		FD34	Number of Rev starting	10000 times	-
103		FE59	External equipment counter	Times	-
105		E965	Pump 5 run time	100 hours	-
106		E966	Pump 6 run time	100 hours	-
107		E967	Pump 7 run time	100 hours	-
108		E968	Pump 8 run time	100 hours	-
109		E969	Pump 9 run time	100 hours	-
110		FD35	Number of trip	Times	-
111		FD36	Number of serious failure trip	Times	-
112		FD37	Number of slight failure trip	Times	-
113		FD38	Number of specified trip 1	Times	-
114		FD39	Number of specified trip 2	Times	-
115		FD40	Number of specified trip 3	Times	-
120	FD83	FE83	Internal temperature 1	-	-
124	FE78	FE78	Power circuit board temperature	-	-
130	FD96	FD96	External PID3 set value	-	-
131	FD97	FD97	External PID3 feedback value	-	-
132	FD98	FD98	External PID3 result value	-	-
133	FE96	FE96	External PID4 set value	-	-
134	FE97	FE97	External PID4 feedback value	-	-
135	FE98	FE98	External PID4 result value	-	-
150	FD00 *5	FE00	Signed output frequency	0.1Hz	0.01Hz
151	FD02 *5	FE02	Signed frequency command value	0.1Hz	0.01Hz
152	FD15 *5	FE15	Signed stator frequency	0.1Hz	0.01Hz
153	FD16 *5	FE16	Signed speed feedback frequency (real time)	0.1Hz	0.01Hz
154	FD17 *5	FE17	Signed speed feedback frequency (1-second filter)	0.1Hz	0.01Hz
155	FD18	FE18	Signed torque	1%	0.01%
156	FD19	FE19	Signed torque command	1%	0.01%
158	FD20	FE20	Signed torque current	1%	0.01%
159	FD22 *5	FE22	Signed PID feedback value	0.1Hz	0.01Hz
160	FE37	FE37	Signed terminal RX input value	1%	0.01%
161	FE38	FE38	Signed terminal AI4 input value	1%	0.01%
162	FE39	FE39	Signed terminal AI5 input value	1%	0.01%

*1 Disabled with <FMSL: Terminal FM function>.
*2 Disabled with <F670: Terminal AM function>.
*3 For details, refer to RS485 Communication Function Instruction Manual (Exxxxxxx).
*4 Monitor is limited from -32700 to 32700.
*5 FD00(FE00), FD02(FE02), FD15(FE15), FD16(FE16), FD17(FE17), FD22(EF22) are unsigned value.
Internal polarity is used for signed analog output or monitor.

11. 8 Input terminal function

The function No. in the following table can be assigned to parameters <F110>-<F124>, <F127>, <F128>. and <F151>-<F158>.

Function number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
0	1	-	No function	Disabled	-
2	3	F	Fwd run	ON: Forward run (except deceleration stop) OFF: Deceleration stop	[7. 2. 1]
4	5	R	Rev run	ON: Reverse run (except deceleration stop) OFF: Deceleration stop	
6	7	ST	Standby	ON: Ready for operation, OFF: Coast stop (gate OFF)	[5. 4. 2] [6. 3. 1] [6. 34. 8] [6. 8. 2] [7. 2. 1]
8	9	RES1	Reset 1	ON: Acceptance of reset command, ON→OFF: Trip reset	[7. 2. 1] [13. 1]
10	11	SS1	Preset speed switching 1	Selection of 31-speed SS1 to SS5 (5 bits)	[5. 3. 7] [7. 2. 1]
12	13	SS2	Preset speed switching 2		
14	15	SS3	Preset speed switching 3		
16	17	SS4	Preset speed switching 4		
18	19	JOG	Jog run	ON: Jog run enabled	[6. 10] [7. 2. 1]
20	21	EXT	Emergency off	ON: "E" trip after <F603> operation	[6. 30. 4] [7. 2. 1]
22	23	DB	DC braking	ON: DC braking	[6. 8. 1] [6. 8. 3] [7. 2. 1]
24	25	AD1	Acc/Dec switching 1	Selection of Acc/Dec 1 - 4 AD2, AD3 (2 bits)	[7. 2. 1]
26	27	AD2	Acc/Dec switching 2		
28	29	VFSW1	V/f switching 1	Selection of V/f 1 - 4 VFSW1, VFSW2 (2 bits)	
30	31	VFSW2	V/f switching 2		
32	33	OCS2	Stall prevention switching/Torque limit switching 1	ON: <F185: Stall prevention level 2> enabled OFF: <F601: Stall prevention level 1> enabled	[6. 24. 1] [6. 27. 2] [6. 30. 2] [7. 2. 1]
34	35	TRQL2	Torque limit switching 2	Selection of Power running/Regenerative torque limit 1 - 4 OCS2, TRQL1 (2 bits)	[6. 24. 1] [6. 27. 2] [7. 2. 1]
36	37	PID	PID control OFF	ON: PID control OFF	[5. 3. 8] [7. 2. 1]
38	39	PTTN1	Pattern operation 1	ON: Pattern operation 1 enabled	[6. 28] [7. 2. 1]
40	41	PTTN2	Pattern operation 2	ON: Pattern operation 2 enabled	
42	43	PTTNC	Pattern operation continuation	ON: Pattern operation continued	
44	45	PTTNS	Pattern operation start	ON: Pattern operation start	
46	47	OH2	External thermal trip	ON: "OH2" trip	[7. 2. 1]

Function number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
48	49	SCLC	Communication priority cancel	ON: Run at the setting of <CMOd: Run command select> and <FMOd: Frequency command select 1> OFF: Run by communication	[6. 38. 2] [7. 2. 1]
50	51	HD	3-wire operation hold/ stop	ON: Forward run (F), Reverse run (R) held, 3-wire operation OFF: Deceleration stop	[7. 2. 1]
52	53	IDC	PID differential/integral reset	ON: PID differential/integral cleared	[5. 3. 8] [7. 2. 1]
54	55	PIDSW	PID plus/minus switching	ON: Plus/minus characteristics of <F359: PID control 1> setting OFF: Characteristics of <F359: PID control 1> setting	[7. 2. 1]
56	57	FORCE	Forced run	ON: Forced run, continues in a slight failure condition (Set <F650: Forced run> = "1: Enabled". Frequency command value = <F294: Preset speed 15 / Forced run speed>.) *Stop with power off	[6. 12. 2] [6. 31] [7. 2. 1]
58	59	FIRE	Fire speed run	ON: Fire speed run (Set <F650: Fire speed run> = "1: Enabled". Frequency command value = <F294: Preset speed 15 / Forced run speed>.) *Stop with power off	
60	61	DWELL	Dwell operation	ON: Dwell operation (Stop acceleration and deceleration and run the motor at a constant speed)	[6. 19] [7. 2. 1]
62	63	KEB	Synchronized Acc/Dec	ON: Deceleration stop with synchronizing at power failure	[7. 2. 1]
64	65	MYF	My function start	ON: My function start (When <A977: My function> = "1: Enabled by permission signal")	
66	67	AUTT	Offline auto-tuning	<F400> = "3" ON: Offline auto-tuning executed <F400> = "6" ON: Offline auto-tuning executed at run command while this signal is ON. <F400> = "7" ON: Offline auto-tuning executed only for <F402> at run command while this signal is ON.	[6. 23. 1] [6. 23. 2] [7. 2. 1]
68	69	SGSW	Speed control gain switching	ON: Use F463-F465 OFF: Use F460-F462	[7. 2. 1]
70	71	SRVL	Servo lock	ON: Servo lock	
72	73	SIMP	Simple positioning	ON: Simple positioning operation	
74	75	CKWH	Cumulative power monitor clear	ON: Clear cumulative power (kWh) monitor display	[6. 36] [7. 2. 1]
76	77	TRACE	Trace trigger	ON: Trace trigger (start) signal	[7. 2. 1]
78	79	HSLL	Light-load high-speed operation inhibited	ON: Light-load high-speed operation inhibited OFF: Light-load high-speed operation permitted	
80	81	HDFP	Terminal FP output hold	ON: Terminal [FP] is held ON once turned ON	
82	83	HDR1	Terminal R1 output hold	ON: Terminal [R1] is held ON once turned ON	
84	85	HDR2	Terminal R2 output hold	ON: Terminal [R2] is held ON once turned ON	
88	89	UP	Terminal Up frequency	ON: Frequency command increased	[6. 6. 5] [7. 2. 1]
90	91	DOWN	Terminal Down frequency	ON: Frequency command decreased	
92	93	CLR	Terminal Up, Down frequency clear	OFF-> ON: Clear Terminal Up, Down frequency command	
94	95	DANC	Dancer correction OFF	ON: Dancer correction OFF	[7. 2. 1]
96	97	FRR	Coast stop	ON: Coast stop (gate OFF)	[6. 34. 8] [7. 2. 1]
98	99	FR	Fwd/Rev	ON: Forward command, OFF: Reverse command	[7. 2. 1]
100	101	RS	Run/Stop	ON: Run command, OFF: Stop command	

Function number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
102	103	CPSW	Commercial powr run switching	ON: Commercial power run, OFF: Inverter run	[6. 20] [7. 2. 1]
104	105	FCHG	FMOd/F207 priority switching	ON: <F207: Frequency command select 2> enabled (When <F200: Frequency command priority select> = "0") OFF: <FMOd: Frequency command select 1> enabled	[5. 4. 1] [7. 2. 1]
106	107	FMTB	Terminal II priority	ON: Frequency command of Terminal [II] enabled OFF: <FMOd: Frequency command select 1> enabled	[7. 2. 1]
108	109	CMTB	Terminal run priority	ON: Run command of terminal enabled OFF: <CMOd: Run command select> enabled	[5. 2. 1] [7. 2. 1]
110	111	PWE	Parameter writing unlocked	ON: Parameter writing unlocked OFF: <F700: Parameter reading & writing access lockout> setting	[6. 34. 1] [7. 2. 1]
112	113	STSW	Speed control/Torque control switching	ON: Torque control, OFF: Speed control	[7. 2. 1]
114	115	EXCUT	External equipment counter	ON: Count the signals (Monitor number "103" can monitor the number of ON signal)	[6. 30. 21] [7. 2. 1]
116	117	PI1SW	PID 1, 2 switching	ON: PID2, OFF: PID1	[7. 2. 1]
118	119	SS5	Preset speed switching 5	Selection of 31-speed SS1 to SS5 (5 bits)	[5. 3. 7] [7. 2. 1]
120	121	FSTP1	Quick deceleration 1	ON: Dynamic quick deceleration OFF: Canceled *Operation is resumed when dynamic quick deceleration is canceled	[7. 2. 1]
122	123	FSTP2	Quick deceleration 2	ON: Quick deceleration OFF: Canceled *Operation is resumed when quick deceleration is canceled	
124	125	PREX	Preliminary excitation	ON: Preliminary excitation	
126	127	BRK	Brake	ON: Brake closed	
130	131	BRKA	Brake answerback	ON: Comparison signal with output terminal function "68: During brake release" ("E-11" trip when mismatching)	[6. 30. 15] [7. 2. 1]
134	135	TVS	Traverse operation	ON: Traverse operation permission	[7. 2. 1]
136	137	RSC	Rescue operation	ON: Rescure operation (Low voltage operation)	
138	139	PMPSW	Pump control switching	ON: Pump switching during pump control	
140	141	SLOWF	Fwd slowdown	ON: Forward run toward the setting value of <F383: Hit and stop frequency>	
142	143	STOPF	Fwd stop	ON: Stop (Forward run only)	
144	145	SLOWR	Rev slowdown	ON: Reverse run toward the setting value of <F383: Hit and stop frequency>	
146	147	STOPR	Rev stop	ON: Stop (Reverse run only)	
148	149	SLOFR	Fwd/Rev slowdown	ON: Stop (Forward/Reverse run)	
150	151	HSC	Hit and stop clear	ON: Hit and stop cleared	

Function number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
152	153	MOT2	No. 2 motor switching	ON: No.2 motor setting + No.2 Acc/Dec + No.2 Stall (Torque limit) (V/f constant, <F170>, <F171>, <F172>, <F182>, <F185>, <F500>, <F501>, <F503>) <tHrA> (not <F182>) when <F632> = "2", "3" OFF: No.1 motor setting + No.1 Acc/Dec + No. 1 Stall (Torque limit) (<Pt>, <vL>, <vLv>, <vb>, <tHrA>, <ACC>, <dEC>, <F502>, <F601>)	[7. 2. 1]
154	155	PID3	External PID3 enabled	ON: External PID3 enabled	
156	157	PID4	External PID4 enabled	ON: External PID4 enabled	
158	159	RES2	Reset 2	ON: Reset accepted, ON -> OFF: Trip reset	
162	163	PID3R	External PID3 differential/ integral reset	ON: External PID3 differential/integral reset	
164	165	PID3S	External PID3 plus/minus switching	ON: Plus/minus characteristics of <A340: PID control 3> setting OFF: Characteristics of <A340: PID control 3> setting	
170	171	PID4R	External PID4 differential/ integral reset	ON: External PID4 differential/integral reset	
172	173	PID4S	External PID4 plus/minus switching	ON: Plus/minus characteristics of <A370: PID control 4> setting OFF: Characteristics of <A370: PID control 4> setting	
176	177	PMPR	Pump control release	ON: Pump release during pump control	
200	201	PWP	Parameter writing locked	ON: Parameter writing locked (Reading unlocked) OFF: <F700: Parameter reading & writing access lockout> setting	[6. 34. 1] [7. 2. 1]
202	203	PRWP	Parameter reading locked	ON: Parameter reading & writing access lockout OFF: <F700: Parameter reading & writing access lockout> setting	

11. 9 Output terminal function

The function No. in the following table can be assigned to parameters <F130>, <F132>-<F134>, <F137>, <F138>, and <F159>-<F163>.

Function Number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
0	1	LL	Lower limit frequency (LL)	ON: Output frequency over <LL: Lower limit frequency>	[7. 2. 2]
2	3	UL	Upper limit frequency (UL)	ON: Output frequency is <UL: Upper limit frequency> or more	[7. 2. 2]
4	5	LOW	Low-speed signal	ON: Output frequency is <F100: Low-speed signal output frequency> or more	[6. 1. 1] [7. 2. 2]
6	7	RCH	Acc/Dec completed	Output frequency is within command frequency ± <F102: Reach signal detection band>	[6. 1. 2] [7. 2. 2]
8	9	RCHF	Specified frequency attainment	ON: Output frequency is within <F101: Reach signal specified frequency> ± <F102: Reach signal detection band>	[6. 1. 3] [7. 2. 2]
10	11	FL1	Failure signal 1	ON: Tripped	[6. 30. 5] [6. 30. 6] [6. 30. 7] [6. 30. 8] [6. 30. 10] [6. 30. 14] [7. 2. 2]
12	13	FL2	Failure signal 2	ON: At trip, except "EF", "OCL", "EPHO", and "OL2"	[7. 2. 2]
14	15	POC	Overcurrent (OC) pre-alarm	ON: Output current is <F601: Stall prevention level 1> or more	
16	17	POLI	Inverter overload (OL1) pre-alarm	ON: Calculated value of overload protection level is a specific level or more	
18	19	POLM	Motor overload (OL2) pre-alarm	ON: Calculated value of overload protection level is <F657: Overload alarm level> or more	
20	21	POH	Overheat (OH) pre-alarm	ON: Approx. 95°C or more of IGBT element OFF: Under approx. 95°C of IGBT element (90°C or less after detection is turned on)	
22	23	POP	Overvoltage (OP) pre-alarm	ON: Overvoltage limit in operation	
24	25	MOFF	Power circuit undervoltage (MOFF) alarm	ON: Main circuit undervoltage (MOFF) detected	
26	27	UC	Undercurrent (UC) alarm	ON: When the output current falls below the value set by <F611: Undercurrent detection level> and remains below <F611: Undercurrent detection level>+<F609: Undercurrent detection hysteresis> for the period of time specified by <F612: Undercurrent detection time> OFF: Output current is over <F611> (<F611>+<F609> or more after detection turns on)	[6. 30. 7] [7. 2. 2]
28	29	OT	Overtorque (OT) alarm	ON: When the torque becomes <F616: Overtorque detection level during power running> or more, and remains over <F616: Overtorque detection level during power running> - <F619: Overtorque detection hysteresis> for the time specified by <F618: Overtorque detection time> OFF: Torque is under <F616> (<F616>-<F619> or less after detection turns on)	[6. 30. 8] [7. 2. 2]
30	31	POLR	Braking resistor overload (OLr) pre-alarm	ON: 50% or more of calculated value of <F309: Braking resistor capacity> set overload protection level	[6. 15. 4] [7. 2. 2]

Function Number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
32	33	E	Emergency off trip	ON: During emergency off trip ("E" is displayed)	[7. 2. 2]
34	35	RETRY	During retry	ON: During retry	
36	37	PTNS	Pattern operation end	ON: All pattern operation end	[6. 28] [7. 2. 2]
38	39	PIDL	PID deviation limit	ON: Within the setting value of <F364: PID1 deviation upper-limit>, <F365: PID1 deviation lower-limit>	[7. 2. 2]
40	41	RUN	Run/Stop	ON: During run or DC braking, OFF: During stop	
42	43	HFL	Serious failure	ON: At trip *1, OFF: Other than those trip above	
44	45	LFL	Slight failure	ON: At trip ("OC1", "OC2", "OC3", "OP1", "OP2", "OP3", "OH", "OL1", "OL2", "OL3", "OLr") OFF: Other than those trip above	
46	47	CPSW1	Commercial power/ Inverter Switching 1	ON: For inverter run	
48	49	CPSW2	Commercial power/ Inverter Switching 2	ON: For commercial power run	
50	51	FAN	During cooling fan run	ON: During cooling fan run	[6. 30. 11] [7. 2. 2]
52	53	JOG	During jog run	ON: During jog run	[7. 2. 2]
54	55	JBM	During terminal run	ON: During terminal run, OFF: Other than terminal run	
56	57	COT	Cumulative run time alarm	ON: Cumulative operation time is <F621: Cumulative run time alarm > or more	[6. 30. 12] [7. 2. 2]
58	59	COMOP	Communication option communication time-out	ON: Time-out of communication option occurs (held until reset)	[7. 2. 2]
60	61	FR	Fwd/Rev run	ON: During reverse run, OFF: During forward run * Command direction or OFF during stop	
62	63	RDY1	Ready for run 1	ON: Run when frequency command is ON	
64	65	RDY2	Ready for run 2	ON: Run when ST, RUN, or frequency command is ON	
68	69	BR	During brake	ON: Brake, OFF: Break release	
70	71	PAL	During alarm or pre-alarm	ON: Alarm or pre-alarm occuring	
72	73	FSL	During Fwd speed limit	ON: <F426: Fwd speed limit level> or more (Torque control)	
74	75	RSL	During Rev speed limit	ON: <F428: Rev speed limit level> or more (Torque control)	
76	77	HLTH	Inverter healthy output	Output while switching ON and OFF over at every 1 sec. (to check inverter soundness)	
78	79	COME	RS485 communication time-out	ON:RS485 communication time-out	[6. 38. 1] [7. 2. 2]
92	93	DATA1	Designated data bit 0	ON: bit0 of FA50 is ON, OFF: bit0 of FA50 is OFF	[7. 2. 2]
94	95	DATA2	Designated data bit 1	ON: bit1 of FA50 is ON, OFF: bit1 of FA50 is OFF	
106	107	LLD1	Light load detection 1	ON: Under heavy load torque(<F335> to <F338>)	
108	109	HLD	Heavy load detection	ON: Heavy load torque(<F335> to <F338>)or more	
110	111	PTL	During positive torque limit	ON: During positive torque limit	
112	113	MTL	During negative torque limit	ON: During negative torque limit	
114	115	RCRY	For external relay of rush current suppression	ON: For external relay of rush current suppression	
116	117	FL4	Failure signal 4	ON: During trip (including retry waite time)	[6. 15. 3] [7. 2. 2]

Function Number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
118	119	STPC	Stop positioning completion	ON: Stop position completion	[7. 2. 2]
120	121	LLS	During sleep	ON: During sleep	
122	123	KEB	During synchronized Acc/ Dec	ON: During synchronized acceleration/deceleration	
124	125	TVS	During traverse operation	ON: During traverse operation	
126	127	TVSD	During traverse Dec	ON: During traverse deceleration	
128	129	LTA	Parts replacement alarm	ON: Any one of cooling fan, control board capacitor, or power circuit capacitor reaches parts replacement time	[6. 30. 17] [7. 2. 2]
130	131	POT	Overtorque (OT) pre-alarm	ON: Torque current is 70% of <F616: Overtorque detection level during power running> setting value or more OFF: Torque current is under <F616> x 70%-<F619: Overtorque detection hysteresis>	[7. 2. 2]
132	133	FMOD	Frequency command 1/ Frequency command 2	ON: <F207: Frequency command select 2> enabled OFF: <FMOd: Frequency command select 1> enabled	
134	135	FL3	Failure signal 3	ON: During trip (except Emergency off)	
136	137	FLC	Hand/Auto	ON: Run command or panel run, OFF: Other than those at left	
138	139	FORCE	During forced run	ON: During forced run	[6. 31] [7. 2. 2]
140	141	FIRE	During fire speed run	ON: During fire speed run	
142	143	UTA	Undertorque alarm	ON: Undertorque alarm level or more	[7. 2. 2]
144	145	PIDF	PID1,2 frequency command agreement	ON: Frequency commanded by <F389: PID1 set value select > and <F360: PID1 feedback input select > are within ± <F374: PID1 set value agreement detection band>	
150	151	PTCA	PTC input pre-alarm	ON: PTC thermal input value is 60% of <F646: PTC detection resistance> or more	[6. 30. 19] [7. 2. 2]
152	153	STO	During Safe Torque Off (STO)	ON: Open between [STOA]-[STOB]-[PLC] OFF: Short circuit between [STOA]-[STOB]-[PLC]	[7. 2. 2]
154	155	DISK	Analog input disconnecting alarm	ON: The input value of terminal [II] is <F633: II analog input disconnection detection level> or less	
156	157	LI1	Terminal F ON/OFF	ON: Terminal [F] is ON, OFF: Terminal [F] is OFF	
158	159	LI2	Terminal R ON/OFF	ON: Terminal [R] is ON, OFF: Terminal [R] is OFF	
160	161	LTAF	Cooling fan replacement alarm	ON: Cooling fan reaches parts replacement time	[6. 30. 17] [7. 2. 2]
162	163	NSA	Number of starting alarm	ON: Number of starting is <F648: Number of starting alarm> or more	[6. 30. 21] [7. 2. 2]
164	165	LLD2	Light load detection 2	ON: Light load detection (compatible with old model)	[7. 2. 2]
166	167	DACC	During Acc	ON: During acceleration	
168	169	DDEC	During Dec	ON: During deceleration	
170	171	DRUN	During constant speed run	ON: During constant speed run	
172	173	DDC	During DC braking	ON: During DC braking	
174	175	HSTOP	During hit and stop	ON: During hit and stop	
176	177	SRVLR	During run including servo lock	ON: During run including servo lock	[7. 2. 2]

Function Number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
178	179	SRVL	During servo lock	ON: During servo lock	[7. 2. 2]
180	181	IPU	For input cumulative power	ON: Input cumulative power unit reach	
182	183	SMPA	Shock monitoring alarm	ON: Current / torque value reach the shock monitoring detection condition	
184	185	ENSA	Number of external equipment starting alarm	ON: Number of starting of external equipment is <F658: Number of external equipment starting alarm> or more	[6. 30. 21] [7. 2. 2]
186	187	VFS1	V/f switching status 1	ON: V/f switching status 1	[7. 2. 2]
188	189	VFS2	V/f switching status 2	ON: V/f switching status 2	
190	191	FAL	Cooling fan fault alarm	ON: Cooling fan fault	[6. 30. 11] [7. 2. 2]
192	193	ETHE	Embedded Ethernet communication time-out	ON: Embedded Ethernet communication time-out	[7. 2. 2]
194	195	CLD1	Calendar 1	ON: Calendar 1	
196	197	CLD2	Calendar 2	ON: Calendar 2	
198	199	CLD3	Calendar 3	ON: Calendar 3	
200	201	CLD4	Calendar 4	ON: Calendar 4	
202	203	PID2	During PID2 control	ON: During PID2 control	
204	205	PID3	During External PID3 control	ON: During External PID3 control	
206	207	PID3L	External PID3 deviation limit	ON: Within the setting value of <A346: PID3 deviation upper-limit>, <A347: PID3 deviation lower-limit>	
208	209	PID4	During External PID4 control	ON: During External PID4 control	
210	211	PID4L	External PID4 deviation limit	ON: Within the setting value of <A376: PID4 deviation upper-limit>, <A377: PID4 deviation lower-limit>	
212	213	PMPC	Pump control	ON: For pump operation	
222	223	MYF1	My function output 1	ON: My function output 1	
224	225	MYF2	My function output 2	ON: My function output 2	
226	227	MYF3	My function output 3	ON: My function output 3	
228	229	MYF4	My function output 4	ON: My function output 4	
230	231	MYF5	My function output 5	ON: My function output 5	
232	233	MYF6	My function output 6	ON: My function output 6	
234	235	MYF7	My function output 7	ON: My function output 7	
236	237	MYF8	My function output 8	ON: My function output 8	
238	239	MYF9	My function output 9	ON: My function output 9	
240	241	MYF10	My function output 10	ON: My function output 10	
242	243	MYF11	My function output 11	ON: My function output 11	
244	245	MYF12	My function output 12	ON: My function output 12	
246	247	MYF13	My function output 13	ON: My function output 13	
248	249	MYF14	My function output 14	ON: My function output 14	
250	251	MYF15	My function output 15	ON: My function output 15	
252	253	MYF16	My function output 16	ON: My function output 16	[7. 2. 2]
254	-	AOFF	Always OFF	Always OFF	–

Function Number		Symbol	Function	Action	Reference
Positive logic	Negative logic				
-	255	AON	Always ON	Always ON	–

*1 At trip "OCL", "OCR", "EPH1", "EPH0", "Ot", "Ot2", "OtC3", "UtC3", "OH2", "E", "EEP1"-"EEP3", "Err2"-"Err5", "UC", "UP1", "Etn", "Etn1"-"Etn3", "EF2", "PrF", "EtyP", "E-13", "E-18"-"E-21", "E-23", "E-26", "E-32", "E-37", "E-39"

11. 10 Setup menu

Parameter title	Function		Mainly North America	Mainly Asia	Mainly Europe	China	Japan
FH	Maximum frequency (Hz)		80.0	80.0	80.0	50.0	80.0
F307	Supply voltage compensation		2	2	2	2	3
F319	Regenerative over-flux upper limit (%)		120	120	120	140	140
F417	Motor rated speed (min^{-1})		*1	*1	*1	*1	*1
vLv, F171, F175, F179	Base frequency Voltage (V)		230	230	230	200	200
			460	400	400	380	400
vL, UL, F170, F174, F178, F204, F213, F219, F225, F231, F237, F330, F335, F364, F367, F370, F426, F428, F814, A316, A319, A322, A346, A349, A352, A376, A379, A382	Frequency (Hz)		60.0	50.0	50.0	50.0	60.0
F606, F643	Frequency (max of set value) (Hz)		60.0	50.0	50.0	50.0	60.0
F405	Motor rated Capacity (kW)	3.7	4.0	4.0	4.0	3.7	3.7
		0.4	0.4	0.4	0.4	0.37	0.4

*1 Depending on the region and the capacity. Refer to [11. 6].

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11. 11 Guidance function

Embedded Ethernet setting	
<AUF>=1	
C081-C096	Device name 1-16
C610	Emb Eth. IP setting mode
C611-C614	Emb Eth. IP address setting value
C615-C618	Emb Eth. Subnet mask setting value
C619-C622	Emb Eth. Default gateway setting value
C629-C632	Emb Eth. IP address monitor
C633-C636	Emb Eth. Subnet mask monitor
C637-C640	Emb Eth. Default gateway monitor
Preset speed operation	
<AUF>=2	
CMOd	Run command select
FMOd	Frequency command select
ACC	Acceleration time 1
dEC	Deceleration time 1
FH	Maximum frequency
UL	Upper limit frequency
Sr1-Sr7	Preset speed 1-7
F111-F116	Terminal xx function
F287-F294	Preset speed 8-15
Analog frequency command	
<AUF>=3	
CMOd	Command mode selection
FMOd	Frequency mode selection
ACC	Acceleration time 1
dEC	Deceleration time 1
FH	Maximum frequency
UL	Upper limit frequency
LL	Lower limit frequency
F201	RR point 1 input value
F202	RR point 1 frequency
F203	RR point 2 input value
F204	RR point 2 frequency
F216	II point 1 input value
F217	II point 1 frequency
F218	II point 2 input value
F219	II point 2 frequency

Motor 1,2 switching	
<AUF>=4	
vL	Base frequency
vLv	Base frequency voltage 1
vb	Manual torque boost
tHrA	Motor overload protection current 1
ACC	Acceleration time 1
dEC	Deceleration time 1
F111-F116	Terminal xx function
F170	Base frequency 2
F171	Base frequency voltage 2
F172	Manual torque boost 2
F182	Motor overload protection current 2
F185	Stall prevention level 2
F415	Motor rated current
F500	Acceleration time 2
F501	Deceleration time 2
F601	Stall prevention level 1
Motor parameter	
<AUF>=5	
Pt	V/f pattern
vL	Base frequency
vLv	Base frequency voltage 1
F405	Motor rated capacity
F415	Motor rated current
F417	Motor rated speed
F400	Offline auto-tuning
PM motor parameter	
<AUF>=6	
Pt	Motor control type
vL	Motor base frequency
vLv	Motor nominal voltage
F400	Auto tuning
F402	Automatic torque boost
F405	Motor rated capacity
F415	Motor nominal current
F417	Motor nominal speed
F458	Current control P gain
F460	Speed loop P gain
F461	Speed loop I gain
F462	Load inertia
F910	Step-out detection current
F911	Step-out detection time
F912	Auto tune Lq axis
F913	Auto tune Ld axis
F914	Current stall prevention frequency
F915	Starting method
F916	Id current at starting
F917	Lq ratio at 100% load
F918	Lq ratio at 200% load
F919	Reluctance torque ratio

12 Specifications

In this chapter, the inverter's model and type, standard specification, outside dimensions, and approx. mass are described.

12. 1 Model and main standard specification

■ Standard specification depending on model

< 240 V class: HD rating >

Item		Specification														
Voltage class		240 V class														
Frame size		A1				A2	A3		A4			A5			A6	
Applicable motor (kW)		0.4	0.75	1.5	2.2	4.0	5.5	7.5	11	15	18.5	22	30	37	45	55
Applicable motor (HP)		0.5	1	2	3	5	7.5	10	15	20	25	30	40	50	60	75
Rating	Type	VFAS3-														
	Form	2004P	2007P	2015P	2022P	2037P	2055P	2075P	2110P	2150P	2185P	2220P	2300P	2370P	2450P	2550P
	Output capacity (kVA) *1	1.3	1.8	3.0	4.3	7.1	9.7	12.5	17.8	24.2	29.9	35.3	46.9	56.8	67.1	80.4
	Output current (A) *2	3.3	4.6	8.0	11.2	18.7	25.4	32.7	46.8	63.4	78.4	92.6	123	149	176	211
	Output voltage	3-phase 200 V to 240 V (The maximum output voltage is equal to the input supply voltage)														
	Overload current rating	150%-1 minute, 180%-2 s														
Electrical braking	Dynamic braking circuit	Built-in													Optional	
	Dynamic braking resistor	External braking resistor (Optional)														
Power supply	Voltage-frequency	3-phase 200 V to 240 V - 50/60 Hz														
	Allowable fluctuation	Voltage 170 V to 264 V *3, Frequency ± 5%														
	Required power supply capacity (kVA) *4	0.7	1.4	2.4	3.7	5.9	7.7	10.5	15.7	20.6	24.9	30.7	40.5	49.6	61.0	73.3
Degree of protection (IEC60529)		IP20													IP00	
Cooling method		Forced air-cooled														
Cooling fan noise (dBA) (Reference value) *5		58				54	60		64			63			70	
Color		RAL7016 / RAL7035														
EMC filter		No EMC filter														
DC reactor		Built-in														
UL type1 kit		Built-in													Optional	

*1 Capacity is calculated at 220 V for the 240 V class.

*2 Indicates rated output current when setting <F300: Carrier frequency> into 4 kHz for frame size A1 to A5, 2.5 kHz for frame size A6.

*3 Lower limit of voltage for 240 V class is 180 V when the inverter is used continuously (load of 100%).

*4 Required power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and wires).

*5 These acoustic noise values are not guaranteed because they are just reference values.

< 240 V class: ND rating >

Item		Specification														
Voltage class		240 V class														
Frame size		A1				A2	A3		A4			A5			A6	
Applicable motor (kW)		0.75	1.5	2.2	4.0	5.5	7.5	11	15	18.5	22	30	37	45	55	75
Applicable motor (HP)		1	2	3	5	7.5	10	15	20	25	30	40	50	60	75	100
Rating	Type	VFAS3-														
	Form	2004P	2007P	2015P	2022P	2037P	2055P	2075P	2110P	2150P	2185P	2220P	2300P	2370P	2450P	2550P
	Output capacity (kVA) *1	1.8	3.0	4.3	7.1	9.7	12.5	17.8	24.2	29.9	35.3	46.9	56.8	67.1	80.4	107
	Output current (A) *2	4.6	8.0	11.2	18.7	25.4	32.7	46.8	63.4	78.4	92.6	123	149	176	211	282
	Output voltage	3-phase 200 V to 240 V (The maximum output voltage is equal to the input supply voltage)														
	Overload current rating	120%-1 minute, 135%-2 s														
Electrical braking	Dynamic braking circuit	Built-in													Optional	
	Dynamic braking resistor	External braking resistor (Optional)														
Power supply	Voltage-frequency	3-phase 200 V to 240 V - 50/60 Hz														
	Allowable fluctuation	Voltage 170 V to 264 V *3, Frequency ± 5%														
	Required power supply capacity (kVA) *4	1.2	2.3	3.3	5.9	7.8	10.3	15.0	20.6	24.9	29.4	40.5	49.3	59.6	73.3	98.1
Degree of protection (IEC60529)		IP20													IP00	
Cooling method		Forced air-cooled														
Cooling fan noise (dBA) (Reference value) *5		58				54	60		64			63			70	
Color		RAL7016 / RAL7035														
EMC filter		No EMC filter														
DC reactor		Built-in														
UL type1 kit		Built-in													Optional	

*1 Capacity is calculated at 220 V for the 240 V class.
*2 Indicates rated output current when setting <F300: Carrier frequency> into 4 kHz for frame size A1 to A5, 2.5 kHz for frame size A6.
*3 Lower limit of voltage for 240 V class is 180 V when the inverter is used continuously (load of 100%).
*4 Required power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and wires).
*5 These acoustic noise values are not guaranteed because they are just reference values.

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< 480 V class: HD rating >

Item		Specification												
Voltage class		480 V class												
Frame size		A1					A2		A3			A4		
Applicable motor (kW)		0.4	0.75	1.5	2.2	4.0	5.5	7.5	11	15	18.5	22	30	37
Applicable motor (HP)		0.5	1	2	3	5	7.5	10	15	20	25	30	40	50
Rating	Type	VFAS3-												
	Form	4004PC	4007PC	4015PC	4022PC	4037PC	4055PC	4075PC	4110PC	4150PC	4185PC	4220PC	4300PC	4370PC
	Output capacity (kVA) *1	1.1	1.7	3.0	4.3	7.1	9.7	12.6	17.9	24.2	29.9	35.3	46.9	56.8
	Output current (A) *2	1.5	2.2	4.0	5.6	9.3	12.7	16.5	23.5	31.7	39.2	46.3	61.5	74.5
	Output voltage	3-phase 380 V to 480 V (The maximum output voltage is equal to the input supply voltage)												
	Overload current rating	150%-1 minute, 180%-2 s												
Electrical braking	Dynamic braking circuit	Built-in												
	Dynamic braking resistor	External braking resistor (Optional)												
Power supply	Voltage-frequency	3-phase 380 V to 480 V - 50/60 Hz												
	Allowable fluctuation	Voltage 323V to 528V *3, Frequency ± 5%												
	Required power supply capacity (kVA) *4	0.7	1.4	2.6	3.9	6.6	8.5	11.4	16.6	22.3	27.3	32.7	44.3	53.9
Degree of protection (IEC60529)		IP20												
Cooling method		Forced air-cooled												
Cooling fan noise (dBA) (Reference value) *5		58					54		60			64		
Color		RAL7016 / RAL7035												
EMC filter		Built-in												
DC reactor		Built-in												
UL type1 kit		Built-in												

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Item		Specification									
Voltage class		480 V class									
Frame size		A5			A6			A7	A8		
Applicable motor (kW)		45	55	75	90	110	132	160	200	220	280
Applicable motor (HP)		60	75	100	125	150	200	250	300	350	450
Rating	Type	VFAS3-									
	Form	4450PC	4550PC	4750PC	4900PC	4110KPC	4132KPC	4160KPC	4200KPC	4220KPC	4280KPC
	Output capacity (kVA) *1	67.1	80.8	111	132	161	191	239	295	325	419
	Output current (A) *2	88.0	106	145	173	211	250	314	387	427	550
	Output voltage	3-phase 380 V to 480 V (The maximum output voltage is equal to the input supply voltage)									
	Overload current rating	150%-1 minute, 180%-2 s						150%-1 minute, 165%-2s			
Electrical braking	Dynamic braking circuit	Built-in			Optional			Built-in	Optional		
	Dynamic braking resistor	External braking resistor (Optional)									
Power supply	Voltage-frequency	3-phase 380 V to 480 V - 50/60 Hz						3-phase 380 to 440 V - 50 Hz, 3-phase 380 to 480 V - 60 Hz			
	Allowable fluctuation	Voltage 323 V to 528 V *3, Frequency ± 5%						Voltage 323 to 484 V - 50 Hz, 323 V to 528 V - 60 Hz *3, Frequency ± 5%			
	Required power supply capacity (kVA) *4	65.6	79.5	108	133	155	181	225	275	308	379
Degree of protection (IEC60529)		IP20			IP00						
Cooling method		Forced air-cooled									
Cooling fan noise (dBA) (Reference value) *5		63			70			73	76		
Color		RAL7016 / RAL7035									
EMC filter		Built-in									
DC reactor		Built-in						Attached			
UL type1 kit		Built-in			Optional			-			

*1. Capacity is calculated at 440 V for the 480 V class.
*2. Indicates rated output current when setting <F300: Carrier frequency> into 4 kHz for frame size A1 to A5, 2.5 kHz for frame size A6 to A8.
*3. Lower limit of voltage for 480 V class is 342 V when the inverter is used continuously (load of 100%).
*4. Required power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and wires).
*5. These acoustic noise values are not guaranteed because they are just reference values.

< 480V class: ND rating >

Item		Specification												
Voltage class		480V class												
Frame size		A1					A2		A3			A4		
Applicable motor (kW)		0.75	1.5	2.2	4.0	5.5	7.5	11	15	18.5	22	30	37	45
Applicable motor (HP)		1	2	3	5	7.5	10	15	20	25	30	40	50	60
Rating	Type	VFAS3-												
	Form	4004PC	4007PC	4015PC	4022PC	4037PC	4055PC	4075PC	4110PC	4150PC	4185PC	4220PC	4300PC	4370PC
	Output capacity (kVA) *1	1.7	3.0	4.3	7.1	9.7	12.6	17.9	24.2	29.9	35.3	46.9	56.8	67.1
	Output current (A) *2	2.2	4.0	5.6	9.3	12.7	16.5	23.5	31.7	39.2	46.3	61.5	74.5	88.0
	Output voltage	3-phase 380 V to 480 V (The maximum output voltage is equal to the input supply voltage)												
	Overload current rating	120%-1 minute, 135%-2 s												
Electrical braking	Dynamic braking circuit	Built-in												
	Dynamic braking resistor	External braking resistor (Optional)												
Power supply	Voltage-frequency	3-phase 380 V to 480 V - 50/60 Hz												
	Allowable fluctuation	Voltage 323 V to 528 V *3, Frequency ± 5%												
	Required power supply capacity (kVA) *4	1.2	2.4	3.4	6.1	8.3	10.9	15.6	21.3	26.4	31.4	42.0	52.4	63.2
Degree of protection (IEC60529)		IP20												
Cooling method		Forced air-cooled												
Cooling fan noise (dBA) (Reference value) *5		58					54		60			64		
Color		RAL7016 / RAL7035												
EMC filter		Built-in												
DC reactor		Built-in												
UL type1 kit		Built-in												

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Item		Specification									
Voltage class		480 V class									
Frame size		A5			A6			A7	A8		
Applicable motor (kW)		55	75	90	110	132	160	220	250	280	315
Applicable motor (HP)		75	100	125	150	200	250	350	400	450	500
Rating	Type	VFAS3-									
	Form	4450PC	4550PC	4750PC	4900PC	4110KPC	4132KPC	4160KPC	4200KPC	4220KPC	4280KPC
	Output capacity (kVA) *1	80.8	111	132	161	191	230	325	367	419	469
	Output current (A) *2	106	145	173	211	250	302	427	481	550	616
	Output voltage	3-phase 380 V to 480 V (The maximum output voltage is equal to the input supply voltage)									
	Overload current rating	120%-1 minute, 135%-2 s									
Electrical braking	Dynamic braking circuit	Built-in			Optional			Built-in	Optional		
	Dynamic braking resistor	External braking resistor (Optional)									
Power supply	Voltage-frequency	3-phase 380 V to 480 V - 50/60 Hz						3-phase 380 to 440 V - 50 Hz, 3-phase 380 to 480 V - 60 Hz			
	Allowable fluctuation	Voltage 323 V to 528 V *3, Frequency ± 5%						Voltage 323 to 484 V - 50 Hz, 323 V to 528 V - 60 Hz *3, Frequency ± 5%			
	Required power supply capacity (kVA) *4	77.0	103	125	155	181	214	296	335	379	422
Degree of protection (IEC60529)		IP20			IP00						
Cooling method		Forced air-cooled									
Cooling fan noise (dBA) (Reference value) *5		63			70			73	76		
Color		RAL7016 / RAL7035									
EMC filter		Built-in									
DC reactor		Built-in						Attached			
UL type1 kit		Built-in			Optional			-			

*1. Capacity is calculated at 440 V for the 480 V class.
*2. Indicates rated output current when setting <F300: Carrier frequency> into 4 kHz for frame size A1 to A5, 2.5 kHz for frame size A6 to A8.
*3. Lower limit of voltage for 480 V class is 342 V when the inverter is used continuously (load of 100%).
*4. Required power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and wires).
*5. These acoustic noise values are not guaranteed because they are just reference values.

■ Common specification

Item		Specification
Control specification	Control system	Sinusoidal PWM control
	Output voltage adjustment	Adjustable within the range of 50 - 330 V (240 V class) and 50 - 660 V (480 V class) by correcting the supply voltage
	Output frequency range	Setting between 0.01 - 590 Hz. Default frequency is set to 0.01-50/60 Hz. Maximum frequency adjustment (30 to 590Hz)
	Minimum setting steps of frequency	0.01 Hz: operation panel input (60 Hz base), 0.03 Hz: analog input (60 Hz base, 11 bit/0 - 10 Vdc)
	Frequency accuracy	Analog input: ±0.2% of the maximum output frequency (at 25±10°C) Digital input: ±0.01%±0.022 Hz of the output frequency
	Voltage/frequency characteristics	V/f constant, variable torque, automatic torque boost, vector control, base frequency adjustment 1, 2, 3, and 4 (15 - 590 Hz), V/f 5-point arbitrary setting, torque boost adjustment (0 - 30%), start frequency adjustment (0 - 10 Hz), stop frequency adjustment (0 - 30 Hz)
	Frequency setting signal	3 kΩ potentiometer (possible to connect to 1 - 10 kΩ-rated potentiometer) 0 - 10Vdc (input impedance Zin: 31.5 kΩ) -10 to +10 Vdc (Zin: 31.5 kΩ) 4 - 20 mAdc (Zin: 250 Ω)
	Terminal block frequency command	The characteristic can be set arbitrarily by two-point setting. Compliant with 7 types of input; analog input (RR, RX, II, AI4, AI5), and pulse input (S4, S5)
	Frequency jump	Three frequency can be set. Setting of jump frequency and width.
	Upper and lower limit frequencies	Upper limit frequency: 0 to max. frequency, lower limit frequency: 0 to upper limit frequency
	PWM carrier frequency	Frame size A1 to A4: adjustable between 1.0 - 16 kHz Frame size A5 to A8: adjustable between 2.5 - 8 kHz
	PID control	Adjustment of proportional gain, integral time, differential time and delay filter. Multi PID and external PID control.
	Torque control	Voltage command input specification: -10 - +10 Vdc
	Real time clock	Current time (Year, month, date, hour, minute), Timezone, Daylight saving time, 4 working days and 20 holidays can be set by parameters.
Operation specifications	Acceleration/deceleration time	0.01 - 6000 sec. Selectable from among acceleration/deceleration. times 1, 2, 3 and 4. Automatic acceleration/deceleration function. S-pattern acceleration/deceleration 1 and 2 pattern adjustable.
	DC braking	Adjustment of braking start frequency (0 - <FH>Hz), braking (0 - 100%) and braking time (0 - 25.5 sec.). With emergency off braking function and motor shaft fix control function.
	Forward run/reverse run *1	Forward run with ON of the terminal [F], Reverse run with ON of the terminal [R] (Default setting). Coast stop with OFF of the terminal assigned Stad-by function. Emergency off by panel operation or terminal.
	Jog run *1	Jog run, if selected, allows jog operation from the operation panel Jog run operation by terminal block is possible by setting the parameters.
	Preset speed operation *1	By changing the combination of the terminals [S1], [S2], [S3], [S4], [S5] set frequency + 31-speed operation. Selectable between acceleration/deceleration time, torque limit and V/f by set frequency.
	Retry	Capable of restarting after a check of the power circuit elements in case the protective function is activated. Max. 10 times selectable arbitrarily. Waiting time adjustment (0 - 10 sec.)
	Soft stall	Automatic load reduction control at overloading. (Default: OFF)
	Cooling fan ON/OFF	The cooling fan will be stopped automatically to assure long life when unnecessary.
	Operation panel key operation ON/OFF control	Key lock selectable between STOP key only, MODE key only, etc. All key operations can be locked.
	Regenerative power ride-through control	Possible to keep the motor running using its regenerative energy in case of a momentary power failure. (Default: OFF)
	Auto-restart operation	Possible to restart the motor in coasting in accordance with its speed and direction. (Default: OFF)
	Simplified pattern operation	Possible to select each 8 patterns in 2 groups from 15-speed operation frequency. Max. 16 types of operation possible. Terminal operation/repeat operation possible.
	Commercial inverter switching	Possible to switch operation by commercial power supply or inverter
	Light-load high-speed operation	Increases the operating efficiency of the machine by increasing the rotational speed of the motor when it is operated under light load.
	Droop function	When two or more inverters are used to operate a single load, this function prevents load from concentrating on one inverter due to unbalance.
	Override function	External input signal adjustment is possible to the operation frequency command value.
Protective function	Protective function	Stall prevention, current limit, overcurrent, overvoltage, short circuit on the load side, ground fault on the load side *5, undervoltage, momentary power failure (15 ms or more), non-stop control at momentary power failure, overload protection, arm overload at starting, overcurrent on the load side at starting, overcurrent and overload at braking resistor, overheat, emergency off
	Electronic thermal characteristic	Switchable between standard motor/constant torque motor, adjustment of overload protection and stall prevention level.
	Reset	Reset by 1a contact closed (or 1b contact opened), or by operation panel. Or power supply OFF/ON. This function is also used to save and clear trip records.

(Continued overleaf)

(Continued)

Item			Specification
Display function	Screen of LCD	Alarms	Stall prevention during run, overload limit, overload, undervoltage on power supply side, DC circuit undervoltage, setting error, in retry, upper limit, lower limit.
		Causes of failures	Overcurrent, overvoltage, overheat, short circuit on the load side, ground fault on the load side, inverter overload, arm overcurrent at starting, overcurrent on the load side at starting, cooling fan fault, CPU fault, EEPROM fault, RAM fault, ROM fault, communication error, (braking resistor overcurrent/overload), (emergency off), (undervoltage), (undercurrent), (overtorque), (motor overload), (input phase failure), (output phase failure) The items in the parentheses are selectable.
		Monitoring function	Output frequency, frequency command, forward run/reverse run, output current, DC voltage, output voltage, compensated frequency, terminal input/output information, CPU version, past trip history, cumulative operation time, feedback frequency, torque, torque command, torque current, exiting current, PID feedback value, motor overload factor, inverter overload factor, PBR overload factor, PBR load factor, input power, output power, peak output current, peak DC voltage, RR input, II input, RX input, AI4 input, AI5 input, FM output, AM output, expansion I/O card option CPU version, integral input power, integral output power, communication option reception counter, communication option abnormal counter.
		Free unit display	Display of optional units other than output frequency (motor speed, line speed, etc), current ampere/% switch, voltage volt/% switch
		Automatic edit function	Searches automatically parameters that are different from the default setting parameters. Easy to find changed parameters.
		User default setting	User parameter settings can be saved as default settings. Allows to reset the parameters to the user-defined parameter settings.
	LED	Charge display	Displays power circuit capacitor charging.
Input/output terminal logic function			Possible to select positive logic or negative logic with programmable input/output terminal function menu. 2 or 3 function can be assigned for some terminals. *1 *2 (Default setting: positive logic)
Sink/source switching			Possible to switch between minus common (CC) and plus common (P24) for digital input terminal. (Default setting: external power supply)
output signal	Failure detection signal		1c contact output (250 Vac-2 A-(cosΦ=1), 30Vac-2A(Resistive), 250Vac-1A-(cosΦ=0.4), 30Vdc-1A(L/R=7ms))
	Relay output		2×1a contact output (250 Vac-2 A-(cosΦ=1), 30Vac-2A(Resistive), 250Vac-1A-(cosΦ=0.4), 30Vdc-1A(L/R=7ms))
	Low speed/speed reach signal output *2		Digital output (24 Vdc, max. 50 mA)
	Output for frequency meter/ Output for ammeter *3		Analog output for meter: 1 mA dc full-scale dc ammeter 0 - 20 mA (4 - 20 mA) output: DC ammeter (allowable load resistance: 500 Ω or less) 0 - 10 V output: DC voltmeter (allowable load resistance: 1 kΩ or more)
	Pulse train frequency output		Pulse train output (Up to 30 kpps, duty 50%)
Communication function			Standard equipment: Ethernet (dual port with switch, IEEE802.3/IEEE802.3u : Fast Ethernet, 10/100Mbps: Auto negotiation), RS485 (2-channel) Optional: PROFINET, DeviceNet, PROFIBUS-DP
Environments	Use environments		Indoor use. Place not exposed to direct sunlight and free of corrosive and explosive gases.
	Ambient temperature		-15 to 60°C *4 Frame size A1 to A5: Current reduction, remove the top cover when above 50°C Frame size A6: Current reduction when above 50°C Frame size A7 and A8: Current reduction when above 50°C(HD), above 45°C(ND)
	Storage temperature		-25 to +70°C (Temperature applicable for a short term.)
	Relative humidity		5 to 95% (free from condensation)
	Altitude		4800m or less for TN/TT system (Frame size A1 to A6) 3800m or less for IT system (Frame size A1 to A6) 3000m or less for TN/TT/IT system (Frame size A7 and A8) 2000m or less for corner-earthed system (All frame size) (current reduction necessary if above 1000 m for all frame size)
	Vibration		5.9 m/s^2{0.6G} or less (10 - 55 Hz) *6

*1: 14 digital input terminals (of which 6 are options) are programmable digital input terminals, and they make it possible to arbitrarily select from 178 types of signals.

*2: Programmable digital/pulse train output terminal make it possible to arbitrarily select from 256 types of signals.

*3: Programmable analog output terminals make it possible to arbitrarily select from 54 types of signals.

*4: -10 to 60°C for frame size A7 and A8.
Remove operation panel of the inverter when above 50°C.
For detail of current reduction, see "Instruction manual for load reduction" (E6582116)

*5: This function protects inverters from overcurrent due to output circuit ground fault.

*6: 2.9m/s^2 {0.3G} or less (10-55Hz) for frame size A6 to A8.

12. 2 Outside and Mass

■ Outside dimensions and mass

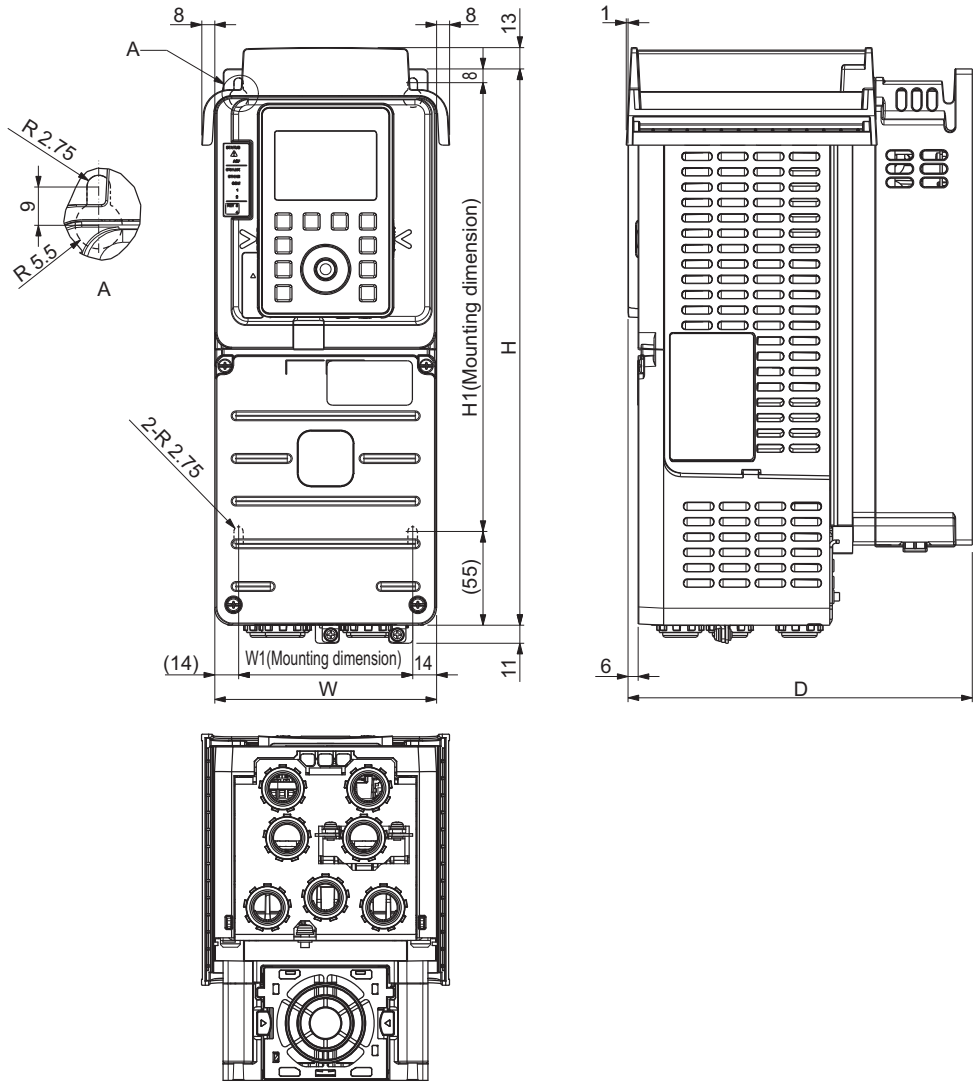
Input voltage Class	Applicable motor capacity (kW)	Inverter type		Dimension (mm)					Frame Size	Approx. mass (kg)
				W	H	D	W1 *1	H1 *1		
3-phase 240 V	0.4	VFAS3-	2004P	130	326	202	102	263	A1	4.3
	0.75		2007P							4.3
	1.5		2015P							4.5
	2.2		2022P							4.6
	4.0		2037P	155	391.5	231	125	324	A2	7.7
	5.5		2055P	195	534.5	232	168	460	A3	13.8
	7.5		2075P							13.8
	11		2110P	210	660	268	174	570	A4	27.3
	15		2150P							27.3
	18.5		2185P							27.3
	22		2220P	265	908	313	220	718	A5	57.6
	30		2300P							57.6
	37		2370P							57.6
	45		2450P	300	850	383	255	820	A6	82
	55		2550P							82
3-phase 480 V	0.4	VFAS3-	4004PC	130	326	202	102	263	A1	4.5
	0.75		4007PC							4.5
	1.5		4015PC							4.5
	2.2		4022PC							4.6
	4.0		4037PC							4.7
	5.5		4055PC	155	391.5	231	125	324	A2	7.7
	7.5		4075PC							7.7
	11		4110PC	195	534.5	232	168	460	A3	13.6
	15		4150PC							14.2
	18.5		4185PC							14.3
	22		4220PC	210	660	268	174	570	A4	28
	30		4300PC							28.2
	37		4370PC							28.7
	45		4450PC	265	908	313	220	718	A5	57.5
	55		4550PC							59
	75		4750PC							59.5
	90		4900PC	300	850	383	255	820	A6	82
	110		4110KPC							82
	132		4132KPC							82
	160		4160KPC	430	1190	377	350	920	A7	110 (168)*2
	200		4200KPC	585	1190	377	540	920	A8	138 (200)*2
	220		4220KPC							140 (210)*2
	280		4280KPC							140 (210)*2

*1 W1 and H1 are the mounting dimensions of the inverter.

*2 Value in ( ) includes attached DC reactor.

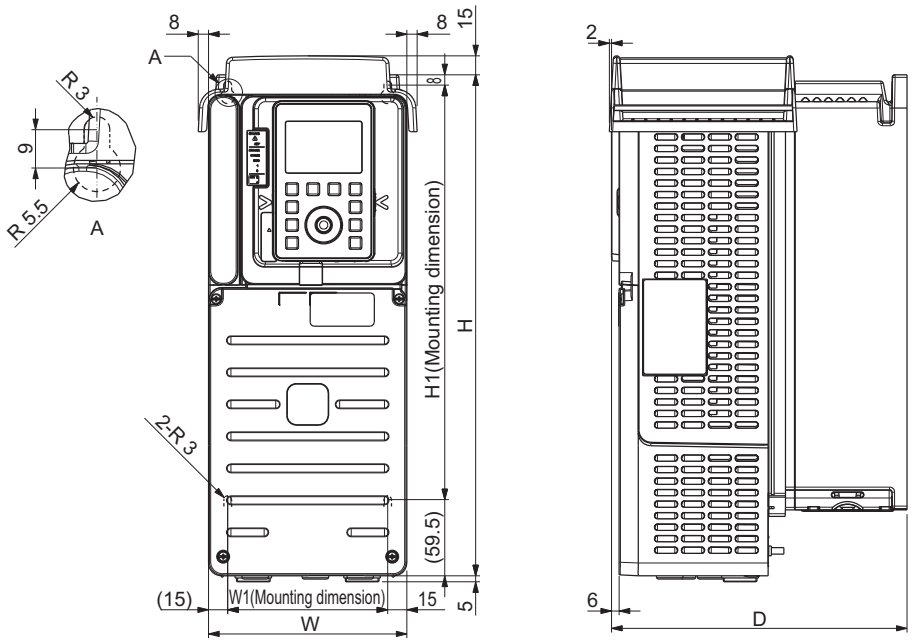
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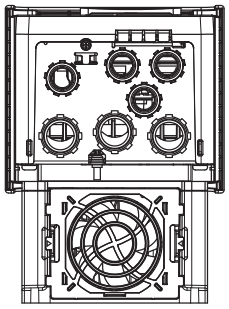
■ **Outline drawing**



Frame size A1

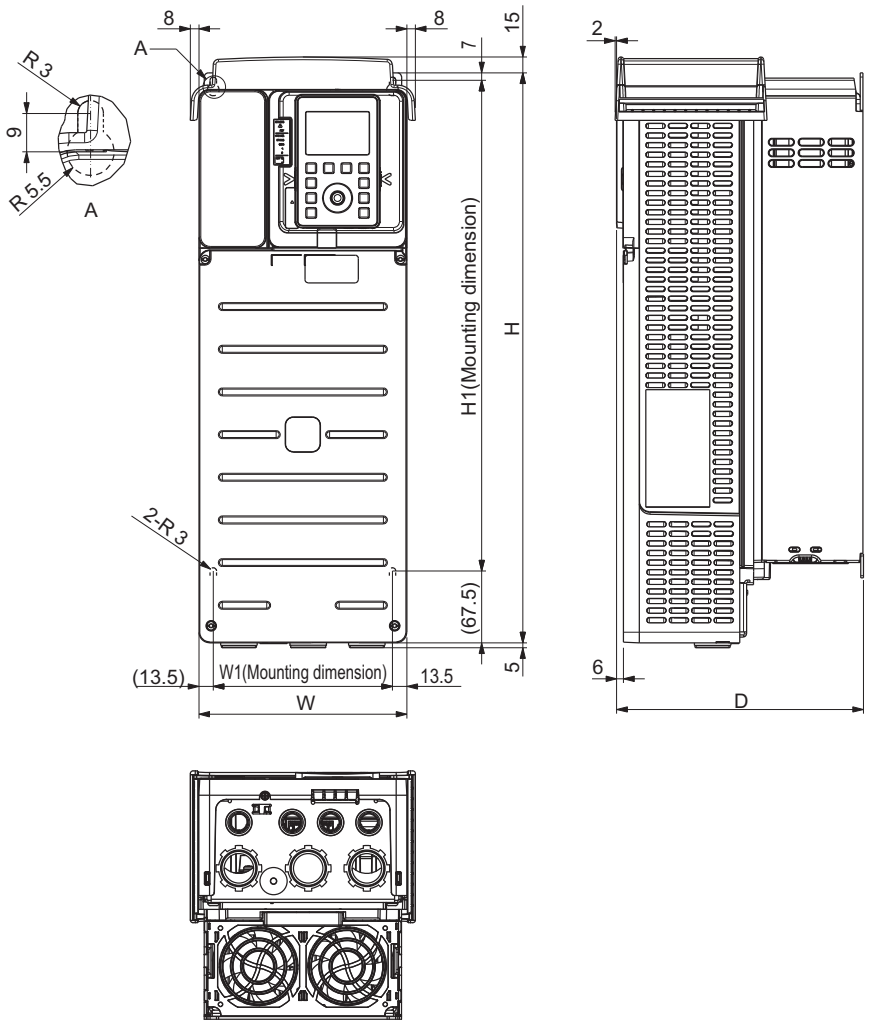
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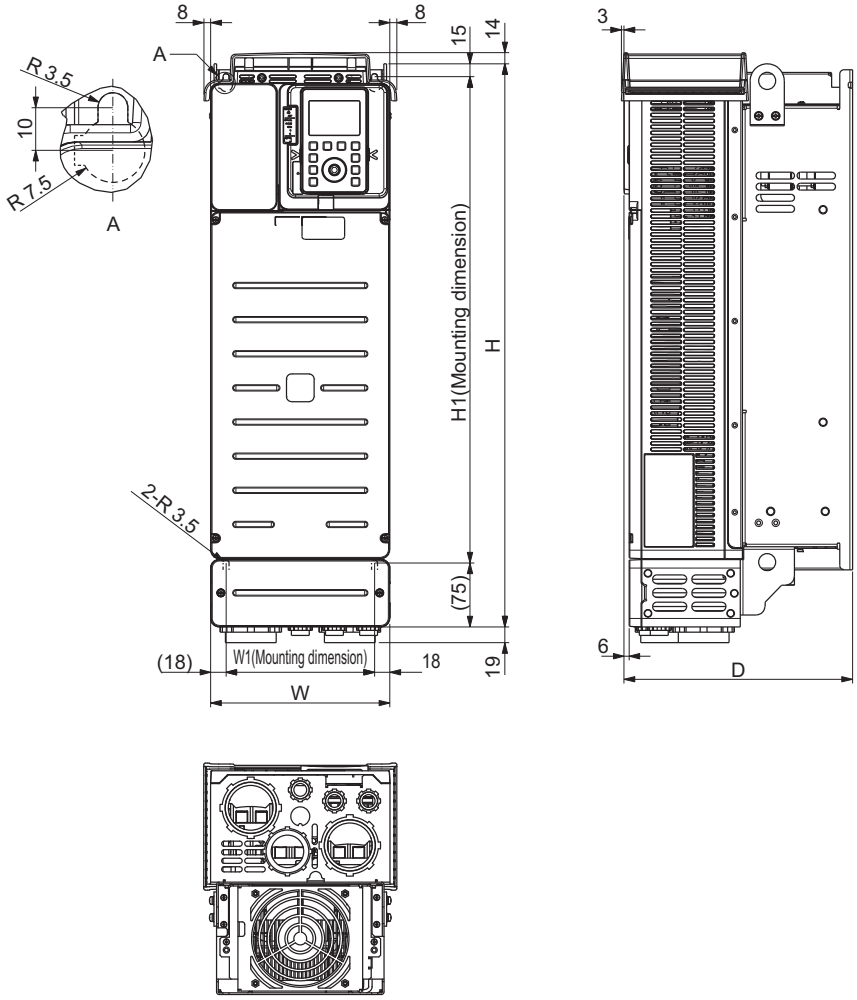
Frame size A2

12

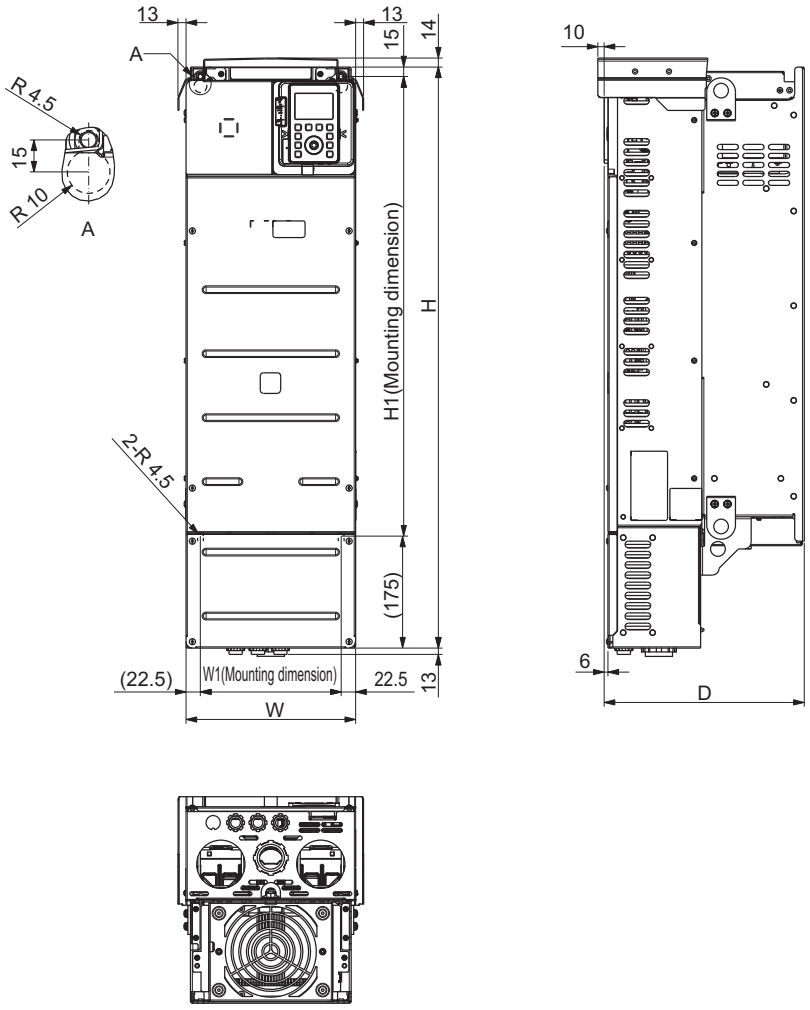


Frame size A3

12

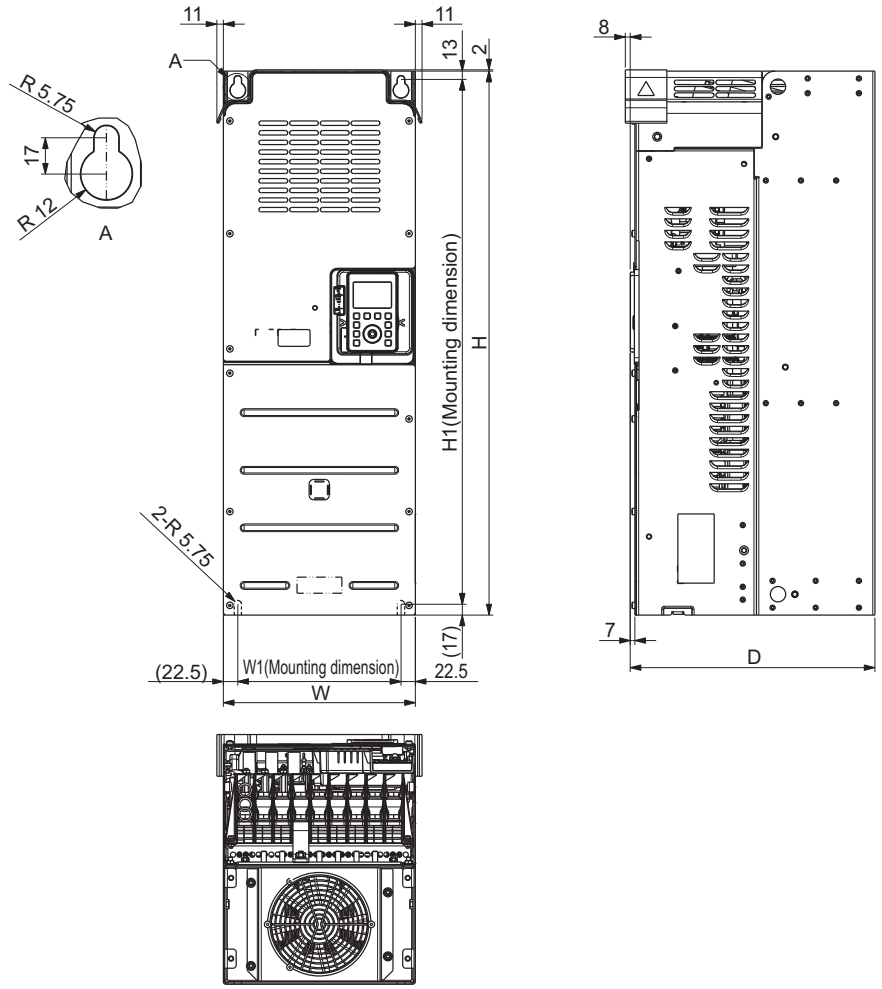


Frame size A4



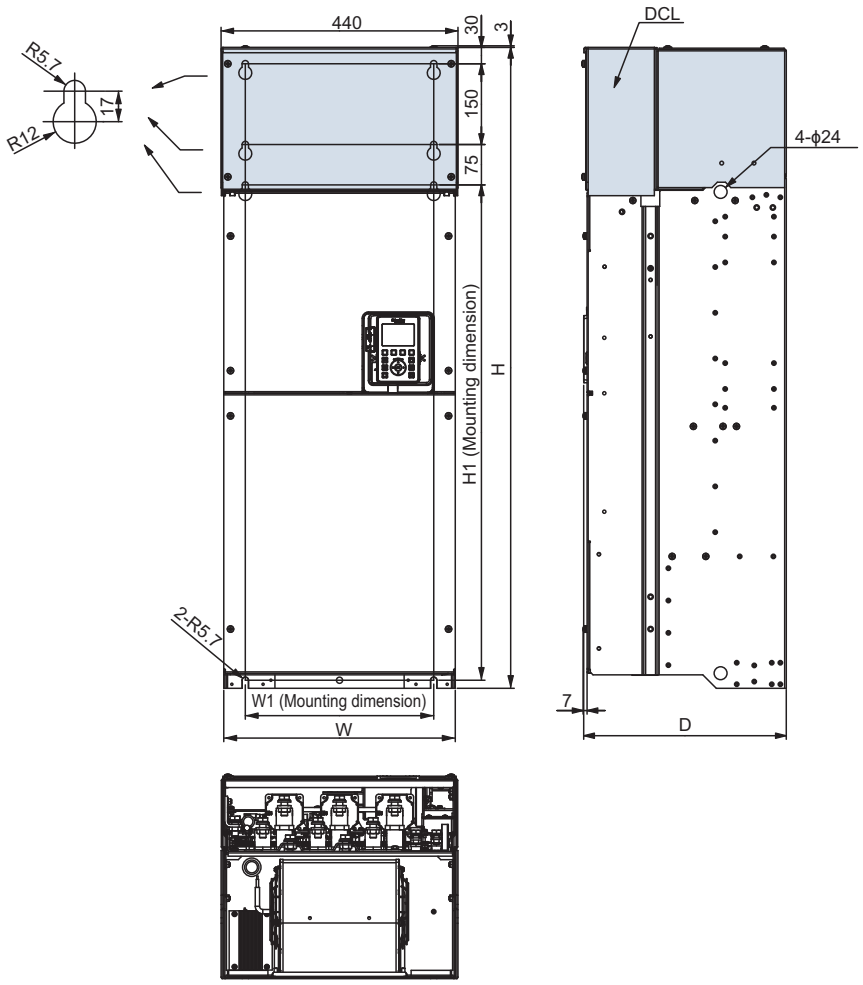
Frame size A5

12



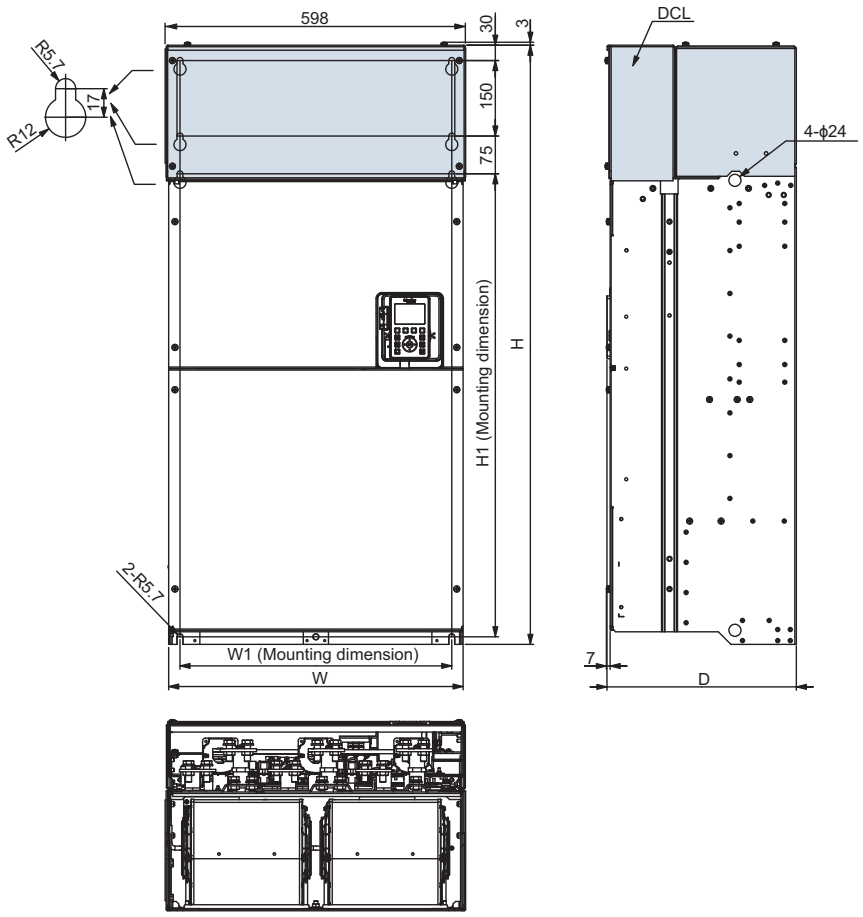
Frame size A6

12



Frame size A7

12



Frame size A8

12

13 Trip information and measures

13. 1 Description of trip and alarm information and measures

If a trip occurs, make failure diagnosis according to the table below before contacting your Toshiba distributor.

■ Term description

Trip	Output of the inverter is turned OFF for protection of the inverter or external equipment. A failure signal can be output if the output terminal function is assigned. (A failure signal is assigned to the terminal [FL] in the default setting).
Alarm	Indicates a condition that the inverter or external equipment may be damaged if continued. A signal can be output if the output terminal function is assigned. Under voltage, etc. are displayed with blinking on the operation panel.
Pre-alarm	A condition close to the trip level. A signal can be output when the output terminal function is assigned. "C", "P", "L", and "H" blink in the operation panel during run for overcurrent, overvoltage, overload, and overheat respectively.
Message	Informs a status of the inverter and setting error. It is not an alarm.

■ Trip information

Trip display	Failure code	Trip name	Detection factor	Measures
E	0011	Emergency off	Emergency off is input. 1) When a run command is other than the operation panel, [STOP/RESET] key was pressed twice. 2) A signal was input to the input terminal in which emergency off is assigned. 3) Emergency off is input from communication.	• Reset after solving problems. • Clear the emergency off signal.
E-11	002B	Brake answer error *	The system does not reply even after the setting time in <F630: Brake answer wait time> elapsed.	• Check the system. • Check if the <F630> setting is correct. When not used, set <F630>="0.0: Disabled".
E-12	002C	PG error	1) PG is disconnected. 2) Error exists in PG wiring. 3) PG voltage is improper.	• Check the PG wiring. • Check if the PG settings are correct. <F376: PG phases number select>, <F379: PG option voltage>

*Enable/Disable can be selected for trip with a parameter.

Trip display	Failure code	Trip name	Detection factor	Measures
E-13	002D	Abnormal speed error	1) When <Pt: V/f Pattern> = "0" to "9", an over speed condition occurred. Over speed condition: In case F623≠0.0, F624≠0.0, the condition which estimated frequency is not inside of "output frequency - <F624>" to "output frequency + <F623>" continues <F622> times. 2) When <Pt: V/f Pattern> = "10" to "11", over speed continued by PG failure, etc. Over speed condition: In case F623≠0.0, F624≠0.0, the condition which measured frequency is not inside of "output frequency - <F624>" to "output frequency + <F623>" continues <F622> times. 3) Due to overvoltage limit operation, the output frequency exceeded <FH: Maximum frequency> +12 Hz or <FH> + <vL: Base frequency 1> x 0.1.	1) 3) • Check whether a problem exists in input voltage. • When the regenerative energy is large, install a braking resistor (option). 2) Check the PG wiring and setting.
E-18	0032	Analog input disconnecting *	The input level of the terminal [II] became the setting value or less of <F633: II analog input disconnection detection level>	• Check that the signal line connected to the terminal [II] is not disconnected. • Check if the <F633> setting is correct.
E-19	0033	CPU communication error	Communication error between control CPU.	Turn off the power and then turn it on again. If the error occurs again, contact your Toshiba distributor.
E-20	0034	Over torque boost	• The setting value of the <F402: Automatic torque boost> is very high. • Impedance on the motor is low.	Set the motor parameters according to the motor characteristic, and perform auto-tuning. <vL: Base frequency 1>, <vLv: Base frequency voltage>, <F405: Motor rated capacity>, <F415: Motor rated current>, <F417: Motor rated speed>, <F400: Offline auto-tuning>, etc.
E-21	0035	CPU1 fault B	Control CPU fault.	Fault in internal inverter. Contact your Toshiba distributor.
E-22	0036	Embedded Ethernet fault	Fault in the embedded Ethernet.	Fault in internal inverter. Contact your Toshiba distributor.
E-23	0037	Option fault (slot A)	Fault in the option connected to slot A.	Fault in the option. Contact your Toshiba distributor.
E-24	0038	Option fault (slot B)	Fault in the option connected to slot B.	Fault in the option. Contact your Toshiba distributor.
E-25	0039	Option fault (slot C)	Fault in option 3.	Fault in the option. Contact your Toshiba distributor.
E-26	003A	CPU2 fault	Control CPU fault.	Fault in internal inverter. Contact your Toshiba distributor.

*Enable/Disable can be selected for trip with a parameter.

13

Trip display	Failure code	Trip name	Detection factor	Measures
E-29	003D	Control power option failure *	1) Failure on the control power supply option. 2) The setting of <F647: Control power option failure detection> is improper.	1) When input voltage of the control power supply is normal and the voltage between terminals [+SU]-[CC] is under 20 Vdc, it is a failure in the control power supply option. Contact your Toshiba distributor. 2) When the control power supply option is not used, set <F647> = "0".
E-31	003F	Rush current suppression relay fault	1) Fault on the rush current suppression relay. 2) The power was turned ON/OFF frequently.	1) Fault in internal inverter. Contact your Toshiba distributor. 2) Instead of turning ON/OFF with the power supply, turn ON/OFF with a run command.
E-32	0040	PTC failure	1) PTC protection for the motor became enabled. 2) Failure in the PTC circuit.	1) Check the motor and PTC. 2) Failure in internal inverter. Contact your Toshiba distributor.
E-37	0045	Servo lock error	1) The lock up torque or more external load is applied to the motor. 2) Setting of motor parameters is improper.	1) Reduce the load to apply the servo lock. 2) Set the motor parameters according to the motor characteristic, and perform auto-tuning. <vL: Base frequency 1>, <vLv: Base frequency voltage>, <F405: Motor rated capacity>, <F415: Motor rated current>, <F417: Motor rated speed>, <F400: Offline auto-tuning>, etc.
E-38	0046	Communication time-out of A6 Brake Unit	1) The wire linked VF-AS3 to A6 Brake Unit is disconnected. 2) The A6 Brake Unit is failed.	1) Check the wire linked VF-AS3 to A6 Brake Unit. 2) Turn off the power and then turn it on again. If the fault occurs again, contact your Toshiba distributor.
E-39	0047	PM control error	During auto-tuning or initial position, the motor current became very high.	Measure inductance with a LCR meter, etc., and set to the parameter directly.
E-42	004A	Cooling fan fault	The cooling fan failed.	The cooling fan needs to be replaced. Contact your Toshiba distributor.
E-43	004B	Communication time-out (embedded Ethernet)	Embedded Ethernet communication timed out.	Check the Ethernet communication equipment and wiring.
E-44	004C	Battery of panel failure	Calendar function is activated, and under one of these cases. 1) A battery is not in. 2) The battery level is low.	1) Put a battery. 2) Replace the battery.
E-45	004D	GD2 auto-tuning error	• The value of F459 is not fixed. • Estimated value of F459 is out of parameter range.	1) Modify the value of F481, F482 and do the tuning again. 2) Modify F480 to 0, and set the appropriate value of F459 manually.
E-48	0050	A6 Brake Unit internal fault	An internal error occurred in A6 Brake Unit.	Turn off the power and then turn it on again. If the fault occurs again, contact your Toshiba distributor.
E-99	0058	Trip for test *	Trip for test occurred.	Reset if no problem is found.

*Enable/Disable can be selected for trip with a parameter.

Trip display	Failure code	Trip name	Detection factor	Measures
EEP1	0012	EEPROM fault 1	Fault occurred during internal data writing.	Turn off the power and then turn it on again. If the fault occurs again, contact your Toshiba distributor.
EEP2	0013	EEPROM fault 2	1) While setting <tyP: Default setting>, the power was turned OFF or momentary power failure occurred. 2) Fault occurred during internal data writing.	1) Set <tyP> again. If the fault occurs again, contact your Toshiba distributor. 2) Turn off the power and then turn it on again. If the fault occurs again, contact your Toshiba distributor.
EEP3	0014	EEPROM fault 3	Fault occurred during internal data reading.	Turn off the power and then turn it on again. If the fault occurs again, contact your Toshiba distributor.
EF2	0022	Grounding fault *	1) Grounding fault occurred in the output wiring or the motor. 2) Fault can occur depends on motor, in case of rapid acceleration/deceleration.	1) Check grounding fault in the wiring on the output side and the motor. 2) Increase the acceleration/deceleration time. <ACC/dEC acceleration/ deceleration time 1>
EPHI	0008	Input phase loss *	1) Input side phase has failed.	1) Check phase failure in the wiring on the input side.
EPHO	0009	Output phase loss *	1) Output side phase has failed. 2) Output current is quite small (less than 8%) to motor rated current.	1) Check phase failure in the wiring on the output side. 2) Set <F605> to 0
Err2	0015	RAM fault	Control RAM fault.	Fault in internal inverter. Contact your Toshiba distributor.
Err3	0016	ROM fault	Control ROM fault.	Fault in internal inverter. Contact your Toshiba distributor.
Err4	0017	CPU1 fault A	Control CPU fault.	Fault in internal inverter. Contact your Toshiba distributor.
Err5	0018	Communication time-out (RS485)	RS485 communication timed out.	Check the communication equipment and wiring on RS485 communication.
Err6	0019	Gate array fault	Fault in the gate array.	Fault in internal inverter. Contact your Toshiba distributor.
Err7	001A	Current detector fault	Fault in the output current detector.	Fault in internal inverter. Contact your Toshiba distributor.
Err8	001B	Communication time-out (option)	Communication option timed out.	Check the communication equipment and wiring on communication option.
Err9	001C	Panel disconnection during run	While running with a run command from the operation panel and extension panel, the cable connecting the inverter and panel are disconnected.	Check the connection on the inverter and panel.

*Enable/Disable can be selected for trip with a parameter.

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Trip display	Failure code	Trip name	Detection factor	Measures
Etn	0028	Auto-tuning error	1) The motor parameter does not match the motor characteristic. 2) Executed auto-tuning while the motor is rotating. 3) The output frequency does not increase within few minutes.	1) Set the motor parameters according to the motor characteristic. <vL: Base frequency 1>, <vLv: Base frequency voltage>, <F405: Motor rated capacity>, <F415: Motor rated current>, <F417: Motor rated speed>, etc. 2) Check that the motor is stopped, and perform auto-tuning again. 3) Check that the motor is not stopped while the output frequency is risin on the system.
Etn1	0054	Auto-tuning error 1	1) The motor is not connected. 2) Something other than the motor is connected. 3) In the induction motor, an improper value, a synchronized motor speed value or a value close to it is set in <F417: Motor rated speed>.	1) and 2) Check that the motor is connected. 3) Set <F417> according to the motor rating.
Etn2	0055	Auto-tuning error 2	The motor parameter does not match the motor characteristic.	Set the motor parameters according to the motor characteristic. <vL: Base frequency 1>, <vLv: Base frequency voltage>, <F405: Motor rated capacity>, <F415: Motor rated current>, <F417: Motor rated speed>, etc.
Etn3	0056	Auto-tuning error 3	The setting on <vL: Base frequency 1> or <F417: Motor rated speed> does not match the motor rating.	Set <vL: Base frequency 1> or <F417: Motor rated speed> according to the motor rating.
EtyP	0029	Inverter type error	1) Internal error exists. 2) Replaced the printed circuit board (contact your Toshiba distributor for replacing the printed circuit board).	1) Error in internal inverter. Contact your Toshiba distributor. 2) Set <tyP: Default setting> = "6: Initialize typeform".
OC1	0001	Overcurrent (during acceleration)	1) The acceleration time is short. 2) <Pt: V/f Pattern> does not match the machinery. 3) Momentary power failure occurred, and tried to start the rotating motor. 4) Tried to run the special motor (impedance small). 5) Tried to run a low inductance motor like a high-speed motor. 6) When <Pt> = "11", polarity of PG is opposite. 7) When <F614: Pulse width of short circuit detection at start> = "0", and <F613>=2, or 3, inverter output short circuit.	1) Increase the acceleration time. <ACC: Acceleration time 1>, etc. 2) Set <Pt: V/f Pattern> according to the machinery. 3) Set <F301: Auto-restart>. Depending on the characteristic of machinery, <F302: Regenerative power ride-through> = "1" is also effective. 4) When <Pt> is set to "0", "1", "2", or "7", lower <vb: Manual torque boost 1>. For settings other than "0", "1", "2", or "7", perform auto-tuning with <F400: Offline auto-tuning>. <F402: Automatic torque boost> is set matching the motor. 5) Change the inverter to large capacity.
OC2	0002	Overcurrent (during deceleration)	1) The deceleration time is short. 2) Tried to run a low inductance motor like a high-speed motor. 3) When <Pt> = "11", polarity of PG is opposite. 4) When <F614: Pulse width of short circuit detection at start> = "0", and <F613>=2, or 3 inverter output short circuit.	1) Increase the deceleration time. <dEC: Deceleration time 1>, etc. 2) Change the inverter to large capacity.

*Enable/Disable can be selected for trip with a parameter.

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Trip display	Failure code	Trip name	Detection factor	Measures
OC3	0003	Overcurrent (during constant speed running)	1) The load changed rapidly. 2) Error occurred in the machinery (something got stuck, etc.). 3) Tried to run a low inductance motor like a high-speed motor. 4) When <Pt> = "11", polarity of PG is opposite. 5) When <F614: Pulse width of short circuit detection at start> = "0", and <F613>=2, or 3 inverter output short circuit.	1) Suppress load fluctuation. 2) Check whether a problem exists in the machinery. 3) Change the inverter to large capacity.
OCA1	0005	Overcurrent (U-phase arm)	Fault on IGBT in U-phase.	Fault in internal inverter. Contact your Toshiba distributor.
OCA2	0006	Overcurrent (V-phase arm)	Fault on IGBT in V-phase.	Fault in internal inverter. Contact your Toshiba distributor.
OCA3	0007	Overcurrent (W-phase arm)	Fault on IGBT in W-phase.	Fault in internal inverter. Contact your Toshiba distributor.
OCL	0004	Overcurrent (load side at startup)	1) Short circuit occurred on the output side. 2) The motor and output side wiring have defective insulation. 3) Impedance on the motor is low.	1) Check the wiring on the output side. 2) Check the insulation on the output side. 3) Set <F613: Short circuit detection at start> to "2" or "3".
OCr	0024	Overcurrent (Braking resistor)	1) When "Enabled" is set in <F304: Dynamic braking, OLr trip>: • The braking resistor is not connected. • The braking resistor connection is disconnected. • A braking resistor with a resistance value under the minimum allowable resistance value is connected. 2) Short circuit occurred between [PB] and [PC/-]. 3) IGBT fault on the dynamic braking drive circuit control.	1) Check if an adequate braking resistor is connected. When a braking resistor is not necessary, set "Disabled" in <F304>. 2) Check for problems on impedance of the braking resistor, wiring, etc. 3) Fault in internal inverter. Contact your Toshiba distributor. * This trip can not be reset. For trip clear, turn off the power and then turn it on again.
OH	0010	Overheat	1) The cooling fan is not working. 2) Ambient temperature is high. 3) The vent of the cooling fan is blocked. 4) Other heating units are nearby.	1) Replace if the cooling fan is not working during run. 2) Lower the ambient temperature. Reset after the inverter cools down. 3) Make sure the vent of the cooling fan is not blocked. 4) Place other heating units away from the inverter.
OH2	002E	External thermal trip *	A signal of external thermal trip is input.	Check that the motor is not overloaded.
OL1	000D	Overload (Inverter)	1) Sudden acceleration occurs and the acceleration time is short. 2) <Pt: V/f Pattern> does not match the machinery. 3) Momentary power failure occurred, and tried to start the rotating motor. 4) The DC braking amount is large. 5) The load is large for the inverter capacity.	1) Increase the acceleration time. <ACC: Acceleration time 1>, etc. 2) Set <Pt: V/f Pattern> according to the machinery. 3) Set <F301: Auto-restart>. Depending on the characteristic of machinery, <F302: Regenerative power ride-through> = "1" is also effective. 4) Set <F251: DC braking current> small and <F252: DC braking time> short. 5) Change the inverter to large capacity.

*Enable/Disable can be selected for trip with a parameter.

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Trip display	Failure code	Trip name	Detection factor	Measures
OL2	000E	Overload (Motor) *	1) The motor is locked up. 2) Operation continues in low-speed range. 3) The motor is overloaded. 4) The setting of the electronic thermal does not match the motor characteristic. 5) <Pt: V/f Pattern> does not match the machinery.	1) Check the machinery. 2), 3), and 4) Set the electronic thermal according to the motor. <OLM: Motor overload protection characteristic>, <tHrA: Motor overload protection current 1>, etc. 5) Set <Pt: V/f Pattern> according to the machinery.
OL3	003E	Overload (IGBT)	1) While operating the low-speed range (15 Hz or less) with high carrier frequency, overload occurred. 2) Momentary power failure occurred, and tried to start the rotating motor.	1) • Reduce the load. • Lower the carrier frequency. Or set <F316: Carrier frequency control> to "Valid decrease". • Increase the output frequency. 2) Set <F301: Auto-restart>. Depending on the characteristic of machinery, <F302: Regenerative power ride-through> = "1" is also effective.
OLr	000F	Overload (Braking resistor) *	1) The braking rate is large. 2) The deceleration time is short.	• Increase the deceleration time. <dEC: Deceleration time 1>, etc. • Change the braking resistor (option) to a large capacity, and set <F309: Braking resistor capacity>.
OP1	000A	Overvoltage (during acceleration)	1) Input voltage is high and showed abnormal fluctuation. 2) Connection is made as the following system. • Power supply capacity is 500 kVA or more. • The power factor improvement capacitor was opened/closed. • Equipment is connected that uses thyristor on the same system. 3) Momentary power failure occurred, and tried to start the rotating motor.	1) Use within the power supply voltage range. When no problem is found in the input voltage, install an input AC reactor (option). 2) Install an input AC reactor (option). 3) Set <F301: Auto-restart>. Depending on the characteristic of machinery, <F302: Regenerative power ride-through> = "1" is also effective.
OP2	000B	Overvoltage (during deceleration)	1) The deceleration time is short and the regenerative energy is large. 2) <F305: Overvoltage limit operation> is set to "1: Disabled". 3) Input voltage is high and showed abnormal fluctuation. 4) Connection is made as the following system. • Power supply capacity is 500 kVA or more. • The power factor improvement capacitor was opened/closed. • Equipment is connected that uses thyristor on the same system.	1) • Increase the deceleration time. <dEC: Deceleration time 1>, etc. • When the regenerative energy is large, install a braking resistor. 2) Change <F305> = "0", "2", and "3" to enable the Overvoltage limit operation. When the deceleration time is limited, install a braking resistor (option). 3) Use within the power supply voltage range. When no problem is found in the input voltage, install an input AC reactor (option). 4) Install an input AC reactor (option).

*Enable/Disable can be selected for trip with a parameter.

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Trip display	Failure code	Trip name	Detection factor	Measures
OP3	000C	Overvoltage (during constant speed running)	1) Input voltage is high and showed abnormal fluctuation. 2) Connection is made as the following system. • Power supply capacity is 500 kVA or more. • The power factor improvement capacitor was opened/closed. • Equipment is connected that uses thyristor on the same system. 3) The motor was rotated with the force on the load side, and it became to regenerative status.	1) Use within the power supply voltage range. When no problem is found in the input voltage, install an input AC reactor (option). 2) Install an input AC reactor (option). 3) Install a braking resistor (option).
Ot	0020	Overtorque *	The load torque reached the overtorque level during run.	• Check the load side. • Check the overtorque detection setting is correct. <F615: Overtorque trip>, <F616: Overtorque detection level during power running>, <F617: Overtorque detection level during regen>, <F618: Overtorque detection time>, etc.
Ot2	0041	Overtorque 2	1) The output current during power running reached <F601: Stall prevention level 1> or more, and the setting time in <F452: Stall detection time during power running> elapsed. 2) The power running torque during power running reached <F441: Power running torque limit level 1> or more, and the setting time in <F452: Stall detection time during power running> elapsed.	• Reduce the load. • Lower the detection level of <F601> or <F441>.
OtC3	0048	Overtorque/ Overcurrent *	Overtorque or overcurrent on the shock monitoring function was detected.	• Check the load. • When no problem is found, check if the shock monitoring function setting is correct. <F590: Shock monitoring> to <F598: Shock monitoring detection condition>
PrF	003B	STO circuit fault	Fault in the safe torque off (STO) circuit.	Fault inside the inverter. Contact your Toshiba distributor.
SOUT	002F	PM step-out *	1) The load changed rapidly. 2) Sudden acceleration/deceleration occurs. 3) The motor shaft is locked up. 4) Output side phase has failed.	1) and 2) Increase the acceleration/ deceleration time. <ACC: Acceleration time1>, <dEC: Deceleration time 1>, etc. 3) Check the motor and release the lock. 4) Check the wiring on the output side.
UC	001D	Undercurrent *	The output current declined to the undercurrent detection level during run.	• Check the load. • Check that the undercurrent detection setting is correct. <F610: Undercurrent trip>, <F611: Undercurrent detection level>, <F612: Undercurrent detection time>, etc.

*Enable/Disable can be selected for trip with a parameter.

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Trip display	Failure code	Trip name	Detection factor	Measures
UP1	001E	Undervoltage (Power circuit) *	The input voltage (power circuit) declined.	• Check the input voltage. • Check that the undervoltage detection setting is correct. <F625: Undervoltage detection level>, <F627: Undervoltage trip>, etc. • To avoid trip in momentary power failure, set <F627> = "0: Disabled", and set <F301: Auto-restart> and <F302: Regenerative power ride-through level> to "1".
Ut	003C	Undertorque *	The load torque reached the undertorque level during run.	• Check the load side. • Check that the undertorque detection setting is correct. <F651: Undertorque trip>, <F652: Undertorque detection level during power running>, <F653: Undertorque detection level during regen>, <F654: Undertorque detection time>, etc.
UtC3	0049	Undertorque/ Undercurrent *	Undertorque or undercurrent on the shock monitoring function was detected.	• Check the load. • When no problem is found, check if the shock monitoring function setting is correct. <F590: Shock monitoring> to <F598: Shock monitoring detection condition>

*Enable/Disable can be selected for trip with a parameter.

■ Alarm information

Alarm display	English	Detection factor	Measures
A-09	Panel disconnection alarm	The cable connecting the inverter and panel are disconnected during run with a run command from the operation panel and extension panel.	Check the connection on the inverter and panel.
A-17	Key failure alarm	• [RUN] or [STOP/RESET] key on the operation panel is pressed and hold for 20 seconds or more. • The operation panel key has failed.	Check the operation panel. If the failure occurs again, contact your Toshiba distributor.
A-18	Analog input disconnection alarm	The input level of the terminal [II] became the setting value or less of <F633: II analog input disconnection detection level> .	• Check that the signal line connected to the terminal [II] is not disconnected. • Check that the <F633> setting is correct.
A-43	Communication alarm (embedded Ethernet)	Condition very close to the communication time out trip.	Perform the same measures with communication time out "E-43".
COFF	Control power option alarm	1) Undervoltage on the control power supply input between [+SU] and [CC]. 2) The setting of <F647: Control power option failure detection> is improper.	1) Check the voltage on the control power supply input between [+SU] and [CC]. 20 Vdc or more is required. 2) When the control power supply option is not used, set <F647> = "0". *When [COFF] occurs, turn the power OFF once, and reset.
MOFF	Undervoltage alarm	The input voltage (power circuit) declined.	Check the input voltage. If no problem is found, internal error may be the issue. Contact your Toshiba distributor.

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Alarm display	English	Detection factor	Measures
PrA	STO activated	1) Open state between [STOA]/[STOB] and [PLC] terminal. 2) 24V output terminal [PLC]/[P24] overload. 3) SW1 is set on "PLC" position and an external power is not supplied.	1) Short circuit [STOA] - [STOB] - [PLC]. (By default, short circuit is done with a shorting bar). 2) Check 24V load. 3) Check SW1 position and external power supply.
t	Communication alarm (RS485, option)	Condition very close to the communication time out trip.	Perform the same measures with communication time out "Err5" and "Err8".
tUn1	Brake learning error	1) The load is heavy. 2) Parameter setting is improper. 3) Braking operation is abnormal.	1) Perform learning with no load or light load in approx. 3 % or less rating. 2) Set the motor parameters and learning related parameters in advance. 3) Check the brake.
tUn3	Light-load high-speed learning error	Setting of the motor parameter is improper.	Set the motor parameters according to the motor.

■ Pre-alarm information

Pre-alarm display	English	Detection factor	Measures
C	Overcurrent pre-alarm	Condition close to the overcurrent trip.	Perform the same measures with overcurrent "OC1", "OC2", and "OC3".
H	Overheat pre-alarm	Condition close to the overheat trip.	Perform the same measures with overheat "OH".
L	Motor overload pre-alarm	Condition close to the overload trip.	Perform the same measures with overload "OL1", "OL2", and "OL3".
P	Overvoltage pre-alarm	Condition close to the overvoltage trip.	Perform the same measures with overvoltage "OP1", "OP2", and "OP3".

■ Message information

Message display	English	Description	Remarks
A-01	V/f 5-point setting error 1	When <Pt:V/f Pattern> = "7: V/f 5-point setting", two or more from <vL>, <F190>, <F192>, <F194>, <F196> and <F198> are set to the same value other than 0.0 Hz.	Set different value on each parameter.
A-02	V/f 5-point setting error 2	Inclination of V/f is large.	• Set V/f 5-point and <vLv>/<vL> for the V/f inclination to be gentle. • Increase the value of <VL>, or decrease the value of <VLV>.
A-05	Base frequency setting error	Tries to run in frequency over 10 times of the base frequency.	• Check that the base frequency setting is correct. <vL: Base frequency 1>, etc. • Operate in frequency within 10 times of the base frequency.
ASIA	Setting for Asia	Setting for Asia is selected in the setup menu.	-
Atn	During auto tuning	Auto-tuning in progress.	A message that indicates auto-tuning in progress. No problem if the message disappears after several seconds.

Message display	English	Description	Remarks
CHn	Setting for China	Setting for China is selected in the setup menu.	-
CLr	Reset command acceptable	The following was operated after trip is occurring. 1) Pressed [STOP] key once. 2) Set the reset terminal ON. (During trip resetting operation)	Reset is performed with the following operation. 1) Press [STOP] key again. 2) Set the reset terminal OFF.
db	During DC braking	DC braking in progress.	-
dbOn	During motor shaft fixing	Motor shaft fixing in progress.	A message indicates the motor fixing control in progress. When standby is turned OFF, the control stops.
E1	Panel display one digit overflow	The display digit on the operation panel overflowed by one digit.	-
E2	Panel display two digits overflow	The display digit on the operation panel overflowed by two digits.	-
E3	Panel display three digits overflow	The display digit on the operation panel overflowed by three digits.	-
EASy	Easy mode	Switched to [Easy mode].	-
End	Last of data	The last data item in <History function>.	-
EOFF	Emergency off command acceptable	When a run command is other than the operation panel, [STOP/RESET] key was pressed once.	To apply emergency off, press [STOP] key again. If emergency off does not occur, press other keys.
Err1	Frequency point setting error	The setting on point 1 and point 2 of the frequency command is close.	Set apart point 1 and point 2 of the frequency command.
EU	Setting for Europe	Setting for Europe is selected in the setup menu.	-
FAIL	Password failure	Entered number in <F739: Password verification> does not match <F738: Password setting>.	-
FIrE	During Fire speed run/Forced run	Fire speed run/Forced run is in progress. ("FIrE" and the output frequency are alternately displayed)	A message indicates fire speed run/forced run in progress. It stops when turning the power OFF.
FJOG	Fwd JOG	Forward jog run in progress.	-
HEAd	Head of data	The first data item in <History function>.	-
HI	Upper limit of setting value	The upper limit of the setting value.	-
Init	During Initializing	• Set <tyP: Default setting> = "3" or "13" and initialization is in progress. • Region setting in progress with the setup menu.	No problem if the display shows "0.0" after several seconds.
JP	Setting for Japan	Setting for Japan is selected in the setup menu.	-
LO	Lower limit of setting value	The lower limit of the setting value.	-
LStP	During run sleep	Run sleep in progress.	-
n---	No detailed information of past trip	While "nErr" and a value are alternately displayed, [OK] key is pressed and detailed information are read.	Normal display.

Message display	English	Description	Remarks
nErr	No error	No trip records in the past trip history on [Monitor mode].	-
OFF	Standby OFF	The input terminal with assigned standby is OFF.	-
PASS	Password coincidence	Entered number in <F739: Password verification> matched <F738: Password setting>.	-
rJOG	Rev JOG	Reverse jog run in progress.	-
rtry	During Retry/Speed search	Retry/speed search in progress.	-
SEt	Region setting acceptable	• Display at first power on. • Display after setting <SEt> = "0".	Set a region to use in the setup menu.
Srvo	During servo lock	Servo lock in progress.	-
Std	Setting mode	Switched to [Setting mode].	-
StOP	During deceleration stop at power failure	Deceleration stop at power failure in progress.	A message indicates deceleration stop during power failure. The stop state is kept until the run command is turned OFF.
tUn	During learning	Learning the brake sequence or light-load high-speed operation in progress. ("tUn1" and the output frequency are alternately displayed)	-
tUn2	Light-load high-speed learning setting error	Error exists in learning operation.	Refer to Operation Manual, and perform learning operation.
U---	Waiting for search	Waiting for search condition in <Changed parameters search & edit>.	-
U--F	During forward search	Forward search in progress in <Changed parameters search & edit>.	-
Undo	All key unlocked	When "Locked" is set in <F737: Panel keys lockout>, pressed [OK] key for five seconds or more.	The key operation on the operation panel is temporarily valid.
U--r	During reverse search	Reverse search in progress in <Changed parameters search & edit>.	-
USA	Setting for North America	Setting for North America is selected in the setup menu.	-

13. 2 How to reset trip

Important

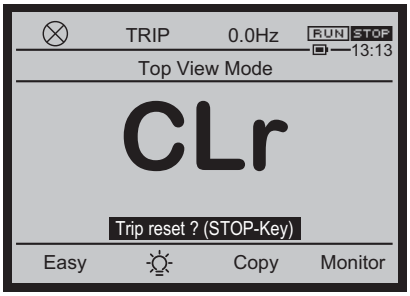
- Reset the inverter that has tripped after eliminating the cause of the trip.
  If it is not eliminated, the inverter will trip again even after reset. Pay enough attention.

The inverter can be reset with the following four methods after a trip occurs.

(1) Panel operation

You can reset from the operation panel even if terminal run or communication run is performed when the trip occurs.
The following is the reset procedure.

1 Press the [STOP/RESET] key with the trip displayed.
"CLr" blinks in the main area, and "Trip reset? (STOP-Key)" is displayed on the lower side.
- The backlight is red.
  (It is white when the setting of the backlight is changed.)



2 When you press the [STOP/RESET] key again while "CLr" is blinking, the trip is reset.
The display on the screen once disappears, and the screen immediately after power on is displayed.
The backlight returns to while.

(2) Terminal input (external signal)

Short the terminal [RES] and then open.
The inverter is reset when the terminal is opened.
In the default setting, the function "8: Reset 1" is assigned to the terminal [RES].
To reset with other input terminal, assignment of the reset function is required.

(3) Communication

For details, refer to "RS485 Communication Function Instruction Manual" (E6582143).

(4) Turning off power

Turn OFF the power and then turn it ON again.
When the power is off, some contents of the monitor at the time of the trip are lost.

To retain the contents of the monitor at the time of the trip, set <F602: Trip record retention> to "1: Retain at power off." Even after the inverter is reset with power off, the stored contents of the trip are displayed.
For details, refer to [6. 30. 3].

Important	• The inverter can be reset with power off, however, note that the equipment and the motor are damaged if the power is turned off frequently.

■ **When the inverter cannot be reset immediately after the trip**

1) For overload (inverter) "OL1", overload (motor) "OL2" and overload (braking resistor) "OLr", virtual cooling time is provided. During this time, the inverter cannot be reset by external signal or from the operation panel.

The reference virtual cooling time is as follows.
- "OL1": approximately 30 seconds after the occurrence of a trip
- "OL2": approximately 120 seconds after the occurrence of a trip
- "OLr": approximately 20 seconds after the occurrence of a trip

For overload (IGBT) "OL3", there is no virtual cooling time.

2) In case of overheat "OH", the inverter checks the temperature within. Wait until the temperature in the inverter falls sufficiently before resetting the inverter.

3) In case of overvoltage "OP1", "OP2" and "OP3", wait until the power circuit voltage decrease under the setting value of <F626: Overvoltage limit operation level>.

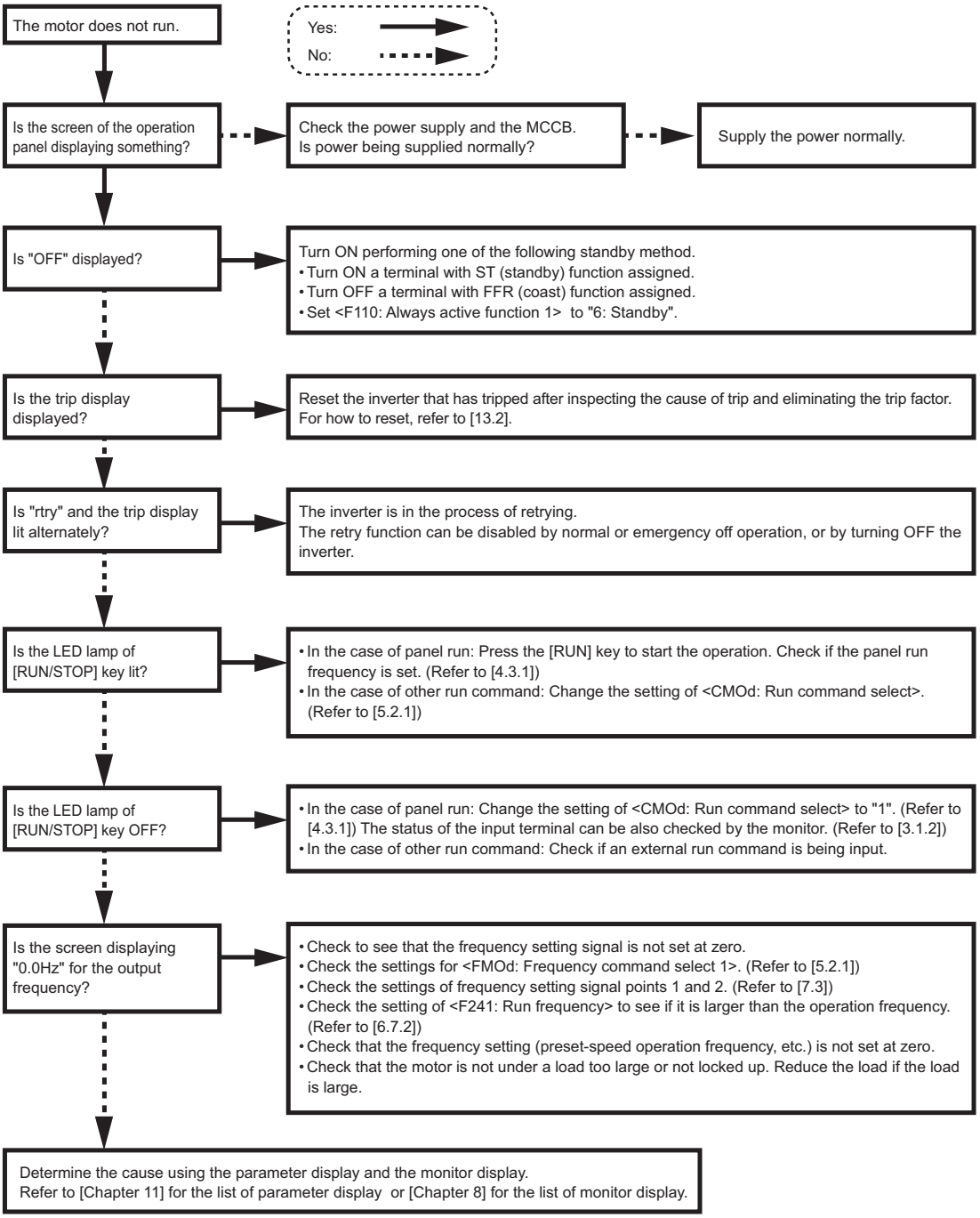
4) The inverter cannot be reset while the emergency off signal is being input to the input terminal.

5) The inverter cannot be reset while a pre-alarm occurs.

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13. 3 If motor does not run while no trip message is displayed

If the motor does not run while no trip message is displayed, follow these steps to track down the cause.



13. 4 How to determine causes of other problems

The following table provides a listing of other problems, their possible causes and measures.

Problems	Causes	Measures
The motor runs in the wrong direction.	- The phase sequence of the output terminals [U/T1], [V/T2] and [W/T3] is wrong.	- Invert the phases of the output terminals [U/T1], [V/T2] and [W/T3].
	- The Fwd/Rev run signals are input inversely in terminal run.	- Invert the Fwd/Rev run signal terminals of the external input device. (Refer to [7. 2])
	- The setting of <Fr: Panel Fwd/Rev run select> is incorrect in panel run.	- Change <Fr> setting.
The motor runs but its frequency does not change.	- The load is large.	- Reduce the load.
	- The overload stall function is activated.	- Disable the overload stall function OFF in <OLM: Motor overload protection characteristic>, and reduce the load (Refer to [5. 2. 5]).
	- <FH: Maximum frequency> and <UL: Upper limit frequency> are set too low.	- Increase the setting values of these parameters.
	- The value of analog signal in the frequency command is small.	- Check the value of the signal, circuit, wiring, etc.
		- Check the characteristics (point 1 and point 2 setting) of the analog signal. (Refer to [7. 3])
	- If the motor runs at a low speed, the torque boost value is too large.	- Check if an overcurrent alarm or overload alarm has occurred and adjust <vb: Manual torque boost 1> and <ACC: Acceleration time 1>. (Refer to [5. 3. 6] and [5. 2. 4])
The motor does not accelerate or decelerate smoothly.	- <ACC: Acceleration time 1> or <dEC: Deceleration time 1> is set too short.	- Increase the value of each parameter.
A too large current flows into the motor.	- The load is large.	- Reduce the load.
	- If the motor runs at a low speed, the torque boost value is too large.	- Check if the value of <vb: Manual torque boost 1> is too large. (Refer to [5. 3. 6])
The motor runs at a higher or lower speed than the specified one.	- The motor has an improper voltage rating.	- Use a motor with a proper voltage rating.
	- The motor terminal voltage is too low.	- Check the setting value of <vLv: Base frequency voltage 1>. (Refer to [5. 2. 2])
		- Change the wire size to large.
	- The reduction gear ratio, etc., are not set properly.	- Adjust the reduction gear ratio, etc.
	- The frequency command is not set correctly.	- Check the value and range of the frequency command.
		- Adjust <vL: Base frequency 1> to the motor. (Refer to [5. 2. 2])

Problems	Causes	Measures
The motor speed fluctuates during run.	- The load is large or small, and load fluctuation is large.	- Reduce the load fluctuation.
	- The inverter or motor used does not have a rating large enough to drive the load.	- Change the inverter and motor to large capacity.
	- The frequency command fluctuates.	- Check if the frequency command such as the analog signal changes.
	- Vector control is not performed properly when <Pt: V/f Pattern> is set to "3" or "9".	- Check the settings and conditions of the motor parameters and vector control. (Refer to [5. 3. 4])
Parameter settings cannot be changed.	- <F700: Parameter reading&writing access lockout> is set to "1" to "4" (Locked).	- Set <F700> to "0: Unlocked".
	- The password is set with <F738: Password setting>.	- Input the password to <F739: Password verification> to clear. (Refer to [6. 34. 1])
	- Input terminal functions: "200" to "203" (Parameter writing/reading locked) are assigned to one of the digital input terminals, and the input terminal is ON.	- Turn off the applicable input terminal.
	- For reasons of safety, some parameters cannot be changed during run.	- Refer to [6. 34. 1].

The following is how to deal with parameter setting-related problems.

Problems	Measures
You forget parameters which have been reset.	- You can search for all changed parameters and set. For details, refer to "Changed parameters search & edit <GrU>" in [4. 2. 1].
You want to return all changed parameters to their respective default settings.	- You can return all parameters to default settings. For details, refer to [5. 3. 9].

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14 Maintenance and inspection

⚠ WARNING

Mandatory action

- Perform daily inspection and periodic inspection on equipment.
  If you use the inappropriate inverter, not only will the three-phase motor not rotate correctly, but it will cause serious accidents such as overheating and burning out.
- Before inspection, perform the following steps.
  (1) Turn off the power to the inverter.
  (2) Wait at least 15 minutes and verify that the charge lamp is no longer lit.
  (3) Use a tester that can measure DC voltages (800 VDC or more), and verify that the voltage to the DC main circuits between [PA/+] and [PC/-] is 45V or less, and verify that the residual voltage of AC main circuits cable is 45V or less.
  Performing inspection without carrying out these steps can lead to electric shock.
  When using the PM motor, please verify that the PM motor is stopped. While the PM motor is rotating even after the power is turned off, as a high voltage is generated in the output terminals [U/T1], [V/T2] and [W/T3] on the PM motor side, touching the output terminals will result in electric shock.

To prevent a failure due to the influence of the operating environment such as temperature, humidity, dust, or vibration, or to aging or lives of the used parts, perform daily inspection and periodical inspection.

14. 1 Daily inspection and cleaning

The electronic parts are vulnerable to heat. Therefore, be sure to install the inverter in a well-ventilated, dust-free environment with low ambient temperature.
The purpose of the daily inspection is to maintain the environment and to find any sign of abnormal operation before a failure occurs by recording and comparing the operation data.

14. 1. 1 Checkpoints for daily inspection

Perform daily inspection according to the following items and table:

- Are any abnormalities found in the installation environment?
- Does the cooling system have any problems?
- Is unusual vibration or sound found?
- Is abnormal overheat or discoloration found?
- Is an unusual smell found?
- Is adhesion or accumulation of foreign substances (conductive substances) found?
- Is unusual vibration, sound, or overheat found in the motor?

Item to be inspected daily	Inspection procedure			Criteria and action
	Inspection item	Cycle	Check method	
Indoor environment	Dust	As required	Visual check	Eliminate any problems if any.
	Gas	As required	Smell check	
	Liquid drops such as water	As required	Visual check	Check for any trace of liquid.
	Room temperature	As required	Thermometer	Inverter ambient temperature: 60°C or less (Operation panel: 50°C or less)
Inverter unit and parts Peripheral devices	Vibration and noise	As required	Tactile check on the unit outer surface	• If any abnormalities are found in the inverter unit, check the cooling fans, etc. • Check the peripheral devices (transformers, reactors, magnetic contactors, thermal relays, etc.) for abnormality. Stop operation as required.
Operation data (output side)	Output current	As required	Moving-iron type AC Ammeter	• To be within the rating • No large difference is to be found compared to the data for normal operation.
	Output voltage*1	As required	Rectifier type AC voltmeter	
	Ambient temperature (at startup, during run, and at stop)	As required	Thermometer	

*1 The voltage value may vary depending on the measurement device used. Therefore, be sure to use the same voltmeter for inspection, and record the indicated values.

14. 1. 2 Daily cleaning

To clean the inverter, use a soft cloth to slightly wipe off the dirt or stains on the inverter surface.
If the dirt or stains persist, slightly wipe it off with a cloth dampened with neutral detergent or ethanol.

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Important

- Do not use the following chemicals and solvents. Failure to do so results in damaged inverter molded parts (unit, plastic covers, etc.) or peeled coating.
  - Acetone
  - Benzen
  - Chloroform
  - Ethylene chloride
  - Ethyl acetate
  - Glycerin
  - Tetrachloroethane
  - Trichloroethylene
  - Xylene

14. 2 Periodical inspection

Perform periodical inspection once every three to six months depending on the operating conditions.

⚠ WARNING

Mandatory action

- Before inspection, perform the following steps.
  (1) Turn off the power to the inverter.
  (2) Wait at least 15 minutes and verify that the charge lamp is no longer lit.
  (3) Use a tester that can measure DC voltages (800 VDC or more), and verify that the voltage to the DC main circuits between [PA/+] and [PC/-] is 45V or less, and verify that the residual voltage of AC main circuits cable is 45V or less.

  Performing inspection without carrying out these steps can lead to electric shock.
  When using the PM motor, please verify that the PM motor is stopped. While the PM motor is rotating even after the power is turned off, as a high voltage is generated in the output terminals [U/T1], [V/T2] and [W/T3] on the PM motor side, touching the output terminals will result in electric shock.

14. 2. 1 Checkpoints for periodical inspection

The periodical inspection items and check methods are shown in the following table.

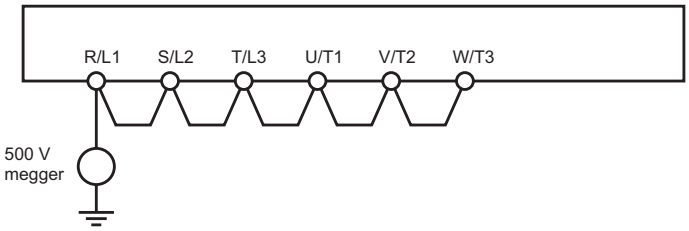
Periodical inspection item	Check method and action
Check the screw parts of the wiring terminals for looseness.	Tighten the screw parts of the wiring terminals with a screwdriver.
Check the caulked parts of the wiring terminals for any poor caulking.	Visually check the caulked parts for any trace of overheat.
Check the wiring for any damage.	Visual check
Clean dirt or dust.	Clean it with a vacuum cleaner.
Perform an insulation resistance test on the power terminal block.	Test only the power terminal block at 500 V mega to check that the insulation resistance is a few MΩ or more (the value is lower for the built-in noise filter models).
Check the input voltage and output voltage.	Periodically check the input-side voltage with a moving-iron type AC voltmeter (recommended).
	Periodically check the output-side voltage with a rectifier type AC voltmeter (recommended).
Check the ambient temperature.	Measure the ambient temperature of the inverter every time at startup, during run, and at stop.

■ Notes for periodical inspection

When you use a vacuum cleaner for cleaning, pay attention to the vents, printed circuit boards, etc. Keep in mind that adhesion of dirt or dust may result in an unexpected accident. Be sure to keep them dust free.

Perform an insulation resistance test of the power terminal block only on the inverter as shown in the following figure.

- Remove the power supply wiring connected to the power terminal block and the wiring to the motor.
- Wire each power terminal.



Also, remove the wiring of the power circuit output terminals [U/T1], [V/T2], and [W/T3], and perform an insulation resistance test only on the motor. When you perform an insulation resistance test on the peripheral circuits in the parts other than the motor, remove all the wiring connected to the inverter so that a test voltage will not be applied to the inverter.

Important

- Perform an insulation resistance test only on the power terminal block. Do not perform an insulation resistance test on the control terminals in the parts other than the power circuit, or on the circuit terminals mounted on the printed circuit board.
- Do not perform a dielectric test. Failure to do so may result in damaged internal parts.

14. 2. 2 Periodical inspection on the replacement parts

The inverter consists of a large number of electronic parts such as semiconductor devices. The following parts age because of the configurations or the physical properties. If they are left unused for a long time, the performance of the inverter will deteriorate, thus resulting in a failure. Be sure to perform periodical inspection for preventive maintenance.
For replacement of each replacement part, contact your Toshiba distributor. Do not replace the parts on your own for safety.

WARNING

Prohibited

- Do not replace parts.
  This will result in electric shock, fire and other injury. Please call your Toshiba distributor for repairs and replacement of expendable parts.

Important

- The replacement cycle of the parts are influenced by the ambient temperature and the use conditions. The replacement cycle of the parts listed here are based on the assumption that they will be used in an environment (without corrosive gas, oil mist, dust, and metal powder, etc.) at an ambient temperature within the specification.
- The design life expectancies and the standard replacement cycles do not warrant the lives.

■ Cooling fan inspection

The inspection items for the cooling fans are as follows:

- Are the cooling fans rotating stably?
- Is any unusual sound or vibration found?

The design life expectancies of the cooling fans that cool down the heat-generating parts are as follows:

VFAS3-2004P to 2550P,
VFAS3-4004PC to 4132KPC: Design life expectancy 10 years
VFAS3-4160KPC to 4280KPC: Design life expectancy 5 years (9 years for inner air fan)
* Average ambient temperature 40°C, load factor 80% or less, 24-hour operation per day

Also, replace the fans when unusual sound or vibration is found.
For replacement of the cooling fans, contact your Toshiba distributor.

■ Smoothing aluminum electrolytic capacitor inspection

The inspection items for the smoothing aluminum electrolytic capacitor are as follows:

- Is liquid leak found?
- Is the safety valve lifted?

The design life expectancy of the smoothing aluminum electrolytic capacitor is 10 years.
* Average ambient temperature 40°C, load factor 80% or less, 24-hour operation per day
For replacement of the smoothing aluminum electrolytic capacitor, contact your Toshiba distributor. The inverter unit may need to be replaced depending on the capacity because the smoothing aluminum electrolytic capacitor is mounted on the printed circuit board.

Memo	• You can check the parts replacement alarm and output signals in [Monitor mode]. For details, refer to [8. 1. 1]. • The design life expectancy of the smoothing aluminum electrolytic capacitor becomes shorter at high ambient temperature, and becomes longer at low ambient temperature.

■ **Standard replacement cycle of the other principal parts**

The estimated parts replacement cycles are shown in the following figure. They are based on the assumption that they will be used under normal use conditions (average ambient temperature of 40°C, load factor of 80% or less, 24-hour operation per day, with no corrosive gas, oil mist, dust, metal powder, etc. present). These replacement cycles are not the lives of the parts. They are based on the assumption that more parts will become abnormal when they are used over these cycles.

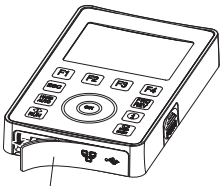
Part name	Standard replacement cycle*1	Replacement method
Relays	-	To be determined by inspection
Aluminum electrolytic capacitor on the printed circuit board	10 years *2	Replace with a new one. (To be determined by inspection)
Battery CR2032 *3 (used in the operation panel)	The remaining capacity of the battery is indicated into the LCD screen with icons (see 3. 1. 2)	Replace with a new one.

*1 The replacement cycles greatly vary depending on the operating environment.
*2 It is based on the case where the inverter output current is 80% of the inverter rated current.
*3 Use CR2032EC (Toshiba).

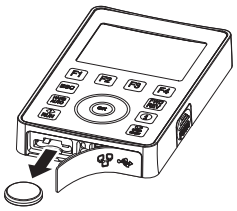
14. 2. 3 How to replace the battery

1 Remove the operation panel from the inverter. Refer to [10. 3. 8]

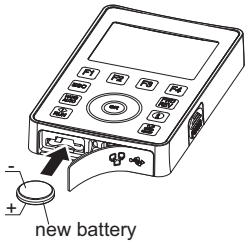
2 Open the slot cover at bottom (left side) of operation panel



3 Eject the battery by using insulated tool (to avoid short-circuit by remaining charge)
For disposal of battery, see [16]



4 Insert new battery, at that time take care the polarity.



5 Close the slot cover
Then, clock setting is needed, because the clock is not kept by replacing the battery
Refer to E6582110 for setting.

14

14. 3 In case of a failure

Should a failure occurs, contact your Toshiba distributor. Before contact, check the information on the name plate attached on the right side of the inverter unit, and presence or absence of the optional parts to inform the distributor of them as well as inverter problems.

14. 4 Cautions for storage

If you store the inverter temporarily or for a long time after purchase, follow the instructions below.

(1) Storage location

Store the inverter indoors. Avoid to be exposed to direct sunlight, corrosive, explosive or flammable gases, salt, oil mist, dust, metal powder, vapor or condensation.
Storage temperature and Relative humidity are shown in the table below.

(2) Periodical check

If no power is supplied to the inverter for a long time, the performance of its main circuit smoothing aluminum electrolytic capacitor declines.
When leaving the inverter unused for a long time, energize it for an hour or more each without load in accordance with the table below, to recover the performance of the electrolytic capacitor. Then check the function of the inverter.

	Storage temperature [°C]	Relative humidity	how to recover the performance of the electrolytic capacitor
Short-term Storage (within one month such as during transportation)	-25 to 70	within 95%	Supplying power without load is not required.
Long-term Storage (exceeding one month)	-10 to 40	within 90%	Supply power once every two years for an hour or more.

15 Warranty

Any part of the inverter that proves defective will be repaired and adjusted free of charge under the following conditions:

(1) This warranty applies only to the inverter main unit.

(2) Any part of the inverter which fails or is damaged under normal use within twelve months from the date of delivery shall be repaired free of charge.

(3) For the following kinds of failure or damage, the repair cost shall be borne by the customer even within the warranty period.

- Failure or damage caused by improper or incorrect use or handling, or unauthorized repair or modification of the inverter
- Failure or damage caused by the inverter falling or an accident during transportation after the purchase
- Failure or damage caused by fire, salty damage, corrosive gas, earthquake, storm or flood, lightning, abnormal voltage supply, or other natural disasters
- Failure or damage caused by the use of the inverter for any purpose or application other than the intended one

(4) All expenses incurred by Toshiba for on-site services shall be charged to the customer, unless a service contract is signed beforehand between the customer and Toshiba, in which case the service contract has priority over this warranty.

16 Disposal

⚠ CAUTION

Mandatory action

- If you dispose of the inverter, have it done by a specialist in industry waste disposal.*1
  If you dispose of the inverter by yourself, this can result in explosion of capacitor or production of noxious gases, resulting in injury.
- When you dispose of the operation panel, insulate the terminals of the lithium battery by wrapping the terminals with tapes.
  If the terminals contact with other metal or batteries, this will result in heat rising up, explosion, and fire.

*1 Persons who specialize in the processing of waste and known as “industrial waste product collectors and transporters” or “industrial waste disposal persons”. Please observe any applicable law, regulation, rule or ordinance for industrial waste disposal.

When you dispose of your old inverter, ask a specialist in industry waste disposal.
Failure to do so results in injuries due to an explosion of the capacitor or generation of noxious gas.
Also, when you dispose of the operation panel, wrap the terminals of the lithium battery with tape, etc. to insulate it. If the terminals come in contact with other metal parts or batteries, heat generation, an explosion, or firing may occur.

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SIEMENS

SIMATIC

S7
S7-1200 Programmable controller

System Manual

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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

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The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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Preface

Purpose of the manual

The S7-1200 series is a line of programmable logic controllers (PLCs) that can control a variety of automation applications. Compact design, low cost, and a powerful instruction set make the S7-1200 a perfect solution for controlling a wide variety of applications. The S7-1200 models and the Windows-based programming tool give you the flexibility you need to solve your automation problems.

This manual provides information about installing and programming the S7-1200 PLCs and is designed for engineers, programmers, installers, and electricians who have a general knowledge of programmable logic controllers.

Required basic knowledge

To understand this manual, it is necessary to have a general knowledge of automation and programmable logic controllers.

Scope of the manual

This manual is valid for STEP 7 Basic V10.5 and the S7-1200 product family. For a complete list of the S7-1200 products described in this manual, refer to the technical specifications (Page 279).

Certification, CE label, C-Tick, and other standards

Refer to the technical specifications (Page 279) for more information.

Service and support

In addition to our documentation, we offer our technical expertise on the Internet at:

http://www.siemens.com/automation/support-request

Contact your Siemens distributor or sales office for assistance in answering any technical questions, for training, or for ordering S7 products. Because your sales representatives are technically trained and have the most specific knowledge about your operations, process and industry, as well as about the individual Siemens products that you are using, they can provide the fastest and most efficient answers to any problems you might encounter.

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Product overview

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1.1 Introducing the S7-1200 PLC

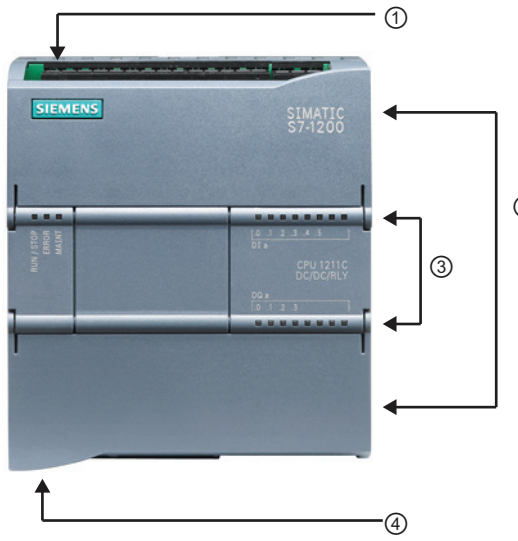
The S7-1200 programmable logic controller (PLC) provides the flexibility and power to control a wide variety of devices in support of your automation needs. The compact design, flexible configuration, and powerful instruction set combine to make the S7-1200 a perfect solution for controlling a wide variety of applications.

The CPU combines a microprocessor, an integrated power supply, input circuits, and output circuits in a compact housing to create a powerful PLC. After you download your program, the CPU contains the logic required to monitor and control the devices in your application. The CPU monitors the inputs and changes the outputs according to the logic of your user program, which can include Boolean logic, counting, timing, complex math operations, and communications with other intelligent devices.

Several security features help protect access to both the CPU and the control program:

- Every CPU provides password protection that allows you to configure access to the CPU functions.
- You can use "know-how protection" to hide the code within a specific block. See the "Programming concepts" (Page 89) chapter for details.

The CPU provides a PROFINET port for communication over a PROFINET network. Communication modules are available for communicating over RS485 or RS232 networks.



① Power connector
② Removable user wiring connectors (behind the doors)
② Memory card slot under top door
③ Status LEDs for the on-board I/O
④ PROFINET connector (on the bottom of the CPU)

The different CPU models provide a diversity of features and capabilities that help you create effective solutions for your varied applications. For detailed information about a specific CPU, see the technical specifications (Page 279).

Feature	CPU 1211C	CPU 1212C	CPU 1214C
Physical size (mm)	90 x 100 x 75		110 x 100 x 75
User memory • Work memory • Load memory • Retentive memory	 • 25 Kbytes • 1 Mbyte • 2 Kbytes		 • 50 Kbytes • 2 Mbytes • 2 Kbytes
Local on-board I/O • Digital • Analog	 • 6 inputs/4 outputs • 2 inputs	 • 8 inputs/6 outputs • 2 inputs	 • 14 inputs/10 outputs • 2 inputs
Process image size	1024 bytes inputs (I) and 1024 bytes outputs (Q)		
Bit memory (M)	4096 bytes		8192 bytes
Signal modules expansion	None	2	8
Signal board	1		
Communication modules	3 (left-side expansion)		
High-speed counters • Single phase • Quadrature phase	3 • 3 at 100 kHz • 3 at 80 kHZ	4 • 3 at 100 kHz 1 at 30 kHz • 3 at 80 kHz 1 at 20 kHz	6 • 3 at 100 kHz 3 at 30 kHz • 3 at 80 kHz 3 at 20 kHz
Pulse outputs	2		
Memory card	SIMATIC Memory card (optional)		
Real time clock retention time	10 days, typical / 6 day minimum at 40 degrees C.		
PROFINET	1 Ethernet communications port		
Real math execution speed	18 µs/instruction		
Boolean execution speed	0.1 µs/instruction		

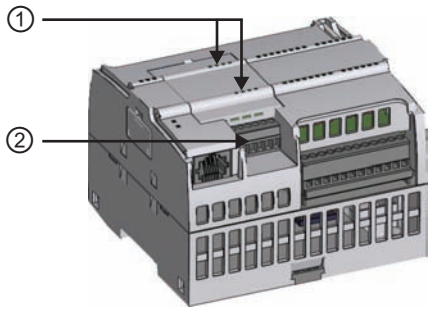
The S7-1200 family provides a variety of signal modules and signal boards for expanding the capabilities of the CPU. You can also install additional communication modules to support other communication protocols. For detailed information about a specific module, see the technical specifications (Page 279).

Module		Input only	Output only	Combination in/out
Signal module (SM)	Digital	8 x DC In	8 x DC Out 8 x Relay Out	8 x DC In/8 x DC Out 8 x DC In/8 x Relay Out
		16 x DC In	16 x DC Out 16 x Relay Out	16 x DC In/16 x DC Out 16 x DC In/16 x Relay Out
	Analog	4 x Analog In 8 x Analog In	2 x Analog Out 4 x Analog Out	4 x Analog In/2 x Analog Out
Signal board (SB)	Digital	-	-	2 x DC In/2 x DC Out
	Analog	-	1 x Analog Out	-
Communication module (CM) • RS485 • RS232				

1.2 Signal boards

A signal board (SB) allows you to add I/O to your CPU. You can add one SB with either digital or analog I/O. An SB connects on the front of the CPU.

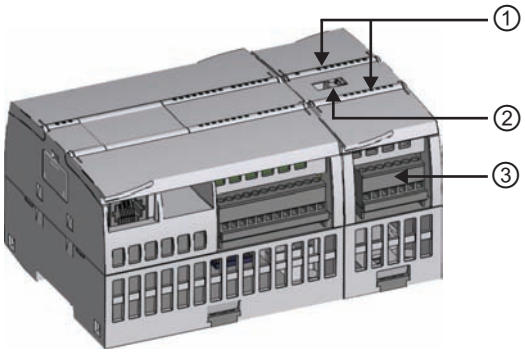
- SB with 4 digital I/O (2 x DC inputs and 2 x DC outputs)
- SB with 1 analog output



① Status LEDs on the SB
② Removable user wiring connector

1.3 Signal modules

You can use signal modules to add additional functionality to the CPU. Signal modules connect to the right side of the CPU.

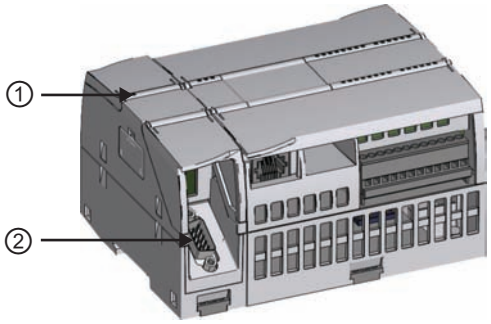


① Status LEDs for the I/O of the signal module
② Bus connector
③ Removable user wiring connector

1.4 Communication modules

The S7-1200 family provides communication modules (CMs) for additional functionality to the system. There are two communication modules: RS232 and RS485.

- The CPU supports up to 3 communication modules
- Each CM connects to the left side of the CPU (or to the left side of another CM)



① Status LEDs for the communication module
② Communication connector

1.5 STEP 7 Basic

The STEP 7 Basic software provides a user-friendly environment to develop, edit, and monitor the logic needed to control your application, including the tools for managing and configuring all of the devices in your project, such as PLCs and HMI devices. STEP 7 Basic provides two programming languages (LAD and FBD) for convenience and efficiency in developing the control program for your application, and also provides the tools for creating and configuring the HMI devices in your project.

To help you find the information you need, STEP 7 Basic provides an extensive online help system.

To install STEP 7 Basic, insert the CD into the CD-ROM drive of your computer. The installation wizard starts automatically and prompts you through the installation process. Refer to the Readme file for more information.

Note

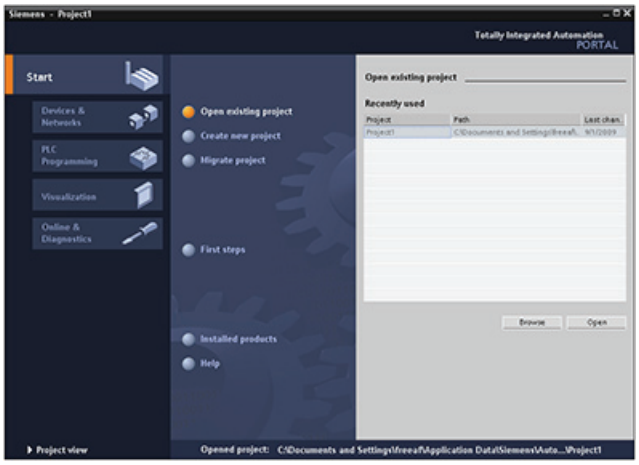
To install the STEP 7 Basic software on a PC running Windows 2000, Windows XP, or Windows Vista operating system, you must log in with Administrator privileges.

1.5.1 Different views to make the work easier

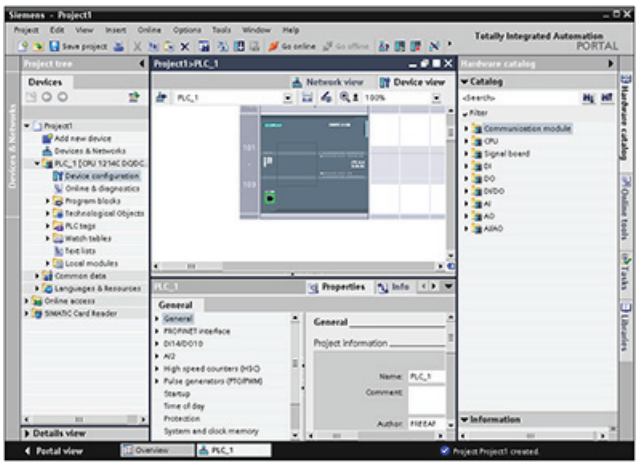
To help increase your productivity, the Totally Integrated Automation Portal provides two different views of the toolset: a task-oriented set of portals that are organized on the functionality of the tools (Portal view), or a project-oriented view of the elements within the project (Project view). Choose which view helps you work most efficiently. With a single click, you can toggle between the Portal view and the Project view.

The Portal view provides a functional view of the project tasks and organizes the functions of the tools according to the tasks to be accomplished, such as creating the configuration of the hardware components and networks.

You can easily determine how to proceed and which task to choose.



The Project view provides access to all of the components within a project. With all of these components in one place, you have easy access to every aspect of your project. The project contains all of the elements that have been created or completed.



1.5.2 Help when you need it

Finding answers to your questions quickly

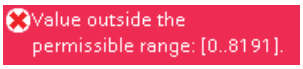
To help you resolve issues quickly and efficiently, STEP 7 Basic provides intelligent point-of-need assistance:

- An entry field provides "rollout" help to assist you with entering the correct information (valid ranges and type of data) for that field. For example, if you were to enter an invalid value, a message text box would roll out to provide the range of valid values.
- Some of the tool tips in the interface (such as for the instructions) "cascade" to provide additional information. Some of the cascading tool tips link to specific topics in the online information system (online help).

In addition, STEP 7 Basic has a comprehensive information system that fully describes the functionality of the SIMATIC tools.

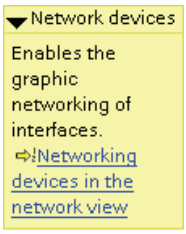
Rollout help and cascading tool tips

Entry fields of various dialogs and task cards provide feedback in the form of a message box that rolls out and informs you about the range or types of data required.



The elements of the software interface provide tool tips to explain the functionality of the element. Some of the elements, such as the "Open" or "Save" icons, require no additional information. However, some of the elements provide a mechanism for displaying additional description about the element. This additional information "cascades" in a box from the tool tip. (A black triangle alongside the tool tip signifies that more information is available.)

Hovering over an element of the software interface displays the tool tip. To display additional information, simply hover your cursor over the tool tip. Some of the cascading tool tips also provide links to related topics in the information system. Clicking the link displays the specific topic.



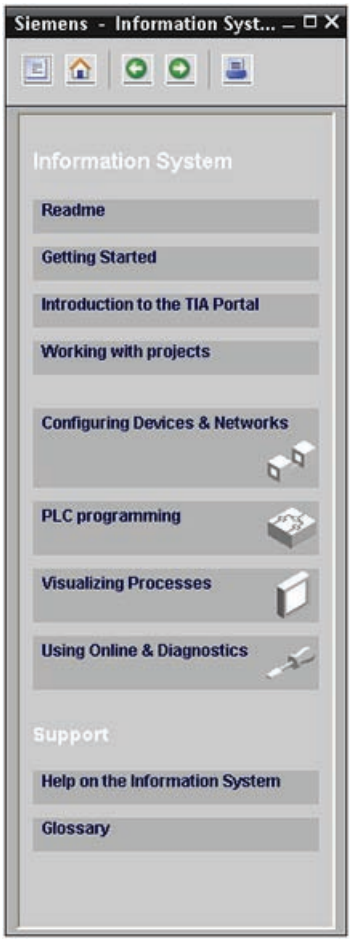
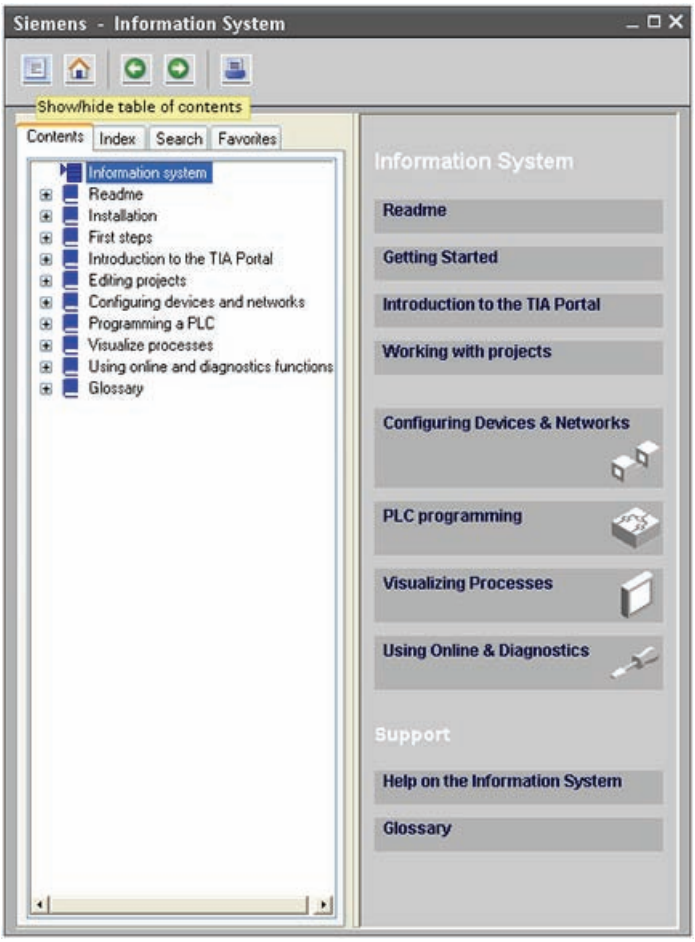
Information system

STEP 7 Basic provides a comprehensive online information and help system that describes all of the SIMATIC products that you have installed. The information system also includes reference information and examples. To display the information system, choose from the following access points:

- From the Portal view, select the Start portal and click the "Help" command.
- From the Project view, select the "Show help" command in the "Help" menu.
- From a cascading tool tip, click a link to display more information about that topic.

The information system opens in a window that does not obscure the work areas.

Click the "Show/hide contents" button on the information system to display the contents and undock the help window. You can then resize the help window. Use the "Contents" or "Index" tabs to search through the information system by topic or by key word.

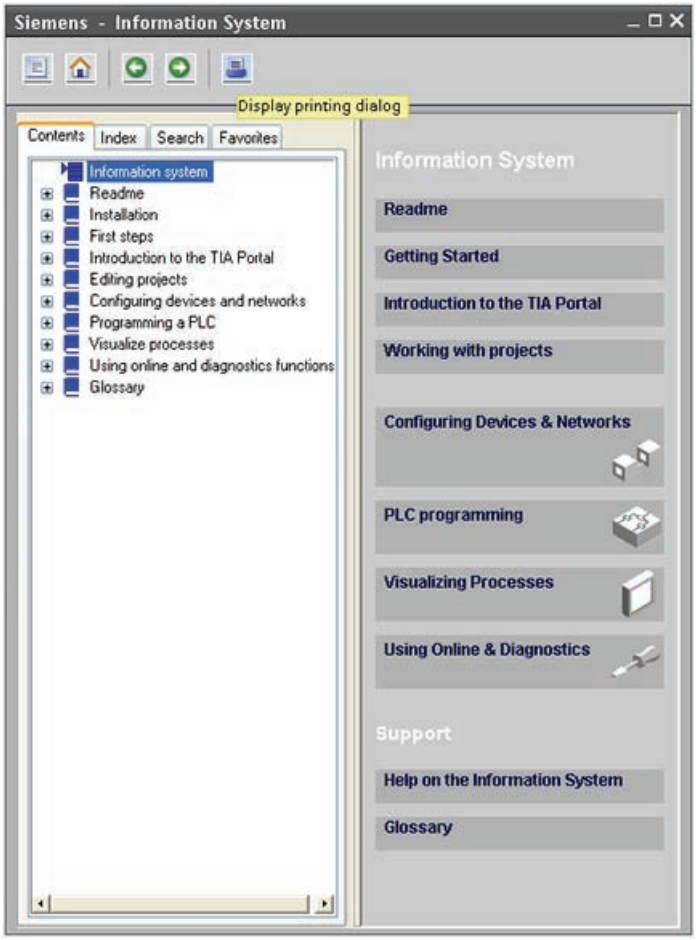
Help window (default)	Help window with contents displayed
	

Note

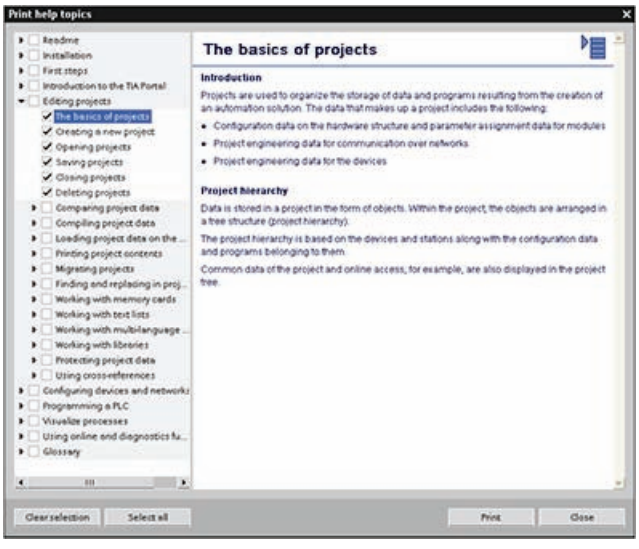
If STEP 7 Basic is maximized, clicking the "Show/hide contents" button does not undock the help window. Click the "Restore down" button to undock the help window. You can then move and resize the help window.

Printing topics from the information system

To print from the information system, click the "Print" button on the help window.



To print from the information system, click the "Print" button on the help window.



The "Print" dialog allows you to select the topics to print. Make certain that the panel displays a topic. You can then select any other topic to print. Click the "Print" button to send the selected topics to your printer.

1.6 Display panels

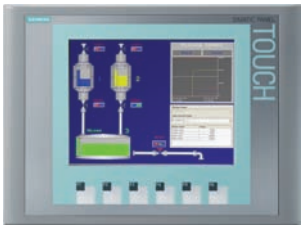
As visualization becomes a standard component for most machine designs, the SIMATIC HMI Basic Panels provide touch-screen devices for basic operator control and monitoring tasks. All panels are have a protection rating for IP65 and have CE, UL, cULus, and NEMA 4x certification.



KTP 400 Basic PN

- Mono (STN, gray scale)
- 4" touch screen with 4 tactile keys
- Portrait or landscape
- Size: 3.8"
- Resolution: 320 x 240

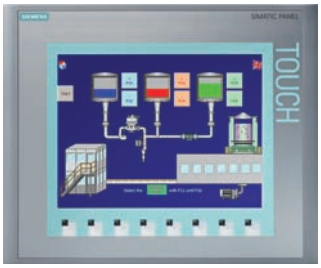
- 128 tags
- 50 process screens
- 200 alarms
- 25 curves
- 32 KB recipe memory
- 5 recipes, 20 data records, 20 entries



KTP 600 Basic PN

- Color (TFT, 256 colors) or Mono (STN, gray scales)
- 6" touch screen with 6 tactile keys
- Portrait or landscape
- Size: 5.7"
- Resolution: 320 x 240

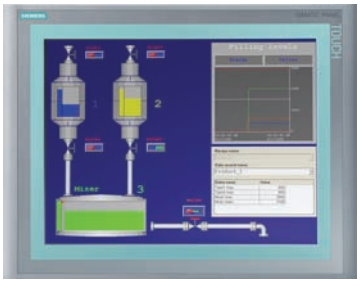
- 128 tags
- 50 process screens
- 200 alarms
- 25 curves
- 32 KB recipe memory
- 5 recipes, 20 data records, 20 entries



KTP1000 Basic PN

- Color (TFT, 256 colors)
- 10" touch screen with 8 tactile keys
- Size: 10.4"
- Resolution: 640 x 480

- 256 tags
- 50 process screens
- 200 alarms
- 25 curves
- 32 KB recipe memory
- 5 recipes, 20 data records, 20 entries



TP1500 Basic PN

- Color (TFT, 256 colors)
- 15" touch screen
- Size: 15.1"
- Resolution: 1024 x 768

- 256 tags
- 50 process screens
- 200 alarms
- 25 curves
- 32 KB recipe memory (integrated flash)
- 5 recipes, 20 data records, 20 entries

Installation

2

The S7-1200 equipment is designed to be easy to install. You can install an S7-1200 either on a panel or on a standard rail, and you can orient the S7-1200 either horizontally or vertically. The small size of the S7-1200 allows you to make efficient use of space.

⚠ WARNING

The SIMATIC S7-1200 PLCs are Open Type Controllers. It is required that you install the S7-1200 in a housing, cabinet, or electric control room. Entry to the housing, cabinet, or electric control room should be limited to authorized personnel.

Failure to follow these installation requirements could result in death, severe personal injury and/or property damage.

Always follow these requirements when installing S7-1200 PLCs.

Separate the S7-1200 devices from heat, high voltage, and electrical noise

As a general rule for laying out the devices of your system, always separate the devices that generate high voltage and high electrical noise from the low-voltage, logic-type devices such as the S7-1200.

When configuring the layout of the S7-1200 inside your panel, consider the heat-generating devices and locate the electronic-type devices in the cooler areas of your cabinet. Reducing the exposure to a high-temperature environment will extend the operating life of any electronic device.

Consider also the routing of the wiring for the devices in the panel. Avoid placing low-voltage signal wires and communications cables in the same tray with AC power wiring and high-energy, rapidly-switched DC wiring.

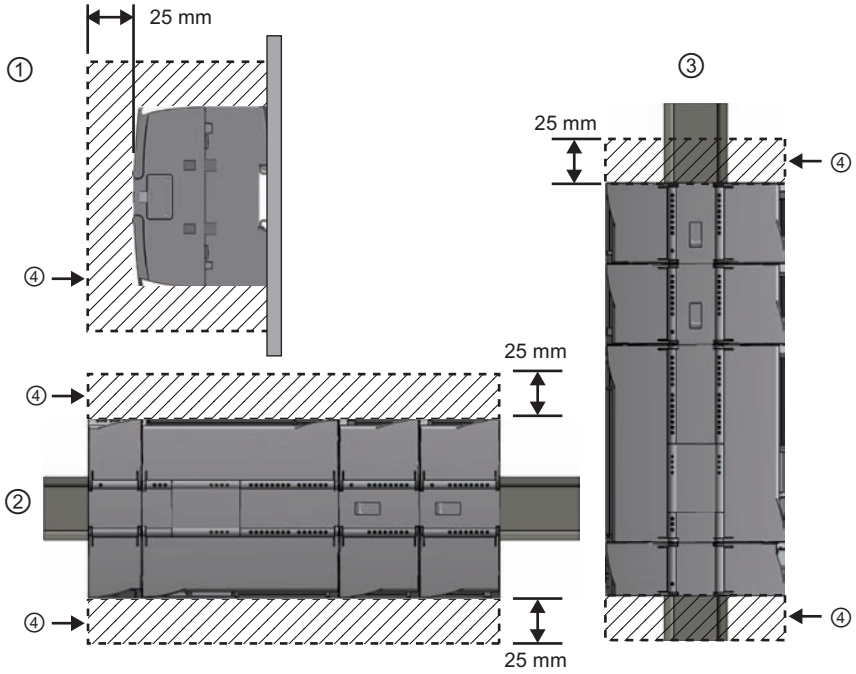
Provide adequate clearance for cooling and wiring

S7-1200 devices are designed for natural convection cooling. For proper cooling, you must provide a clearance of at least 25 mm above and below the devices. Also, allow at least 25 mm of depth between the front of the modules and the inside of the enclosure.

⚠ CAUTION

For vertical mounting, the maximum allowable ambient temperature is reduced by 10 degrees C. Orient a vertically mounted S7-1200 system so that the CPU is at the low end of the assembly.

When planning your layout for the S7-1200 system, allow enough clearance for the wiring and communications cable connections.



①	Side view	③	Vertical installation
②	Horizontal installation	④	Clearance area

Power budget

Your CPU has an internal power supply that provides power for the CPU, the signal modules, signal board and communication modules and for other 24 VDC user power requirements.

Refer to the technical specifications (Page 279) for information about the 5 VDC logic budget supplied by your CPU and the 5 VDC power requirements of the signal modules, signal board, and communication modules. Refer to the "Calculating a power budget" (Page 321) to determine how much power (or current) the CPU can provide for your configuration.

The CPU provides a 24 VDC sensor supply that can supply 24 VDC for input points, for relay coil power on the signal modules, or for other requirements. If your 24 VDC power requirements exceed the budget of the sensor supply, then you must add an external 24 VDC power supply to your system. Refer to the technical specifications (Page 279) for the 24 VDC sensor supply power budget for your particular S7-1200 CPU.

If you require an external 24 VDC power supply, ensure that the power supply is not connected in parallel with the sensor supply of the CPU. For improved electrical noise protection, it is recommended that the commons (M) of the different power supplies be connected.

⚠ WARNING

Connecting an external 24 VDC power supply in parallel with the 24 VDC sensor supply can result in a conflict between the two supplies as each seeks to establish its own preferred output voltage level.

The result of this conflict can be shortened lifetime or immediate failure of one or both power supplies, with consequent unpredictable operation of the PLC system. Unpredictable operation could result in death, severe personal injury and/or property damage.

The DC sensor supply and any external power supply should provide power to different points.

Some of the 24 VDC power input ports in the S7-1200 system are interconnected, with a common logic circuit connecting multiple M terminals. For example, the following circuits are interconnected when designated as "not isolated" in the data sheets: the 24 VDC power supply of the CPU, the power input for the relay coil of an SM, or the power supply for a non-isolated analog input. All non-isolated M terminals must connect to the same external reference potential.

⚠ WARNING

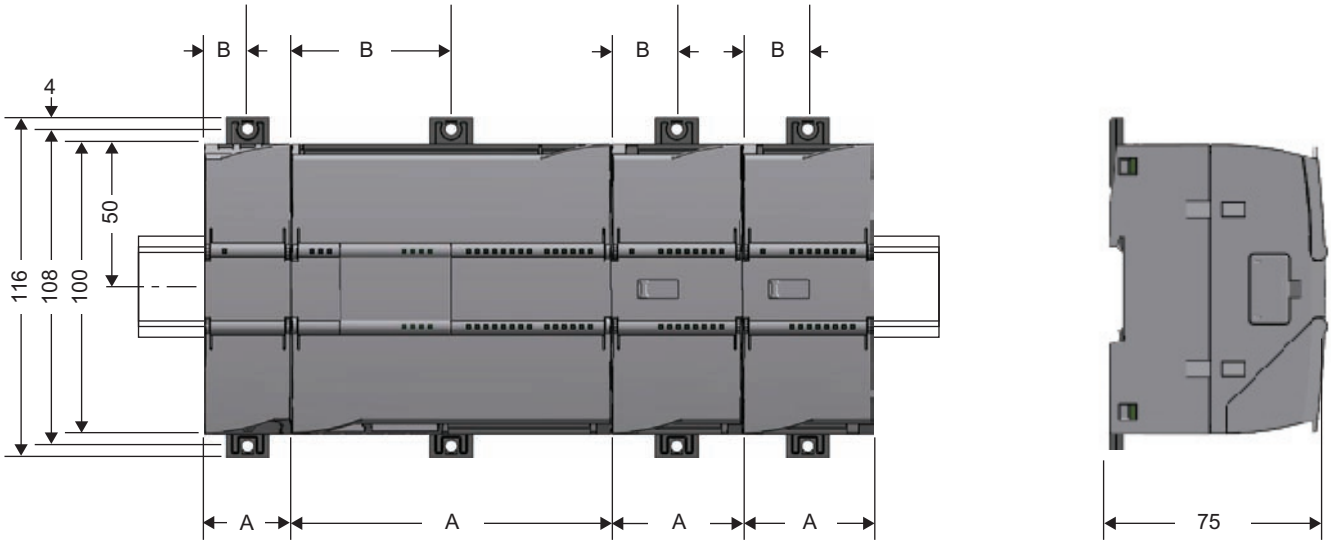
Connecting non-isolated M terminals to different reference potentials will cause unintended current flows that may cause damage or unpredictable operation in the PLC and any connected equipment.

Failure to comply with these guidelines could cause damage or unpredictable operation which could result in death or serve personal injury and/or property damage.

Always ensure that all non-isolated M terminals in an S7-1200 system are connected to the same reference potential.

2.2 Installation and removal procedures

Mounting dimensions (mm)



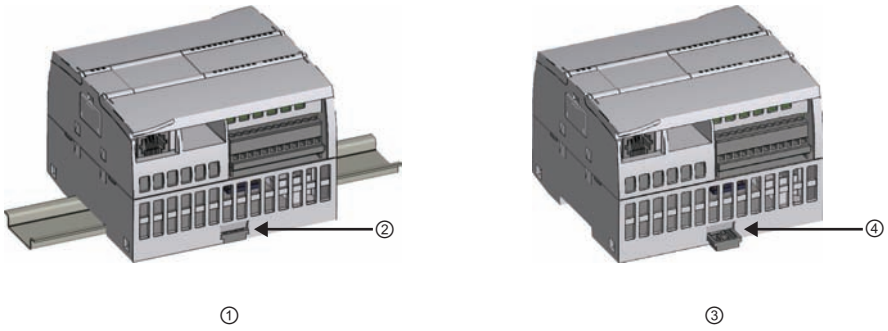
S7-1200 Devices		Width A	Width B
CPUs:	CPU 1211C and CPU 1212C	90 mm	45 mm
	CPU 1214C	110 mm	55 mm
Signal modules:	8 and 16 point DC and Relay (8I, 16I, 8Q, 16Q, 8I/8Q) Analog (4AI, 8AI, 4AI/4AQ, 2AQ, 4AQ)	45 mm	22.5 mm
	16I/16Q Relay (16I/16Q)	70 mm	35 mm
Communication modules:	CM 1241 RS232 and CM 1241 RS485	30 mm	15 mm

The CPUs, SMs and CMs support DIN rail mounting and panel mounting. Use the DIN rail clips on the module to secure the device on the rail. These clips also snap into an extended position to provide screw mounting positions to mount the unit directly on a panel. The interior dimension of the hole for the DIN clips on the device is 4.3 mm.

A 25 mm thermal zone must be provided above and below the unit for free air circulation.

Installing and removing the S7-1200 devices

The CPU can be easily installed on a standard DIN rail or on a panel. DIN rail clips are provided to secure the device on the DIN rail. The clips also snap into an extended position to provide a screw mounting position for panel-mounting the unit.



① ③

① DIN rail installation
② DIN rail clip in latched position
③ Panel installation
④ Clip in extended position for panel mounting

Before you install or remove any electrical device, ensure that the power to that equipment has been turned off. Also, ensure that the power to any related equipment has been turned off.

⚠ WARNING

Installation or removal of S7-1200 or related equipment with the power applied could cause electric shock or unexpected operation of equipment.

Failure to disable all power to the S7-1200 and related equipment during installation or removal procedures could result in death, severe personal injury and/or property damage due to electric shock or unexpected equipment operation.

Always follow appropriate safety precautions and ensure that power to the S7-1200 is disabled before attempting to install or remove S7-1200 CPUs or related equipment.

Always ensure that whenever you replace or install an S7-1200 device you use the correct module or equivalent device.

⚠ WARNING

Incorrect installation of an S7-1200 module may cause the program in the S7-1200 to function unpredictably.

Failure to replace an S7-1200 device with the same model, orientation, or order could result in death, severe personal injury and/or property damage due to unexpected equipment operation.

Replace an S7-1200 device with the same model, and be sure to orient and position it correctly.

2.2.1 Installing and removing the CPU

Installation

You can install the CPU on a panel or on a DIN rail.

Note

Attach any communication modules to the CPU and install the assembly as a unit. Install signal modules separately after the CPU has been installed.

To mount the CPU on a panel, follow these steps:

1. Locate, drill, and tap the mounting holes (M4 or American Standard number 8), using the dimensions shown in the mounting dimensions.
2. Extend the mounting clips from the module. Make sure the DIN rail clips on the top and bottom of the CPU are in the extended position.
3. Secure the module to the panel, using screws placed into the clips.

Note

If your system is subject to a high vibration environment, or is mounted vertically, panel mounting the S7-1200 will provide a greater level of protection.

To install the CPU on a DIN rail, follow these steps:

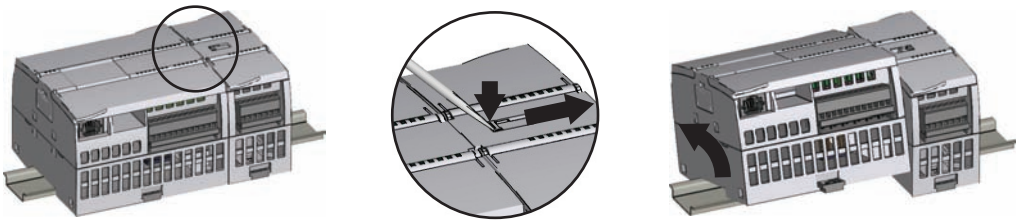




1. Install the DIN rail. Secure the rail to the mounting panel every 75 mm.
2. Hook the CPU over the top of the DIN rail.
3. Pull out the DIN rail clip on the bottom of the CPU to allow the CPU to fit over the rail.
4. Rotate the CPU down into position on the rail.
5. Push in the clips to latch the CPU to the rail.

Removal

To prepare the CPU for removal, remove power from the CPU and disconnect the I/O connectors, wiring, and cables from the CPU. Remove the CPU and any attached communication modules as a unit. All signal modules should remain installed.



If a signal module is connected to the CPU, retract the bus connector:

1. Place a screwdriver beside the tab on the top of the signal module.
2. Press down to disengage the connector from the CPU.
3. Slide the tab fully to the right.

Remove the CPU:

1. Pull out the DIN rail clip to release the CPU from the rail.
2. Rotate the CPU up and off the rail, and remove the CPU from the system.

2.2.2 Installing and removing a signal module

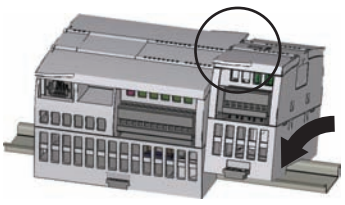
Installation

Install your SM after installing the CPU.



Remove the cover for the connector from the right side of the CPU.

- Insert a screwdriver into the slot above the cover.
- Gently pry the cover out at its top and remove the cover. Retain the cover for reuse.



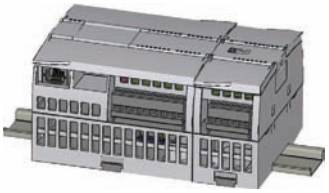
Position the SM beside the CPU.

1. Hook the SM over the top of the DIN rail.
2. Pull out the bottom DIN rail clip to allow the SM to fit over the rail.
3. Rotate the SM down into position beside the CPU and push the bottom clip in to latch the SM onto the rail.



Extend the bus connector.

1. Place a screwdriver beside the tab on the top of the SM.
2. Slide the tab fully to the left to extend the bus connector into the CPU.



Extending the bus connector makes both mechanical and electrical connections for the SM.

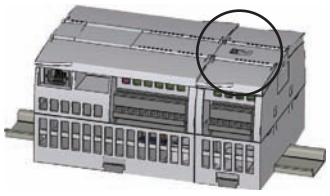
Follow the same procedure to install a signal module to a signal module.

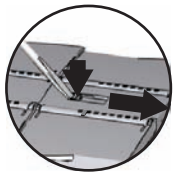
Removal

You can remove any SM without removing the CPU or other SMs in place. To prepare for removing the SM, remove power from the CPU and remove the I/O connectors and wiring from the SM.

Retract the bus connector.

1. Place a screwdriver beside the tab on the top of the SM.
2. Press down to disengage the connector from the CPU.
3. Slide the tab fully to the right.

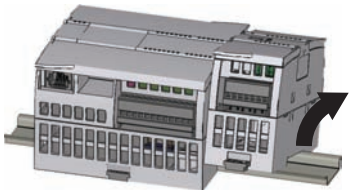




If there is another SM to the right, repeat this procedure for that SM.

Remove the SM:

1. Pull out the bottom DIN rail clip to release the SM from the rail.
2. Rotate the SM up and off the rail. Remove the SM from the system.
3. If required, cover the bus connector on the CPU to avoid contamination.



Follow the same procedure to remove a signal module from a signal module.

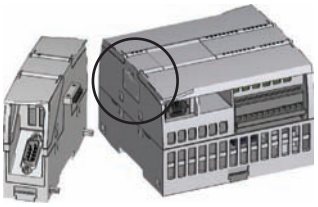
2.2.3 Installing and removing a communication module

Installation

Attach the CM to the CPU before installing the assembly as a unit to the DIN rail or panel.

Remove the bus cover from the left side of the CPU:

1. Insert a screwdriver into the slot above the bus cover.
2. Gently pry out the cover at its top.

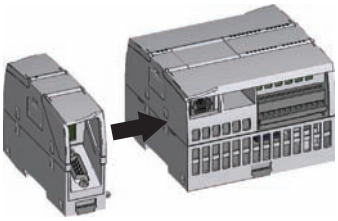


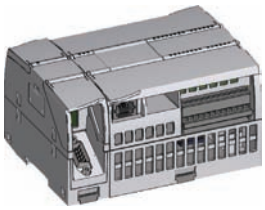


Remove the bus cover. Retain the cover for reuse.

Connect the units:

1. Align the bus connector and the posts of the CM with the holes of the CPU
2. Firmly press the units together until the posts snap into place.





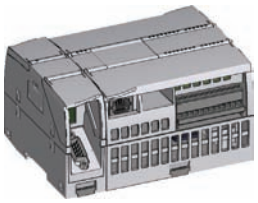
Installing the units on the DIN rail or on a panel.

1. For DIN rail mounting, make sure the upper DIN rail clip is in the latched (inner) position and that the lower DIN rail clip is in the extended position for the CPU and attached CMs.
2. Install the CPU and attached CMs as shown in Installing and removing the CPU (Page 26).
3. After installing the devices on the DIN rail, move the lower DIN rail clips to the latched position to lock the devices on the DIN rail.

For panel mounting, make sure the DIN rail clips are pushed to the extended position.

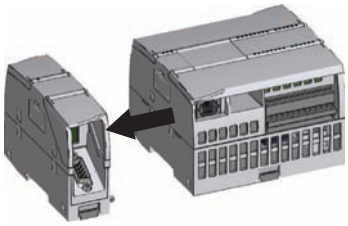
Removal

Remove the CPU and CM as a unit from the DIN rail or panel.



Prepare for CM removal.

1. Remove power from the CPU.
2. Remove the I/O connectors and all wiring and cables from the CPU and CMs.
3. For DIN rail mounting, move the lower DIN rail clips on the CPU and CMs to the extended position.
4. Remove the CPU and CMs from the DIN rail or panel.



Remove the CM.

1. Grasp the CPU and CMs firmly.
2. Pull them apart.

Do not use a tool to separate the modules because this will damage the units.

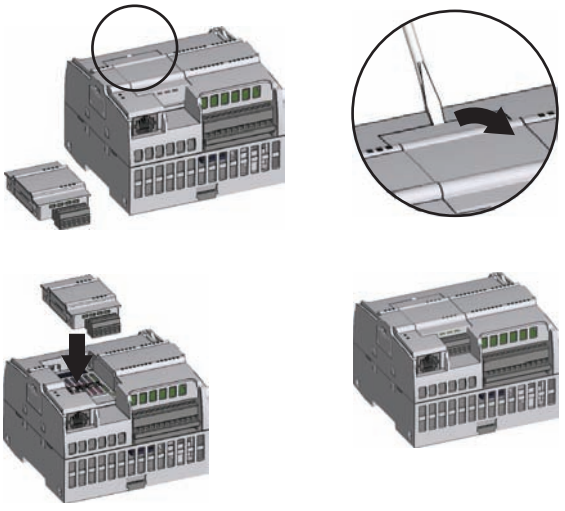
2.2.4 Installing and removing a signal board

Installation

Prepare the CPU for installation of the SB by removing the power from the CPU and removing the top and bottom terminal block covers from the CPU.

To install the SB, follow these steps:

1. Place a screwdriver into the slot on top of the CPU at the rear of the cover.
2. Gently pry the cover up and remove it from the CPU.
3. Place the SB straight down into its mounting position in the top of the CPU.
4. Firmly press the SB into position until it snaps into place.
5. Replace the terminal block covers.

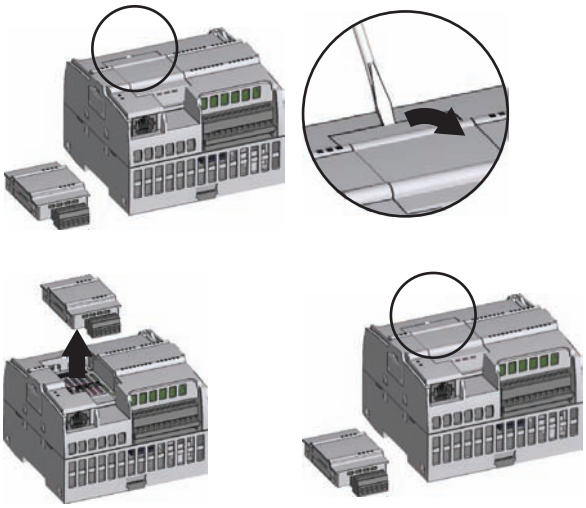


Removal

Prepare the CPU for removal of the SB by removing power from the CPU and removing the top and bottom terminal block covers from the CPU.

To remove the SB, follow these steps:

1. Place a screwdriver into the slot on top of the SB.
2. Gently pry the SB up to disengage it from the CPU.
3. Remove the SB straight up from its mounting position in the top of the CPU.
4. Replace the SB cover.
5. Replace the terminal block covers.



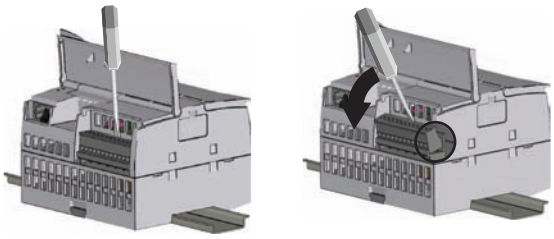
2.2.5 Removing and reinstalling the S7-1200 terminal block connector

The CPU, SB and SM modules provide removable connectors to make connecting the wiring easy. To prepare the system for terminal block connector removal:

- Remove power from the CPU.
- Open the cover above the connector.

To remove the connector, follow these steps:

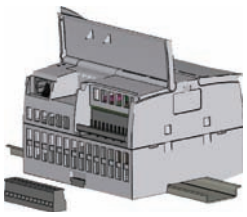
1. Inspect the top of the connector and locate the slot for the tip of the screwdriver.
2. Insert a screwdriver into the slot.
3. Gently pry the top of the connector away from the CPU. The connector will release with a snap.
4. Grasp the connector and remove it from the CPU.

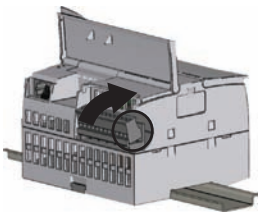


To install the connector, follow these steps:

1. Prepare the components for terminal block installation by removing power from the CPU and opening the cover for the terminal block.
2. Align the connector with the pins on the unit.
3. Align the wiring edge of the connector inside the rim of the connector base.
4. Press firmly down and rotate the connector until it snaps into place.

Check carefully to ensure that the connector is properly aligned and fully engaged.





2.3 Wiring guidelines

Proper grounding and wiring of all electrical equipment is important to help ensure the optimum operation of your system and to provide additional electrical noise protection for your application and the S7-1200. Refer to the technical specifications (Page 279) for the S7-1200 wiring diagrams.

Prerequisites

Before you ground or install wiring to any electrical device, ensure that the power to that equipment has been turned off. Also, ensure that the power to any related equipment has been turned off.

Ensure that you follow all applicable electrical codes when wiring the S7-1200 and related equipment. Install and operate all equipment according to all applicable national and local standards. Contact your local authorities to determine which codes and standards apply to your specific case.

⚠ WARNING

Installation or wiring the S7-1200 or related equipment with power applied could cause electric shock or unexpected operation of equipment. Failure to disable all power to the S7-1200 and related equipment during installation or removal procedures could result in death, severe personal injury, and/or damage due to electric shock or unexpected equipment operation.

Always follow appropriate safety precautions and ensure that power to the S7-1200 is disabled before attempting to install or remove the S7-1200 or related equipment.

Always take safety into consideration as you design the grounding and wiring of your S7-1200 system. Electronic control devices, such as the S7-1200, can fail and can cause unexpected operation of the equipment that is being controlled or monitored. For this reason, you should implement safeguards that are independent of the S7-1200 to protect against possible personal injury or equipment damage.

⚠ WARNING

Control devices can fail in an unsafe condition, resulting in unexpected operation of controlled equipment. Such unexpected operations could result in death, severe personal injury and/or property damage.

Use an emergency stop function, electromechanical overrides, or other redundant safeguards that are independent of the S7-1200.

Guidelines for isolation

S7-1200 AC power supply boundaries and I/O boundaries to AC circuits have been designed and approved to provide safe separation between AC line voltages and low voltage circuits. These boundaries include double or reinforced insulation, or basic plus supplementary insulation, according to various standards. Components which cross these boundaries such as optical couplers, capacitors, transformers, and relays have been approved as providing safe separation. Isolation boundaries which meet these requirements have been identified in S7-1200 product data sheets as having 1500 VAC or greater isolation. This designation is based on a routine factory test of (2Ue + 1000 VAC) or equivalent according to approved methods. S7-1200 safe separation boundaries have been type tested to 4242 VDC.

The sensor supply output, communications circuits, and internal logic circuits of an S7-1200 with included AC power supply are sourced as SELV (safety extra-low voltage) according to EN 61131-2.

To maintain the safe character of the S7-1200 low voltage circuits, external connections to communications ports, analog circuits, and all 24 V nominal power supply and I/O circuits must be powered from approved sources that meet the requirements of SELV, PELV, Class 2, Limited Voltage, or Limited Power according to various standards.

⚠ WARNING

Use of non-isolated or single insulation supplies to supply low voltage circuits from an AC line can result in hazardous voltages appearing on circuits that are expected to be touch safe, such as communications circuits and low voltage sensor wiring.

Such unexpected high voltages could cause electric shock resulting in death, severe personal injury and/or property damage.

Only use high voltage to low voltage power converters that are approved as sources of touch safe, limited voltage circuits.

Guidelines for grounding the S7-1200

The best way to ground your application is to ensure that all the common and ground connections of your S7-1200 and related equipment are grounded to a single point. This single point should be connected directly to the earth ground for your system.

All ground wires should be as short as possible and should use a large wire size, such as 2 mm^2 (14 AWG).

When locating grounds, consider safety-grounding requirements and the proper operation of protective interrupting devices.

Guidelines for wiring the S7-1200

When designing the wiring for your S7-1200, provide a single disconnect switch that simultaneously removes power from the S7-1200 CPU power supply, from all input circuits, and from all output circuits. Provide over-current protection, such as a fuse or circuit breaker, to limit fault currents on supply wiring. Consider providing additional protection by placing a fuse or other current limit in each output circuit.

Install appropriate surge suppression devices for any wiring that could be subject to lightning surges.

Avoid placing low-voltage signal wires and communications cables in the same wire tray with AC wires and high-energy, rapidly switched DC wires. Always route wires in pairs, with the neutral or common wire paired with the hot or signal-carrying wire.

Use the shortest wire possible and ensure that the wire is sized properly to carry the required current. The connector accepts wire sizes from 2 mm^2 to 0.3 mm^2 (14 AWG to 22 AWG). Use shielded wires for optimum protection against electrical noise. Typically, grounding the shield at the S7-1200 gives the best results.

When wiring input circuits that are powered by an external power supply, include an overcurrent protection device in that circuit. External protection is not necessary for circuits that are powered by the 24 VDC sensor supply from the S7-1200 because the sensor supply is already current-limited.

All S7-1200 modules have removable connectors for user wiring. To prevent loose connections, ensure that the connector is seated securely and that the wire is installed securely into the connector. To avoid damaging the connector, be careful that you do not over-tighten the screws. The maximum torque for the connector screw is 0.56 N-m (5 inch-pounds).

To help prevent unwanted current flows in your installation, the S7-1200 provides isolation boundaries at certain points. When you plan the wiring for your system, you should consider these isolation boundaries. Refer to the technical specifications for the amount of isolation provided and the location of the isolation boundaries. Do not depend on isolation boundaries rated less than 1500 VAC as safety boundaries.

Guidelines for inductive loads

You should equip inductive loads with suppression circuits to limit voltage rise when the control output turns off. Suppression circuits protect your outputs from premature failure due to the high voltages associated with turning off inductive loads. In addition, suppression circuits limit the electrical noise generated when switching inductive loads. Placing an external suppression circuit so that it is electrically across the load, and physically located near the load is most effective in reducing electrical noise.

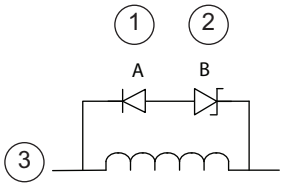
Note

The effectiveness of a given suppression circuit depends on the application, and you must verify it for your particular use. Always ensure that all components used in your suppression circuit are rated for use in the application.

Control DC inductive loads

S7-1200 DC outputs include suppression circuits that are adequate for the inductive loads in most applications. Since the relays can be used for either a DC or an AC load, internal protection is not provided. The following figure shows a sample suppression circuit for a DC load.

In most applications, the addition of a diode (A) across the inductive load is suitable, but if your application requires faster turn-off times, then the addition of a Zener diode (B) is recommended.

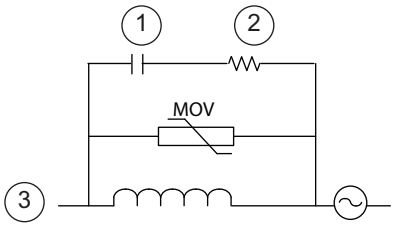


① I1N4001 diode or equivalent
② 8.2 V Zener (DC outputs), 36 V Zener (Relay outputs)
③ Output point

Be sure to size your Zener diode properly for the amount of current in your output circuit.

Relay outputs that control AC loads

When you use a relay output to switch 115 V/230 VAC loads, place resistor/capacitor networks across the AC load as shown in this figure. You can also use a metal oxide varistor (MOV) to limit peak voltage. Ensure that the working voltage of the MOV is at least 20% greater than the nominal line voltage.



① 0.1 µ F
② 100 to 120 Ω
③ Output point

Guidelines for lamp loads

Lamp loads are damaging to relay contacts because of the high turn-on surge current. This surge current will nominally be 10 to 15 times the steady state current for a Tungsten lamp. A replaceable interposing relay or surge limiter is recommended for lamp loads that will be switched a large number of times during the lifetime of the application.

PLC concepts

3

3.1 Execution of the user program

The CPU supports the following types of code blocks that allow you to create an efficient structure for your user program:

- Organization blocks (OBs) define the structure of the program. Some OBs have predefined behavior and start events, but you can also create OBs with custom start events.
- Functions (FCs) and function blocks (FBs) contain the program code that corresponds to specific tasks or combinations of parameters. Each FC or FB provides a set of input and output parameters for sharing data with the calling block. An FB also uses an associated data block (called an instance DB) to maintain state of values between execution that can be used by other blocks in the program.
- Data blocks (DBs) store data that can be used by the program blocks.

Execution of the user program begins with one or more optional start-up organization blocks (OBs) which are executed once upon entering RUN mode, followed by one or more program cycle OBs which are executed cyclically. An OB can also be associated with an interrupt event, which can be either a standard event or an error event, and executes whenever the corresponding standard or error event occurs.

A function (FC) or a function block (FB) is a block of program code that can be called from an OB or from another FC or FB, down to the following levels:

- 16 from the program cycle or startup OB
- 4 from time delay interrupt, cyclic interrupt, hardware interrupt, time error interrupt, or diagnostic error interrupt OB

FCs are not associated with any particular data block (DB), while FBs are tied directly to a DB and use the DB for passing parameters and storing interim values and results.

The size of the user program, data, and configuration is limited by the available load memory and work memory in the CPU. There is no limit to the number of blocks supported within the available amount of work memory.

Each cycle includes writing the outputs, reading the inputs, executing the user program instructions, and performing system maintenance or background processing. The cycle is referred to as a scan cycle or scan.

The signal board, signal modules and communication modules are detected and logged in only upon power up.

Note

Insertion and extraction of a signal board, signal modules, and communications module under power (hot) is not supported. The only exception is the SIMATIC memory card, which can be inserted or removed while the CPU is under power.

Under the default configuration, all digital and analog I/O points are updated synchronously with the scan cycle using an internal memory area called the process image. The process image contains a snapshot of the physical inputs and outputs (the physical I/O points on the CPU, signal board, and signal modules).

The CPU performs the following tasks:

- The CPU writes the outputs from the process image output area to the physical outputs.
- The CPU reads the physical inputs just prior to the execution of the user program and stores the input values in the process image input area. This ensures that these values remain consistent throughout the execution of the user instructions.
- The CPU executes the logic of the user instructions and updates the output values in the process image output area instead of writing to the actual physical outputs.

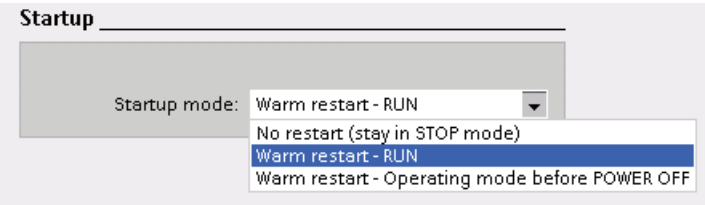
This process provides consistent logic through the execution of the user instructions for a given cycle and prevents the flickering of physical output points that might change state multiple times in the process image output area.

You can specify whether digital and analog I/O points are to be stored in the process image. If you insert a module in the device view, its data is located in the process image of the S7-1200-CPU (default). The CPU handles the data exchange between the module and the process image area automatically during the update of the process image. To remove digital or analog points from the process-image automatic update, select the appropriate device in Device configuration, view the Properties tab, expand if necessary to locate the desired I/O points, and then select "IO addresses/HW identifier". Then change the entry for "Process image:" from "Cyclic PI" to "---". To add the points back to the process-image automatic update, change this selection back to "Cyclic PI".

You can immediately read physical input values and immediately write physical output values when an instruction executes. An immediate read accesses the current state of the physical input and does not update the process image input area, regardless of whether the point is configured to be stored in the process image. An immediate write to the physical output updates both the process image output area (if the point is configured to be stored in the process image) and the physical output point. Append the suffix ":P" to the I/O address if you want the program to immediately access I/O data directly from the physical point instead of using the process image.

Configuring the startup parameters

You use the CPU properties to configure how the CPU starts up after a power cycle.



Select whether the CPU starts in STOP mode, RUN mode, or in the previous mode (prior to the power cycle).

The CPU performs a warm restart before going to RUN mode. Warm restart resets all non-retentive memory to the default start values, but retains the current values stored in the retentive memory.

Note

The CPU always performs a restart after a download

Whenever you download an element of your project (such as a program block, data block, or hardware configuration), the CPU performs a restart on the next transition to RUN mode. In addition to clearing the inputs, initializing the outputs and initializing the non-retentive memory, the restart also initializes the retentive memory areas.

After the restart that follows a download, all subsequent STOP-to-RUN transitions perform a warm restart (that does not initialize the retentive memory).

3.1.1 Operating modes of the CPU

The CPU has three modes of operation: STOP mode, STARTUP mode, and RUN mode. Status LEDs on the front of the CPU indicate the current mode of operation.

- In STOP mode, the CPU is not executing the program, and you can download a project.
- In STARTUP mode, the startup OBs (if present) are executed once. Interrupt events are not processed during the startup phase of RUN mode.
- In RUN mode, the scan cycle is executed repeatedly. Interrupt events can occur and be processed at any point within the program cycle phase.

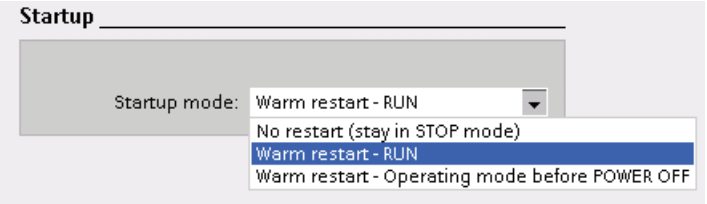
  You cannot download a project while in RUN mode.

The CPU supports a warm restart for entering the RUN mode. Warm restart does not include a memory reset. All non-retentive system and user data are initialized at warm restart. Retentive user data is retained.

A memory reset clears all work memory, clears retentive and non-retentive memory areas, and copies load memory to work memory. A memory reset does not clear the diagnostics buffer or the permanently saved values of the IP address.

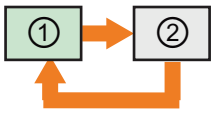
You can specify the power-up mode of the CPU complete with restart method using the programming software. This configuration item appears under the Device Configuration for the CPU under Startup. When power is applied, the CPU performs a sequence of power-up diagnostic checks and system initialization. The CPU then enters the appropriate power-up mode. Certain detected errors will prevent the CPU from entering the RUN mode. The CPU supports the following power-up modes:

- STOP mode
- Go to RUN mode after warm restart
- Go to previous mode after warm restart



You can change the current operating mode using the "STOP" or "RUN" commands from the online tools of the programming software. You can also include a STP instruction in your program to change the CPU to STOP mode. This allows you to stop the execution of your program based on the program logic.

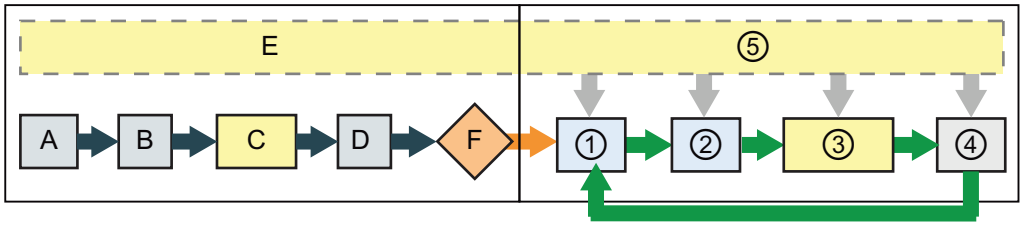
In STOP mode, the CPU ① handles any communication requests (as appropriate) and ② performs self-diagnostics.



In STOP mode, the CPU does not execute the user program, and the automatic updates of the process image do not occur.

You can download your project only when the CPU is in STOP mode.

In RUN mode, the CPU performs the tasks shown in the following figure.



STARTUP

A	Clears the I memory area
B	Initializes the outputs with either the last value or the substitute value
C	Executes the startup OBs
D	Copies the state of the physical inputs to I memory
E	Stores any interrupt events into the queue to be processed in RUN mode
F	Enables the writing of Q memory to the physical outputs

RUN

①	Writes Q memory to the physical outputs
②	Copies the state of the physical inputs to I memory
③	Executes the program cycle OBs
④	Performs self-test diagnostics
⑤	Processes interrupts and communications during any part of the scan cycle

STARTUP processing

Whenever the operating state changes from STOP to RUN, the CPU clears the process image inputs, initializes the process image outputs and processes the startup OBs. Any read accesses to the process-image inputs by instructions in the startup OBs will read zero rather than the current physical input value. Therefore, to read the current state of a physical input during the startup mode, you must perform an immediate read. The startup OBs and any associated FCs and FBs are executed next. If more than one startup OB exists, each is executed in order according to the OB number, with the lowest OB number executing first.

Each startup OB includes startup information that helps you determine the validity of retentive data and the time-of-day clock. You can program instructions inside the startup OBs to examine these startup values and to take appropriate action. The following startup locations are supported by the Startup OBs:

Input	Data Type	Description
LostRetentive	BOOL	This bit is true if the retentive data storage areas have been lost
LostRTC	BOOL	This bit is true if the time-of-day clock (Real time Clock) has been lost

The CPU also performs the following tasks during the startup processing.

- Interrupts are queued but not processed during the startup phase
- No cycle time monitoring is performed during the startup phase
- Configuration changes to HSC (high-speed counter), PWM (pulse-width modulation), and PtP (point-to-point communication) modules can be made in startup
- Actual operation of HSC, PWM and point-to-point communication modules only occurs in RUN

After the execution of the startup OBs finishes, the CPU goes to RUN mode and processes the control tasks in a continuous scan cycle.

Processing the scan cycle during RUN mode

For each scan cycle, the CPU writes the outputs, reads the inputs, executes the user program, updates communication modules, performs internal housekeeping chores, and responds to user interrupt events and communication requests. Communication requests are handled periodically throughout the scan.

These actions (except for user interrupt events) are serviced regularly and in sequential order. User interrupt events which are enabled, are serviced according to priority in the order in which they occur.

The system guarantees that the scan cycle will be completed in a time period called the maximum cycle time; otherwise a time error event is generated.

- Each scan cycle begins by retrieving the current values of the digital and analog outputs from the process image and then writing them to the physical outputs of the CPU, SB, and SM modules configured for automatic I/O update (default configuration). When a physical output is accessed by an instruction, both the output process image and the physical output itself are updated.
- The scan cycle continues by reading the current values of the digital and analog inputs from the CPU, SB, and SMs configured for automatic I/O update (default configuration), and then writing these values to the process image. When a physical input is accessed by an instruction, the value of the physical input is accessed by the instruction, but the input process image is not updated.
- After reading the inputs, the user program is executed from the first instruction through the end instruction. This includes all the program cycle OBs plus all their associated FCs and FBs. The program cycle OBs are executed in order according to the OB number with the lowest OB number executing first.

Communications processing occurs periodically throughout the scan, possibly interrupting user program execution.

Self-diagnostic checks include periodic checks of the system and the I/O module status checks.

Interrupts can occur during any part of the scan cycle, and are event-driven. When an event occurs, the CPU interrupts the scan cycle and calls the OB that was configured to process that event. After the OB finishes processing the event, the CPU resumes execution of the user program at the point of interruption.

Organization blocks (OBs)

OBs control the execution of the user program. Each OB must have a unique OB number. Some default OB numbers are reserved below 200. Other OBs must be numbered 200 or greater.

Specific events in the CPU trigger the execution of an organization block. OBs cannot call each other or be called from an FC or FB. Only a start event, such as a diagnostic interrupt or a time interval, can start the execution of an OB. The CPU handles OBs according to their respective priority classes, with higher priority OBs executed before lower priority OBs. The lowest priority class is 1 (for the main program cycle), and the highest priority class is 27 (for the time-error interrupts).

OBs control the following operations:

- Program cycle OBs execute cyclically while the CPU is in RUN mode. The main block of the program is a program cycle OB. This is where you place the instructions that control your program and where you call additional user blocks. Multiple program cycle OBs are allowed and are executed in numerical order. OB 1 is the default. Other program cycle OBs must be identified as OB 200 or greater.
- Startup OBs execute one time when the operating mode of the CPU changes from STOP to RUN, including powering up in the RUN mode and in commanded STOP-to-RUN transitions. After completion, the main "Program cycle" OB will begin executing. Multiple startup OBs are allowed. OB 100 is the default. Others must be OB 200 or greater.
- Time-delay OBs execute at a specified interval after an event is configured by the Start interrupt (SRT_DINT) instruction. The delay time is specified in the input parameter of the extended instruction SRT_DINT. A time-delay OB interrupts normal cyclic program execution when a specified delay time has expired. You can configure up to 4 time-delay events at any given time, with one OB allowed for each configured time-delay event. The time-delay OB must be OB 200 or greater.
- Cyclic interrupt OBs execute at a specified interval. A cyclic interrupt OB will interrupt cyclic program execution at user defined intervals, such as every 2 seconds. You can configure up to 4 cyclic interrupt events, with one OB allowed for each configured cyclic interrupt event. The OB must be OB 200 or greater.
- Hardware interrupt OBs execute when the relevant hardware event occurs, including rising and falling edges on built-in digital inputs and HSC events. A hardware interrupt OB will interrupt normal cyclic program execution in reaction to a signal from a hardware event. You define the events in the properties of the hardware configuration. One OB is allowed for each configured hardware event. The OB must be OB 200 or greater.
- Time-error interrupt OBs execute when a time error is detected. A time error interrupt OB will interrupt normal cyclic program execution if the maximum cycle time has been exceeded. The maximum cycle time is defined in the properties of the PLC. OB 80 is the only OB number supported for the time error event. You can configure the action to take when no OB 80 is present: either ignore the error or change to STOP.
- Diagnostic error interrupt OBs execute when a diagnostic error is detected and reported. A diagnostic OB interrupts the normal cyclic program execution if a diagnostics-capable module recognizes an error (if the diagnostic error interrupt has been enabled for the module). OB 82 is the only OB number supported for the diagnostic error event. If there is no diagnostic OB in the program, you can configure the CPU to either ignore the error or to change to STOP.

3.1.2 Event execution priorities and queuing

The CPU processing is controlled by events. The events trigger interrupt OBs to be executed. The interrupt OB for an event is specified during the creation of the block, during Device configuration or with an ATTACH or DETACH instruction. Some events happen on a regular basis like the program cycle or cyclic events. Other events happen only a single time, like the startup event and time delay events. Some events happen when there is a change triggered by the hardware, such as an edge event on an input point or a high speed counter event. There are also events like the diagnostic error and time error event which only happen when there is an error. The event priorities, priority groups and queues are used to determine the processing order for the event interrupt OBs.

The program cycle event happens once during each program cycle (or scan). During the program cycle, the CPU writes the outputs, reads the inputs and executes program cycle OBs. The program cycle event is required and is always enabled. You may have no program cycle OBs, or you may have multiple OBs selected for the program cycle event. After the program cycle event is triggered, the lowest numbered program cycle OB (usually OB1) is executed. The other program cycle OBs are executed sequentially, in numerical order, within the program cycle.

The cyclic interrupt events allows you to configure the execution of an interrupt OB at a configured time interval. The time interval is configured when the OB is created and selected to be a cyclic interrupt OB. The cyclic events will interrupt the program cycle and execute the cyclic interrupt OB (the cyclic event is in a higher priority group than the program cycle event). Only one cyclic interrupt OB can be attached to a cyclic event. The CPU supports four cyclic interrupt events. The cyclic interrupt OBs have a phase shift property so that the execution of cyclic interrupts with the same time period can be offset from one another by the phase shift amount.

The startup event happens one time on a STOP to RUN transition and causes the startup OBs to be executed. Multiple OBs can be selected for the startup event. The startup OBs are executed in numerical order.

The time delay interrupt events allow you to configure the execution of an interrupt OB after a specified delay time has expired. The delay time is specified with the SRT_DINT instruction. The time delay events will interrupt the program cycle to execute the time delay interrupt OB. Only one time delay interrupt OB can be attached to a time delay event. The CPU supports four time delay events.

The hardware interrupt events are triggered by a change in the hardware, such as a rising or falling edge on an input point, or a HSC (High Speed Counter) event. There can be one interrupt OB selected for each hardware interrupt event. The hardware events are enabled in Device configuration. The OBs are specified for the event in the Device configuration or with an ATTACH instruction in the user program. The CPU supports several hardware interrupt events. The exact events are based on the CPU model and the number of input points.

The time and diagnostic error interrupt events are triggered when the CPU detects an error. These events are a higher priority group that the other interrupt events and can interrupt the execution of the time delay, cyclic and hardware interrupt events. One interrupt OB can be specified for each of the time error and diagnostic error interrupt events.

Understanding event execution priorities and queuing

The number of pending (queued) events from a single source is limited using a different queue for each event type. Upon reaching the limit of pending events for a given event type, the next event is lost. Refer to the following section on "Understanding time error events" for more information regarding queue overflows.

Each CPU event has an associated priority, and the event priorities are classified into priority groups. The following table summarizes the queue depths, priority groups and priorities for the supported CPU events.

Note

You cannot change the priority or the priority group assignments or the queue depths.

In general, events are serviced in order of priority (highest priority first). Events of the same priority are serviced on a "first-come, first-served" basis.

Event Type (OB)	Quantity	Valid OB Numbers	Queue Depth	Priority Group	Priority
Program Cycle	1 program cycle event Multiple OBs allowed	1 (default) 200 or greater	1	1	1
Startup	1 startup event [1] Multiple OBs allowed	100 (default) 200 or greater	1		1
Time Delay	4 time delay events 1 OB per event	200 or greater	8	2	3
Cyclic	4 cyclic events 1 OB per event	200 or greater	8		4
Edges	16 rising edge events 16 falling edge events 1 OB per event	200 or greater	32		5
HSC	6 CV = PV events 6 direction changed events 6 external reset events 1 OB per event	200 or greater	16		6
Diagnostic Error	1 event	82 only	8		9
Time Error event/ MaxCycle time event	1 time error event 1 MaxCycle time event	80 only	8	3	26
2xMaxCycle time event	1 2xMaxCycle time event	No OB called	-	3	27

[1] Special cases for the startup event

- The startup event and the program cycle event will never occur at the same time because the startup event will run to completion before the program cycle event will be started (controlled by the operating system).
- No events are allowed to interrupt the startup event. Events that occur during the startup event are instead queued for later processing after the startup event is finished.

After the execution of an OB has started, processing of the OB cannot be interrupted by the occurrence of another event from the same or lower priority group. Such events are queued for later processing, allowing the current OB to finish.

However, an event from a higher priority group will interrupt the current OB, and the CPU then executes the OB for the higher-priority event. After the higher-priority OB finishes, the CPU executes the OBs for any other events queued in this higher priority group, based on the priority within that group. When no other events are pending (queued) in this higher

priority group, the CPU then returns to the lower priority group and resumes the processing of the pre-empted OB at the point where the processing of that OB had been interrupted.

Interrupt latency

The interrupt event latency (the time from notification of the CPU that an event has occurred until the CPU begins execution of the first instruction in the OB that services the event) is approximately 210 µsec, provided that a program cycle OB is the only event service routine active at the time of the interrupt event.

Understanding time error events

The occurrence of any of several different time error conditions results in a time error event. The following time errors are supported:

- Maximum cycle time exceeded
- Requested OB cannot be started
- Queue overflow occurred

The maximum cycle time exceeded condition results if the program cycle does not complete within the specified maximum scan cycle time. See the section on "Monitoring the cycle time (Page 43)" for more information regarding the maximum cycle time condition, how to configure the maximum scan cycle time, and how to reset the cycle timer.

The requested OB cannot be started condition results if an OB is requested by a cyclic interrupt or a time-delay interrupt, but the requested OB is already being executed.

The queue overflow occurred condition results if the interrupts are occurring faster than they can be processed. The number of pending (queued) events is limited using a different queue for each event type. If an event occurs when the corresponding queue is full, a time error event is generated.

All time error events trigger the execution of OB 80 if it exists. If OB 80 does not exist, then the CPU ignores the error. If two maximum cycle time exceeded conditions occur within the same program cycle without resetting the cycle timer, then the CPU transitions to STOP, regardless of whether OB 80 exists. See the section on "Monitoring the cycle time". (Page 43)

OB 80 includes startup information that helps you determine which event and OB generated the time error. You can program instructions inside OB 80 to examine these startup values and to take appropriate action. The following startup locations are supported by OB 80:

Input	Data type	Description
fault_id	BYTE	16#01 - maximum cycle time exceeded 16#02 - requested OB cannot be started 16#07 and 16#09 - queue overflow occurred
csg_OBnr	OB_ANY	Number of the OB which was being executed when the error occurred
csg_prio	UINT	Priority of the OB causing the error

No time error interrupt OB 80 is present when you create a new project. If desired, you add a time error interrupt OB 80 to your project by double-clicking "Add new block" under "Program blocks" in the tree, then choose "Organization block", and then "Time error interrupt".

Understanding diagnostic error events

Some devices are capable of detecting and reporting diagnostic errors. The occurrence or removal of any of several different diagnostic error conditions results in a diagnostic error event. The following diagnostic errors are supported:

- No user power
- High limit exceeded
- Low limit exceeded
- Wire break
- Short circuit

All diagnostic error events trigger the execution of OB 82 if it exists. If OB 82 does not exist, then the CPU ignores the error. No diagnostic error interrupt OB 82 is present when you create a new project. If desired, you add a diagnostic error interrupt OB 82 to your project by double-clicking "Add new block" under "Program blocks" in the tree, then choose "Organization block", and then "Diagnostic error interrupt".

OB 82 includes startup information that helps you determine whether the event is due to the occurrence or removal of an error, and the device and channel which reported the error. You can program instructions inside OB 82 to examine these startup values and to take appropriate action. The following startup locations are supported by OB 82:

Input	Data type	Description
IOstate	WORD	IO state of the device
laddr	HW_ANY	Hardware identifier of the device or functional unit that reported the error
channel	UINT	Channel number
multierror	BOOL	TRUE if more than one error is present (*not supported in early releases*)

Bit 4 of the IO_state indicates whether the event is due to the occurrence or removal of an error. Bit 4 is 1 if an error is present (example: wire break) and is 0 if the error is no longer present.

The ladder input contains the hardware identifier (HW ID) of the device or functional unit which returned the error. The HW ID is assigned automatically when components are inserted in the device or network view and appears in the Constants tab of PLC tags. A name is also assigned automatically for the HW ID. These entries in the Constants tab of the PLC tags cannot be changed.

The channel number begins at 0 for the first input point (analog or digital) and begins at 64 for the first output point (analog or digital). The different offsets are necessary to distinguish inputs from outputs in the event the device contains both. If an error affects the complete device or functional unit, such as no user power, the most-significant bit of the channel-number word is set (channel number 32768).

Monitoring the cycle time

The cycle time is the time that the CPU operating system requires to execute the cyclic phase of the RUN mode. The CPU provides two methods of monitoring the cycle time:

- Maximum scan cycle time
- Fixed minimum scan cycle time

Scan cycle monitoring begins after the startup event is complete. Configuration for this feature appears under the "Device Configuration" for the CPU under "Cycle time".

The CPU always monitors the scan cycle and reacts if the maximum scan cycle time is exceeded. If the configured maximum scan cycle time is exceeded, an error is generated and is handled one of two ways:

- If no time error interrupt OB 80 is present, then the CPU generates an error and continues to execute the user program
- If a time error interrupt OB 80 is present, then the CPU executes OB 80

The RE_TRIGR instruction (Re-trigger cycle time monitoring) allows you to reset the timer that measures the cycle time. However, this instruction only functions if executed in a program cycle OB; the RE_TRIGR instruction is ignored if executed in OB 80. If the maximum scan cycle time is exceeded twice within the same program cycle with no RE_TRIGR instruction execution between the two, then the CPU transitions to STOP immediately. The use of repeated executions of the RE_TRIGR instruction can create an endless loop or a very long scan.

Typically, the scan cycle executes as fast as it can be executed and the next scan cycle begins as soon as the current one completes. Depending upon the user program and communication tasks, the time period for a scan cycle can vary from scan to scan. To eliminate this variation, the CPU supports an optional fixed minimum scan cycle time (also called fixed scan cycle). When this optional feature is enabled and a fixed minimum scan cycle time is provided in ms, the CPU will maintain the minimum cycle time within ±1 ms for the completion of each CPU scan.

In the event that the CPU completes the normal scan cycle in less time than the specified minimum cycle time, the CPU spends the additional time of the scan cycle performing runtime diagnostics and/or processing communication requests. In this way the CPU always takes a fixed amount of time to complete a scan cycle.

In the event that the CPU does not complete the scan cycle in the specified minimum cycle time, the CPU completes the scan normally (including communication processing) and does not create any system reaction as a result of exceeding the minimum scan time. The following table defines the ranges and defaults for the cycle time monitoring functions.

Cycle time	Range (ms)	Default
Maximum scan cycle time[1]	1 to 6000	150 ms
Fixed minimum scan cycle time[2]	1 to maximum scan cycle time	Disabled

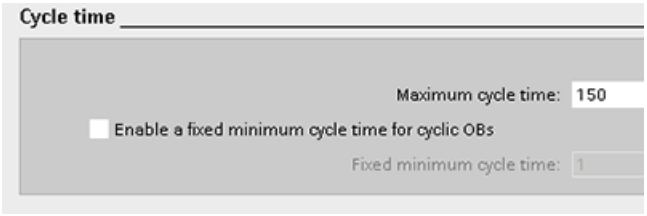
[1] The maximum scan cycle time is always enabled. Configure a cycle time between 1 ms to 6000 ms. The default is 150 ms.

[2] The fixed minimum scan cycle time is optional , and is disabled by default. If required, configure a cycle time between 1 ms and the maximum scan cycle time.

Configuring the cycle time and communication load

You use the CPU properties in the Device configuration to configure the following parameters:

- Cycle time: You can enter a maximum scan cycle time. You can also enter a fixed minimum scan cycle time.



- Communications load: You can configure a percentage of the time to be dedicated for communication tasks.



For more information about the scan cycle, see "Monitoring the cycle time". (Page 43)

3.1.3 CPU memory

Memory management

The CPU provides the following memory areas to store the user program, data, and configuration:

- Load memory is non-volatile storage for the user program, data and configuration. When a project is downloaded to the CPU, it is first stored in the Load memory area. This area is located either in a memory card (if present) or in the CPU. This non-volatile memory area is maintained through a power loss. The memory card supports a larger storage space than that built-in to the CPU.
- Work memory is volatile storage for some elements of the user project while executing the user program. The CPU copies some elements of the project from load memory into work memory. This volatile area is lost when power is removed, and is restored by the CPU when power is restored.
- Retentive memory is non-volatile storage for a limited quantity of work memory values. The retentive memory area is used to store the values of selected user memory locations during power loss. When a power down occurs, the CPU has enough hold-up time to retain the values of a limited number of specified locations. These retentive values are then restored upon power up.

To display the memory usage for the current project, right-click the CPU (or one of its blocks) and select "Resources" from the context. To display the memory usage for the current CPU, double-click "Online and diagnostics", expand "Diagnostics", and select "Memory".

Retentive memory

Data loss after power failure can be avoided by marking certain data as retentive. The following data can be configured to be retentive:

- Bit memory(M): You can define the precise width of the memory for bit memory in the PLC tag table or in the assignment list. Retentive bit memory always starts at MB0 and runs consecutively up through a specified number of bytes. Specify this value from the PLC tag table or in the assignment list by clicking the "Retain" toolbar icon. Enter the number of M bytes to retain starting at MB0.
- Tags of a function block (FB): If an FB was created with the "Symbolic access only" box selected, then the interface editor for this FB includes a "Retain" column. In this column, you can select either "Retain" or "Non-Retain" individually for each tag. An instance DB that was created when this FB is placed in the program editor shows this retain column as well, but only for display; you cannot change the retentive state from within the instance DB interface editor for an FB that was configured to be "Symbolic access only".

  If an FB was created with the "Symbolic access only" box deselected, then the interface editor for this FB does not include a "Retain" column. An instance DB created when this FB is inserted in the program editor shows a "Retain" column which is available for edit. In this case, selecting the "Retain" option for any tag results in **all** tags being selected. Similarly, deselecting the option for any tag results in **all** tags being deselected. For an FB that was configured to **not** be "Symbolic access only", you can change the retentive state from within the instance DB editor, but all tags are set to the same retentive state together.

  After you create the FB, you cannot change the option for "symbolic access only". This option can only be selected when the FB is created. To determine whether an existing FB was configured for "symbolic access only", right-click the FB in the Project tree, select "Properties", and then select "Attributes".
- Tags of a global data block: The behavior of a global DB with regard to retentive state assignment is similar to that of an FB. Depending on the setting for symbolic addressing you can define the retentive state either for individual or for all tags of a global data block.
  - If the "Symbolic access only" attribute of the DB is checked, the retentive state can be set for each individual tag.
  - If the "Symbolic access only" attribute of the DB is un-checked, the retentive-state setting applies to all tags of the DB; either all tags are retentive or no tag is retentive.

A total of 2048 bytes of data can be retentive. To see how much is available, from the PLC tag table or the assignment list, click on the "Retain" toolbar icon. Although this is where the retentive range is specified for M memory, the second row indicates the total remaining memory available for M and DB combined.

Diagnostics buffer

The CPU supports a diagnostic buffer which contains an entry for each diagnostic event. Each entry includes a date and time the event occurred, an event category, and an event description. The entries are displayed in chronological order with the most recent event at the top. While the CPU maintains power, up to 50 most recent events are available in this log. When the log is full, a new event replaces the oldest event in the log. When power is lost, the ten most recent events are saved.

The following types of events are recorded in the diagnostics buffer:

- Each system diagnostic event; for example, CPU errors and module errors
- Each state change of the CPU (each power up, each transition to STOP, each transition to RUN)

To access the diagnostic buffer, you must be online. Locate the log under "Online & diagnostics / Diagnostics / Diagnostics buffer". For more information regarding troubleshooting and debugging, refer to the "Online and diagnostics" chapter.

Time of day clock

The CPU supports a time-of-day clock. A super-capacitor supplies the energy required to keep the clock running during times when the CPU is powered down. The super-capacitor charges while the CPU has power. After the CPU has been powered up at least 2 hours, then the super-capacitor has sufficient charge to keep the clock running for typically 10 days.

The Time of Day Clock is set to system time, which is Coordinated Universal Time (UTC). STEP 7 Basic sets the Time of Day Clock to system time. There are instructions to read the system time (RD_SYS_T) or local time (RD_LOC_T). Local time is calculated by using the time zone and daylight saving time offsets that you set in the CPU Clock device configuration.

Configure the time-of-day clock for the CPU under the "Time of day" property. You can also enable daylight saving time and specify the start and end times for daylight saving time. To set the time-of-day clock, you must be online and in the "Online & diagnostics" view of the CPU. Use the "Set time of day" function.

System and clock memory

You use the CPU properties to enable bytes for "system memory" and "clock memory". Your program logic can reference the individual bits of these functions.

- You can assign one byte in M memory for system memory. The byte of system memory provides the following four bits that can be referenced by your user program:
  - "Always 0 (low)" bit is always set to 0.
  - "Always 1 (high)" bit is always set to 1.
  - "Diagnostic graph changed" is set to 1 for one scan after the CPU logs a diagnostic event. Because the CPU does not set the "diagnostic graph changed" bit until the end of the first execution of the of the program cycle OBs, your user program cannot detect if there has been a diagnostic change either during the execution of the startup OBs or the first execution of the program cycle OBs.
  - "First scan" bit is set to1 for the duration of the first scan after the startup OB finishes. (After the execution of the first scan, the "first scan" bit is set to 0.)
- You can assign one byte in M memory for clock memory. Each bit of the byte configured as clock memory generates a square wave pulse. The byte of clock memory provides 8 different frequencies, from 0.5 Hz (slow) to 10 Hz (fast). You can use these bits as control bits, especially when combined with edge instructions, to trigger actions in the user program on a cyclic basis.

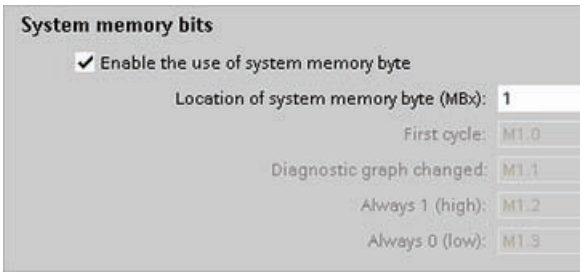
The CPU initializes these bytes on the transition from STOP mode to STARTUP mode. The bits of the clock memory change synchronously to the CPU clock throughout the STARTUP and RUN modes.

CAUTION

Overwriting the system memory or clock memory bits can corrupt the data in these functions and cause your user program to operate incorrectly, which can cause damage to equipment and injury to personnel.

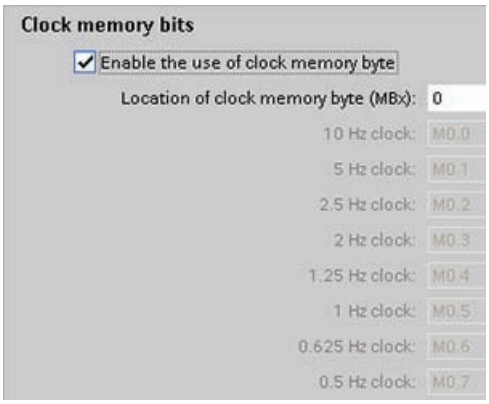
Because both the clock memory and system memory are unreserved in M memory, instructions or communications can write to these locations and corrupt the data.

Avoid writing data to these locations to ensure the proper operation of these functions, and always implement an emergency stop circuit for your process or machine.



System memory configures a byte that turns on (value = 1) for the following conditions.

- First scan: Turns on for the first scan cycle in run mode
- Diagnostic graph changed:
- Always 1 (high): Always turned on
- Always 0 (low): Always turned off



Clock memory configures a byte that cycles the individual bits on and off at fixed intervals.

The clock flags each generate a square wave pulse on the corresponding M memory bit. These bits can be used as control bits, especially when combined with edge instructions, to trigger actions in the user code on a cyclic basis.

Configuring the behavior of output values when the CPU is in STOP mode

You can configure the behavior of the digital and analog outputs when the CPU is in STOP mode. For any output of a CPU, SB or SM, you can set the outputs to either freeze the value or use a substitute value:

- Substituting a specified output value (default): You enter a substitute value for each output (channel) of that CPU, SB, or SM device.

  The default substitute value for digital output channels is OFF, and the default substitute value for analog output channels is 0.

- Freezing the outputs to remain in last state: The outputs retain their current value at the time of the transition from RUN to STOP. After power up, the outputs are set to the default substitute value.

You configure the behavior of the outputs in Device Configuration. Select the individual devices and use the "Properties" tab to configure the outputs for each device.

When the CPU changes from RUN to STOP, the CPU retains the process image and writes the appropriate values for both the digital and analog outputs, based upon the configuration.

3.1.4 Password protection for the S7-1200 CPU

The CPU provides 3 levels of security for restricting access to specific functions. When you configure the security level and password for a CPU, you limit the functions and memory areas that can be accessed without entering a password.



To configure the password, follow these steps:

1. In the "Device configuration", select the CPU.
2. In the inspector window, select the "Properties" tab.
3. Select the "Protection" property to select the protection level and to enter a password.

The password is case sensitive.

Each level allows certain functions to be accessible without a password. The default condition for the CPU is to have no restriction and no password-protection. To restrict access to a CPU, you configure the properties of the CPU and enter the password.

Entering the password over a network does not compromise the password protection for the CPU. A password-protected CPU allows only one user unrestricted access at a time. Password protection does not apply to the execution of user program instructions including communication functions. Entering the correct password provides access to all of the functions.

PLC-to-PLC communications (using communication instructions in the code blocks) are not restricted by the security level in the CPU. HMI functionality is also not restricted.

Security level	Access restrictions
No protection	Allows full access without password-protection.
Write protection	Allows HMI access and all forms of PLC-to-PLC communications without password-protection. Password is required for modifying (writing to) the CPU and for changing the CPU mode (RUN/STOP).
Read/write protection	Allows HMI access and all forms of PLC-to-PLC communications without password-protection. Password is required for reading the data in the CPU, for modifying (writing to) the CPU, and for changing the CPU mode (RUN/STOP).

3.1.5 Recovery from a lost password

If you have lost the password for a password-protected CPU, use an empty transfer card to delete the password-protected program. The empty transfer card erases the internal load memory of the CPU. You can then download a new user program from STEP 7 Basic to the CPU.

For information about the creation and use of an empty transfer card, see the section of transfer cards (Page 63).

⚠ WARNING

If you insert a transfer card in a running CPU, the CPU goes to STOP. Control devices can fail in an unsafe condition, resulting in unexpected operation of controlled equipment. Such unexpected operations could result in death or serious injury to personnel, and/or damage to equipment.

You must remove the transfer card before setting the CPU to RUN mode.

3.2 Data storage, memory areas and addressing

The CPU provides several options for storing data during the execution of the user program:

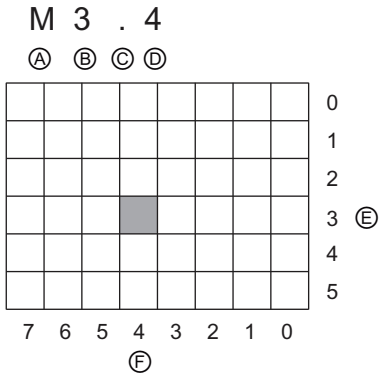
- Global memory: The CPU provides a variety of specialized memory areas, including inputs (I), outputs (Q) and bit memory (M). This memory is accessible by all code blocks without restriction
- Data block (DB): You can include DBs in your user program to store data for the code blocks. The data stored persists when the execution of the associated code block comes to an end. A "global" DB stores data that can be used by all code blocks, while an instance DB stores data for a specific FB and is structured by the parameters for the FB.
- Temp memory: Whenever a code block is called, the operating system of the CPU allocates the temporary, or local, memory (L) to be used during the execution of the block. When the execution of the code block finishes, the CPU reallocates the local memory for the execution of other code blocks.

Each different memory location has a unique address. Your user program uses these addresses to access the information in the memory location.

Memory area	Description	Force	Retentive
I Process image input	Copied from physical inputs at the beginning of the scan cycle	No	No
I_:P (Physical input)	Immediate read of the physical input points on the CPU, SB, and SM	Yes	No
Q Process image output	Copied to physical outputs at the beginning of the scan cycle	No	No
Q_:P (Physical output)	Immediate write to the physical output points on the CPU, SB, and SM	Yes	No
M Bit memory	Control and data memory	No	Yes

Memory area	Description	Force	Retentive
L Temp memory	Temporary data for a block, local to that block	No	No
DB Data block	Data memory and also parameter memory for FBs	No	Yes

Each different memory location has a unique address. Your user program uses these addresses to access the information in the memory location. The figure shows how to access a bit (which is also called "byte.bit" addressing). In this example, the memory area and byte address (I = input, and 3 = byte 3) are followed by a period (".") to separate the bit address (bit 4).



A Memory area identifier
B Byte address: byte 3
C Separator ("byte.bit")
D Bit location of the byte (bit 4 of 8)
E Bytes of the memory area
F Bits of the selected byte

You can access data in most memory areas (I, Q, M, DB, and L) as bytes, words, or double words by using the "byte address" format. To access a byte, word, or double word of data in the memory, you must specify the address in a way similar to specifying the address for a bit. This includes an area identifier, data size designation, and the starting byte address of the byte, word, or double word value. Size designators are B (byte), W (word) and D (double-word), for example, IB0, MW20, or QD8. References such as I0.3 and Q1.7 access the process image. To access the physical input or output, append the reference with ":P" (such as I0.3:P, Q1.7:P, or "Stop:P").

Accessing the data in the memory areas of the CPU

STEP 7 Basic facilitates symbolic programming. Typically, tags are created either in PLC tags, a data block, or in the interface at the top of an OB, FC, or FB. These tags include a name, data type, offset, and comment. Additionally, in a data block, an initial value can be specified. You can use these tags when programming by entering the tag name at the instruction parameter. Optionally you can enter the absolute operand (memory, area, size and offset) at the instruction parameter. The examples in the following sections show how to enter absolute operands. The % character is inserted automatically in front of the absolute operand by the program editor. You can toggle the view in the program editor to one of these: symbolic, symbolic and absolute, or absolute.

I (process image input): The CPU samples the peripheral (physical) input points just prior to the cyclic OB execution of each scan cycle and writes these values to the input process image. You can access the input process image as bits, bytes, words, or double words. Both read and write access is permitted, but typically, process image inputs are only read.

Bit	I[byte address].[bit address]	I0.1
Byte, Word, or Double Word	I[size][starting byte address]	IB4, IW5, or ID12

By appending a ":P" to the address, you can immediately read the digital and analog inputs of the CPU, SB or SM. The difference between an access using I_:P instead of I is that the data comes directly from the points being accessed rather than from the input process image. This I_:P access is referred to as an "immediate read" access because the data is retrieved immediately from the source instead of from a copy that was made the last time the input process image was updated.

Because the physical input points receive their values directly from the field devices connected to these points, writing to these points is prohibited. That is, I_:P accesses are read-only, as opposed to I accesses which can be read or write.

I_:P accesses are also restricted to the size of inputs supported by a single CPU, SB, or SM, rounded up to the nearest byte. For example, if the inputs of a 2 DI / 2 DQ SB are configured to start at I4.0, then the input points can be accessed as I4.0:P and I4.1:P or as IB4:P. Accesses to I4.2:P through I4.7:P are not rejected, but make no sense since these points are not used. Accesses to IW4:P and ID4:P are prohibited since they exceed the byte offset associated with the SB.

Accesses using I_:P do not affect the corresponding value stored in the input process image.

Bit	I[byte address].[bit address]:P	I0.1:P
Byte, Word, or Double word	I[size][starting byte address]:P	IB4:P, IW5:P, or ID12:P

Q (process image output): The CPU copies the values stored in the output process image to the physical output points. You can access the output process image in bits, bytes, words, or double words. Both read and write access is permitted for process image outputs.

Bit	Q[byte address].[bit address]	Q1.1
Byte, Word, or Double word	Q[size][starting byte address]	QB5, QW10, QD40

By appending a ":P" to the address, you can immediately write to the physical digital and analog outputs of the CPU, SB or SM. The difference between an access using Q_:P instead of Q is that the data goes directly to the points being accessed in addition to the output process image (writes to both places). This Q_:P access is sometimes referred to as an "immediate write" access because the data is sent immediately to the target point; the target point does not have to wait for the next update from the output process image.

Because the physical output points directly control field devices that are connected to these points, reading from these points is prohibited. That is, Q_:P accesses are write-only, as opposed to Q accesses which can be read or write.

Q_:P accesses are also restricted to the size of outputs supported by a single CPU, SB, or SM, rounded up to the nearest byte. For example, if the outputs of a 2 DI / 2 DQ SB are configured to start at Q4.0, then the output points can be accessed as Q4.0:P and Q4.1:P or as QB4:P. Accesses to Q4.2:P through Q4.7:P are not rejected, but make no sense since these points are not used. Accesses to QW4:P and QD4:P are prohibited since they exceed the byte offset associated with the SB.

Accesses using Q_:P affect both the physical output as well as the corresponding value stored in the output process image.

Bit	Q[byte address].[bit address]:P	Q1.1:P
Byte, Word, or Double word	Q[size][starting byte address]:P	QB5:P, QW10:P or QD40:P

M (bit memory area): Use the bit memory area (M memory) for both control relays and data to store the intermediate status of an operation or other control information. You can access the bit memory area in bits, bytes, words, or double words. Both read and write access is permitted for M memory.

Bit	M[byte address].[bit address]	M26.7
Byte, Word, or Double Word	M[size][starting byte address]	MB20, MW30, MD50

Temp (temporary memory): The CPU allocates the temp memory on an as-needed basis. The CPU allocates the temp memory for the code block at the time when the code block is started (for an OB) or is called (for an FC or FB). The allocation of temp memory for a code block might reuse the same temp memory locations previously used by a different OB, FC or FB. The CPU does not initialize the temp memory at the time of allocation and therefore the temp memory might contain any value.

Temp memory is similar to M memory with one major exception: M memory has a "global" scope, and temp memory has a "local" scope:

- M memory: Any OB, FC, or FB can access the data in M memory, meaning that the data is available globally for all of the elements of the user program.
- Temp memory: Access to the data in temp memory is restricted to the OB, FC, or FB that created or declared the temp memory location. Temp memory locations remain local and are not shared by different code blocks, even when the code block calls another code block. For example: When an OB calls an FC, the FC cannot access the temp memory of the OB that called it.

The CPU provides temp (local) memory for each of the three OB priority groups:

- 16 Kbytes for startup and program cycle, including associated FBs and FCs
- 4 Kbytes for standard interrupt events including FBs and FCs
- 4 Kbytes for error interrupt events including FBs and FCs

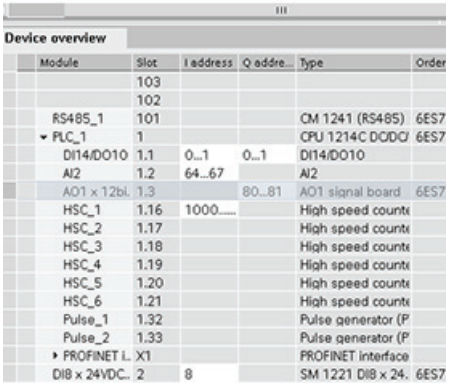
You access temp memory by symbolic addressing only.

DB (data block): Use the DB memory for storing various types of data, including intermediate status of an operation or other control information parameters for FBs, and data structures required for many instructions such as timers and counters. You can specify a data block to be either read/write or read only. You can access data block memory in bits, bytes, words, or double words. Both read and write access is permitted for read/write data blocks. Only read access is permitted for read-only data blocks.

Bit	DB[data block number].DBX[byte address].[bit address]	DB1.DBX2.3
Byte, Word, or Double Word	DB[data block number].DB [size][starting byte address]	DB1.DBB4, DB10.DBW2, DB20.DBD8

Addressing the I/O in the CPU and I/O modules





When you add a CPU and I/O modules to your configuration screen, I and Q addresses are automatically assigned.

You can change the default addressing by selecting the address field in the configuration screen and typing new numbers. Digital inputs and outputs are assigned in complete 8 bit bytes, whether the module uses all the points or not. Analog inputs and outputs are assigned in groups of 2 points (4 bytes). In this example, you could change the address of the DI16 to 2..3 instead of 8..9. The tool will assist you by changing address ranges that are the wrong size or conflict with other addresses.

The figure shows an example of a CPU 1214C with two SMs.

3.3 Data types

Data types are used to specify both the size of a data element as well as how the data are to be interpreted. Each instruction parameter supports at least one data type, and some parameters support multiple data types. Hold the cursor over the parameter field of an instruction to see which data types are supported for a given parameter.

A formal parameter is the identifier on an instruction that marks the location of data to be used by that instruction (example: the IN1 input of an ADD instruction). An actual parameter is the memory location or constant containing the data to be used by the instruction (example %MD400 "Number_of_Widgets"). The data type of the actual parameter specified by you must match one of the supported data types of the formal parameter specified by the instruction.

When specifying an actual parameter, you must specify either a tag (symbol) or an absolute memory address. Tags associate a symbolic name (tag name) with a data type, memory area, memory offset, and comment, and can be created either in the PLC tags editor or in the Interface editor for a block (OB, FC, FB, or DB). If you enter an absolute address that has no associated tag, you must use an appropriate size that matches a supported data type, and a default tag will be created upon entry.

You can also enter a constant value for many of the input parameters. The following table describes the supported elementary data types including examples of constant entry. All except String are available in the PLC tags editor and the block Interface editors. String is available only in the block Interface editors. The following table defines the elementary data types.

Data type	Size (bits)	Range	Constant Entry Examples
Bool	1	0 to 1	TRUE, FALSE, 0, 1
Byte	8	16#00 to 16#FF	16#12, 16#AB
Word	16	16#0000 to 16#FFFF	16#ABCD, 16#0001
DWord	32	16#00000000 to 16#FFFFFFFF	16#02468ACE
Char	8	16#00 to 16#FF	'A', 't', '@'
Sint	8	-128 to 127	123, -123
Int	16	-32,768 to 32,767	123, -123
Dint	32	-2,147,483,648 to 2,147,483,647	123, -123
USInt	8	0 to 255	123
UInt	16	0 to 65,535	123
UDInt	32	0 to 4,294,967,295	123
Real	32	+/-1.18 x 10^{-38} to +/-3.40 x 10^{38}	123.456, -3.4, -1.2E+12, 3.4E-3
LReal	64	+/-2.23 x 10^{-308} to +/-1.79 x 10^{308}	12345.123456789 -1.2E+40
Time	32	T#-24d_20h_31m_23s_648ms to T#24d_20h_31m_23s_647ms Stored as: -2,147,483,648 ms to +2,147,483,647 ms	T#5m_30s 5#-2d T#1d_2h_15m_30x_45ms
String	Variable	0 to 254 byte-size characters	'ABC'

Although not available as data types, the following BCD numeric format is supported by the conversion instructions.

Format	Size (bits)	Numeric Range	Constant Entry Examples
BCD16	16	-999 to 999	123, -123
BCD32	32	-9999999 to 9999999	1234567, -1234567

Format for real numbers

Real (or floating-point) numbers are represented as 32-bit single-precision numbers (Real), or 64-bit double-precision numbers (LReal) as described in the ANSI/IEEE 754-1985 standard. Single-precision floating-point numbers are accurate up to 6 significant digits and double-precision floating point numbers are accurate up to 15 significant digits. You can specify a maximum of 6 significant digits (Real) or 15 (LReal) when entering a floating-point constant to maintain precision.

Calculations that involve a long series of values including very large and very small numbers can produce inaccurate results. This can occur if the numbers differ by 10 to the power of x, where x > 6 (Real), or 15 (LReal). For example (Real): 100 000 000 + 1 = 100 000 000.

Format for the string data type

The CPU supports the STRING data type for storing a sequence of single-byte characters. The STRING data type contains a total character count (number of characters in the string) and the current character count. The STRING type provides up to 256 bytes for storing the

maximum total character count (1 byte), the current character count (1 byte), and up to 254 characters, with each character stored in 1 byte.

You can use literal strings (constants) for instruction parameters of type IN using single quotes. For example, 'ABC' is a three-character string that could be used as input for parameter IN of the S_CONV instruction. You can also create string variables by selecting data type "String" in the block interface editors for OB, FC, FB, and DB. You cannot create a string in the PLC tags editor. You can specify the maximum string size in bytes when declaring your string; for example, "MyString[10]" would specify a 10-byte maximum size for MyString. If you do not include the brackets with a max size specifier, 254 is assumed.

The following example defines a STRING with maximum character count of 10 and current character count of 3. This means the STRING currently contains 3 one-byte characters, but could be expanded to contain up to 10 one-byte characters.

Total Character Count	Current Character Count	Character 1	Character 2	Character 3	...	Character 10
10	3	'C' (16#43)	'A' (16#41)	'T' (16#54)	...	-
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	...	Byte 11

Arrays

You can create an array that contains multiple elements of an elementary type. Arrays can be created in the block interface editors for OB, FC, FB, and DB. You cannot create an array in the PLC tags editor.

To create an array from the block interface editor, choose data type "Array [lo .. hi] of type", then edit "lo", "hi", and "type" as follows:

- lo - the starting (lowest) index for your array
- hi - the ending (highest) index for your array
- type - one of the elementary data types, such as BOOL, SINT, UDINT

Negative indices are supported. You can name the array in the Name column of the block interface editor. The following table shows examples of arrays as they might appear in the block interface editor:

Name	Data type	Comment
My_Bits	Array [1 .. 10] of BOOL	This array contains 10 Boolean values
My_Data	Array [-5 .. 5] of SINT	This array contains 11 SINT values, including index 0

You reference elements of arrays in your program using the following syntax:

- Array_name[*i*], where *i* is the desired index.

Examples as they might appear in the program editor as a parameter input:

- #My_Bits[3] - references the third bit of array "My_Bits"
- #My_Data[-2] - references the fourth SINT of array "My_Data"

The # symbol is inserted automatically by the program editor.

DTL (Data and Time Long) data type

The DTL data type is a structure of 12 bytes that saves information on date and time in a predefined structure. You can define a DTL in either the Temp memory of the block or in a DB.

Length (bytes)	Format	Value range	Example of value input
12	Clock and calendar (Year-Month tag:Hour:Minute:Second.Nanoseconds)	Min.: DTL#1970-01-01-00:00:00.0 Max.: DTL#2554-12-31-23:59:59.999 999 999	DTL#2008-12-16-20:30:20.250

Each component of the DTL contains a different data type and range of values. The data type of a specified value must match the data type of the corresponding components.

Byte	Component	Data type	Value range
0	Year	UINT	1970 to 2554
1			
2	Month	USINT	1 to 12
3	Day	USINT	1 to 31
4	Day of week	USINT	1(Sunday) to 7(Saturday) The weekday is not considered in the value entry.
5	Hour	USINT	0 to 23
6	Minute	USINT	0 to 59
7	Second	USINT	0 to 59
8	Nanoseconds	UDINT	0 to 999 999 999
9			
10			
11			

3.4 Using a memory card

NOTICE
The CPU supports only the pre-formatted SIMATIC memory card (Page 318). If you use a Windows formatter to reformat the SIMATIC memory card, the CPU cannot use the reformatted memory card. Before you copy any program to the formatted memory card, delete any previously saved program from the memory card.

Use the memory card either as transfer card or as a program card. Any program that you copy to the memory card contains all of the code blocks and data blocks, any technology objects, and the device configuration. The program does **not** contain force values.

- Use a transfer card to copy a program to the internal load memory of the CPU without using STEP 7 Basic. After you insert the transfer card, the CPU first erases the user program and any force values from the internal load memory, and then copies the program from the transfer card to the internal load memory. When the transfer process is complete, you must remove the transfer card.

  You can use an empty transfer card to access a password-protected CPU when the password has been lost or forgotten (Page 53). Inserting the empty transfer card deletes the password-protected program in the internal load memory of the CPU. You can then download a new program to the CPU.

- Use a program card as external load memory for the CPU. Inserting a program card in the CPU erases all of the CPU internal load memory (the user program and any force values). The CPU then executes the program in external load memory (the program card). Downloading to a CPU that has a program card updates only the external load memory (the program card).

  Because the internal load memory of the CPU was erased when you inserted the program card, the program card **must** remain in the CPU. If you remove the program card, the CPU goes to STOP mode. (The error LED flashes to indicate that program card has been removed.)

The program on a memory card includes the code blocks, the data blocks, the technology objects, and the device configuration. The memory card does **not** contain any force values. The force values are not part of the program, but are stored in the load memory, whether the internal load memory of the CPU, or the external load memory (a program card). If a program card is inserted in the CPU, then STEP 7 Basic applies the force values only to the external load memory on the program card.

3.4.1 Inserting a memory card in the CPU

WARNING

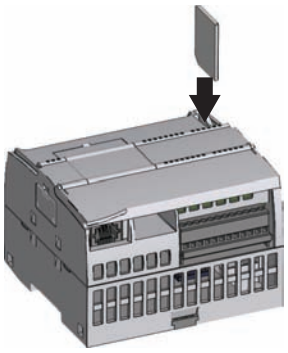
If you insert a memory card (whether configured as a program or transfer card) into a running CPU, the CPU goes immediately to STOP mode. Control devices can fail in an unsafe condition, resulting in unexpected operation of controlled equipment. Such unexpected operations could result in death or serious injury to personnel, and/or damage to equipment. Always install an emergency stop circuit for your application or process.

CAUTION

Electrostatic discharge can damage the memory card or the receptacle on the CPU.

Make contact with a grounded conductive pad and/or wear a grounded wrist strap when you handle the memory card. Store the memory card in a conductive container.

To insert a memory card, open the top CPU door and insert the memory card in the slot. A push-push type connector allows for easy insertion and removal. The memory card is keyed for proper installation.





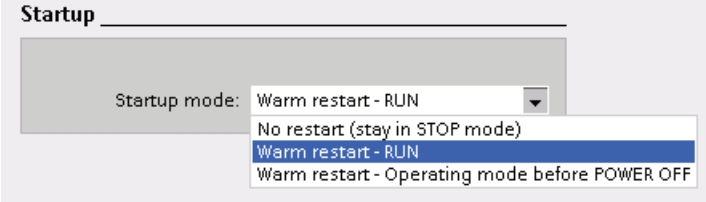
Check that the memory card is not write-protected. Slide the protection switch away from the "Lock" position.

Note

If you insert a memory card with the CPU in STOP mode, the diagnostic buffer displays a message that the memory card evaluation has been initiated. Please disregard this message. The evaluation of the memory card does not start until you change the CPU to RUN mode, reset the CPU memory with an MRES, or power-cycle the CPU.

3.4.2 Configuring the startup parameter of the CPU before copying the project to the memory card

When you copy a program to a transfer card or a program card, the program includes the startup parameter for the CPU. Before copying the program to the memory card, always ensure that you have configured the operating mode for the CPU following a power-cycle. Select whether the CPU starts in STOP mode, RUN mode, or in the previous mode (prior to the power cycle).



3.4.3 Transfer card

CAUTION
Electrostatic discharge can damage the memory card or the receptacle on the CPU. Make contact with a grounded conductive pad and/or wear a grounded wrist strap whenever you handle the memory card. Store the memory card in a conductive container.

Creating a transfer card

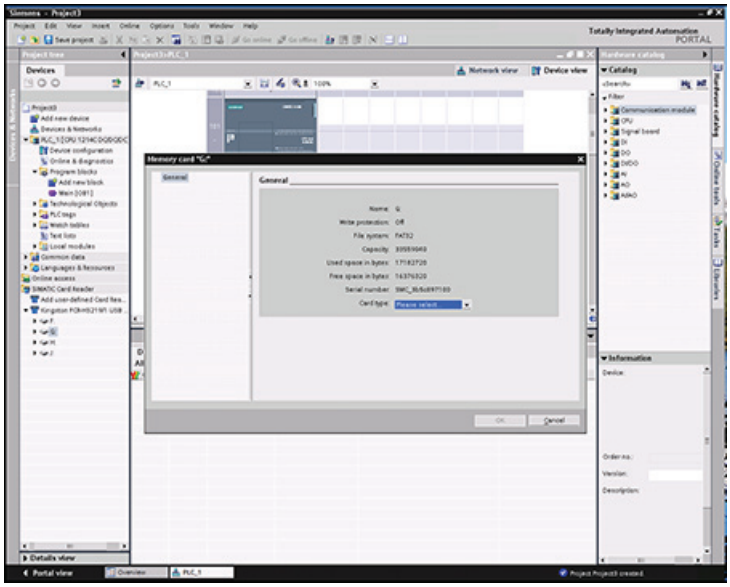
Always remember to configure the startup parameter of the CPU (Page 63) before copying a program to the transfer card. To create a transfer card, follow these steps:

1. Insert a blank memory card into the card reader/writer attached to your programming device.

   (If the memory card is not blank, delete the "SIMATIC.S7S" folder and the "S7_JOB.S7S" file on the memory card using an application such as Windows Explorer.)

2. In the Project tree (Project view), expand the "SIMATIC Card Reader" folder and select your card reader.
3. Display the "Memory card" dialog by right-clicking the memory card in the card reader and selecting "Properties" from the context menu.
4. In the "Memory card" dialog, select "Transfer" from the drop-down menu.

   At this point, STEP 7 Basic creates the empty transfer card. If you are creating an empty transfer card, such as to recover from a lost CPU password (Page 53), remove the transfer card from the card reader.



5. Add the program by selecting the CPU device (such as PLC_1 [CPU 1214 DC/DC/DC]) in the Project tree and dragging the CPU device to the memory card. (Another method is to copy the CPU device and paste it to the memory card.) Copying the CPU device to the memory card opens the "Load preview" dialog.
6. In the "Load preview" dialog, click the "Load" button to copy the CPU device to the memory card.
7. When the dialog displays a message that the CPU device (program) has been loaded without errors, click the "Finish" button.

Using a transfer card

To transfer the program to a CPU, follow these steps:

1. Insert the transfer card into the CPU (Page 62). If the CPU is in RUN, the CPU will go to STOP mode. (The maintenance LED flashes to indicate that the memory card needs to be evaluated.)
2. Use one of the following options to evaluate the memory card:
   - Power-cycle the CPU.
   - Perform a STOP-to-RUN transition.
   - Perform a memory reset (MRES).
3. After the rebooting and evaluating the memory card, the CPU copies the program to the internal load memory of the CPU. When the copy operation is complete, the CPU flashes the maintenance LED to indicate that the transfer card can be removed.
4. Remove the "Transfer" card from the CPU.
5. Use one of the following options to evaluate the new program transferred to internal load memory:
   - Power-cycle the CPU.
   - Perform a STOP-to-RUN transition.
   - Perform a memory reset (MRES).

The CPU then goes to the start-up mode (RUN or STOP) that you configured for the project.

Note

You must remove the transfer card before setting the CPU to RUN mode.

3.4.4 Program card

CAUTION
Electrostatic discharge can damage the memory card or the receptacle on the CPU. Make contact with a grounded conductive pad and/or wear a grounded wrist strap when you handle the memory card. Store the memory card in a conductive container.



Check that the memory card is not write-protected. Slide the protection switch away from the "Lock" position.

Before you copy any program elements to the program card, delete any previously saved programs from the memory card.

Creating a program card

When used as a program card, the memory card is the external load memory of the CPU. If you remove the program card, the internal load memory of the CPU is empty.

Note

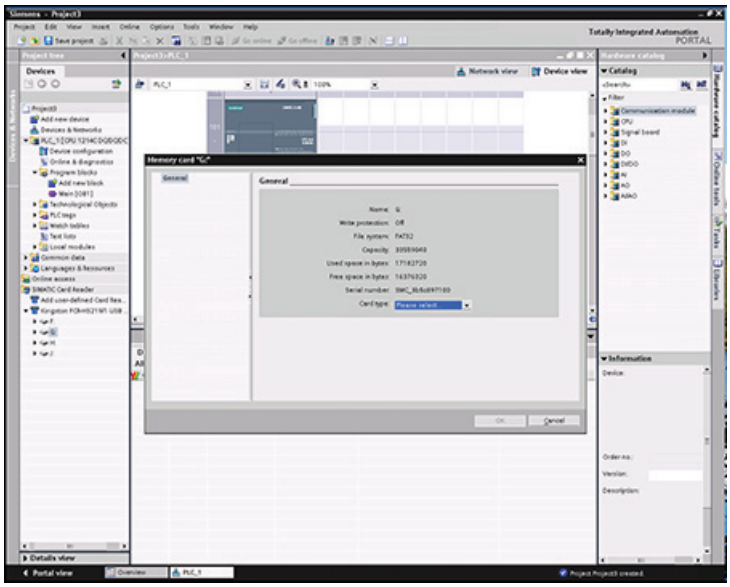
If you insert a blank memory card into the CPU and perform a memory card evaluation by either power cycling the CPU, performing a STOP to RUN transition, or performing a memory reset (MRES), the program and force values in internal load memory of the CPU are copied to the memory card. (The memory card is now a program card.) After the copy has been completed, the program in internal load memory of the CPU is then erased. The CPU then goes to the configured startup mode (RUN or STOP).

Always remember to configure the startup parameter of the CPU (Page 63) before copying a project to the program card. To create a program card with STEP 7 Basic, follow these steps:

1. Insert a blank memory card into the card reader/writer attached to your programming device.

   (If the memory card is not blank, delete the "SIMATIC.S7S" folder and the "S7_JOB.S7S" file on the memory card using an application such as Windows Explorer.)

2. In the Project tree (Project view), expand the "SIMATIC Card Reader" folder and select your card reader.
3. Display the "Memory card" dialog by right-clicking the memory card in the card reader and selecting "Properties" from the context menu.
4. In the "Memory card" dialog, select "Program" from the drop-down menu.



5. Add the program by selecting the CPU device (such as PLC_1 [CPU 1214 DC/DC/DC]) in the Project tree and dragging the CPU device to the memory card. (Another method is to copy the CPU device and paste it to the memory card.) Copying the CPU device to the memory card opens the "Load preview" dialog.
6. In the "Load preview" dialog, click the "Load" button to copy the CPU device to the memory card.
7. When the dialog displays a message that the CPU device (program) has been loaded without errors, click the "Finish" button.

Using a program card as the load memory for your CPU

CAUTION
If you insert a blank memory card into the CPU, the CPU goes to STOP mode. If you power-cycle the CPU, change the CPU from STOP to RUN mode, or reset the CPU memory (MRES), the CPU copies the internal load memory of the CPU to the memory card (which configure the memory card as a program card) and erases the program from the internal load memory. If you remove the program card, the CPU has no program in the internal load memory.

To use a program card with your CPU, follow these steps:

1. Insert the program card into the CPU. If the CPU is in RUN mode, the CPU goes to STOP mode. The maintenance LED flashes to indicate that the program card needs to be evaluated
2. Use one of the following options to evaluate the program card:
   - Power-cycle the CPU.
   - Perform a STOP-to-RUN transition.
   - Perform a memory reset (MRES).
3. The CPU reboots itself. After rebooting and evaluating the program card, the CPU erases the internal load memory of the CPU.

The CPU then goes to the start-up mode (RUN or STOP) that you configured for the CPU.

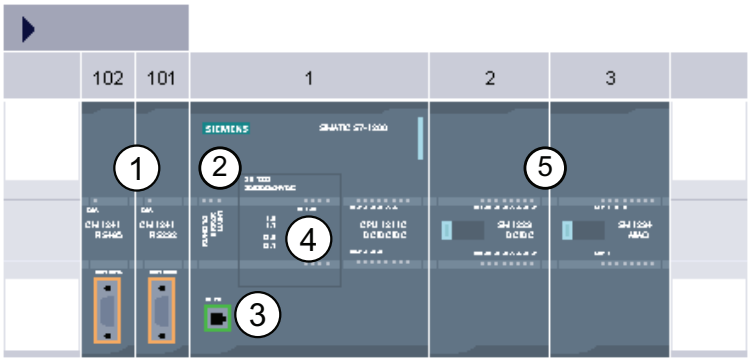
The program card must remain in the CPU. Removing the program card leaves the CPU with no program in internal load memory.

⚠ WARNING
If you remove the program card, the CPU loses its external load memory and generates an error. The CPU goes to STOP mode and flashes the error LED. Control devices can fail in an unsafe condition, resulting in unexpected operation of controlled equipment. Such unexpected operations could result in death or serious injury to personnel, and/or damage to equipment.

Device configuration

4

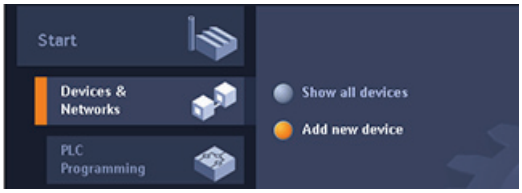
You create the device configuration for your PLC by adding a CPU and additional modules to your project.



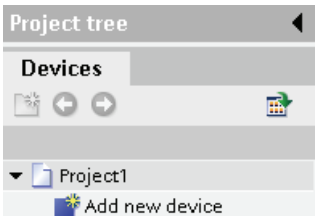
① Communications module (CM): Up to 3, inserted in slots 101, 102, and 103
② CPU: Slot 1
③ Ethernet port of CPU
④ Signal board (SB): up to 1, inserted in the CPU
⑤ Signal module (SM) for digital or analog I/O: up to 8, inserted in slots 2 through 9 (CPU 1214C allows 8, CPU 1212C allows 2, CPU 1211C does not allow any)

To create the device configuration, add a device to your project.

- In the Portal view, select "Devices & Networks" and click "Add device".



- In the Project view, under the project name, double-click "Add new device".



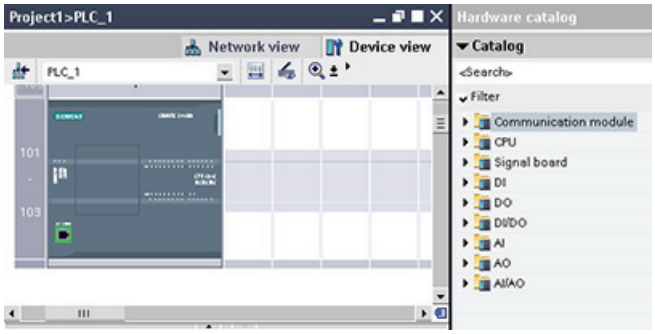
4.2 Inserting a CPU

You create your device configuration by inserting a CPU into your project. Selecting the CPU from the "Add a new device" dialog creates the rack and CPU.

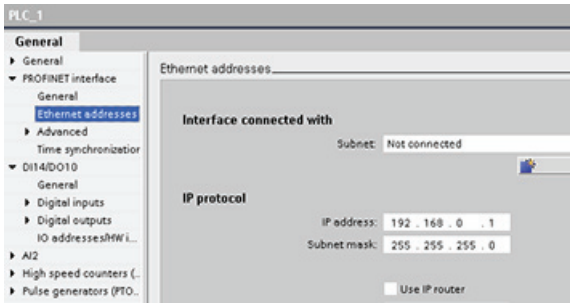
"Add a new device" dialog



Device view of the hardware configuration



Selecting the CPU in the Device view displays the CPU properties in the inspector window.



Note

The CPU does not have a pre-configured IP address. You must manually assign an IP address for the CPU during the device configuration. If your CPU is connected to a router on the network, you also enter the IP address for a router.

4.3 Detecting the configuration for an unspecified CPU

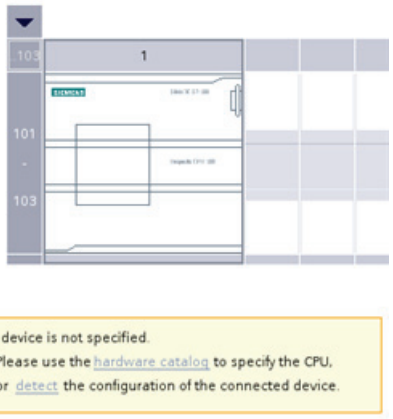
Uploading an existing hardware configuration is easy



If you are connected to a CPU, you can upload the configuration of that CPU, including any modules, to your project. Simply create a new project and select the "unspecified CPU" instead of selecting a specific CPU. (You can also skip the device configuration entirely by selecting the "Create a PLC program" from the "First steps". STEP 7 Basic then automatically creates an unspecified CPU.)

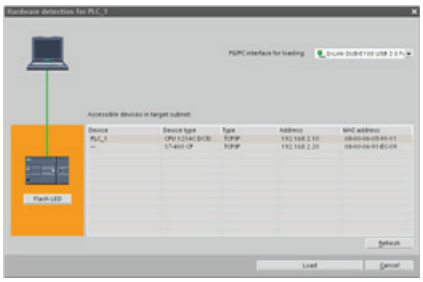
From the program editor, you select the "Hardware detection" command from the "Online" menu.

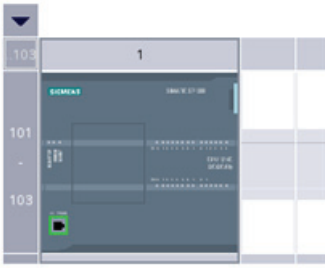
From the device configuration editor, you select the option for detecting the configuration of the connected device.





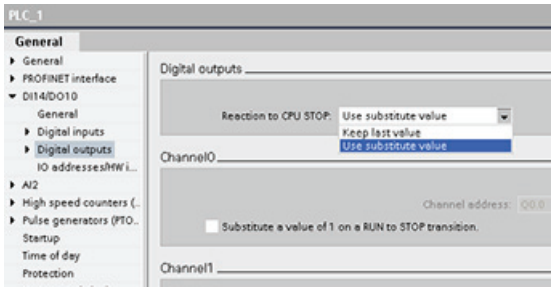
After you select the CPU from the online dialog, STEP 7 Basic uploads the hardware configuration from the CPU, including any modules (SM, SB, or CM). You can then configure the parameters for the CPU and the modules.





4.4 Configuring the operation of the CPU

To configure the operational parameters for the CPU, select the CPU in the Device view (blue outline around whole CPU), and use the "Properties" tab of the inspector window.



Edit the properties to configure the following parameters:

- PROFINET interface: Sets the IP address for the CPU and time synchronization
- DI, DO, and AI: Configures the behavior of the local (on-board) digital and analog I/O
- High-speed counters and pulse generators: Enables and configures the high-speed counters (HSC) and the pulse generators used for pulse-train operations (PTO) and pulse-width modulation (PWM)

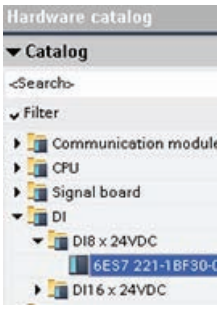
  When you configure the outputs of the CPU or signal board as pulse generators (for use with the PWM or basic motion control instructions), the corresponding outputs addresses (Q0.0, Q0.1, Q4.0, and Q4.1) are removed from the Q memory and cannot be used for other purposes in your user program. If your user program writes a value to an output used as a pulse generator, the CPU does not write that value to the physical output.
- Startup: Selects the behavior of the CPU following an off-to-on transition, such as to start in STOP mode or to go to RUN mode after a warm restart
- Time of day: Sets the time, time zone and daylight saving time
- Protection: Sets the read/write protection and password for accessing the CPU
- System and clock memory: Enables a byte for "system memory" functions (for a "first-scan" bit, an "always-on" bit, and an "always-off" bit) and enables a byte for "clock memory" functions (where each bit toggles on and off at a predefined frequency).
- Cycle time: Defines a maximum cycle time or a fixed minimum cycle time
- Communications load: Allocates a percentage of the CPU time to be dedicated to communication tasks

4.5 Adding modules to the configuration

Use the hardware catalog to add modules to the CPU. There are three types of modules:

- Signal modules (SM) provide additional digital or analog I/O points. These modules are connected to the right side of the CPU.
- Signal boards (SB) provide just a few additional I/O points for the CPU. The SB is installed on the front of the CPU.
- Communication modules (CM) provide an additional communication port (RS232 or RS485) for the CPU. These modules are connected to the left side of the CPU.

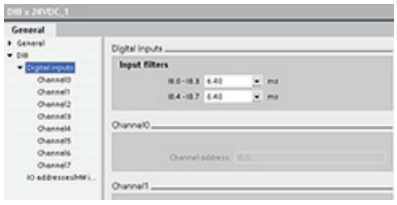
To insert a module into the hardware configuration, select the module in the hardware catalog and either double-click or drag the module to the highlighted slot.

Module	Select the module	Insert the module	Result
SM			
SB			
CM			

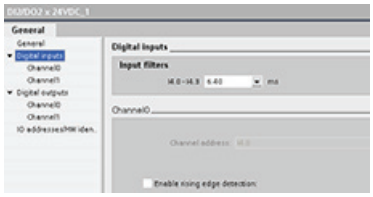
4.6 Configuring the parameters of the modules

To configure the operational parameters for the modules, select the module in the Device view and use the "Properties" tab of the inspector window to configure the parameters for the module.

Configuring a signal module (SM) or a signal board (SB)



- Digital I/O: Inputs can be configured for rising-edge detection or falling-edge detection (associating each with an event and hardware interrupt) and also for "pulse catch" (to stay on after a momentary pulse) through the next update of the input process image. Outputs can use a freeze or substitute value.



- Analog I/O: For individual inputs, configure parameters, such as measurement type (voltage or current), range and smoothing, and to enable underflow or overflow diagnostics. Outputs provide parameters such as output type (voltage or current) and for diagnostics, such as short-circuit (for voltage outputs) or upper/lower limit diagnostics
- I/O diagnostic addresses: Configures the start address for the set of inputs and outputs of the module

Configuring a communication module (CM)

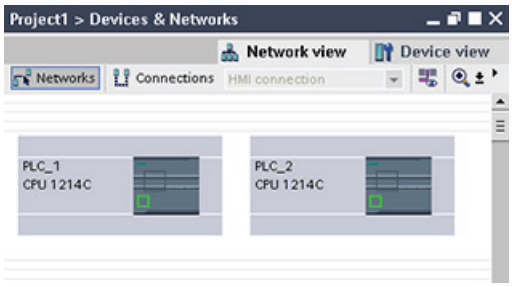
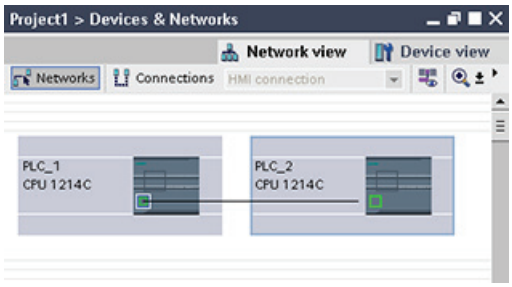
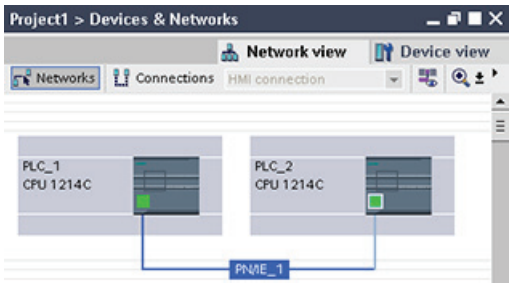


- Port configuration: Configures the communication parameters, such as baud rate, parity, data bits, stop bits, flow control, XON and XOFF characters, and wait time
- Transmit message configuration: Enables and configures transmit related options
- Receive message configuration: Enables and configures the message-start and message-end parameters

These configuration parameters can be changed by your program.

4.7 Creating a network connection

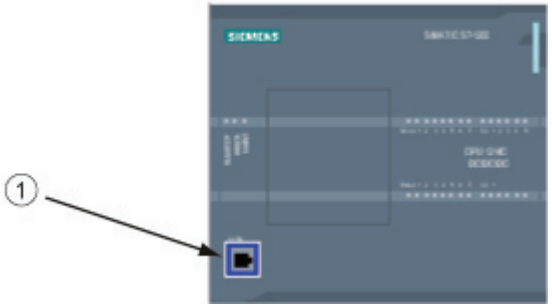
Use the "Network view" of Device configuration to create the network connections between the devices in your project. After creating the network connection, use the "Properties" tab of the inspector window to configure the parameters of the network.

Action	Result
Select "Network view" to display the devices to be connected.	
Select the port on one device and drag the connection to the port on the second device.	
Release the mouse button to create the network connection.	

4.8 Configuring an IP address in your project

Configuring the PROFINET interface

After you configure the rack with the CPU (Page 72) , you can configure parameters for the PROFINET interface. To do so, click the green PROFINET box on the CPU to select the PROFINET port. The "Properties" tab in the inspector window displays the PROFINET port.



① PROFINET port

Configuring the IP address

Ethernet (MAC) address: In a PROFINET network, each device is assigned a Media Access Control address (MAC address) by the manufacturer for identification. A MAC address consists of six groups of two hexadecimal digits, separated by hyphens (-) or colons (:), in transmission order, (for example, 01-23-45-67-89-AB or 01:23:45:67:89:AB).

IP address: Each device must also have an Internet Protocol (IP) address. This address allows the device to deliver data on a more complex, routed network.

Each IP address is divided into four 8-bit segments and is expressed in a dotted, decimal format (for example, 211.154.184.16). The first part of the IP address is used for the Network ID (What network are you on?), and the second part of the address is for the Host ID (unique for each device on the network). An IP address of 192.168.x.y is a standard designation recognized as part of a private network that is not routed on the Internet.

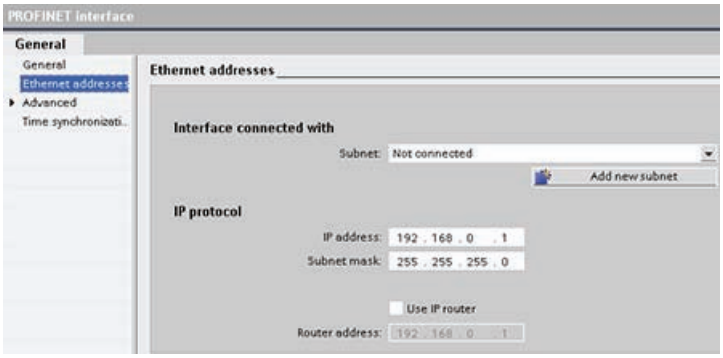
Subnet mask: A subnet is a logical grouping of connected network devices. Nodes on a subnet tend to be located in close physical proximity to each other on a Local Area Network (LAN). A mask (known as the subnet mask or network mask) defines the boundaries of an IP subnet.

A subnet mask of 255.255.255.0 is generally suitable for a small local network. This means that all IP addresses on this network should have the same first 3 octets, and the various devices on this network are identified by the last octet (8-bit field). An example of this is to assign a subnet mask of 255.255.255.0 and an IP addresses of 192.168.2.0 through 192.168.2.255 to the devices on a small local network.

The only connection between different subnets is via a router. If subnets are used, an IP router must be employed.

IP router: Routers are the link between LANs. Using a router, a computer in a LAN can send messages to any other networks, which might have other LANs behind them. If the destination of the data is not within the LAN, the router forwards the data to another network or group of networks where it can be delivered to its destination.

Routers rely on IP addresses to deliver and receive data packets.



IP addresses properties:
In the Properties window, select the "Ethernet address" configuration entry. The TIA Portal displays the Ethernet address configuration dialog, which associates the software project with the IP address of the CPU that will receive that project.

Note

The CPU does not have a pre-configured IP address. You must manually assign an IP address for the CPU. If your CPU is connected to a router on a network, you must also enter the router's IP address. All IP addresses are configured when you download the project.

Refer to "Assigning IP addresses to programming and network devices (Page 212)" for more information.

The following table defines the parameters for the IP address:

Parameter		Description
Subnet	Name of the Subnet to which the device is connected. Click the "Add new subnet" button to create a new subnet. "Not connected" is the default. Two connection types are possible: • The "Not connected" default provides a local connection. • A subnet is required when your network has two or more devices.	
IP protocol	IP address	Assigned IP address for the CPU
	Subnet mask	Assigned subnet mask
	Use IP router	Click the checkbox to indicate the use of an IP router
	Router address	Assigned IP address for the router, if applicable

Programming concepts

5

5.1 Guidelines for designing a PLC system

When designing a PLC system, you can choose from a variety of methods and criteria. The following general guidelines can apply to many design projects. Of course, you must follow the directives of your own company's procedures and the accepted practices of your own training and location.

Recommended steps	Tasks
Partition your process or machine	Divide your process or machine into sections that have a level of independence from each other. These partitions determine the boundaries between controllers and influence the functional description specifications and the assignment of resources.
Create the functional specifications	Write the descriptions of operation for each section of the process or machine, such as the I/O points, the functional description of the operation, the states that must be achieved before allowing action for each actuator (such as a solenoid, a motor, or a drive), a description of the operator interface, and any interfaces with other sections of the process or machine.
Design the safety circuits	Identify any equipment that might require hard-wired logic for safety. Remember that control devices can fail in an unsafe manner, which can produce unexpected startup or change in the operation of machinery. Where unexpected or incorrect operation of the machinery could result in physical injury to people or significant property damage, consider the implementation of electromechanical overrides (which operate independently of the PLC) to prevent unsafe operations. The following tasks should be included in the design of safety circuits: • Identify any improper or unexpected operation of actuators that could be hazardous. • Identify the conditions that would assure the operation is not hazardous, and determine how to detect these conditions independently of the PLC. • Identify how the PLC affects the process when power is applied and removed, and also identify how and when errors are detected. Use this information only for designing the normal and expected abnormal operation. You should not rely on this "best case" scenario for safety purposes. • Design the manual or electromechanical safety overrides that block the hazardous operation independent of the PLC. • Provide the appropriate status information from the independent circuits to the PLC so that the program and any operator interfaces have necessary information. • Identify any other safety-related requirements for safe operation of the process.
Specify the operator stations	Based on the requirements of the functional specifications, create the following drawings of the operator stations: • Overview drawing that shows the location of each operator station in relation to the process or machine. • Mechanical layout drawing of the devices for the operator station, such as display, switches, and lights. • Electrical drawings with the associated I/O of the PLC and signal modules.

Recommended steps	Tasks
Create the configuration drawings	Based on the requirements of the functional specification, create configuration drawings of the control equipment: • Overview drawing that shows the location of each PLC in relation to the process or machine. • Mechanical layout drawing of each PLC and any I/O modules, including any cabinets and other equipment. • Electrical drawings for each PLC and any I/O modules, including the device model numbers, communications addresses, and I/O addresses.
Create a list of symbolic names	Create a list of symbolic names for the absolute addresses. Include not only the physical I/O signals, but also the other elements (such as tag names) to be used in your program.

5.2 Structuring your user program

When you create a user program for the automation tasks, you insert the instructions for the program into code blocks:

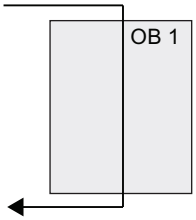
- An organization block (OB) responds to a specific event in the CPU and can interrupt the execution of the user program. The default for the cyclic execution of the user program (OB 1) provides the base structure for your user program and is the only code block required for a user program. If you include other OBs in your program, these OBs interrupt the execution of OB 1. The other OBs perform specific functions, such as for startup tasks, for handling interrupts and errors, or for executing specific program code at specific time intervals.
- A function block (FB) is a subroutine that is executed when called from another code block (OB, FB, or FC). The calling block passes parameters to the FB and also identifies a specific data block (DB) that stores the data for the specific call or instance of that FB. Changing the instance DB allows a generic FB to control the operation of a set of devices. For example, one FB can control several pumps or valves, with different instance DBs containing the specific operational parameters for each pump of valve.
- A function (FC) is a subroutine that is executed when called from another code block (OB, FB, or FC). The FC does not have an associated instance DB. The calling block passes parameters to the FC. The output values from the FC must be written to a memory address or to a global DB.

Choosing the type of structure for your user program

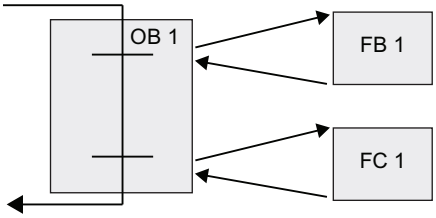
Based on the requirements of your application, you can choose either a linear structure or a modular structure for creating your user program:

- A linear program executes all of the instructions for your automation tasks in sequence, one after the other. Typically, the linear program puts all of the program instructions into the OB for the cyclic execution of the program (OB 1).
- A modular program calls specific code blocks that perform specific tasks. To create a modular structure, you divide the complex automation task into smaller subordinate tasks that correspond to the technological functions of the process. Each code block provides the program segment for each subordinate task. You structure your program by calling one of the code blocks from another block.

Linear structure:



Modular structure:



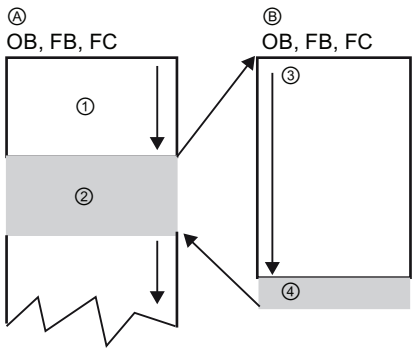
By creating generic code blocks that can be reused within the user program, you can simplify the design and implementation of the user program. Using generic code blocks has a number of benefits:

- You can create reusable blocks of code for standard tasks, such as for controlling a pump or a motor. You can also store these generic code blocks in a library that can be used by different applications or solutions.
- When you structure the user program into modular components that relate to functional tasks, the design of your program can be easier to understand and to manage. The modular components not only help to standardize the program design, but can also help to make updating or modifying the program code quicker and easier.
- Creating modular components simplifies the debugging of your program. By structuring the complete program as a set of modular program segments, you can test the functionality of each code block as it is developed.
- Creating modular components that relate to specific technological functions can help to simplify and reduce the time involved with commissioning the completed application.

5.3 Using blocks to structure your program

By designing FBs and FCs to perform generic tasks, you create modular code blocks. You then structure your program by having other code blocks call these reusable modules. The calling block passes device-specific parameters to the called block.

A Calling block
B Called (or interrupting) block
① Program execution
② Operation that calls another block
③ Program execution
④ Block end (returns to calling block)



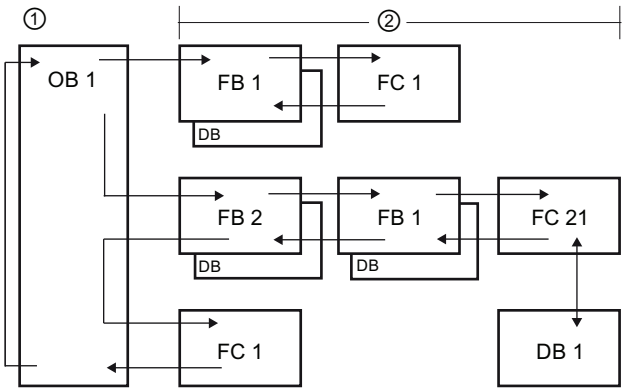
When a code block calls another code block, the CPU executes the program code in the called block. After execution of the called block is complete, the CPU resumes the execution of the calling block.

Processing continues with execution of the instruction that follows after the block call.

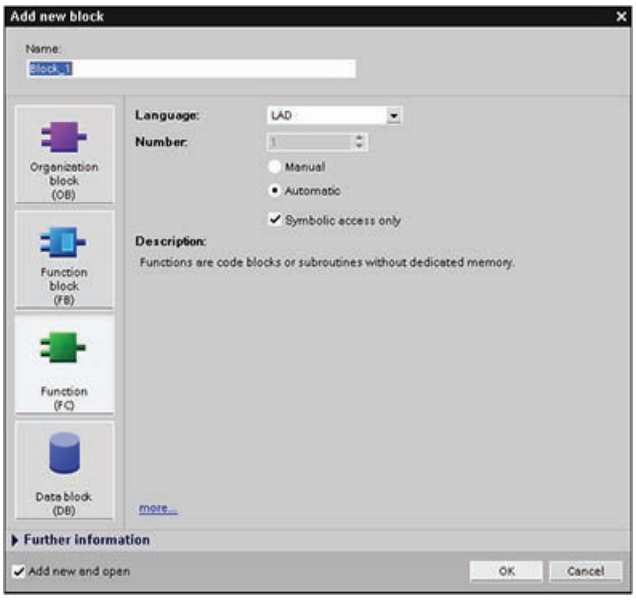
You can nest the block calls for a more modular structure.

① Start of cycle

② Nesting depth



Creating reusable code blocks



Use the "Add new block" dialog under "Program blocks" in the Project navigator to create OBs, FBs, FCs, and global DBs.

When you create code block, you select the programming language for the block. You do not select a language for a DB because it only stores data.

5.3.1 Organization block (OB)

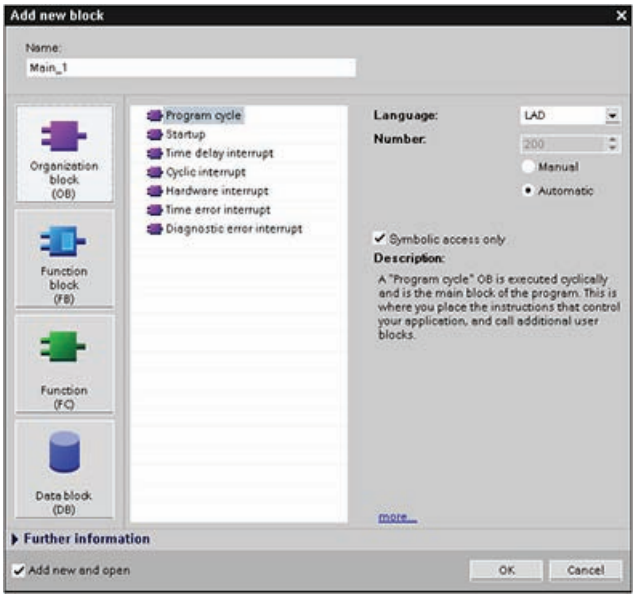
Organization blocks provide structure for your program. They serve as the interface between the operating system and the user program. OBs are event driven. An event, such as a diagnostic interrupt or a time interval, will cause the CPU to execute an OB. Some OBs have predefined start events and behavior.

The program cycle OB contains your main program. You can include more than one program cycle OB in your user program. During RUN mode, the program cycle OBs execute at the lowest priority level and can be interrupted by all other types of program processing. The startup OB does not interrupt the program cycle OB because the CPU executes the startup OB before going to RUN mode.

After finishing the processing of the program cycle OBs, the CPU immediately executes the program cycle OBs again. This cyclic processing is the "normal" type of processing used for programmable logic controllers. For many applications, the entire user program is located in a single program cycle OB.

You can create other OBs to perform specific functions, such as startup tasks, for handling interrupts and errors, or for executing specific program code at specific time intervals. These OBs interrupt the execution of the program cycle OBs.

Use the "Add new block" dialog to create new OBs in your user program.



Depending on their respective priority levels, one OB can interrupt another OB. Interrupt handling is always event-driven. When such an event occurs, the CPU interrupts the execution of the user program and calls the OB that was configured to handle that event. After finishing the execution of the interrupting OB, the CPU resumes the execution of the user program at the point of interruption.

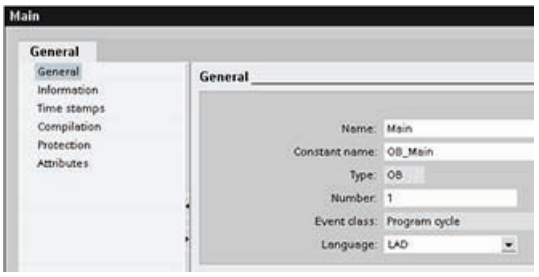
The CPU determines the order for handling interrupt events by a priority assigned to each OB. Each event has a particular servicing priority. Several interrupt events can be combined into priority classes. For more information, refer to the PLC concepts chapter section on execution of the user program (Page 37).

Creating an additional OB within a class of OB

You can create multiple OBs for your user program, even for the program cycle and startup OB classes. Use the "Add new block" dialog to create a OB. Enter the name for your OB and enter an OB number greater than 200.

If you create multiple program cycle OBs for your user program, the CPU executes each program cycle OB in numerical sequence, starting with the main program cycle OB (default: OB 1). For example: after first program cycle OB (OB1) finishes, the CPU executes the second program cycle OB (such as OB 200).

Configuring the operation of an OB



You can modify the operational parameters for an OB. For example, you can configure the time parameter for a time-delay OB or for a cyclic OB.

5.3.2 Function (FC)

A function (FC) is a code block that typically performs a specific operation on a set of input values. The FC stores the results of this operation in memory locations.

Use FCs to perform the following tasks:

- To perform standard and reusable operations, such as for mathematical calculations.
- To perform technological functions, such as for individual controls using bit logic operations.

An FC can also be called several times at different points in a program. This reuse simplifies the programming of frequently recurring tasks.

An FC does not have an associated instance data block (DB). The FC uses the local data stack for the temporary data used to calculate the operation. The temporary data is not saved. To store data permanently, assign the output value to a global memory location, such as M memory or to a global DB.

5.3.3 Function block (FB)

A function block (FB) is a code block that uses an instance data block for its parameters and static data. FBs have variable memory that is located in a data block (DB), or "instance" DB. The instance DB provides a block of memory that is associated with that instance (or call) of the FB and stores data after the FB finishes. You can associate different instance DBs with different calls of the FB. The instance DBs allow you to use one generic FB to control multiple devices. You structure your program by having one code block make a call to an FB and an instance DB. The CPU then executes the program code in that FB, and stores the block parameters and the static local data in the instance DB. When the execution of the FB finishes, the CPU returns to the code block that called the FB. The instance DB retains the values for that instance of the FB. These values are available to subsequent calls to the function block either in the same scan cycle or other scan cycles.

Reusable code blocks with associated memory

You typically use an FB to control the operation for tasks or devices that do not finish their operation within one scan cycle. To store the operating parameters so that they can be quickly accessed from one scan to the next, each FB in your user program has one or more instance DBs. When you call an FB, you also specify an instance DB that contains the block parameters and the static local data for that call or "instance" of the FB. The instance DB maintains these values after the FB finishes execution.

By designing the FB for generic control tasks, you can reuse the FB for multiple devices by selecting different instance DBs for different calls of the FB.

An FB stores the input (IN), output (OUT), and in/out (IN_OUT) parameters in an instance DB.

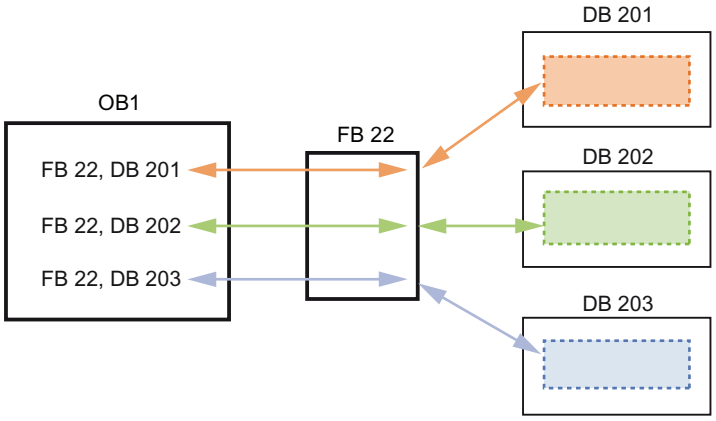
Assigning initial values

If the input, output, or in/out parameters of a function block (FB) are not assigned with values, the values stored in the instance data block (DB) will be used. In some cases, you must assign parameters.

You can assign initial values to the parameters in the FB interface. These values are transferred to the associated instance DB. If you do not assign parameters, the values currently stored in the instance DB will be used.

Using a single FB with DBs

The following figure shows an OB that calls one FB three times, using a different data block for each call. This structure allows one generic FB to control several similar devices, such as motors, by assigning a different instance data block for each call for the different devices. Each instance DB stores the data (such as speed, ramp-up time, and total operating time) for an individual device. In this example, FB 22 controls three separate devices, with DB 201 storing the operational data for the first device, DB 202 storing the operational data for the second device, and DB 203 storing the operational data for the third device.



5.3.4 Data block (DB)

You create data blocks (DB) in your user program to store data for the code blocks. All of the program blocks in the user program can access the data in a global DB, but an instance DB stores data for a specific function block (FB). You can define a DB as being read-only.

The data stored in a DB is not deleted when the execution of the associated code block comes to an end. There are two types of DBs:

- A global DB stores data for the code blocks in your program. Any OB, FB, or FC can access the data in a global DB.
- An instance DB stores the data for a specific FB. The structure of the data in an instance DB reflects the parameters (Input, Output, and InOut) and the static data for the FB. (The Temp memory for the FB is not stored in the instance DB.)

Note

Although the instance DB reflects the data for a specific FB, any code block can access the data in an instance DB.

5.4 Understanding data consistency

The CPU maintains the data consistency for all of the elementary data types (such as Words or DWords) and all of the system-defined structures (for example, IEC_TIMERS or DTL). The reading or writing of the value cannot be interrupted. (For example, the CPU protects the access to a DWord value until the four bytes of the DWord have been read or written.) To ensure that the program cycle OBs and the interrupt OBs cannot write to the same memory location at the same time, the CPU does not execute an interrupt OB until the read or write operation in the program cycle OB has been completed.

If your user program shares multiple values in memory between a program cycle OB and an interrupt OB, your user program must also ensure that these values are modified or read consistently. You can use the DIS_AIRT and EN_AIRT instructions in your program cycle OB to protect any access to the shared values.

- Insert a DIS_AIRT instruction in the code block to ensure that an interrupt OB cannot be executed during the read or write operation.
- Insert the instructions that read or write the values that could be altered by an interrupt OB.
- Insert an EN_AIRT instruction at the end of the sequence to cancel the the DIS_AIRT and allow the execution of the interrupt OB.

A communication request from an HMI device or another CPU can also interrupt execution of the program cycle OB. The communication requests can also cause issues with data consistency issues. The CPU ensures that the elementary data types are always read and written consistently by the user program instructions. Because the user program is interrupted periodically by communications, it is not possible to guarantee that multiple values in the CPU will all be updated at the same time by the HMI. For example, the values displayed on a given HMI screen could be from different scan cycles of the CPU.

The PtP (Point-to-Point) instructions, and the PROFINET instructions (such as TSEND_C and TRCV_C) transfer buffers of data that could be interrupted. Ensure the data consistency for the buffers of data by avoiding any read or write operation to the buffers in both the program cycle OB and an interrupt OB. If it is necessary to modify the buffer values for these

instructions in an interrupt OB, use a DIS_AIRT instruction to delay any interruption (an interrupt OB or a communication interrupt from an HMI or another CPU) until an EN_AIRT instruction is executed.

Note

The use of the DIS_AIRT instruction delays the processing of interrupt OBs until the EN_AIRT instruction is executed, affecting the interrupt latency (time from an event to the time when the interrupt OB is executed) of your user program.

5.5 Selecting the programming language

You have the option of choosing either the LAD (ladder logic) or FBD (Function Block Diagram) programming language.

LAD programming language

LAD is a graphical programming language. The representation is based on circuit diagrams.



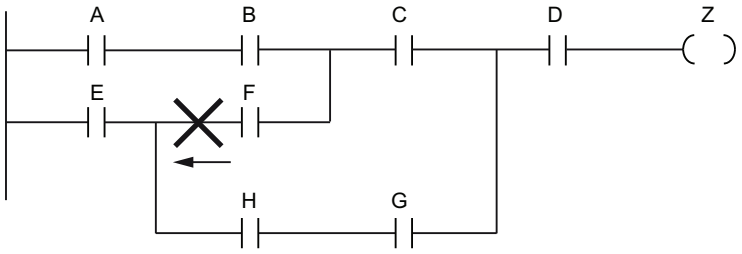
The elements of a circuit diagram, such as normally closed and normally open contacts, and coils are linked to form networks.

To create the logic for complex operations, you can insert branches to create the logic for parallel circuits. Parallel branches are opened downwards or are connected directly to the power rail. You terminate the branches upwards.

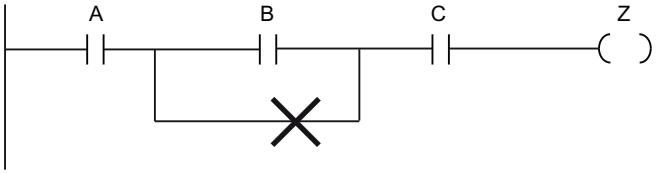
LAD provides "box" instructions for a variety of functions, such as math, timer, counter, and move.

Consider the following rules when creating a LAD network:

- Every LAD network must terminate with a coil or a box instruction. Do not terminate a network with either a Compare instruction or an Edge-detection (Positive-edge or Negative-edge) instruction.
- You cannot create a branch that could result in a power flow in the reverse direction.



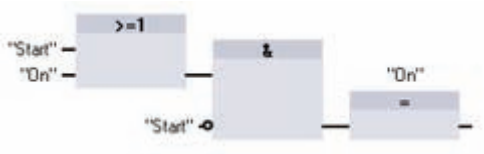
- You cannot create a branch that would cause a short circuit.



Function Block Diagram (FBD) programming language

Like LAD, FBD is also a graphical programming language. The representation of the logic is based on the graphical logic symbols used in Boolean algebra.

Mathematical functions and other complex functions can be represented directly in conjunction with the logic boxes. To create the logic for complex operations, insert parallel branches between the boxes.



Understanding EN and ENO for the "box" instructions

Both LAD and FBD use "power flow" (EN and ENO) for some "box" instructions. Certain instructions (such as math and move instructions) display parameters for EN and ENO. These parameters relate to power flow and determine whether the instruction is executed during that scan.

- EN (Enable In) is a Boolean input for boxes in LAD and FBD. Power flow (EN = 1) must be present at this input for the box instruction to be executed. If the EN input of a LAD box is connected directly to the left power rail, then box will always be executed.
- ENO (Enable Out) is a Boolean output for boxes in LAD and FBD. If the box has power flow at the EN input and the box executes its function without error, then the ENO output passes power flow (ENO = 1) to the next element. If an error is detected in the execution of the box instruction, then power flow is terminated (ENO = 0) at the box instruction that generated the error.

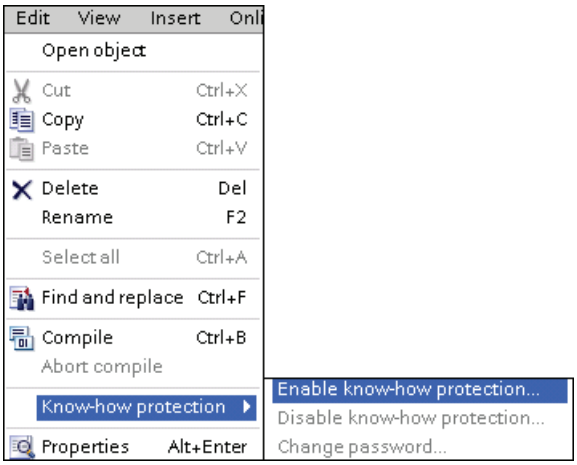
Program editor	Inputs/outputs	Operands	Data type
LAD	EN, ENO	Power flow	BOOL
FBD	EN	I, I:P, Q, M, DB, Temp, Power Flow	BOOL
	ENO	Power Flow	BOOL

5.6 Copy protection

Copy or "know-how" protection allows you to prevent one or more code blocks (OB, FB, or FC) in your program from unauthorized access. You create a password to limit access to the code block.

When you configure a block for "know-how" protection, the code within the block cannot be accessed except after entering the password.

To copy-protect the block, select the "Know how protection" command from the "Edit" menu. You then enter a password that allows access to the block.



The password-protection prevents unauthorized reading or modification of the code block. Without the password, you can read only the following information about the code block:

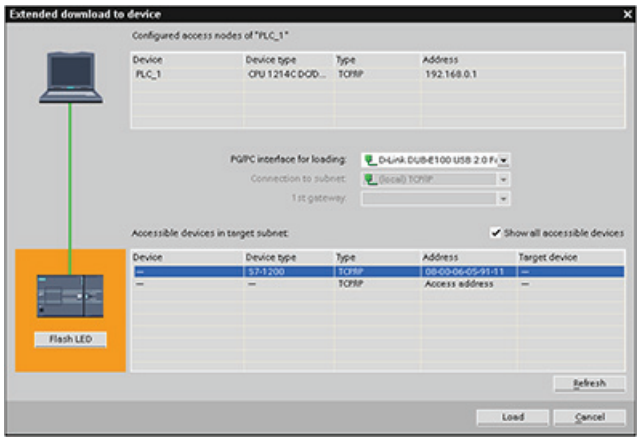
- Block title, block comment, and block properties
- Transfer parameters (IN, OUT, IN_OUT, Return)
- Call structure of the program
- Global tags in the cross references (without information on the point of use), but local tags are hidden

5.7 Downloading the elements of your program

You can download the elements of your project from the programming device to the CPU. When you download a project, the CPU stores the user program (OBs, FCs, FBs and DBs) in permanent memory.

You can download your project from the programming device to your CPU from any of the following locations:

- "Project tree": Right-click the program element, and then click the context-sensitive "Download" selection.
- "Online" menu: Click the "Download to device" selection.
- Toolbar: Click the "Download to device" icon.



5.8 Uploading the elements of your program

You can upload all program blocks and the tag table from an online CPU to an offline project, but you cannot upload the device configuration or watch tables. You cannot upload into an empty project; you must have an offline CPU to be able to upload. You cannot upload a single block; you can only upload the whole program. If an upload is performed, the offline CPU will be "cleared" (all blocks and tag table are deleted) before the upload after a check-question. You cannot edit a block in the online area; you must first upload it to the offline area, then modify it there, and then download it back to the PLC.

There are two ways to perform the upload: drag and drop in the Project tree, or synchronize in the Compare editor.

Drag and drop in the project tree

1. Create a new project.
2. Add a CPU device which matches the CPU you are uploading from.
3. Expand the CPU node once so that the "Program blocks" folder is visible.
4. From the Project tree, expand the node for "Online access", expand the node for the desired network, and double click "Update accessible devices.
5. After the available CPUs are listed, expand the node for the CPU of interest.
6. Left-click and hold the Program blocks folder from the Online access area and drag it up to the Program blocks folder from the offline area, then release the left mouse button. The mouse pointer should change to a '+' when you are over the correct area.
7. You should see the "Upload preview" dialog open. Click in the box for "Continue", and then click "Upload from device".
8. Allow the upload to complete. You should now see all the program blocks, technology blocks, and tags in the offline area.
9. Since the device configuration cannot be uploaded, use Device configuration to manually setup the CPU properties, including the desired IP address, and to add the other devices to the offline project.

You can also drag from the online area to the "Program blocks" area of an existing program. That is, the Program-blocks offline area does not have to be empty. In this case, the existing program will be deleted and replaced by the online program.

Synchronize in the compare editor

1. Open the project that contains the project.
2. In the Project tree, select the offline CPU to compare.
3. Open the "Compare" editor either by right-clicking the offline CPU, or by selecting the "Compare offline/online" command from the "Tools" menu.
4. The Compare editor lists the differences under the "Program blocks" folder. Click the symbol in the action column. To upload the project, select "Upload from device".
5. Click the "Synchronize online and offline" button to copy the project from the online CPU to the offline CPU.

5.9 Debugging and testing the program

You use "watch tables" for monitoring and modifying the values of a user program being executed by the online CPU. You can create and save different watch tables in your project to support a variety of test environments. This allows you to reproduce tests during commissioning or for service and maintenance purposes.

With a watch table, you can monitor and interact with the CPU as it executes the user program. You can display or change values not only for the tags of the code blocks and data blocks, but also for the memory areas of the CPU, including the inputs and outputs (I and Q), peripheral inputs and outputs (I:P and Q:P), bit memory (M), and data blocks (DB).

With the watch table, you can enable the physical outputs (Q:P) of a CPU in STOP mode. For example, you can assign specific values to the outputs when testing the wiring for the CPU.

The watch table also allows you to "force" or set a tag to a specific value. For more information about forcing, see the section on forcing values in the CPU (Page 273) in the "Online and Diagnostics" chapter.

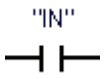
Programming instructions

6

6.1 Basic instructions

6.1.1 Bit logic

LAD contacts



Normally Open



Normally Closed

You can connect contacts to other contacts and create your own combination logic. If the input bit you specify uses memory identifier I (input) or Q (output), then the bit value is read from the process-image register. The physical contact signals in your control process are wired to I terminals on the PLC. The CPU scans the wired input signals and continuously updates the corresponding state values in the process-image input register.

You can specify an immediate read of a physical input using ":P" following the I offset (example: "%I3.4:P"). For an immediate read, the bit data values are read directly from the physical input instead of the process image. An immediate read does not update the process image.

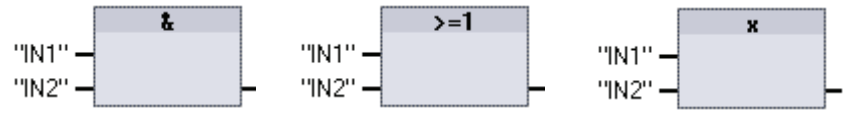
Parameter	Data type	Description
IN	Bool	Assigned bit

- The Normally Open contact is closed (ON) when the assigned bit value is equal to 1.
- The Normally Closed contact is closed (ON) when the assigned bit value is equal to 0.
- Contacts connected in series create AND logic networks.
- Contacts connected in parallel create OR logic networks.

FBD, AND, OR, and XOR boxes

In FBD programming, LAD contact networks are transformed into AND (&), OR (>=1), and exclusive OR (x) box networks where you can specify bit values for the box inputs and outputs. You may also connect to other logic boxes and create your own logic combinations. After the box is placed in your network, you can drag the "Insert binary input" tool from the "Favorites" toolbar or instruction tree and then drop it onto the input side of the box to add more inputs. You can also right-click on the box input connector and select "Insert input".

Box inputs and outputs can be connected to another logic box, or you can enter a bit address or bit symbol name for an unconnected input. When the box instruction is executed, the current input states are applied to the binary box logic and, if true, the box output will be true.



AND logic OR logic XOR logic

Parameter	Data type	Description
IN1, IN2	Bool	Input bit

- All inputs of an AND box must be TRUE for the output to be TRUE.
- Any input of an OR box must be TRUE for the output to be TRUE.
- An odd number of the inputs of an XOR box must be TRUE for the output to be TRUE.

NOT logic inverter

For FBD programming, you can drag the "Negate binary input" tool from the "Favorites" toolbar or instruction tree and then drop it on an input or output to create a logic inverter on that box connector.

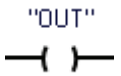


LAD: NOT contact inverter FBD: AND box with one inverted logic input FBD: AND box with inverted logic input and output

The LAD NOT contact inverts the logical state of power flow input.

- If there is no power flow into the NOT contact, then there is power flow out.
- If there is power flow into the NOT contact, then there is no power flow out.

LAD output coil



Output coil



Inverted output coil

The coil output instruction writes a value for an output bit. If the output bit you specify uses memory identifier Q, then the CPU turns the output bit in the process-image register on or off, setting the specified bit equal to power flow status. The output signals for your control actuators are wired to the Q terminals of the S7-1200. In RUN mode, the CPU system continuously scans your input signals, processes the input states according to your program logic, and then reacts by setting new output state values in the process-image output register. After each program execution cycle, the CPU system transfers the new output state reaction stored in the process-image register to the wired output terminals.

You can specify an immediate write of a physical output using ":P" following the Q offset (example: "%Q3.4:P"). For an immediate write, the bit data values are written to the process image output and directly to physical output.

Parameter	Data type	Description
OUT	Bool	Assigned bit

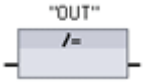
- If there is power flow through an output coil, then the output bit is set to 1.
- If there is no power flow through an output coil, then the output coil bit is set to 0.
- If there is power flow through an inverted output coil, then the output bit is set to 0.
- If there is no power flow through an inverted output coil, then the output bit is set to 1.

FBD output assignment box

In FBD programming, LAD coils are transformed into assignment (= and /=) boxes where you specify a bit address for the box output. Box inputs and outputs can be connected to other box logic or you can enter a bit address.



Output assignment



Inverted output assignment



Output assignment with inverted output

Parameter	Data type	Description
OUT	Bool	Assigned bit

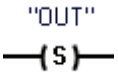
- If the output box input is 1, then the OUT bit is set to 1.
- If the output box input is 0, then the OUT bit is set to 0.
- If the inverted output box input is 1, then the OUT bit is set to 0.
- If the inverted output box input is 0, then the OUT bit is set to 1.

6.1.1.1 Set and reset instructions

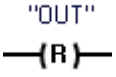
S and R: Set and Reset 1 bit

- When S (Set) is activated, then the data value at the OUT address is set to 1. When S is not activated, OUT is not changed.
- When R (Reset) is activated, then the data value at the OUT address is set to 0. When R is not activated, OUT is not changed.
- These instructions can be placed anywhere in the network.

LAD: Set



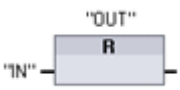
LAD: Reset



FBD: Set



FBD: Reset



Parameter	Data type	Description
IN (or connect to contact/gate logic)	Bool	Bit location to be monitored
OUT	Bool	Bit location to be set or reset

SET_BF and RESET_BF: Set and Reset Bit Field

LAD: SET_BF



LAD: RESET_BF



FBD: SET_BF



FBD: RESET_BF



Parameter	Data type	Description
n	Constant	Number of bits to write
OUT	Element of a boolean array	Starting element of a bit field to be set or reset Example: #MyArray[3]

- When SET_BF is activated, a data value of 1 is assigned to "n" bits starting at address OUT. When SET_BF is not activated, OUT is not changed.
- RESET_BF writes a data value of 0 to "n" bits starting at address OUT. When RESET_BF is not activated, OUT is not changed.
- These instructions must be the right-most instruction in a branch.

RS and SR: Set-dominant and Reset-dominant bit latches



RS is a set dominant latch where the set dominates. If the set (S1) and reset (R) signals are both true, the output address OUT will be 1.

SR is a reset dominant latch where the reset dominates. If the set (S) and reset (R1) signals are both true, the output address OUT will be 0.



The OUT parameter specifies the bit address that is set or reset. The optional OUT output Q reflects the signal state of the "OUT" address.

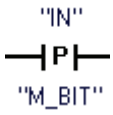
Parameter	Data type	Description
S, S1	BOOL	Set input; 1 indicates dominance
R, R1	BOOL	Reset input; 1 indicates dominance
OUT	BOOL	Assigned bit output "OUT"
Q	BOOL	Follows state of "OUT" bit

Instruction	S1	R	"OUT" bit
RS	0	0	Previous state
	0	1	0
	1	0	1
	1	1	1
	S	**R1**	
SR	0	0	Previous state
	0	1	0
	1	0	1
	1	1	0

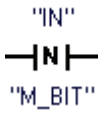
6.1.1.2 Positive and negative edge instructions

Positive and Negative transition detectors

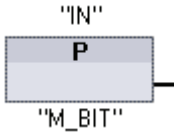
P contact: LAD



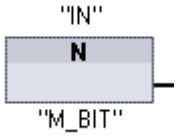
N contact: LAD



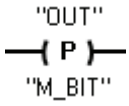
P box: FBD



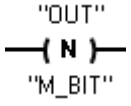
N box: FBD



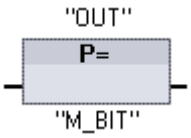
P coil: LAD



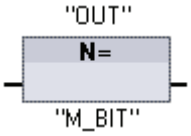
N coil: LAD



P= box: FBD



N= box: FBD



P_TRIG: LAD\FBD



N_TRIG: LAD\FBD



Parameter	Data type	Description
M_BIT	Bool	Memory bit in which the previous state of the input is saved
IN	Bool	Input bit whose transition edge is to be detected
OUT	Bool	Output bit which indicates a transition edge was detected
CLK	Bool	Power flow or input bit whose transition edge is to be detected
Q	Bool	Output which indicates an edge was detected

P contact: LAD	The state of this contact is TRUE when a positive transition (OFF-to-ON) is detected on the assigned "IN" bit. The contact logic state is then combined with the power flow in state to set the power flow out state. The P contact can be located anywhere in the network except the end of a branch.
N contact: LAD	The state of this contact is TRUE when a negative transition (ON-to-OFF) is detected on the assigned input bit. The contact logic state is then combined with the power flow in state to set the power flow out state. The N contact can be located anywhere in the network except the end of a branch.
P box: FBD	The output logic state is TRUE when a positive transition (OFF-to-ON) is detected on the assigned input bit. The P box can only be located at the beginning of a branch.
N box: FBD	The output logic state is TRUE when a negative transition (ON-to-OFF) is detected on the assigned input bit. The N box can only be located at the beginning of a branch.
P coil: LAD	The assigned bit "OUT" is TRUE when a positive transition (OFF-to-ON) is detected on the power flow entering the coil. The power flow in state always passes through the coil as the power flow out state. The P coil can be located anywhere in the network.
N coil: LAD	The assigned bit "OUT" is TRUE when a negative transition (ON-to-OFF) is detected on the power flow entering the coil. The power flow in state always passes through the coil as the power flow out state. The N coil can be located anywhere in the network.
P= box: FBD	The assigned bit "OUT" is TRUE when a positive transition (OFF-to-ON) is detected on the logic state at the box input connection or on the input bit assignment if the box is located at the start of a branch. The input logic state always passes through the box as the output logic state. The P= box can be located anywhere in the branch.
N= box: FBD	The assigned bit "OUT" is TRUE when a negative transition (ON-to-OFF) is detected on the logic state at the box input connection or on the input bit assignment if the box is located at the start of a branch. The input logic state always passes through the box as the output logic state. The N= box can be located anywhere in the branch.
P_TRIG: LAD/FBD	The Q output power flow or logic state is TRUE when a positive transition (OFF-to-ON) is detected on the CLK input state (FBD) or CLK power flow in (LAD). In LAD, the P_TRIG instruction cannot be located at the beginning or end of a network. In FBD, the P_TRIG instruction can be located anywhere except the end of a branch.
N_TRIG (LAD/FBD)	The Q output power flow or logic state is TRUE when a negative transition (ON-to-OFF) is detected on the CLK input state (FBD) or CLK power flow in (LAD). In LAD, the N_TRIG instruction cannot be located at the beginning or end of a network. In FBD, the P_TRIG instruction can be located anywhere except the end of a branch.

All edge instructions use a memory bit (M_BIT) to store the previous state of the input signal being monitored. An edge is detected by comparing the state of the input with the state of the memory bit. If the states indicate a change of the input in the direction of interest, then an edge is reported by writing the output TRUE. Otherwise, the output is written FALSE.

Note

Edge instructions evaluate the input and memory-bit values each time they are executed, including the first execution. You must account for the initial states of the input and memory bit in your program design either to allow or to avoid edge detection on the first scan.

Because the memory bit must be maintained from one execution to the next, you should use a unique bit for each edge instruction, and you should not use this bit any other place in your program. You should also avoid temporary memory and memory that can be affected by other system functions, such as an I/O update. Use only M, global DB, or Static memory (in an instance DB) for M_BIT memory assignments.

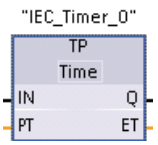
6.1.2 Timers

You use the timer instructions to create programmed time delays:

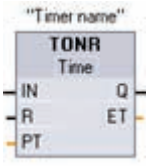
- TP: The Pulse timer generates a pulse with a preset width time.
- TON: The ON-delay timer output Q is set to ON after a preset time delay.
- TOF: The OFF-delay timer output Q is reset to OFF after a preset time delay.
- TONR: The ON-delay Retentive timer output is set to ON after a preset time delay. Elapsed time is accumulated over multiple timing periods until the R input is used to reset the elapsed time.
- RT: Reset a timer by clearing the time data stored in the specified timer instance data block.

Each timer uses a structure stored in a data block to maintain timer data. You assign the data block when the timer instruction is placed in the editor.

When you place timer instructions in a function block, you can select the Multi-instance data block option, the timer structure names can be different with separate data structures, but the timer data is contained in a single data block and does not require a separate data block for each timer. This reduces the processing time and data storage necessary for handling the timers. There is no interaction between the timer data structures in the shared Multi-instance data block.



TP, TON, and TOF timers have the same input and output parameters.



The TONR timer has the additional reset input parameter R.

Create you own "Timer name" that names the timer Data Block and describes the purpose of this timer in your process.

"Timer name"
----[RT]----

The RT instruction resets the timer data for the specified timer.

Parameter	Data type	Description
IN	Bool	Enable timer input
R	Bool	Reset TONR elapsed time to zero
PT	Bool	Preset time value input
Q	Bool	Timer output
ET	Time	Elapsed time value output
Timer data block	DB	Specify which timer to reset with the RT instruction

Parameter IN starts and stops the timers:

- The 0 to 1 transition of parameter IN starts timers TP, TON, and TONR.
- The 1 to 0 transition of parameter IN starts timer TOF.

The following table shows the effect of value changes in the PT and IN parameters.

Timer	Changes in the PT and IN parameters
TP	• Changing PT has no effect while the timer runs. • Changing IN has no effect while the timer runs.
TON	• Changing PT has no effect while the timer runs. • Changing IN to FALSE, while the timer runs, resets and stops the timer.
TOF	• Changing PT has no effect while the timer runs. • Changing IN to TRUE, while the timer runs, resets and stops the timer.
TONR	• Changing PT has no effect while the timer runs, but has an effect when the timer resumes. • Changing IN to FALSE, while the timer runs, stops the timer but does not reset the timer. Changing IN back to TRUE will cause the timer to start timing from the accumulated time value.

TIME values

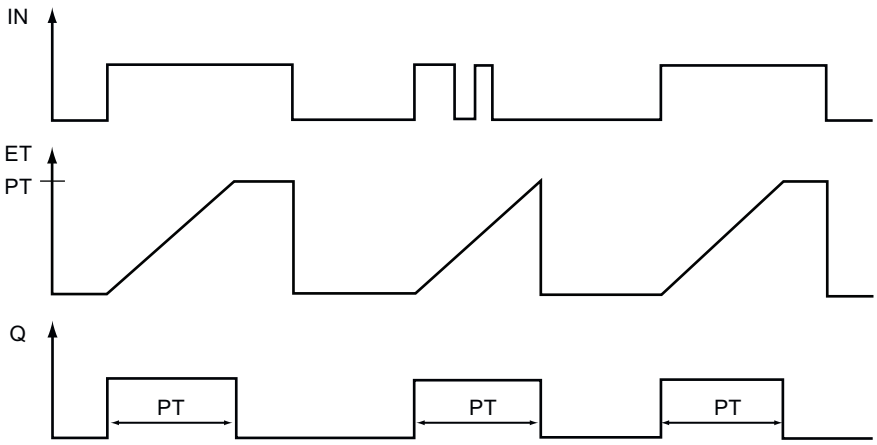
PT (preset time) and ET (elapsed time) values are stored in memory as signed double integers that represent milliseconds of time. TIME data uses the T# identifier and can be entered as a simple time unit "T#200ms" or as compound time units "T#2s_200ms".

Data type	Size	Valid number ranges
TIME	32 bits	T#-24d_20h_31m_23s_648ms to T#24d_20h_31m_23s_647ms
	Stored as	-2,147,483,648 ms to +2,147,483,647 ms

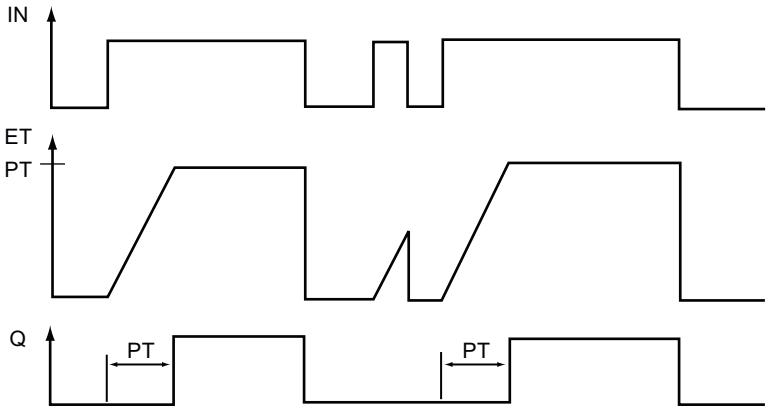
Note

The negative range of the TIME data type shown above cannot be used with the timer instructions. Negative PT (preset time) values are set to zero when the timer instruction is executed. ET (elapsed time) is always a positive value.

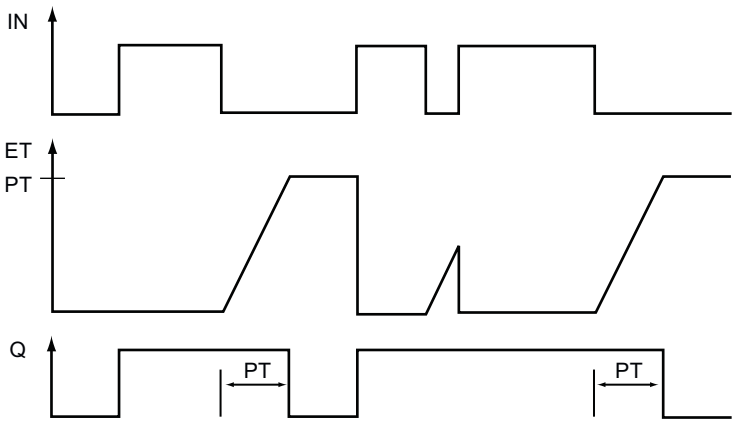
TP: Pulse timing diagram



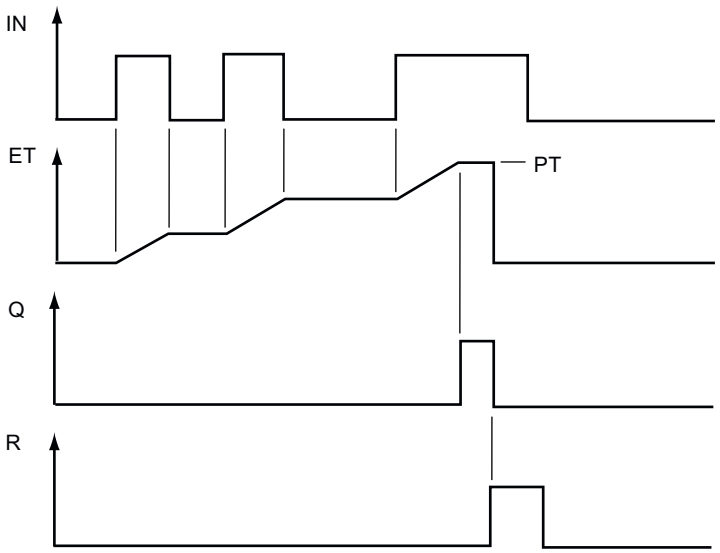
TON: ON-delay timing diagram



TOF: OFF-delay timing diagram



TONR: ON-delay Retentive timing diagram



6.1.3 Counters

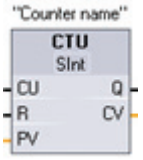
6.1.3.1 Counters

You use the counter instructions to count internal program events and external process events:

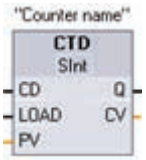
- CTU is a count up counter.
- CTD is a count down counter.
- CTUD is a count up and down counter.

Each counter uses a structure stored in a data block to maintain counter data. You assign the data block when the counter instruction is placed in the editor. These instructions use software counters whose maximum counting rate is limited by the execution rate of the OB in which they are placed. The OB that the instructions are placed in must be executed often enough to detect all transitions of the CU or CD inputs. For faster counting operations, see the CTRL_HSC instruction.

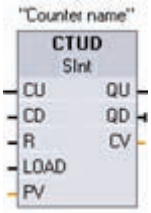
When you place counter instructions in a function block, you can select the Multi-instance data block option, the counter structure names can be different with separate data structures, but the counter data is contained in a single data block and does not require a separate data block for each counter. This reduces the processing time and data storage necessary for the counters. There is no interaction between the counter data structures in the shared multi-instance data block.



Select the count value data type from the drop-down list under the box name.



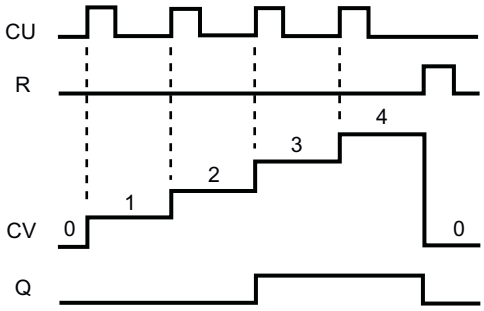
Create your own "Counter name" that names the counter Data Block and describes the purpose of this counter in your process.



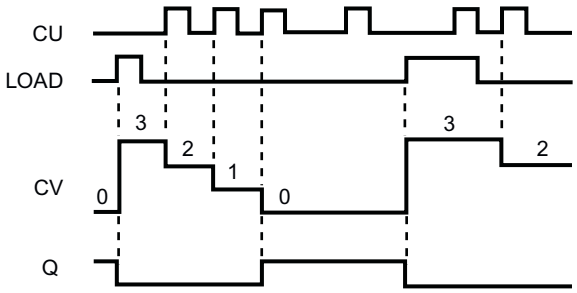
Parameter	Data type	Description
CU, CD	Bool	Count up or count down, by one count
R (CTU, CTUD)	Bool	Reset count value to zero
LOAD (CTD, CTUD)	Bool	Load control for preset value
PV	SInt, Int, DInt, USInt, UInt, UDInt	Preset count value
Q, QU	Bool	True if CV >= PV
QD	Bool	True if CV <= 0
CV	SInt, Int, DInt, USInt, UInt, UDInt	Current count value

The numerical range of count values depends on the data type you select. If the count value is an unsigned integer type, you can count down to zero or count up to the range limit. If the count value is a signed integer, you can count down to the negative integer limit and count up to the positive integer limit.

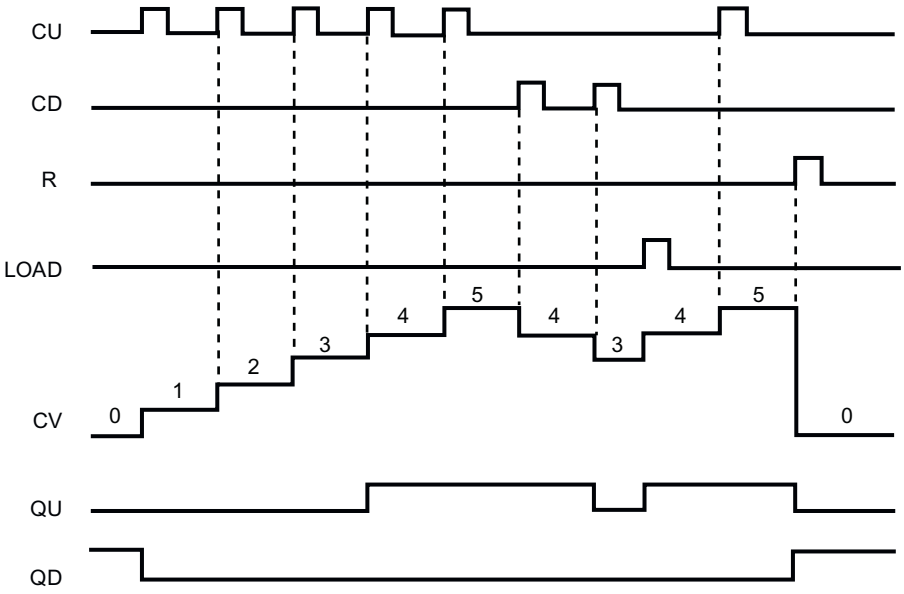
CTU: CTU counts up by 1 when the value of parameter CU changes from 0 to 1. If the value of parameter CV (Current count value) is greater than or equal to the value of parameter PV (Preset count value), then the counter output parameter Q = 1. If the value of the reset parameter R changes from 0 to 1, then the current count value is reset to 0. The following figure shows a CTU timing diagram with an unsigned integer count value (where PV = 3).



CTD: CTD counts down by 1 when the value of parameter CD changes from 0 to 1. If the value of parameter CV (Current count value) is equal to or less than 0, the counter output parameter Q = 1. If the value of parameter LOAD changes from 0 to 1, the value at parameter PV (Preset value) is loaded to the counter as the new CV (Current count value). The following figure shows a CTD timing diagram with an unsigned integer count value (where PV = 3).



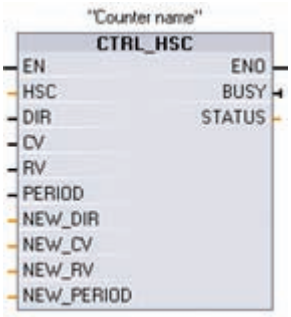
CTUD: CTUD counts up or down by 1 on the 0 to 1 transition of the Count up (CU) or Count down (CD) inputs. If the value of parameter CV (Current count value) is equal to or greater than the value of parameter PV (Preset value), then the counter output parameter QU = 1. If the value of parameter CV is less than or equal to zero, then the counter output parameter QD = 1. If the value of parameter LOAD changes from 0 to 1, then the value at parameter PV (Preset value) is loaded to the counter as the new CV (Current count value). If the value of the reset parameter R is changes from 0 to 1, the current count value is reset to 0. The following figure shows a CTUD timing diagram with an unsigned integer count value (where PV = 4).



6.1.3.2 CTRL_HSC instruction

The CTRL_HSC instruction controls the high-speed counters that are used to count events that occur faster than the OB execution rate. The counting rate of the CTU, CTD, and CTUD counter instructions is limited by the execution rate of the OB in which they are placed. Refer to the CPU technical specifications (Page 284) for the HSC maximum clock input rates.

A typical use for high-speed counters is to count pulses generated by a motion control shaft encoder.



Each CTRL_HSC instruction uses a structure stored in a data block to maintain data. You assign the data block when the CTRL_HSC instruction is placed in the editor.

Create you own "Counter name" that names the counter Data Block and describes the purpose of this counter in your process.

Parameter	Parameter type	Data type	Description
HSC	IN	HW_HSC	HSC identifier
DIR	IN	Bool	1 = Request new direction
CV	IN	Bool	1 = Request to set new counter value
RV	IN	Bool	1= Request to set new reference value
PERIOD	IN	Bool	1 = Request to set new period value (only for frequency measurement mode)
NEW_DIR	IN	Int	New direction: 1= forward -1= backward
NEW_CV	IN	DInt	New counter value
NEW_RV	IN	DInt	New reference value
NEW_PERIOD	IN	Int	New period value in seconds: .01, .1, or 1 (only for frequency measurement mode)
BUSY	OUT	Bool	Function busy
STATUS	OUT	Word	Execution condition code

You must configure the high-speed counters in the project settings PLC device configuration before you can use high-speed counters in your program. The HSC device configuration settings select counting modes, I/O connections, interrupt assignment, and operation as a high-speed counter or as a device to measure pulse frequency. You can operate the high-speed counter with no program control or with program control.

Many high-speed counter configuration parameters are set only in the project device configuration. Some high-speed counter parameters are initialized in the project device configuration, but can be modified later under program control.

The CTRL_HSC instruction parameters provide program control of the counting process:

- Set the counting direction to a NEW_DIR value
- Set the current count value to a NEW_CV value
- Set the reference value to a NEW_RV value
- Set the Period value (for frequency measurement mode) to a NEW_PERIOD value

If the following boolean flag values are set to 1 when the CTRL_HSC instruction is executed, the corresponding NEW_xxx value is loaded to the counter. Multiple requests (more than one flag is set at the same time) are processed in a single execution of the CTRL_HSC instruction.

- DIR = 1 is a request to load a NEW_DIR value, 0 = no change
- CV = 1 is a request to load a NEW_CV value, 0 = no change
- RV = 1 is a request to load a NEW_RV value, 0 = no change
- PERIOD = 1 is a request to load a NEW_PERIOD value, 0 = no change

The CTRL_HSC instruction is usually placed in a hardware interrupt OB that is executed when the counter hardware interrupt event is triggered. For example, if a CV=RV event triggers the counter interrupt, then a hardware interrupt OB code block executes the CTRL_HSC instruction and can change the reference value by loading a NEW_RV value.

The current count value is not available in the CTRL_HSC parameters. The Process Image address that stores the current count value is assigned during the high-speed counter hardware configuration. You may use program logic to directly read the count value and the value returned to your program will be a correct count for the instant in which the counter was read. The counter will continue to count high-speed events. Therefore, the actual count value could change before your program completes a process using an old count value.

CTRL_HSC parameter details:

- If an update of a parameter value is not requested, then the corresponding input values are ignored.
- The DIR parameter is only valid if the configured counting direction is set to "User program (internal direction control)". You determine how to use this parameter in the HSC device configuration.
- For a S7-1200 HSC on the CPU or on the Signal Board, the BUSY parameter always has a value of 0.

Condition codes: In the case of an error, ENO is set to 0, and the STATUS output contains a condition code.

STATUS value (W#16#...)	Description
0	No error
80A1	HSC identifier does not address a HSC
80B1	Illegal value in NEW_DIR
80B2	Illegal value in NEW_CV
80B3	Illegal value in NEW_RV
80B4	Illegal value in NEW_PERIOD

6.1.3.3 Operation of the high-speed counter

A high-speed counter (HSC) can be used as an input for an incremental shaft encoder. The shaft encoder provides a specified number of counts per revolution and a reset pulse that occurs once per revolution. The clock(s) and the reset pulse from the shaft encoder provide the inputs to the HSC.

The HSC is loaded with the first of several presets, and the outputs are activated for the time period where the current count is less than the current preset. The HSC provides an interrupt when the current count is equal to preset, when reset occurs, and also when there is a direction change.

As each current-count-value-equals-preset-value interrupt event occurs, a new preset is loaded and the next state for the outputs is set. When the reset interrupt event occurs, the first preset and the first output states are set, and the cycle is repeated.

Since the interrupts occur at a much lower rate than the counting rate of the HSC, precise control of high-speed operations can be implemented with relatively minor impact to the scan cycle of the CPU. The method of interrupt attachment allows each load of a new preset to be performed in a separate interrupt routine for easy state control. (Alternatively, all interrupt events can be processed in a single interrupt routine.)

Selecting the functionality for the HSC

All HSCs function the same way for the same counter mode of operation. There are four basic types of HSC:

- Single-phase counter with internal direction control
- Single-phase counter with external direction control
- Two-phase counter with 2 clock inputs
- A/B phase quadrature counter

You can use each HSC type with or without a reset input. When you activate the reset input (with some restrictions, see the following table), the current value is cleared and held clear until you deactivate the reset input.

- Frequency function: Some HSC modes allow the HSC to be configured (Type of counting) to report the frequency instead of a current count of pulses. Three different frequency measuring periods are available: 0.01, 0.1, or 1.0 seconds.

  The frequency measuring period determines how often the HSC calculates and reports a new frequency value. The reported frequency is an average value determined by the total number of counts in the last measuring period. If the frequency is rapidly changing, the reported value will be an intermediate between the highest and lowest frequency occurring during the measuring period. The frequency is always reported in Hertz (pulses per second) regardless of the frequency-measuring-period setting.

- Counter modes and inputs: The following table shows the inputs used for the clock, direction control, and reset functions associated with the HSC.

  The same input cannot be used for two different functions, but any input not being used by the present mode of its HSC can be used for another purpose. For example, if HSC1 is in a mode that uses built-in inputs but does not use the external reset (I0.3), then I0.3 can be used for edge interrupts or for HSC2.

Description			Default Input Assignment			Function
HSC	HSC1	Built In or Signal Board or monitor PTO 0[1]	I0.0 I4.0 PTO 0 Pulse	I0.1 I4.1 PTO 0 Direction	I0.3 I4.3 -	
	HSC:	Built In or signal board or monitor PTO 1[1]	I0.2 I4.2 PTO 1 Pulse	I0.3 I4.3 PTO 1 Direction	I0.1 I4.1 -	
	HSC3[2]	Built In	I0.4	I0.5	I0.7	
	HSC4[3]	Built In	I0.6	I0.7	I0.5	
	HSC5[4]	Built In or Signal Board	I1.0 I4.0	I1.1 I4.1	I1.2 I4.3	
	HSC6[4]	Built In or signal board	I1.3 I4.2	I1.4 I4.3	I1.5 I4.1	
Mode	Single-phase counter with internal direction control		Clock	-	-	Count or Frequency
					Reset	Count
	Single-phase counter with external direction control		Clock	Direction	-	Count or Frequency
					Reset	Count
	Two-phase counter with 2 clock inputs		Clock up	Clock down	-	Count or Frequency
					Reset	Count
	A/B-phase quadrature counter		Phase A	Phase B	-	Count or Frequency
					Phase Z	Count
	Monitor pulse train outputs (PTO)[1]		Clock	Direction	-	Count

1 Pulse train output monitoring always uses clock and direction. If the corresponding PTO output is configured for pulse only, then the direction output should generally be set for positive counting.

2 HSC3 with a reset input is not possible for the CPU 1211C which supports only 6 built-in inputs.

3 HSC4 is not possible for the CPU 1211C which supports only 6 built-in inputs.

4 HSC5 and HSC6 are only supported by the CPU 1211C and CPU 1212C when a signal board is installed.

Accessing the current value for the HSC

The CPU stores the current value of each HSC in an input (I) address. The following table shows the default addresses assigned to the current value for each HSC. You can change the I address for the current value by modifying the properties of the CPU in the Device Configuration.

High-speed counter	Data type	Default address
HSC1	DInt	ID1000
HSC2	DInt	ID1004
HSC3	DInt	ID1008
HSC4	DInt	ID1012
HSC5	DInt	ID1016
HSC6	DInt	ID1020

Digital I/O points assigned to HSC devices cannot be forced

The digital I/O points used by high-speed counter devices are assigned during device configuration. When digital I/O point addresses are assigned to these devices, the values of the assigned I/O point addresses cannot be modified by the Watch table force function.

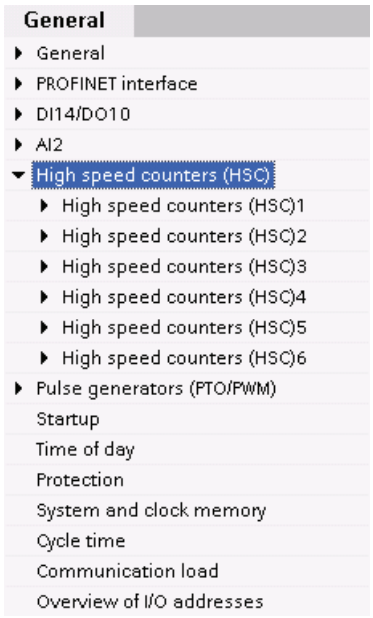
6.1.3.4 Configuration of the HSC

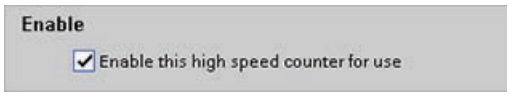
The CPU allows you to configure up to 6 high-speed counters. You edit the "Properties" of the CPU to configure the parameters of each individual HSC.

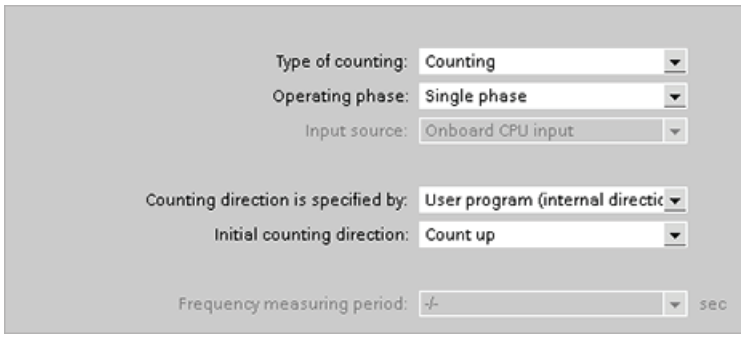
Configure the parameters for the high-speed counters by editing the "Properties" of the CPU.

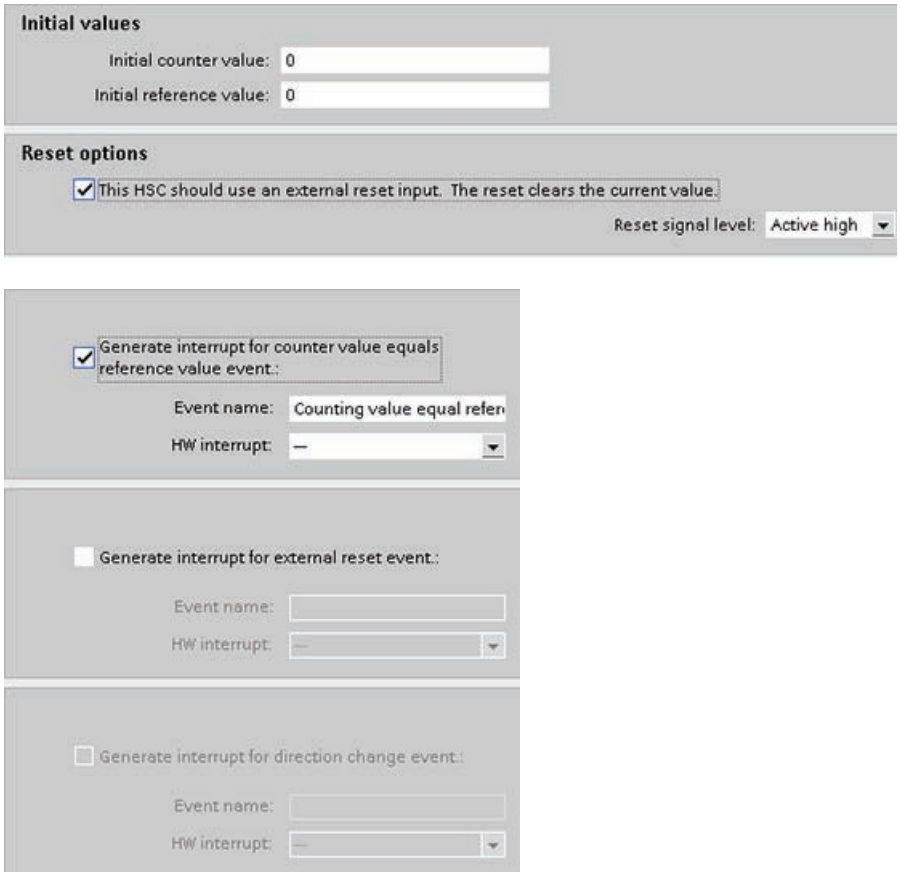
After enabling the HSC, configure the other parameters, such as counter function, initial values, reset options and interrupt events.

After configuring the HSC, you use the CTRL_HSC instruction in your user program to control the operation of the HSC.









6.1.4 Compare



You use the compare instructions to compare two values of the same data type. When the LAD contact comparison is TRUE, then the contact is activated. When the FBD box comparison is TRUE, then the box output is TRUE.

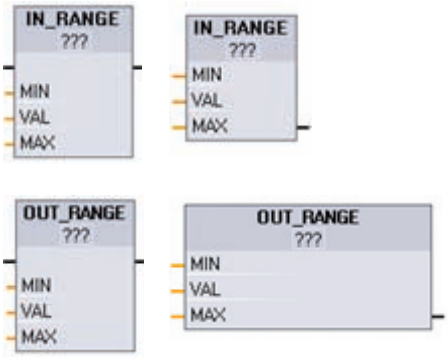
LAD **FBD**

After you click on the instruction in the program editor, you can select the comparison type and data type from the drop-down menus.

Relation type	The comparison is true if:
==	IN1 is equal to IN2
<>	IN1 is not equal to IN2
>=	IN1 is greater than or equal to IN2
<=	IN1 is less than or equal to IN2
>	IN1 is greater than IN2
<	IN1 is less than IN2

Parameter	Data type	Description
IN1, IN2	SInt, Int, DInt, USInt, UInt, UDInt, Real, LReal, String, Char, Time, DTL, Constant	Values to compare

In Range and Out of Range instructions



LAD FBD

You use the IN_RANGE and OUT_RANGE instructions to test whether an input value is in or out of a specified value range. If the comparison is TRUE, then the box output is TRUE.

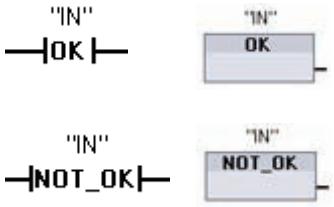
The input parameters MIN, VAL, and MAX must be the same data type.

After you click on the instruction in the program editor, you can select the data type from the dropdown menus.

Relation type	The comparision is TRUE if:
IN_RANGE	MIN <= VAL <= MAX
OUT_RANGE	VAL < MIN or VAL > MAX

Parameter	Data type	Description
MIN, VAL, MAX	SInt, Int, DInt, USInt, UInt, UDInt, Real, Constant	Comparator inputs

OK and Not OK instructions



LAD FBD

You use the OK and NOT_OK instructions to test whether an input data reference is a valid real number according to IEEE specification 754. When the LAD contact is TRUE, the contact is activated and passes power flow. When the FBD box is TRUE, then the box output is TRUE.

A Real or LReal value is invalid if it is +/- INF (infinity), NaN (Not a Number), or if it is a denormalized value. A denormalized value is a number very close to zero. The CPU substitutes a zero for a denormalized value in calculations.

Instruction	The Real number test is TRUE if:
OK	The input value is a valid Real number
NOT_OK	The input value is not a valid Real number

Parameter	Data type	Description
IN	Real, LReal	Input data

6.1.5 Math

Add, subtract, multiply and divide instructions



You use a math box instruction to program the basic mathematical operations:

- ADD: Addition (IN1 + IN2 = OUT)
- SUB: Subtraction (IN1 - IN2 = OUT)
- MUL: Multiplication (IN1 * IN2 = OUT)
- DIV: Division (IN1 / IN2 = OUT)

  An Integer division operation truncates the fractional part of the quotient to produce an integer output.

Click below the box name and select a data type from the drop-down menu.

Note

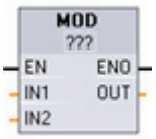
The basic math instruction parameters IN1, IN2, and OUT must be the same data type.

Parameter	Data type	Description
IN1, IN2	SInt, Int, DInt, USInt, UInt, UDInt, Real, LReal, Constant	Math operation inputs
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real, LReal	Math operation output

When enabled (EN = 1), the math instruction performs the specified operation on the input values (IN1 and IN2) and stores the result in the memory address specified by the output parameter (OUT). After the successful completion of the operation, the instruction sets ENO = 1.

ENO status	Description
1	No error
0	The Math operation result value would be outside the valid number range of the data type selected. The least significant part of the result that fits in the destination size is returned.
0	Division by 0 (IN2 = 0): The result is undefined and zero is returned.
0	Real/LReal: If one of the input values is NaN (not a number) then NaN is returned.
0	ADD Real/LReal: If both IN values are INF with different signs, this is an illegal operation and NaN is returned.
0	SUB Real/LReal: If both IN values are INF with the same sign, this is an illegal operation and NaN is returned.
0	MUL Real/LReal: If one IN value is zero and the other is INF, this is an illegal operation and NaN is returned.
0	DIV Real/LReal: If both IN values are zero or INF, this is an illegal operation and NaN is returned.

6.1.5.1 MOD instruction



You use a MOD (modulo) instruction for the IN1 modulo IN2 math operation. The operation IN1 MOD IN2 = IN1 - (IN1 / IN2) = parameter OUT.

Click below the box name and select a data type from the drop-down menu.

Note

The IN1, IN2, and OUT parameters must be the same data type.

Parameter	Data type	Description
IN1 and IN2	Int, DInt, USInt, UInt, UDInt, Constant	Modulo inputs
OUT	Int, DInt, USInt, UInt, UDInt	Modulo output

ENO status	Description
1	No error
0	Value IN2 = 0, OUT is assigned the value zero

NEG instruction



You use the NEG (negation) instruction to invert the arithmetic sign of the value at parameter IN and store the result in parameter OUT.

Click below the box name and select a data type from the drop-down menu.

Note

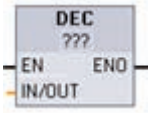
The IN and OUT parameters must be the same data type.

Parameter	Data type	Description
IN	SInt, Int, DInt, Real, LReal, Constant	Math operation input
OUT	SInt, Int, DInt, Real, LReal	Math operation output

ENO status	Description
1	No error
0	The resulting value is outside the valid number range of the selected data type. Example for SInt: NEG (-128) results in +128 which exceeds the data type maximum.

Increment and Decrement instructions





You use the INC and DEC instructions to:

- Increment a signed or unsigned integer number value

  INC (increment): Parameter IN/OUT value +1 = parameter IN/OUT value
- Decrement a signed or unsigned integer number value

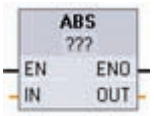
  DEC (decrement): Parameter IN/OUT value - 1 = parameter IN/OUT value

Click below the box name and select a data type from the drop-down menu.

Parameter	Data type	Description
IN/OUT	SInt, Int, DInt, USInt, UInt, UDInt	Math operation input and output

ENO status	Description
1	No error
0	The resulting value is outside the valid number range of the selected data type. Example for SInt: INC (127) results in -128 which exceeds the data type maximum.

Absolute Value instruction



You use the ABS instruction to get the absolute value of a signed integer or real number at parameter IN and store the result in parameter OUT.

Click below the box name and select a data type from the drop-down menu.

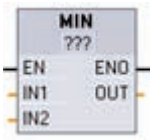
Note

The IN and OUT parameters must be the same data type.

Parameter	Data type	Description
IN	SInt, Int, DInt, Real, LReal	Math operation input
OUT	SInt, Int, DInt, Real, LReal	Math operation output

ENO status	Description
1	No error
0	The math operation result value is outside the valid number range of the selected data type. Example for SInt: ABS (-128) results in +128 which exceeds the data type maximum.

MIN and MAX instructions





You use the MIN (minimum) and MAX (maximum) instructions as follows:

- MIN compares the value of two parameters IN1 and IN2 and assigns the minimum (lesser) value to parameter OUT.
- MAX compares the value of two parameters IN1 and IN2 and assigns the maximum (greater) value to parameter OUT.

Click below the box name and select a data type from the drop-down menu.

Note

The IN1, IN2, and OUT parameters must be the same data type.

Parameter	Data type	Description
IN1, IN2	SInt, Int, DInt, USInt, UInt, UDInt, Real, Constant	Math operation inputs
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real	Math operation output

ENO status	Description
1	No error
0	For Real data type only: • One or both inputs is not a Real number (NaN). • The resulting OUT is +/- INF (infinity).

Limit instruction

You use the Limit instruction to test if the value of parameter IN is inside the value range specified by parameters MIN and MAX. The OUT value is clamped at the MIN or MAX value, if the IN value is outside this range.



- If the value of parameter IN is inside specified range, then the value of IN is stored in parameter OUT.
- If the value of parameter IN is outside of the specified range, then the OUT value is the value of parameter MIN (if the IN value is less than the MIN value) or the value of parameter MAX (if the IN value is greater than the MAX value).

Click below the box name and select a data type from the drop-down menu.

Note

The MIN, IN, MAX, and OUT parameters must be the same data type.

Parameter	Data type	Description
MIN, IN, and MAX	SInt, Int, DInt, USInt, UInt, UDInt, Real, Constant	Math operation inputs
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real	Math operation output

ENO status	Description
1	No error
0	Real: If one or more of the values for MIN, IN and MAX is NaN (Not a Number), then NaN is returned.
0	If MIN is greater than MAX, the value IN is assigned to OUT.

Floating-point math instructions

You use the floating point instructions to program mathematical operations using a Real or LReal data type:

- SQR: Square ($IN^2 = OUT$)
- SQRT: Square root ($\sqrt{IN} = OUT$)
- LN: Natural logarithm (LN(IN) = OUT)
- EXP: Natural exponential ($e^{IN} = OUT$), where base e = 2.71828182845904523536
- SIN: Sine (sin(IN radians) = OUT)
- COS: Cosine (cos(IN radians) = OUT)
- TAN: Tangent (tan(IN radians) = OUT)
- ASIN: Inverse sine (arcsine(IN) = OUT radians), where the sin(OUT radians) = IN
- ACOS: Inverse cosine (arccos(IN) = OUT radians), where the cos(OUT radians) = IN
- ATAN: Inverse tangent (arctan(IN) = OUT radians), where the tan(OUT radians) = IN
- FRAC: Fraction (fractional part of floating point number IN = OUT)
- EXPT: General exponential ($IN1^{IN2} = OUT$)





Click below the box name and select a data type from the drop-down menu. EXPT parameters IN1 and OUT are always Real. You can select the data type for the exponent parameter IN2.

Parameter	Data type	Description
IN, IN1	Real, LReal, Constant	Inputs
IN2	SInt, Int, DInt, USInt, UInt,UDInt, Real, LReal, Constant	EXPT exponent input
OUT	Real, LReal	Outputs

ENO status	Instruction	Condition	Result (OUT)
1	All	No error	Valid result
0	SQR	Result exceeds valid Real/LReal range	+INF
		IN is +/- NaN (not a number)	+NaN
	SQRT	IN is negative	-NaN
		IN is +/- INF (infinity) or +/- NaN	+/- INF or +/- NaN
	LN	IN is 0.0, negative, -INF, or -NaN	-NaN
		IN is +INF or +NaN	+INF or +NaN
	EXP	Result exceeds valid Real/LReal range	+INF
		IN is +/- NaN	+/- NaN
	SIN, COS, TAN	IN is +/- INF or +/- NaN	+/- INF or +/- NaN
	ASIN, ACOS	IN is outside valid range of -1.0 to +1.0	+NaN
		IN is +/- NaN	+/- NaN
	ATAN	IN is +/- NaN	+/- NaN
	FRAC	IN is +/- INF or +/- NaN	+NaN
	EXPT	IN1 is +INF and IN2 is not -INF	+INF
		IN1 is negative or -INF	+NaN if IN2 is Real/LReal, -INF otherwise
		IN1 or IN2 is +/- NaN	+NaN
		IN1 is 0.0 and IN2 is Real/LReal (only)	+NaN

6.1.6 Move

Move and Block Move instructions



Use the move instructions to copy data elements to a new memory address and convert from one data type to another. The source data is not changed by the move process.

- MOVE: Copies a data element stored at a specified address to a new address
- MOVE_BLK: Interruptible move that copies a block of data elements to a new address
- UMOVE_BLK: Uninterruptible move that copies a block of data elements to a new address

MOVE		
Parameter	**Data type**	**Description**
IN	SInt, Int, DInt, USInt, UInt, UDInt, Real, LReal, Byte, Word, DWord, Char, Array, Struct, DTL, Time	Source address
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real, LReal, Byte, Word, DWord, Char, Array, Struct, DTL, Time	Destination address

MOVE_BLK, UMOVE_BLK		
Parameter	**Data type**	**Description**
IN	SInt, Int, DInt, USInt, UInt, UDInt, Real, Byte, Word, DWord	Source start address
COUNT	UInt	Number of data elements to copy
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real, Byte, Word, DWord	Destination start address

Note

Rules for data copy operations

- To copy the Bool data type, use SET_BF, RESET_BF, R, S, or output coil (LAD)
- To copy a single elementary data type, use MOVE
- To copy an array of an elementary data type, use MOVE_BLK or UMOVE_BLK
- To copy a structure, use MOVE
- To copy a string, use S_CONV
- To copy a single character in a string, use MOVE
- The MOVE_BLK and UMOVE_BLK instructions cannot be used to copy arrays or structures to the I, Q, or M memory areas.

The MOVE instruction copies a single data element from the source address specified by the IN parameter to the destination address specified by the OUT parameter.

The MOVE_BLK and UMOVE_BLK instructions have an additional COUNT parameter. The COUNT specifies how many data elements are copied. The number of bytes per element copied depends on the data type assigned to the IN and OUT parameter tag names in the PLC tag table.

MOVE_BLK and UMOVE_BLK instructions differ in how interrupts are handled:

- Interrupt events are **queued and processed** during MOVE_BLK execution. Use the MOVE_BLK instruction when the data at the move destination address is not used within an interrupt OB subprogram or, if used, the destination data does not have to be consistent. If a MOVE_BLK operation is interrupted, then the last data element moved is complete and consistent at the destination address. The MOVE_BLK operation is resumed after the interrupt OB execution is complete.
- Interrupt events are **queued but not processed** until UMOVE_BLK execution is complete. Use the UMOVE_BLK instruction when the move operation must be completed and the destination data consistent, before the execution of an interrupt OB subprogram. For more information, see the section on data consistency (Page 86).

ENO is always true following execution of the MOVE instruction.

ENO status	Condition	Result
1	No error	All COUNT elements were successfully copied
0	Either the source (IN) range or the destination (OUT) range exceeds the available memory area	Elements that fit are copied. No partial elements are copied.

Fill instructions





You use the FILL_BLK and UFILL_BLK instructions as follows:

- FILL_BLK: The interruptible fill instruction fills an address range with copies of a specified data element.
- UFILL_BLK: The uninterruptible fill instruction fills an address range with copies of a specified data element.

Parameter	Data type	Description
IN	SInt, Int, DIntT, USInt, UInt, UDInt, Real, BYTE, Word, DWord	Data source address
COUNT	USInt, UInt	Number of data elements to copy
OUT	SInt, Int, DIntT, USInt, UInt, UDInt, Real, BYTE, Word, DWord	Data destination address

Note

Rules for data fill operations

- To fill with the BOOL data type, use SET_BF, RESET_BF, R, S, or output coil (LAD)
- To fill with a single elementary data type, use MOVE
- To fill an array with an elementary data type, use FILL_BLK or UFILL_BLK
- To fill a single character in a string, use MOVE
- The FILL_BLK and UFILL_BLK instructions cannot be used to fill arrays in the I, Q, or M memory areas.

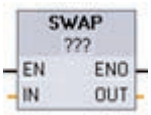
The FILL_BLK and UFILL_BLK instructions copy the source data element IN to the destination where the initial address is specified by the parameter OUT. The copy process repeats and a block of adjacent addresses is filled until the number of copies is equal to the COUNT parameter.

FILL_BLK and UFILL_BLK instructions differ in how interrupts are handled:

- Interrupt events are **queued and processed** during FILL_BLK execution. Use the FILL_BLK instruction when the data at the move destination address is not used within an interrupt OB subprogram or, if used, the destination data does not have to be consistent.
- Interrupt events are **queued but not processed** until UFILL_BLK execution is complete. Use the UFILL_BLK instruction when the move operation must be completed and the destination data consistent, before the execution of an interrupt OB subprogram.

ENO status	Condition	Result
1	No error	The IN element was successfully copied to all COUNT destinations
0	The destination (OUT) range exceeds the available memory area	Elements that fit are copied. No partial elements are copied.

6.1.6.1 Swap instruction



You use the SWAP instruction to reverse the byte order for two-byte and four-byte data elements. No change is made to the bit order within each byte. ENO is always TRUE following execution of the SWAP instruction.

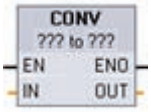
Click below the box name and select a data type from the drop menu.

Parameter	Data type	Description
IN	Word, DWord	Ordered data bytes IN
OUT	Word, DWord	Reverse ordered data bytes OUT

	Example: Parameter IN = MB0 Pre SWAP execution				Example: Parameter OUT = MB4, Post SWAP execution			
Address	MB0	MB1			MB4	MB5		
W#16#1234	12	34			34	12		
WORD	MSB	LSB			MSB	LSB		
Address	MB0	MB1	MB2	MB3	MB4	MB5	MB6	MB7
DW#16#12345678	12	34	56	78	78	56	34	12
DWORD	MSB			LSB	MSB			LSB

6.1.7 Convert

Convert instruction



You use the CONVERT instruction to convert a data element from one data type to another data type. Click below the box name and then select IN and OUT data types from the dropdown list.

After you select the (convert from) data type, a list of possible conversions is shown in the (convert to) dropdown list. Conversions from and to BCD16 are restricted to the Int data type. Conversions from and to BCD32 are restricted to the DInt data type.

Click below the box name and select data types from the drop-down menus.

Parameter	Data type	Description
IN	SInt, Int, DInt, USInt, UInt, UDInt, Byte, Word, DWord, Real, LReal, Bcd16, Bcd32	IN value
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Byte, Word, DWord, Real, LReal, Bcd16, Bcd32	IN value converted to a new data type

ENO status	Description	Result OUT
1	No error	Valid result
0	IN is +/- INF or +/- NaN	+/- INF or +/- NaN
0	Result exceeds valid range for OUT data type	OUT is set to the least-significant bytes of IN

Round and Truncate instructions



ROUND converts a real number to an integer. The real number fraction is rounded to the nearest integer value (IEEE - round to nearest). If the Real number is exactly one-half the span between two integers (i.e. 10.5), then the Real number is rounded to the even integer. For example, ROUND (10.5) = 10 or ROUND (11.5) = 12.



TRUNC converts a real number to an integer. The fractional part of the real number is truncated to zero (IEEE - round to zero).

Parameter	Data type	Description
IN	Real, LReal	Floating point input
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real, LReal	Rounded or truncated output

ENO status	Description	Result OUT
1	No error	Valid result
0	IN is +/- INF or +/- NaN	+/- INF or +/- NaN

Ceiling and Floor instructions



CEIL converts a real number to the smallest integer greater than or equal to that real number (IEEE - round to +infinity).



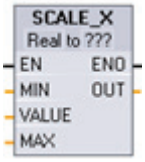
FLOOR converts a real number to the greatest integer smaller than or equal to that real number (IEEE - round to -infinity).

Parameter	Data type	Description
IN	Real, LReal	Floating point input
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real, LReal	Converted output

ENO status	Description	Result OUT
1	No error	Valid result
0	IN is +/- INF or +/- NaN	+/- INF or +/- NaN

6.1.7.1 Scale and normalize instructions

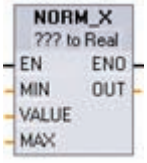
Scale and normalize instructions



SCALE_X scales the normalized real parameter VALUE where (0.0 <= VALUE <= 1.0) in the data type and value range specified by the MIN and MAX parameters:

OUT = VALUE (MAX - MIN) + MIN

For SCALE_X, parameters MIN, MAX, and OUT must be the same data type.



NORM_X normalizes the parameter VALUE inside the value range specified by the MIN and MAX parameters:

OUT = (VALUE - MIN) / (MAX - MIN), where (0.0 <= OUT <= 1.0)

For NORM_X, parameters MIN, VALUE, and MAX must be the same data type.

Click below the box name and select a data type from the drop-down menu.

Parameter	Data type	Description
MIN	SInt, Int, DInt, USInt, UInt, UDInt, Real	Input minimum value for range
VALUE	SCALE_X: Real NORM_X: SInt, Int, DInt, USInt, UInt, UDInt, Real	Input value to scale or normalize
MAX	SInt, Int, DInt, USInt, UInt, UDInt, Real	Input maximum value for range
OUT	SCALE_X: SInt, Int, DInt, USInt, UInt, UDInt, Real NORM_X: Real	Scaled or Normalized output value

Note

SCALE_X parameter VALUE should be restricted to (0.0 <= VALUE <= 1.0)

If parameter VALUE is less than 0.0 or greater than 1.0:

- The linear scaling operation can produce OUT values that are less than the parameter MIN value or above the parameter MAX value for OUT values that fit within the value range of the OUT data type. SCALE_X execution sets ENO = TRUE for these cases.
- It is possible to generate scaled numbers that are not within the range of the OUT data type. For these cases, the parameter OUT value is set to an intermediate value equal to the least-significant portion of the scaled real number prior to final conversion to the OUT data type. SCALE_X execution sets ENO = FALSE in this case.

NORM_X parameter VALUE should be restricted to (MIN <= VALUE <= MAX)

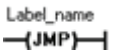
If parameter VALUE is less than MIN or greater than MAX, the linear scaling operation can produce normalized OUT values that are less than 0.0 or greater than 1.0. NORM_X execution sets ENO = TRUE in this case.

ENO status	Condition	Result OUT
1	No error	Valid result
0	Result exceeds valid range for the OUT data type	Intermediate result: The least-significant portion of a real number prior to final conversion to the OUT data type.
0	Parameters MAX <= MIN	SCALE_X: The least-significant portion of the Real number VALUE to fill up the OUT size. NORM_X: VALUE in VALUE data type extended to fill a double word size.
0	Parameter VALUE = +/- INF or +/- NaN	VALUE is written to OUT

6.1.8 Program control

Jump and label instructions

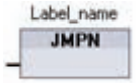
You use program control instructions for conditional control of the execution sequence:





JMP: If there is power flow to a JMP coil (LAD), or if the JMP box input is true (FBD), then program execution continues with the first instruction following the specified label.





JMPN: If there is no power flow to a JMP coil (LAD), or if the JMP box input is false (FBD), then program execution continues with the first instruction following the specified label.





Label: Destination label for a JMP or JMPN jump instruction.

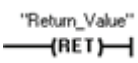
LAD **FBD**

Parameter	Data type	Description
Label_name	Label identifier	Identifier for Jump instructions and the corresponding jump destination program label

You create your label names by typing in the LABEL instruction directly. The available label names for the JMP and JMPN label name field can be selected using the parameter helper icon. You can also type a label name directly into the JMP or JMPN instruction.

Return_Value (RET) execution control instruction

LAD **FBD**





You use the RET instruction to terminate the execution of the current block.

Parameter	Data type	Description
Return_Value	Bool	The "Return_value" parameter of the RET instruction is assigned to the ENO output of the block call box in the calling block.

The optional RET instruction is used to terminate the execution of the current block. If and only if there is power flow to the RET coil (LAD) or if the RET box input is true (FBD), then program execution of the current block will end at that point and instructions beyond the RET instruction will not be executed. If the current block is an OB, the "Return_Value" parameter is ignored. If the current block is a FC or FB, the value of the "Return_Value " parameter is passed back to the calling routine as the ENO value of the called box.

You are not required to use a RET instruction as the last instruction in a block; this is done automatically for you. You can have multiple RET instructions within a single block.

Sample steps for using the RET instruction inside an FC code block:

1. Create a new project and add an FC:
2. Edit the FC:
   - Add instructions from the instruction tree.
   - Add a RET instruction, including one of the following for the "Return_Value" parameter:

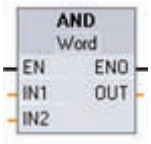
     TRUE, FALSE, or a memory location that specifies the required return value.
   - Add more instructions.
3. Call the FC from MAIN [OB1].

The EN input on the FC box in the MAIN code block must be true to begin execution of the FC.

The value specified by the RET instruction in the FC will be present on the ENO output of the FC box in the MAIN code block following execution of the FC for which power flow to the RET instruction is true.

6.1.9 Logical operations

AND, OR, and XOR instructions



AND: Logical AND for BYTE, WORD, and DWORD data types
OR: Logical OR for BYTE, WORD, and DWORD data types
XOR: Logical exclusive OR for BYTE, WORD, and DWORD data types
Click below the box name and select a data type from the drop menu.

Parameter	Data type	Description
IN1, IN2	Byte, Word, DWord	Logical inputs
OUT	Byte, Word, DWord	Logical output

The data type selection sets parameters IN1, IN2, and OUT to the same data type. The corresponding bit values of IN1 and IN2 are combined to produce a binary logic result, at parameter OUT. ENO is always TRUE following the execution of these instructions.

Invert instruction

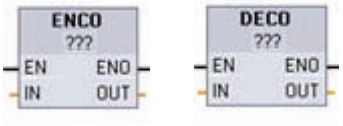


You use the INV instruction to get the binary one's complement of the parameter IN. The one's complement is formed by inverting each bit value of the IN parameter (changing each 0 to 1 and each 1 to 0). ENO is always TRUE following the execution of this instruction.

Click below the box name and select a data type from the drop-down menu.

Parameter	Data type	Description
IN	SInt, Int, DInt, USInt, UInt, UDInt, Byte, Word, DWord	Data element to invert
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Byte, Word, DWord	Inverted output

Encode and decode instructions



ENCO encodes a bit pattern to a binary number.

DECO decodes a binary number to a bit pattern.

Click below the box name and select a data type from the drop-down menu.

Parameter	Data type	Description
IN	ENCO: Byte, Word, DWord DECO: UInt	ENCO: Bit pattern to encode DECO: Value to decode
OUT	ENCO: Int DECO: Byte, Word, DWord	ENCO: Encoded value DECO: Decoded bit pattern

The ENCO instruction converts parameter IN to the binary number corresponding to the bit position of the least-significant set bit of parameter IN and returns the result to parameter OUT. If parameter IN is either 0000 0001 or 0000 0000, then a value of 0 is returned to OUT. If the parameter IN value is 0000 0000, then ENO is set to FALSE.

The DECO instruction decodes a binary number from parameter IN, by setting the corresponding bit position in parameter OUT to a 1 (all other bits are set to 0). ENO is always TRUE following execution of the DECO instruction.

The DECO parameter OUT data type selection of a Byte, Word, or DWord restricts the useful range of parameter IN. If the value of parameter IN exceeds the useful range, then a modulo operation is performed to extract the least significant bits shown below.

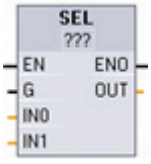
DECO parameter IN range:

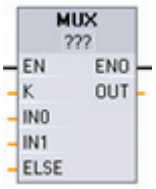
- 3 bits (values 0-7) IN are used to set 1 bit position in a byte OUT
- 4-bits (values 0-15) IN are used to set 1 bit position in a word OUT
- 5 bits (values 0-31) IN are used to set 1 bit position in a double word OUT

DECO IN value		DECO OUT value (Decode single bit position)
		Byte OUT (8 bits):
Min. IN	0	00000001
Max. IN	7	10000000
		Word OUT (16 bits):
Min. IN	0	0000000000000001
Max. IN	15	1000000000000000
		DWord OUT: (32 bits):
Min. IN	0	00000000000000000000000000000001
Max. IN	31	10000000000000000000000000000000

ENO status	Condition	Result (OUT)
1	No error	Valid bit number
0	IN is zero	OUT is set to zero

Select (SEL) and Multiplex (MUX) instructions





- SEL assigns one of two input values to parameter OUT, depending on the parameter G value.
- MUX assigns one of many input values to parameter OUT, depending on the parameter K value. If the parameter K value exceeds the valid range, the parameter ELSE value is assigned to parameter OUT.

Click below the box name and select a data type from the drop-down menu.

SEL	Data type	Description
G	Bool	Selector switch: • FALSE for IN0 • TRUE for IN1
IN0, IN1	SInt, Int, DInt, USInt, UInt, UDInt, Real, Byte, Word, DWord, Time, Char	Inputs
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real, Byte, Word, DWord, Time, Char	Output

MUX	Data type	Description
K	UInt	Selector value: • 0 for IN0 • 1 for IN1 • ...
IN0, IN1, ...	SInt, Int, DInt, USInt, UInt, UDInt, Real, Byte, Word, DWord, Time, Char	Inputs
ELSE	SInt, Int, DInt, USInt, UInt, UDInt, Real, Byte, Word, DWord, Time, Char	Input substitute value (optional)
OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real, Byte, Word, DWord, Time, Char	Output

Input variables and the output variable must be of the same data type.

- The SEL instruction always selects between two IN values.
- The MUX instruction has two IN parameters when first placed in the program editor, but it can be expanded to add more IN parameters.

Use the following methods to add and remove input parameters for the MUX instruction:

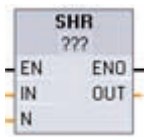
- To add an input, right-click on an input stub for one of the existing IN parameters and select the "Insert input" command.
- To remove an input, right-click on an input stub for one of the existing IN parameters (when there are more than the original two inputs) and select the "Delete" command.

Condition codes: ENO is always TRUE following execution of the SEL instruction.

ENO status (MUX)	MUX condition	MUX result OUT
1	No error	Selected IN value is assigned to OUT
0	K is greater than or equal to the number of IN parameters	No ELSE provided: OUT is unchanged ELSE provided: ELSE value assigned to OUT

6.1.10 Shift and Rotate

Shift instruction



You use the shift instructions to shift the bit pattern of parameter IN. The result is assigned to parameter OUT. Parameter N specifies the number of bit positions shifted:

- SHR: Shift bit pattern right
- SHL: Shift bit pattern left

Click below the box name and select a data type from the drop-down list.

Parameter	Data type	Description
IN	Byte, Word, DWord	Bit pattern to shift
N	UInt	Number of bit positions to shift
OUT	Byte, Word, DWord	Bit pattern after shift operation

- For N=0, no shift occurs and the IN value is assigned to OUT.
- Zeros are shifted into the bit positions emptied by the shift operation.
- If the number of positions to shift (N) exceeds the number of bits in the target value (8 for Byte, 16 for Word, 32 for DWord), then all original bit values will be shifted out and replaced with zeros (zero is assigned to OUT).
- ENO is always TRUE for the shift operations.

SHL example for Word size data: Shift in zeros from the left			
IN	1110 0010 1010 1101	OUT value before first shift:	1110 0010 1010 1101
		After first shift left:	1100 0101 0101 1010
		After second shift left:	1000 1010 1011 0100
		After third shift left:	0001 0101 0110 1000

Rotate instruction



You use the rotate instructions to rotate the bit pattern of parameter IN. The result is assigned to parameter OUT. Parameter N defines the number of bit positions rotated.

- ROR: Rotate bit pattern right
- ROL: Rotate bit pattern left

Click below the box name and select a data type from the drop-down menu.

Parameter	Data type	Description
IN	Byte, Word, DWord	Bit pattern to rotate
N	UInt	Number of bit positions to rotate
OUT	Byte, Word, DWord	Bit pattern after rotate operation

- For N=0, no rotate occurs and the IN value is assigned to OUT.
- Bit data rotated out one side of the target value is rotated into the other side of the target value, so no original bit values are lost.
- If the number of bit positions to rotate (N) exceeds the number of bits in the target value (8 for Byte, 16 for Word, 32 for DWord), then the rotation is still performed.
- ENO is always TRUE following execution of the rotate instructions.

ROR example for WORD size data: Rotate bits out the right -side into the left -side			
IN	0100 0000 0000 0001	OUT value before first rotate:	0100 0000 0000 0001
		After first rotate right:	1010 0000 0000 0000
		After second rotate right:	0101 0000 0000 0000

6.2 Extended instructions

6.2.1 Common error parameters for extended instructions

The extended instruction descriptions describe run-time errors that can occur for each program instruction. In addition to these errors, the common errors listed below are also possible. When a code block is executed and one of the common errors occurs, then the CPU will go to STOP mode unless you use the GetError or GetErrorID instructions within that code block to create a programmed reaction to the error.

Condition code value (W#16#....)	Description
8022	Area too small for input
8023	Area too small for output
8024	Illegal input area
8025	Illegal output area
8028	Illegal input bit assignment
8029	Illegal output bit assignment
8030	Output area is a read-only DB
803A	DB does not exist

6.2.2 Clock and calendar instructions

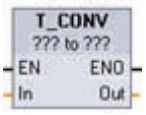
Date and Time instructions

You use the date and time instructions to program calendar and time calculations.

- T_CONV converts the data type of a time value: (Time to DInt) or (DInt to Time)
- T_ADD adds Time and DTL values: (Time + Time = Time) or (DTL + Time = DTL)
- T_SUB subtracts Time and DTL values: (Time - Time = Time) or (DTL - Time = DTL)
- T_DIFF provides the difference between two DTL values as a Time value: DTL - DTL = Time

Data type	Size (bits)	Valid ranges
Time	32 Stored as	T#-24d_20h_31m_23s_648ms to T#24d_20h_31m_23s_647ms -2,147,483,648 ms to +2,147,483,647 ms
DTL data structure		
Year: UInt	16	1970 to 2554
Month: USInt	8	1 to 12
Day: USInt	8	1 to 31
Weekday: USInt	8	1=Sunday to 7=Saturday
Hour: USInt	8	0 to 23

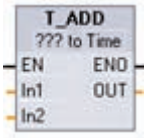
Data type	Size (bits)	Valid ranges
Minute: USInt	8	0 to 59
Second: USInt	8	0 to 59
Nanoseconds: UDInt	32	0 to 999,999,999



T_CONV (Time Convert) converts a Time data type to a DInt data type, or the reverse conversion from DInt data type to Time data type.

Parameter	Parameter type	Data type	Description
IN	IN	DInt, Time	Input Time value or Dint value
OUT	OUT	DInt, Time	Converted DInt value or Time value

Select the IN and OUT data types from the drop-down lists available below the instruction name.



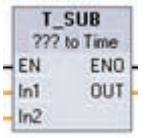
T_ADD (Time Add) adds the input IN1 value (DTL or Time data types) with the input IN2 Time value. Parameter OUT provides the DTL or Time value result.

Two data type operations are possible:

- Time + Time = Time
- DTL + Time = DTL

Parameter	Parameter type	Data type	Description
IN1	IN	DTL, Time	DTL or Time value
IN2	IN	Time	Time value to add
OUT	OUT	DTL, Time	DTL or Time sum

Select the IN1 data type from the drop-down list available below the instruction name. The IN1 data type selection also sets the data type of parameter OUT.



T_SUB (Time Subtract) subtracts the IN2 Time value from IN1 (DTL or Time value). Parameter OUT provides the difference value as a DTL or Time data type.

Two data type operations are possible:

- Time - Time = Time
- DTL - Time = DTL

Parameter	Parameter type	Data type	Description
IN1	IN	DTL, Time	DTL or Time value
IN2	IN	Time	Time value to subtract
OUT	OUT	DTL, Time	DTL or Time difference

Select the IN1 data type from the drop-down list available below the instruction name. The IN1 data type selection also sets the data type of parameter OUT.



T_DIFF (Time Difference) subtracts the IN2 DTL value from IN1 DTL value. Parameter OUT provides the difference value as a Time data type.

- DTL - DTL = Time

Parameter	Parameter type	Data type	Description
IN1	IN	DTL	DTL value
IN2	IN	DTL	DTL value to subtract
OUT	OUT	Time	Time difference

Condition codes: ENO = 1 means no error occurred. ENO = 0 and parameter OUT = 0 errors:

- Invalid DTL value
- Invalid Time value

Clock instructions

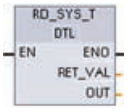
You use the clock instructions to set and read the PLC system clock. The data type DTL is used to provide date and time values.

DTL structure	Size	Valid ranges
Year: UInt	16 bits	1970 to 2554
Month: USInt	8 bits	1 to 12
Day: USInt	8 bits	1 to 31
Weekday: USInt	8 bits	1=Sunday to 7=Saturday
Hour: USInt	8 bits	0 to 23
Minute: USInt	8 bits	0 to 59
Second: USInt	8 bits	0 to 59
Nanoseconds: UDInt	32 bits	0 to 999,999,999



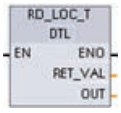
WR_SYS_T (Write System Time) sets the PLC time of day clock with a DTL value at parameter IN. This time value does not include local time zone or daylight saving time offsets.

Parameter	Parameter type	Data type	Description
IN	IN	DTL	Time of day to set in the PLC system clock
RET_VAL	OUT	Int	Execution condition code



RD_SYS_T (Read System Time) reads the current system time from the PLC. This time value does not include local time zone or daylight saving time offsets.

Parameter	Parameter type	Data type	Description
RET_VAL	OUT	Int	Execution condition code
OUT	OUT	DTL	Current PLC system time



RD_LOC_T (Read Local Time) provides the current local time of the PLC as a DTL data type.

Parameter	Parameter type	Data type	Description
RET_VAL	OUT	Int	Execution condition code
OUT	OUT	DTL	Local time

- The local time is calculated by using the time zone and daylight saving time offsets that you set in the CPU Clock device configuration.
- Time zone configuration is an offset to Coordinated Universal Time (UTC) system time.
- Daylight saving time configuration specifies the month, week, day, and hour when daylight saving time begins.
- Standard time configuration also specifies the month, week, day, and hour when standard time begins.
- The time zone offset is always applied to the system time value. The daylight saving time offset is only applied when daylight saving time is in effect.

Condition codes: ENO = 1 means no error occurred. ENO = 0 means an execution error occurred, and a condition code is provided at the RET_VAL output.

RET_VAL (W#16#....)	Description
0000	No error
8080	Local time not available
8081	Illegal year value
8082	Illegal month value

RET_VAL (W#16#....)	Description
8083	Illegal day value
8084	Illegal hour value
8085	Illegal minute value
8086	Illegal second value
8087	Illegal nanosecond value
80B0	The real-time clock has failed

6.2.3 String and character instructions

6.2.3.1 String data overview

String data type

String data is stored as a 2-byte header followed by up to 254 character bytes of ASCII character codes. A String header contains two lengths. The first byte is the maximum length that is given in square brackets when you initialize a string, or 254 by default. The second header byte is the current length that is the number of valid characters in the string. The current length must be smaller than or equal to the maximum length. The number of stored bytes occupied by the String format is 2 bytes greater than the maximum length.

Initialize your String data

String input and output data must be initialized as valid strings in memory, before execution of any string instructions.

Valid String data

Valid string has a maximum length that must be greater than zero but less than 255. The current length must be less than or equal to the maximum length.

Strings cannot be assigned to I or Q memory areas.

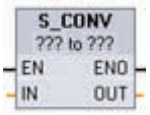
For more information see: Format of the String data type (Page 57)

6.2.3.2 String conversion instructions

String to value and value to string conversions

You can convert number character strings to number values or number values to number character strings with these instructions:

- S_CONV converts (number string to a number value) or (number value to a number string)
- STRG_VAL converts a number string to a number value with format options
- VAL_STRG converts a number value to a number string with format options



S_CONV (String Convert) converts a character string to the corresponding value, or a value to the corresponding character string. The S_CONV instruction has no output formatting options. This makes the S_CONV instruction simpler, but less flexible, than the STRG_VAL and VAL_STRG instructions.

Select the parameter data types from the drop-down lists.

S_CONV (String to value conversions)

Parameter	Parameter type	Data type	Description
IN	IN	String	Input character string
OUT	OUT	String, SInt, Int, DInt, USInt, UInt, UDInt, Real	Output number value

Conversion of the string parameter IN starts at the first character and continues until the end of the string, or until the first character is encountered that is not "0" through "9", "+", "-", or ".". The result value is provided at the location specified in parameter OUT. If the output number value does not fit in the range of the OUT data type, then parameter OUT is set to 0 and ENO is set to FALSE. Otherwise, parameter OUT contains a valid result and ENO is set to TRUE.

Input String format rules:

- If a decimal point is used in the IN string, you must use the "." character.
- Comma characters "," used as a thousands separator to the left of the decimal point are allowed and ignored.
- Leading spaces are ignored.
- Only fixed-point representation is supported. The characters "e" and "E" are not recognized as exponential notation.

S_CONV (Value to string conversions)

Parameter	Parameter type	Data type	Description
IN	IN	String, SInt, Int, DInt, USInt, UInt, UDInt, Real	Input number value
OUT	OUT	String	Output character string

An integer, unsigned integer, or floating point value IN is converted to the corresponding character string at OUT. The parameter OUT must reference a valid string before the conversion is executed. A valid string consists of a maximum string length in the first byte, the current string length in the second byte, and the current string characters in the next bytes. The converted string replaces characters in the OUT string starting at the first character and adjusts the current length byte of the OUT string. The maximum length byte of the OUT string is not changed.

How many characters are replaced depends on the parameter IN data type and number value. The number of characters replaced must fit within the parameter OUT string length. The maximum string length (first byte) of the OUT string should be greater than or equal to the maximum expected number of converted characters.

The following table shows the maximum possible string lengths required for each supported data type.

IN data type	Maximum number of converted characters in OUT string	Example	Total string length including maximum and current length bytes
USInt	3	255	5
SInt	4	-128	6
UInt	5	65535	7
Int	6	-32768	8
UDInt	10	4294967295	12
DInt	11	-2147483648	13

Output String format rules:

- Values written to parameter OUT do not use a leading "+" sign.
- Fixed-point representation is used (no exponential notation).
- The period character "." is used to represent the decimal point when parameter IN is the Real data type.

STRG_VAL instruction



STRG_VAL (String to Value) converts a number character string to the corresponding integer or floating point representation. Conversion begins in the string IN at character offset P and continues until the end of the string, or until the first character is encountered that is not "+", "-", ".", ",", "e", "E", or "0" to "9". The result is placed at the location specified in parameter OUT.

Parameter P is also returned as an offset count in the original string at the position where the conversion terminated. String data must be initialized before execution as a valid string in memory.

Parameter	Parameter type	Data type	Description
IN	IN	String	The ASCII character string to convert
FORMAT	IN	Word	Output format options
P	IN_OUT	UInt	IN: Index to the first character to be converted (first character = 1) OUT: Index to the next character after conversion process ends
OUT	OUT	SInt, Int, DInt, USInt, UInt, UDInt, Real	Converted number value

STRG_VAL FORMAT parameter

The FORMAT parameter for the STRG_VAL instruction is defined below. The unused bit positions must be set to zero.

Bit 16							Bit 8	Bit 7							Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	f	r

f = Notation format
1= Exponential notation
0 = Fixed point notation

r = Decimal point format
1 = "," (comma character)
0 = "." (period character)

FORMAT (W#16#)	Notation format	Decimal point representation
0000 (default)	Fixed point	"."
0001		","
0002	Exponential	"."
0003		","
0004 to FFFF	Illegal values	

Rules for STRG_VAL conversion:

- If the period character "." is used for the decimal point, then commas "," to the left of the decimal point are interpreted as thousands separator characters. The comma characters are allowed and ignored.
- If the comma character "," is used for the decimal point, then periods "." to the left of the decimal point are interpreted as thousands separator characters. These period characters are allowed and ignored.
- Leading spaces are ignored.

VAL_STRG instruction



VAL_STRG (Value to String) converts an integer, unsigned integer, or floating point value to the corresponding character string representation. The value represented by parameter IN is converted to a string referenced by parameter OUT. The parameter OUT must be a valid string before the conversion is executed.

The converted string will replace characters in the OUT string starting at character offset count P to the number of characters specified by parameter SIZE. The number of characters in SIZE must fit within the OUT string length, counting from character position P. This instruction is useful for embedding number characters into a text string. For example, you can put the numbers "120" into the string "Pump pressure = 120 psi".

Parameter	Parameter type	Data type	Description
IN	IN	SInt, Int, DInt, USInt, UInt, UDInt, Real	Value to convert
SIZE	IN	USInt	Number of characters to be written to the OUT string
PREC	IN	USInt	The precision or size of the fractional portion. This does not include the decimal point.
FORMAT	IN	Word	Output format options
P	IN_OUT	UInt	IN: Index to the first OUT string character to be replaced (first character = 1) OUT: Index to the next OUT string character after replacement
OUT	OUT	String	The converted string

Parameter PREC specifies the precision or number of digits for the fractional part of the string. If the parameter IN value is an integer, then PREC specifies the location of the decimal point. For example, if the data value is 123 and PREC = 1, then the result is "12.3". The maximum supported precision for the REAL data type is 7 digits.

If parameter P is greater than the current size of the OUT string, then spaces are added, up to position P, and the result is appended to the end of the string. The conversion ends if the maximum OUT string length is reached.

VAL_STRG FORMAT parameter

The FORMAT parameter for the VAL_STRG instruction is defined below. The unused bit positions must be set to zero.

Bit 16							Bit 8	Bit 7							Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	s	f	r

s = Number sign character	1= use sign character "+" and "-" 0 = use sign character "-" only
f = Notation format	1= Exponential notation 0 = Fixed point notation
r = Decimal point format	1 = "," (comma character) 0 = "." (period character)

FORMAT (WORD)	Number sign character	Notation format	Decimal point representation
W#16#0000	"-" only	Fixed point	"."
W#16#0001			","
W#16#0002		Exponential	"."
W#16#0003			","
W#16#0004	"+" and "-"	Fixed Point	"."
W#16#0005			","
W#16#0006		Exponential	"."
W#16#0007			","
W#16#0008 to W#16#FFFF	Illegal values		

Parameter OUT string format rules:

- Leading space characters are added to the leftmost part of the string when the converted string is smaller than the specified size.
- When the FORMAT parameter sign bit is FALSE, unsigned and signed integer data type values are written to the output buffer without the leading "+" sign. The "-" sign is used if required.
  <leading spaces><digits without leading zeroes>'.'<PREC digits>
- When the sign bit is TRUE, unsigned and signed integer data type values are written to the output buffer always with a leading sign character.
  <leading spaces><sign><digits without leading zeroes>'.'<PREC digits>
- When the FORMAT is set to exponential notation, REAL data type values are written to the output buffer as:
  <leading spaces><sign><digit> '.' <PREC digits>'E' <sign><digits without leading zero>
- When the FORMAT is set to fixed point notation, integer, unsigned integer, and real data type values are written to the output buffer as:
  <leading spaces><sign><digits without leading zeroes>'.'<PREC digits>
- Leading zeros to the left of the decimal point (except the digit adjacent to the decimal point) are suppressed.
- Values to the right of the decimal point are rounded to fit in the number of digits to the right of the decimal point specified by the PREC parameter.
- The size of the output string must be a minimum of three bytes more than the number of digits to the right of the decimal point.
- Values are right-justified in the output string.

Conditions reported by ENO

When an error is encountered during the conversion operation, the following results will be returned:

- ENO is set to 0.
- OUT is set to 0, or as shown in the examples for string to value conversion.
- OUT is unchanged, or as shown in the examples when OUT is a string.

ENO status	Description
1	No error
0	Illegal or invalid parameter; for example, an access to a DB that does not exist
0	Illegal string where the maximum length of the string is 0 or 255
0	Illegal string where the current length is greater than the maximum length
0	The converted number value is too large for the specified OUT data type
0	The OUT parameter maximum string size must be large enough to accept the number of characters specified by parameter SIZE, starting at the character position parameter P
0	Illegal P value where P=0 or P is greater than the current string length
0	Parameter SIZE must be greater than parameter PREC

Examples of S_CONV string to value conversion

IN string	OUT data type	OUT value	ENO
"123"	Int/DInt	123	TRUE
"-00456"	Int/DInt	-456	TRUE
"123.45"	Int/DInt	123	TRUE
"+2345"	Int/DInt	2345	TRUE
"00123AB"	Int/DInt	123	TRUE
"123"	Real	123.0	TRUE
"123.45"	Real	123.45	TRUE
"1.23e-4"	Real	1.23	TRUE
"1.23E-4"	Real	1.23	TRUE
"12,345.67"	Real	12345.67	TRUE
"3.4e39"	Real	3.4	TRUE
"-3.4e39"	Real	-3.4	TRUE
"1.17549e-38"	Real	1.17549	TRUE
"12345"	SInt	0	FALSE
"A123"	N/A	0	FALSE
""	N/A	0	FALSE
"++123"	N/A	0	FALSE
"+-123"	N/A	0	FALSE

Examples of S_CONV value to string conversion

Data type	IN value	OUT string	ENO
UInt	123	"123"	TRUE
UInt	0	"0"	TRUE
UDInt	12345678	"12345678"	TRUE
Real	-INF	"INF"	FALSE
Real	+INF	"INF"	FALSE
Real	NaN	"NaN"	FALSE

Examples of STRG_VAL conversion

IN string	FORMAT (W#16#....)	OUT data type	OUT value	ENO
"123"	0000	Int/DInt	123	TRUE
"-00456"	0000	Int/DInt	-456	TRUE
"123.45"	0000	Int/DInt	123	TRUE
"+2345"	0000	Int/DInt	2345	TRUE
"00123AB"	0000	Int/DInt	123	TRUE
"123"	0000	Real	123.0	TRUE
"-00456"	0001	Real	-456.0	TRUE
"+00456"	0001	Real	456.0	TRUE
"123.45"	0000	Real	123.45	TRUE
"123.45"	0001	Real	12345.0	TRUE
"123,45"	0000	Real	12345.0	TRUE
"123,45"	0001	Real	123.45	TRUE
".00123AB"	0001	Real	123.0	TRUE
"1.23e-4"	0000	Real	1.23	TRUE
"1.23E-4"	0000	Real	1.23	TRUE
"1.23E-4"	0002	Real	1.23E-4	TRUE
"12,345.67"	0000	Real	12345.67	TRUE
"12,345.67"	0001	Real	12.345	TRUE
"3.4e39"	0002	Real	+INF	TRUE
"-3.4e39"	0002	Real	-INF	TRUE
"1.1754943e-38" (and smaller)	0002	Real	0.0	TRUE
"12345"	N/A	SInt	0	FALSE
"A123"	N/A	N/A	0	FALSE
""	N/A	N/A	0	FALSE
"++123"	N/A	N/A	0	FALSE
"+-123"	N/A	N/A	0	FALSE

Examples of VAL_STRG conversion

The examples are based on an OUT string initialized as follows:

"Current Temp = xxxxxxxxxx C"
The "x"character represents space characters allocated for the converted value.

Data type	IN value	P	SIZE	FORMAT (W#16#....)	PREC	OUT string	ENO
UInt	123	16	10	0000	0	Current Temp = xxxxxxx123 C	TRUE
UInt	0	16	10	0000	2	Current Temp = xxxxxx0.00 C	TRUE
UDInt	12345678	16	10	0000	3	Current Temp = x12345.678 C	TRUE
UDInt	12345678	16	10	0001	3	Current Temp = x12345,678 C	TRUE
Int	123	16	10	0004	0	Current Temp = xxxxxx+123 C	TRUE
Int	-123	16	10	0004	0	Current Temp = xxxxxx-123 C	TRUE
Real	-0.00123	16	10	0004	4	Current Temp = xxx-0.0012 C	TRUE
Real	-0.00123	16	10	0006	4	Current Temp = -1.2300E-3 C	TRUE
Real	-INF	16	10	N/A	4	Current Temp = xxxxxx-INF C	FALSE
Real	+INF	16	10	N/A	4	Current Temp = xxxxxx+INF C	FALSE
Real	NaN	16	10	N/A	4	Current Temp = xxxxxxxNaN C	FALSE
UDInt	12345678	16	6	N/A	3	Current Temp = xxxxxxxxxx C	FALSE

6.2.3.3 String operation instructions

Your control program can use the following string and character instructions to create messages for operator display and process logs.

Common errors for all String operations

String operation instructions that are executed with the illegal or invalid String conditions shown below result in an ENO = 0 and a null string output. Error conditions that occur for a specific instruction are listed below the instruction operation description.

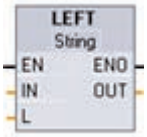
ENO	Condition	OUT
0	Current length of IN1 exceeds maximum length of IN1, or current length of IN2 exceeds maximum length of IN2 (invalid string)	Current length is set to 0
	Maximum length of IN1, IN2 or OUT does not fit within allocated memory range	
	Maximum length of IN1, IN2 or OUT is 0 or 255 (illegal length)	



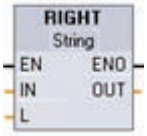
LEN: Get string length



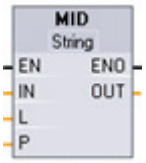
CONCAT: Concatenate two strings



LEFT: Get left substring from string



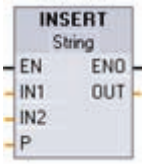
RIGHT: Get right substring form string



MID: Get middle substring from string



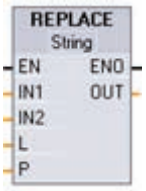
FIND: Find substring or character in string



INSERT: Insert substring in string



DELETE: Delete substring from string



REPLACE: Replace substring in string

LEN instruction

Parameter	Parameter type	Data type	Description
IN	IN	String	Input string
OUT	OUT	UInt	Number of valid characters of IN string

LEN (Length of string) gives the current length of the string IN at output OUT. An empty string has a length of zero. The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No invalid string condition	Valid string length

CONCAT instruction

Parameter	Parameter type	Data type	Description
IN1	IN	String	Input string 1
IN2	IN	String	Input string 2
OUT	OUT	String	Combined string (string 1 + string 2)

CONCAT (Concatenate strings) joins String parameters IN1 and IN2 to form one string provided at OUT. After concatenation, String IN1 is the left part and String IN2 is the right part of the combined string. The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid characters
0	Resulting string after concatenation is larger than maximum length of OUT string	Resulting string characters are copied until the maximum length of the OUT is reached

LEFT instruction

Parameter	Parameter type	Data type	Description
IN	IN	String	Input string
L	IN	Int	Length of the substring to be created, using the left-most L characters of the IN string
OUT	OUT	String	Output string

LEFT (Left substring) provides a substring made of the first L characters of string parameter IN.

- If L is greater than the current length of the IN string, then the entire IN string is returned in OUT.
- If an empty string is the input, then an empty string is returned in OUT.

The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid characters
0	L is less than or equal to 0	Current length is set to 0
	Substring length (L) to be copied is larger than maximum length of OUT string	Characters are copied until the maximum length of OUT is reached

RIGHT instruction

Parameter	Parameter type	Data type	Description
IN	IN	String	Input string
L	IN	Int	Length of the substring to be created, using the right-most L characters of the IN string
OUT	OUT	String	Output string

RIGHT (Right substring) provides the last L characters of a string.

- If L is greater than the current length of the IN string, then the entire IN string is returned in parameter OUT.
- If an empty string is the input, then an empty string is returned in OUT.

The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid characters
0	L is less than or equal to 0	Current length is set to 0
	Substring length (L) to be copied is larger than maximum length of OUT string	Characters are copied until the maximum length of OUT is reached

MID instruction

Parameter	Parameter type	Data type	Description
IN	IN	String	Input string
L	IN	Int	Length of the substring to be created, using L characters of the IN string, beginning at character position P
P	IN	Int	Position of first substring character to be copied: P= 1, for the initial character position of the IN string
OUT	OUT	String	Output string

MID (Middle substring) provides the middle part of a string. The middle substring is L characters long and starts at character position P (inclusive).

If the sum of L and P exceeds the current length of the String parameter IN, then a substring is returned that starts at character position P and continues to the end of the IN string. The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid characters
0	L or P is less than or equal to 0	Current length is set to 0
	P is greater than maximum length of IN	
	Substring length (L) to be copied is larger than maximum length of OUT string	Characters are copied beginning at position P until the maximum length of OUT is reached

DELETE instruction

Parameter	Parameter type	Data type	Description
IN	IN	String	Input string
L	IN	Int	Number of characters to be deleted
P	IN	Int	Position of the first character to be deleted: The first character of the IN string is position number 1
OUT	OUT	String	Output string

DELETE (Delete substring) deletes L characters from string IN. Character deletion starts at character position P (inclusive), and the remaining substring is provided at parameter OUT.

- If L is equal to zero, then the input string is returned in OUT.
- If the sum of L and P is greater than the length of the input string, then the string is deleted to the end.

The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid characters
0	P is greater than current length of IN	IN is copied to OUT with no characters deleted
	L is less than 0, or P is less than or equal to 0	Current length is set to 0
	Resulting string after characters are deleted is larger than maximum length of OUT string	Resulting string characters are copied until the maximum length of OUT is reached

INSERT

Parameter	Parameter type	Data type	Description
IN1	IN	String	Input string 1
IN2	IN	String	Input string 2
P	IN	Int	Last character position in string IN1 before the insertion point for string IN2. The first character of string IN1 is position number 1.
OUT	OUT	String	Result string

INSERT (Insert substring) inserts string IN2 into string IN1. Insertion begins after the character at position P. The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid characters
0	P is greater than length of IN1	IN2 is concatenated with IN1 immediately following the last IN1 character
	P is less than or equal to 0	Current length is set to 0

ENO	Condition	OUT
	Resulting string after insertion is larger than maximum length of OUT string	Resulting string characters are copied until the maximum length of OUT is reached

REPLACE

Parameter	Parameter type	Data type	Description
IN1	IN	String	Input string
IN2	IN	String	String of replacement characters
L	IN	Int	Number of characters to replace
P	IN	Int	Position of first character to be replaced
OUT	OUT	String	Result string

REPLACE (Replace substring) replaces L characters in the string parameter IN1. Replacement starts at string IN1 character position P (inclusive), with replacement characters coming from the string parameter IN2.

- If parameter L is equal to zero, then the string IN2 is inserted at position P of string IN1 without deleting any characters from string IN1.
- If P is equal to one, then the first L characters of string IN1 are replaced with string IN2 characters.

The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid characters
0	P is greater than length of IN1	IN2 is concatenated with IN1 immediately following the last IN1 character
	P points within IN1, but fewer than L characters remain in IN1	IN2 replaces the end characters of IN1 beginning at position P
	L is less than 0, or P is less than or equal to 0	Current length is set to 0
	Resulting string after replacement is larger than maximum length of OUT string	Resulting string characters are copied until the maximum length of OUT is reached

FIND

Parameter	Parameter type	Data type	Description
IN1	IN	String	Search inside this string
IN2	IN	String	Search for this string
OUT	OUT	Int	Character position in string IN1 of the first search match

FIND (Find substring) provides the character position of the substring or character specified by IN2 within the string IN1. The search starts on the left. The character position of the first

occurrence of IN2 string is returned at OUT. If the string IN2 is not found in the string IN1, then zero is returned. The following table shows the condition codes for the instruction.

ENO	Condition	OUT
1	No errors detected	Valid character position
0	IN2 is larger than IN1	Character position is set to 0

6.2.4 Program control instructions

6.2.4.1 Reset scan cycle watchdog instruction



RE_TRIGR (Re-trigger scan time watchdog) is used to extend the maximum time allowed before the scan cycle watchdog timer generates an error.

Use the RE_TRIGR instruction to restart the scan cycle timer during a single scan cycle. This has the effect of extending the allowed maximum scan cycle time by one maximum cycle time period, from the last execution of the RE_TRIGR function.

The CPU restricts the use of the RE_TRIGR instruction to the program cycle, for example, OB1 and functions that are called from the program cycle. This means that the watchdog timer is reset, and ENO = EN, if RE_TRIGR is called from any OB of the program cycle OB list.

ENO = FALSE and the watchdog timer is not reset if RE_TRIGR is executed from a start up OB, an interrupt OB, or an error OB.

Setting the PLC maximum cycle time

You can set the value for maximum scan cycle time in the PLC device configuration for "Cycle time".

Cycle time monitor	Minimum value	Maximum value	Default value
Maximum cycle time	1 ms	6000 ms	150 ms

Watchdog timeout

If the maximum scan cycle timer expires before the scan cycle has been completed, an error is generated. If the error handling code block OB80 is included in the user program, the PLC executes OB 80 where you may add program logic to create a special reaction. If OB80 is not included, the first timeout condition is ignored.

If a second maximum scan time timeout occurs in the same program scan (2 times the maximum cycle time value), an error is triggered that causes the PLC to transition to STOP mode.

In STOP mode, your program execution stops while PLC system communications and system diagnostics continue.

6.2.4.2 Stop scan cycle instruction



STP (Stop PLC scan cycle) puts the PLC in Stop mode. When the PLC is in Stop mode, the execution of your program and physical updates from the process image are stopped.

For more information see: Configuring the outputs on a RUN-to-STOP transition (Page 48)

If EN = TRUE, then the PLC will enter STOP mode, program execution stops, and the ENO state is meaningless. Otherwise, EN = ENO = 0.

6.2.4.3 Get Error instructions

The get error instructions provide information about program block execution errors. If you add a GetError or GetErrorID instruction to your code block, you can handle program errors within your program block.

GET_ERROR



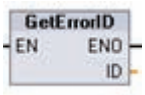
GET_ERROR indicates that a program block execution error has occurred and fills a predefined error data structure with detailed error information.

Parameter	Data type	Description
ERROR	ErrorStruct	Error data structure: You can rename the structure, but not the members within the structure.

ErrorStruct data element	Data type	Description
ERROR_ID	Word	Error identifier
FLAGS	Byte	Always set to 0.
REACTION	Byte	Reaction to the error: • 0 = Ignore; nothing written (write error) • 1 = Substitute: a 0 was used for the input value (read error) • 2 = Skip the instruction
BLOCK_TYPE	Byte	Block type where error occurred: • 1 = OB • 2 = FC • 3 = FB
PAD_0	Byte	Internal fill byte for alignment purposes, will be 0
CODE_BLOCK_NUMBER	UInt	Block number where error occurred
ADDRESS	UDInt	Internal memory location of instruction which encountered error

ErrorStruct data element	Data type	Description
MODE	Byte	Internal mapping for how the remaining fields will be interpreted to be used by STEP 7 Basic
PAD_1	Byte	Internal fill byte for alignment purposes; not used, will be 0
OPERAND_NUMBER	UInt	Internal instruction operand number
POINTER_NUMBER_ LOCATION	UInt	(A) Internal instruction pointer location
SLOT_NUMBER_SCOPE	UInt	(B) Internal memory storage location
AREA	Byte	(C) Memory area referenced when the error was encountered: • L: 16#40 – 4E, 86, 87, 8E, 8F, C0 – CE • I: 16#81 • Q: 16#82 • M: 16#83 • DB: 16#84, 85, 8A, 8B
PAD_2	Byte	Internal fill byte for alignment purposes; not used, will be 0
DB_NUMBER	UInt	(D) DB which was referenced when a DB error occurred, 0 otherwise
OFFSET	UDInt	(E) The bit offset referenced when the error occurred (example: 12 = byte 1, bit 4)

GET_ERR_ID



GET_ERR_ID indicates that a program block execution error has occurred and reports the ID (identifier code) of the error.

Parameter	Data type	Description
ID	Word	Error identifier values for the ErrorStruct ERROR_ID member

ERROR_ID Hexadecimal	ERROR_ID Decimal	Program block execution error
2503	9475	Uninitialized pointer error
2522	9506	Operand out of range read error
2523	9507	Operand out of range write error
2524	9508	Invalid area read error
2525	9509	Invalid area write error
2528	9512	Data alignment read error (incorrect bit alignment)
2529	9513	Data alignment write error (incorrect bit alignment)
2530	9520	DB write protected
253A	9530	Global DB does not Eeist
253C	9532	Wrong version or FC does not exist
253D	9533	Instruction does not exist

ERROR_ID Hexadecimal	ERROR_ID Decimal	Program block execution error
253E	9534	Wrong version or FB does not exist
253F	9535	Instruction does not exist
2575	9589	Program nesting depth error
2576	9590	Local data allocation error
2942	10562	Physical input point does not exist
2943	10563	Physical output point does not exist

Operation

By default, the CPU responds to a block execution error by logging an error in the Diagnostics buffer and transitioning to STOP mode. However, if you place one or more GET_ERROR or ERR_ID instructions within a code block, this block is now set to handle errors within the block. In this case, the CPU does not transition to STOP and does not log an error in the diagnostics buffer. Instead, the error information is reported in the output of the GET_ERROR or GET_ERR_ID instruction. You can read the detailed error information with the GET_ERROR instruction, or read just the error identifier with GET_ERR_ID instruction. Normally the first error is the most important, with the following errors only consequences of the first error.

The first execution of a GET_ERROR or GET_ERR_ID instruction within a block returns the first error detected during block execution. This error could have occurred anywhere between the start of the block and the execution of either GET_ERROR or GET_ERR_ID. Subsequent executions of either GET_ERROR or GET_ERR_ID return the first error since the previous execution of GET_ERROR or GET_ERR_ID. The history of errors is not saved, and execution of either instruction will re-arm the PLC system to catch the next error.

The ErrorStruct data type used by the GET_ERROR instruction can be added in the Data block editor and block interface editors, so your program logic can access these values. Select ErrorStruct from the data type drop-down list to add this structure. You can create multiple ErrorStructs by using unique names. The members of an ErrorStruct cannot be renamed.

Error condition indicated by ENO

If EN = TRUE and GET_ERROR or GET_ERR_ID executes, then:

- ENO = TRUE indicates a code block execution error occurred and error data is present
- ENO = FALSE indicates no code block execution error occurred

You can connect error reaction program logic to ENO which activates after an error occurs. If an error exists, then the output parameter stores the error data where your program has access to it.

GET_ERROR and GET_ERR_ID can be used to send error information from the currently executing block (called block) to a calling block. Place the instruction in the last network of the called block program to report the final execution status of the called block.

6.2.5 Communications instructions

6.2.5.1 Open Ethernet Communication

Open Ethernet communication with automatic connect/disconnect (TSEND_C and TRCV_C)

Note

The processing of the TSEND_C and TRCV_C instructions can take an undetermined amount of time. To ensure that these instructions are processed in every scan cycle, always call them from within the main program cycle scan, such as from a program cycle OB or from a code block that is called from the program cycle scan. Do **not** call these instructions from a hardware interrupt OB, a time-delay interrupt OB, a cyclic interrupt OB, an error interrupt OB, or a startup OB.

For information transferring data with these instructions, see the section on data consistency (Page 86).

TSEND_C description

TSEND_C establishes a TCP or ISO on TCP communication connection to a partner station, sends data, and can terminate the connection. After the connection is set up and established, it is automatically maintained and monitored by the CPU. TSEND_C combines the functions of TCON, TDISCON and TSEND.

The minimum size of data that you can transmit with the TSEND_C instruction is a byte.

Note

The default setting of the LEN parameter (LEN = 0) uses the DATA parameter to determine the length of the data being transmitted. Ensure that the DATA transmitted by the TSEND_C instruction is the same size as the as the DATA parameter of the TRCV_C instruction.

The following functions describe the operation of the TSEND_C instruction:

- To establish a connection, execute TSEND_C with CONT = 1.
- After successful establishing of the connection, TSEND_C sets the DONE parameter for one cycle.
- To terminate the communication connection, execute TSEND_C with CONT = 0. The connection will be aborted immediately. This also affects the receiving station. The connection will be closed there and data inside the receive buffer could be lost.
- To send data over an established connection, execute TSEND_C with a rising edge on REQ. After a successful send operation, TSEND_C sets the DONE parameter for one cycle.
- To establish a connection and send data, execute TSEND_C with CONT =1 and REQ = 1. After a successful send operation, TSEND_C sets the DONE parameter for one cycle.

TRCV_C description

TRCV_C establishes a TCP or ISO on TCP communication connection to a partner CPU, receives data, and can terminate the connection. After the connection is set up and established, it is automatically maintained and monitored by the CPU. The TRCV_C instruction combines the functions of the TCON, TDISCON, and TRCV instructions.

The minimum size of data that you can receive with the TRCV_C instruction is a byte. The TRCV_C instruction does not support the transmission of Boolean data or Boolean arrays.

Note

The default setting of the LEN parameter (LEN = 0) uses the DATA parameter to determine the length of the data being transmitted. Ensure that the DATA transmitted by the TSEND_C instruction is the same size as the as the DATA parameter of the TRCV_C instruction.

The following functions describe the operation of the TRCV_C instruction:

- To establish a connection, execute TRCV_C with parameter CONT = 1.
- To receive data, execute TRCV_C with parameter EN_R = 1. TRCV_C receives the data continuously when parameters EN_R = 1 and CONT = 1.
- To terminate the connection, execute TRCV_C with parameter CONT = 0. The connection will be aborted immediately, and data could be lost.

Receive modes

TRCV_C handles the same receive modes as the TRCV instruction. The following table shows how data is entered in the receive area.

Protocol variant	Entering the data in the receive area	Parameter" connection_type"
TCP	Data reception with specified length	B#16#11
ISO on TCP	protocol-controlled	B#16#12

Note

Due to the asynchronous processing of TSEND_C, you must keep the data in the sender area consistent until the DONE parameter or the ERROR parameter assumes the values TRUE.

For TSEND_C, a TRUE state at the parameter DONE means that the data was sent successfully. It does not mean that the connection partner CPU actually read the receive buffer.

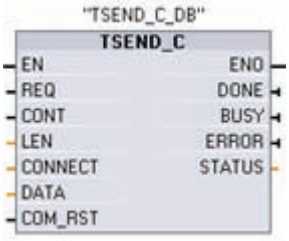
Due to the asynchronous processing of TRCV_C, the data in the receiver area are only consistent when parameter DONE = 1.

The following table shows the relationships between parameters BUSY, DONE and ERROR.

BUSY	DONE	ERROR	Description
TRUE	irrelevant	irrelevant	The job is being processed.
FALSE	TRUE	FALSE	The job successfully completed.

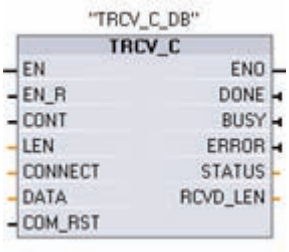
BUSY	DONE	ERROR	Description
FALSE	FALSE	TRUE	The job was ended with an error. The cause of the error can be found in the STATUS parameter.
FALSE	FALSE	FALSE	A new job was not assigned.

TSEND_C parameters



Parameter	Parameter type	Data type	Description
REQ	INPUT	Bool	Control parameter REQ starts the send job with the connection described in CONNECT on a rising edge.
CONT	INPUT	Bool	• 0: disconnect • 1: establish and hold connection
LEN	INPUT	Int	Maximum number of bytes to be sent. (Default = 0, which means that the DATA parameter determines the length of the data to be sent.).
CONNECT	IN_OUT	TCON-Param	Pointer to the connection description
DATA	IN_OUT	Variant	Send area; contains address and length of data to be sent.
COM_RST	IN_OUT	Bool	• 1: Complete restart of the function block, existing connection will be terminated.
DONE	OUTPUT	Bool	• 0: Job not yet started or still running. • 1: Job executed without error.
BUSY	OUTPUT	Bool	• 0: Job is completed. • 1: Job is not yet completed. A new job cannot be triggered.
ERROR	OUTPUT	Bool	• 1: Error occurred during processing. STATUS provides detailed information on the type of error.
STATUS	OUTPUT	Word	Error information

TRCV_C parameters



Parameter	Parameter type	Data type	Description
EN_R	IN	Bool	Control parameter enabled to receive: When EN_R = 1, TRCV_C is ready to receive. The receive job is processed.
CONT	IN	Bool	Control parameter CONT: • 0: disconnect • 1: establish and hold connection
LEN	IN	Int	Length of the receive area in bytes. (Default = 0, which means that the DATA parameter determines the length of the data to be sent.).
CONNECT	IN_OUT	TCON-Param	Pointer to the connection description
DATA	IN_OUT	Variant	Receive area contains start address and maximum length of received data.
COM_RST	IN_OUT	Bool	• 1: Complete restart of the function block; existing connection will be terminated.
DONE	OUT	Bool	• 0: Job not yet started or still running. • 1: Job executed without error.
BUSY	OUT	Bool	• 0: Job is completed. • 1: Job is not yet completed. A new job cannot be triggered.
ERROR	OUT	Bool	• 1: Error occurred during processing. STATUS provides detailed information on the type of error.
STATUS	OUT	Word	Error information
RCVD_LEN	OUT	Int	Amount of data actually received, in bytes

Parameters Error and Status

ERROR	STATUS (W#16#...)	Description
0	0000	Job executed without error
0	7000	No job processing active
0	7001	Start job processing, establishing connection, waiting for connection partner

ERROR	STATUS (W#16#...)	Description
0	7002	Data being sent or received
0	7003	Connection being terminated
0	7004	Connection established and monitored, no job processing active
1	8085	LEN parameter is greater than the largest permitted value
1	8086	The CONNECT parameter is outside the permitted range
1	8087	Maximum number of connections reached; no additional connection possible
1	8088	LEN parameter is larger than the memory area specified in DATA; receiving memory area is too small
1	8089	The parameter CONNECT parameter does not point to a data block.
1	8091	Maximum nesting depth exceeded
1	809A	The CONNECT parameter points to a field that does not match the length of the connection description.
1	809B	The local_device_id in the connection description does not match the CPU.
1	80A1	Communications error: • The specified connection was not yet established • The specified connection is currently being terminated; transmission over this connection is not possible • The interface is being reinitialized
1	80A3	Attempt being made to terminate a nonexistent connection
1	80A4	IP address of the remote partner connection is invalid. For example, the remote partner IP address is the same as the local partner IP address.
1	80A7	Communications error: you have called TDISCON before TCON was complete (TDISCON must first completely terminate the connection referenced by the ID)
1	80B2	The parameter CONNECT parameter points to a data block that was generated with the keyword UNLINKED
1	80B3	Inconsistent parameters: • Error in the connection description • Local port (parameter local_tsap_id) is already present in another connection description • ID in the connection description different from the ID specified as parameter
1	80B4	When using the ISO on TCP (connection_type = B#16#12) to establish a passive connection, condition code 80B4 alerts you that the TSAP entered did not conform to one of the following address requirements: • For a local TSAP length of 2 and a TSAP ID value of either E0 or E1 (hexadecimal) for the first byte, the second byte must be either 00 or 01. • For a local TSAP length of 3 or greater and a TSAP ID value of either E0 or E1 (hexadecimal) for the first byte, the second byte must be either 00 or 01 and all other bytes must be valid ASCII characters. • For a local TSAP length of 3 or greater and the first byte of the TSAP ID does not have a value of either E0 or E1 (hexadecimal), then all bytes of the TSAP ID must be valid ASCII characters. Valid ASCII characters are byte values from 20 to 7E (hexadecimal).
1	80C3	All connection resources are in use.

ERROR	STATUS (W#16#...)	Description
1	80C4	Temporary communications error: • The connection cannot be established at this time • The interface is receiving new parameters • The configured connection is currently being removed by a TDISCON
1	8722	CONNECT parameter: Source area invalid: area does not exist in DB
1	873A	CONNECT parameter: Access to connection description not possible (e.g. DB not available)
1	877F	CONNECT parameter: Internal error such as an invalid ANY reference

Open Ethernet communication with connect/disconnect control

Note

The processing of the TCON, TDISCON, TSEND, and TRCV instructions can take an undetermined amount of time. To ensure that these instructions are processed in every scan cycle, always call them from within the main program cycle scan, such as from a program cycle OB or from a code block that is called from the program cycle scan. Do **not** call these instructions from a hardware interrupt OB, a time-delay interrupt OB, a cyclic interrupt OB, an error interrupt OB, or a startup OB.

Ethernet communication using TCP and ISO on TCP protocols

These program instructions control the communication process:

- TCON makes a connection.
- TSEND and TRCV send and receive data.
- TDISCON breaks the connection.

The minimum size of data that you can transmit or receive with the TSEND and TRCV instructions is a byte. The TRCV instruction does not support the transmission of Boolean data or Boolean arrays. For information transferring data with these instructions, see the section on data consistency (Page 86).

Note

The default setting of the LEN parameter (LEN = 0) uses the DATA parameter to determine the length of the data being transmitted. Ensure that the DATA transmitted by the TSEND instruction is the same size as the as the DATA parameter of the TRCV instruction.

Both communication partners execute the TCON instruction to set up and establish the communications connection. You use parameters to specify the active and passive communication end point partners. After the connection is set up and established, it is automatically maintained and monitored by the CPU.

If the connection is terminated due to a line break or due to the remote communications partner, for example, the active partner attempts to reestablish the configured connection. You do not have to execute TCON again.

An existing connection is terminated and the set-up connection is removed when the TDISCON instruction is executed or when the CPU has gone into STOP mode. To set up and reestablish the connection, you must execute TCON again.

Functional description

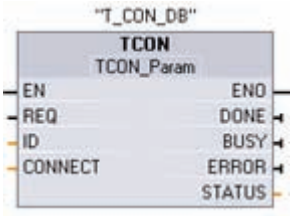
TCON, TDISCON, TSEND, and TRCV operate asynchronously, which means that the job processing extends over multiple instruction executions.

For example, you start a job for setting up and establishing a connection by executing an instruction TCON with parameter REQ = 1. Then you use additional TCON executions to monitor the job progress and test for job completion with parameter DONE.

The following table shows the relationships between BUSY, DONE, and ERROR. Use the table to determine the current job status.

BUSY	DONE	ERROR	Description
TRUE	irrelevant	irrelevant	The job is being processed.
FALSE	TRUE	FALSE	The job successfully completed.
FALSE	FALSE	TRUE	The job was ended with an error. The cause of the error can be found in the STATUS parameter.
FALSE	FALSE	FALSE	A new job was not assigned.

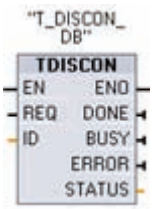
TCON



Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Control parameter REQUEST starts the job for establishing the connection specified by ID. The job starts at rising edge.
ID	IN	CONN_OUC (Word)	Reference to the connection to be established to the remote partner, or between the user program and the communication layer of the operating system. ID must be identical to the associated parameter ID in the local connection description. Value range: W#16#0001 to W#16#0FFF
CONNECT	IN_OUT	TCON-Param	Pointer to the connection description
DONE	OUT	Bool	Status parameter DONE: • 0: Job not yet started or still running • 1: Job executed without error

Parameter	Parameter type	Data type	Description
BUSY	OUT	Bool	BUSY = 1: Job is not yet complete BUSY = 0: Job is complete
ERROR	OUT	Bool	Status parameter ERROR: ERROR = 1: An error occurred in job processing. STATUS provides detailed information on the type of error.
STATUS	OUT	Word	Status parameter STATUS: Error information

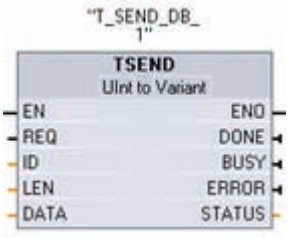
TDISCON



TCP and ISO on TCP: TDISCON terminates a communications connection from the CPU to a communication partner.

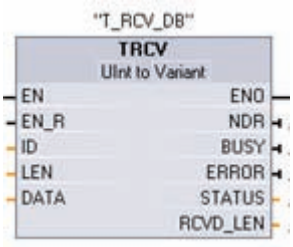
Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Control parameter REQUEST starts the job for establishing the connection specified by ID. The job starts at rising edge.
ID	IN	CONN_OUC (Word)	Reference to the connection to be terminated to the remote partner or between the user program and the communications level of the operating system. ID must be identical to the associated parameter ID in the local connection description. Value range: W#16#0001 to W#16#0FFF
DONE	OUT	Bool	Status parameter DONE: • 0: Job not yet started or still running • 1: Job executed without error
BUSY	OUT	Bool	BUSY = 1: Job is not yet complete BUSY = 0: Job is complete
ERROR	OUT	Bool	ERROR = 1: Error occurred during processing.
STATUS	OUT	Word	Error code

TSEND



Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Control parameter REQUEST starts the send job on a rising edge. The data is transferred from the area specified by DATA and LEN.
ID	IN	CONN_OUC (Word)	Reference to the associated connection. ID must be identical to the associated parameter ID in the local connection description. Value range: W#16#0001 to W#16#0FFF
LEN	IN	Int	Maximum number of bytes to be sent with the job
DATA	IN_OUT	Variant	Pointer to data area to send: Sender area; contains address and length. The address refers to: • The process image input table • The process image output table • A bit memory • A data block
DONE	OUT	Bool	Status parameter DONE: • 0: Job not yet started or still running. • 1: Job executed without error.
BUSY	OUT	Bool	• BUSY = 1: The job is not yet complete. A new job cannot be triggered. • BUSY = 0: Job is complete.
ERROR	OUT	Bool	Status parameter ERROR: ERROR = 1: Error occurred during processing. STATUS provides detailed information on the type of error
STATUS	OUT	Word	Status parameter STATUS: Error information

TRCV



Parameter	Parameter type	Data type	Description
EN_R	IN	Bool	Control parameter enabled to receive: With EN_R = 1, TRCV is ready to receive. The receive job is being processed.
ID	IN	CONN_OUC (Word)	Reference to the associated connection. ID must be identical to the associated parameter ID in the local connection description. Value range: W#16#0001 to W#16#0FFF
LEN	IN	Int	Length of the receive area in bytes (Default = 0, which means that the DATA parameter determines the length of the data to be received.).
DATA	IN_OUT	Variant	Pointer to received data: Receive area that contains address and length. The address refers to: • The process image input table • The process image output table • A bit memory • A data block
NDR	OUT	Bool	Status parameter NDR: • NDR = 0: Job not yet started or still running. • NDR = 1: Job successfully completed.
BUSY	OUT	Bool	• BUSY = 1: The job is not yet complete. A new job cannot be triggered. • BUSY = 0: Job is complete.
ERROR	OUT	Bool	ERROR=1: Error occurred during processing. STATUS provides detailed information on the type of error.
STATUS	OUT	Word	Error information
RCVD_LEN	OUT	Int	Amount of data actually received, in bytes

Receive area

The TRCV instruction writes the received data to a receive area that is specified by the following two variables:

- Pointer to the start of the area
- Length of the area

Note

The default setting of the LEN parameter (LEN = 0) uses the DATA parameter to determine the length of the data being transmitted. Ensure that the DATA transmitted by the TSEND instruction is the same size as the as the DATA parameter of the TRCV instruction.

The following table shows how TRCV enters the received data in the receive area.

Protocol variant	Entering the data in the receive area	Parameter connection type
TCP	Data reception with specified length	B#16#11
ISO on TCP	Protocol-controlled	B#16#12

As soon as all the job data has been received, TRCV transfers it to the receive area and sets NDR to 1.

Condition codes for TCON

ERROR	STATUS (W#16#...)	Explanation
0	0000	Connection was established successfully
0	7000	No job processing active
0	7001	Start job processing, establishing connection
0	7002	Follow-on call (REQ irrelevant), connection being established
1	8086	The ID parameter is outside the permitted range.
1	8087	Maximum number of connections reached; no additional connection possible
1	809B	The local_device_id in the connection description does not match the CPU.
1	80A1	Connection or port is already occupied by user
1	80A2	Local or remote port is occupied by the system
1	80A3	Attempt being made to re-establish an existing connection
1	80A4	IP address of the remote connection end point is invalid; it may match the local IP address
1	80A7	Communications error: you executed TDISCON before TCON was complete. TDISCON must first completely terminate the connection referenced by the ID.
1	80B3	Inconsistent parameter assignment: Group error for the error codes W#16#80A0 to W#16#80A2, W#16#80A4, W#16#80B4 to W#16#80B9

ERROR	STATUS (W#16#...)	Explanation
1	80B4	When using the ISO on TCP (connection_type = B#16#12) to establish a passive connection, condition code 80B4 alerts you that the TSAP entered did not conform to one of the following address requirements: • For a local TSAP length of 2 and a TSAP ID value of either E0 or E1 (hexadecimal) for the first byte, the second byte must be either 00 or 01. • For a local TSAP length of 3 or greater and a TSAP ID value of either E0 or E1 (hexadecimal) for the first byte, the second byte must be either 00 or 01 and all other bytes must be valid ASCII characters. • For a local TSAP length of 3 or greater and the first byte of the TSAP ID does not have a value of either E0 or E1 (hexadecimal), then all bytes of the TSAP ID must be valid ASCII characters. Valid ASCII characters are byte values from 20 to 7E (hexadecimal).
1	80B5	Error in parameter active_est
1	80B6	Parameter assignment error in parameter connection_type
1	80B7	Error in one of the following parameters: block_length, local_tsap_id_len, rem_subnet_id_len, rem_staddr_len, rem_tsap_id_len, next_staddr_len
1	80B8	Parameter in the local connection description and Parameter ID are different
1	80C3	All connection resources are in use.
1	80C4	Temporary communications error: • The connection cannot be established at this time. • The interface is receiving new parameters. • The configured connection is currently being removed by TDISCON.

Condition codes for TDISCON

ERROR	STATUS (W#16#...)	Explanation
0	0000	Connection was terminated successfully
0	7000	No job processing active
0	7001	Start of job processing, connection being terminated
0	7002	Follow-on call (REQ irrelevant), connection being terminated
1	8086	The ID parameter is not in the permitted address range.
1	80A3	Attempt being made to terminate a non-existent connection
1	80C4	Temporary communications error: The interface is receiving new parameters or the connection is currently being established.

Condition codes for TSEND

ERROR	STATUS (W#16#...)	Explanation
0	0000	Send job completed without error
0	7000	No job processing active
0	7001	Start of job processing, data being sent: During this processing the operating system accesses the data in the DATA send area.

ERROR	STATUS (W#16#...)	Explanation
0	7002	Follow-on call (REQ irrelevant), job being processed: The operating system accesses the data in the DATA send area during this processing.
1	8085	LEN parameter is greater than the largest permitted value.
1	8086	The ID parameter is not in the permitted address range
1	8088	LEN parameter is larger than the memory area specified in DATA
1	80A1	Communications error: • The specified connection was not yet established • The specified connection is currently being terminated. Transmission over this connection is not possible. • The interface is being reinitialized.
1	80C3	Internal lack of resources: A block with this ID is already being processed in a different priority class.
1	80C4	Temporary communications error: • The connection to the communications partner cannot be established at this time. • The interface is receiving new parameters or the connection is currently being established.

Condition codes for TRCV

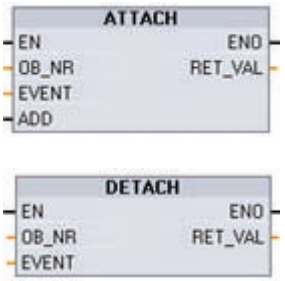
ERROR	STATUS (W#16#...)	Explanation
0	0000	New data accepted: The current length of the received data is shown in RCVD_LEN.
0	7000	Block not ready to receive
0	7001	Block is ready to receive, receive job was activated.
0	7002	Follow-on call, receive job being processed: Data is written to the receive area during this processing For this reason, an error could result in inconsistent data in the receive area.
1	8085	The LEN parameter is greater than the largest permitted value, or you changed the LEN or DATA parameter since the first call.
1	8086	The ID parameter is not in the permitted address range
1	8088	Receive area is too small: The ·Value LEN is greater than the receive area specified by DATA.
1	80A1	Communications error: • The specified connection has not yet been established • The specified connection is currently being terminated. A receive job over this connection is not possible. • The interface is receiving new parameters.
1	80C3	Internal lack of resources: A block with this ID is already being processed in a different priority class.
1	80C4	Temporary communications error: • The connection to the partner cannot be established at the moment. • The interface is receiving new parameter settings or the connection is currently being established.

6.2.5.2 Point-to-Point instructions

The Point-to-Point (PtP) chapter (Page 237) provides detailed information about the PtP instructions and the communication modules.

6.2.6 Interrupt instructions

6.2.6.1 Attach and detach instructions



You can activate and deactivate interrupt event-driven subprograms with the ATTACH and DETACH instructions.

- ATTACH enables interrupt OB subprogram execution for a hardware interrupt event.
- DETACH disables interrupt OB subprogram execution for a hardware interrupt event.

Parameter	Parameter type	Data type	Description
OB_NR	IN	Int	Organization block identifier: Select from the available hardware interrupt OBs that were created using the "Add new block" feature. Double-click on the parameter field, then click on the helper icon to see the available OBs.
EVENT	IN	DWord	Event identifier: Select from the available hardware interrupt events that were enabled in PLC device configuration for digital inputs or high-speed counters. Double-click on the parameter field, then click on the helper icon to see the available events.
ADD (ATTACH only)	IN	Bool	ADD = 0 (default): This event replaces all previous event attachments for this OB. ADD = 1: This event is added to previous event attachments for this OB.
RET_VAL	OUT	Int	Execution condition code

Hardware interrupt events

The following hardware interrupt events are supported by the CPU:

- Rising edge events (all built-in CPU digital inputs plus any signal board digital inputs)
  - A rising edge occurs when the digital input transitions from OFF to ON as a response to a change in the signal from a field device connected to the input.
- Falling edge events (all built-in CPU digital inputs plus any signal board input)
  - A falling edge occurs when the digital input transitions from ON to OFF.
- High-speed counter (HSC) current value = reference value (CV = RV) events (HSC 1 through 6)
  - A CV = RV interrupt for a HSC is generated when the current count transitions from an adjacent value to the value that exactly matches a reference value that was previously established.
- HSC direction changed events (HSC 1 through 6)
  - A direction changed event occurs when the HSC is detected to change from increasing to decreasing, or from decreasing to increasing.
- HSC external reset events (HSC 1 through 6)
  - Certain HSC modes allow the assignment of a digital input as an external reset that is used to reset the HSC count value to zero. An external reset event occurs for such a HSC, when this input transitions from OFF to ON.

Enabling hardware interrupt events in the device configuration

Hardware interrupts must be enabled during the device configuration. You must check the enable-event box in the device configuration for a digital input channel or a HSC, if you want to attach this event during configuration or run time.

Check box options within the PLC device configuration:

- Digital input
  - Enable rising edge detection
  - Enable falling edge detection
- High-speed counter (HSC)
  - Enable this high-speed counter for use
  - Generate interrupt for counter value equals reference value count
  - Generate interrupt for external reset event
  - Generate interrupt for direction change event

Adding new hardware interrupt OB code blocks to your program

By default, no OB is attached to an event when the event is first enabled. This is indicated by the "HW interrupt:" device configuration "<not connected>" label. Only hardware-interrupt OBs can be attached to a hardware interrupt event. All existing hardware-interrupt OBs appear in the "HW interrupt:" drop-down list. If no OB is listed, then you must create an OB of type "Hardware interrupt" as follows. Under the project tree "Program blocks" branch:

1. Double-click "Add new block", select "Organization block (OB)" and choose "Hardware interrupt".
2. Optionally, you can rename the OB, select the programming language (LAD or FBD), and select the block number (switch to manual and choose a different block number than that suggested).
3. Edit the OB and add the programmed reaction that you want to execute when the event occurs. You can call FCs and FBs from this OB, to a nesting depth of four.

OB_NR parameter

All existing hardware-interrupt OB names appear in the device configuration "HW interrupt:" drop-down list and in the ATTACH / DETACH parameter OB_NR drop-list.

EVENT parameter

When a hardware interrupt event is enabled, a unique default event name is assigned to this particular event. You can change this event name by editing the "Event name:" edit box, but it must be a unique name. These event names become tag names in the "Constants" tag table, and appear on the EVENT parameter drop-down list for the ATTACH and DETACH instruction boxes. The value of the tag is an internal number used to identify the event.

General operation

Each hardware event can be attached to a hardware-interrupt OB which will be queued for execution when the hardware interrupt event occurs. The OB-event attachment can occur at configuration time or at run time.

You have the option to attach or detach an OB to an enabled event at configuration time. To attach an OB to an event at configuration time, you must use the "HW interrupt:" drop-down list (click on the down arrow on the right) and select an OB from the list of available hardware-interrupt OBs. Select the appropriate OB name from this list, or select "<not connected>" to remove the attachment.

You can also attach or detach an enabled hardware interrupt event during run time. Use the ATTACH or DETACH program instructions during run time (multiple times if you wish) to attach or detach an enabled interrupt event to the appropriate OB. If no OB is currently attached (either from a "<not connected>" selection in device configuration, or as a result of executing a DETACH instruction), the enabled hardware interrupt event is ignored.

DETACH operation

Use the DETACH instruction to detach either a particular event or all events from a particular OB. If an EVENT is specified, then only this one event is detached from the specified OB_NR; any other events currently attached to this OB_NR will remain attached. If no EVENT is specified, then all events currently attached to OB_NR will be detached.

Condition codes

RET_VAL (W#16#....)	ENO status	Description
0000	1	No error
0001	0	Nothing to Detach (DETACH only)
8090	0	OB does not exist
8091	0	OB is wrong type
8093	0	Event does not exist

6.2.6.2 Start and cancel time delay interrupt instructions

You can start and cancel time delay interrupt processing with the SRT_DINT and CAN_DINT instructions. Each time delay interrupt is a one-time event that occurs after the specified delay time. If the time delay event is cancelled before the time delay expires, the program interrupt does not occur.



SRT_DINT starts a time delay interrupt that executes an OB (organization block) subprogram when the delay time specified by parameter DTIME has elapsed.



CAN_DINT cancels a time delay interrupt that has already started. The time delay interrupt OB is not executed in this case.

SRT_DINT parameters

Parameter	Parameter type	Data type	Description
OB_NR	IN	Int	Organization block (OB) to be started after a time-delay: Select from the available time-delay interrupt OBs that were created using the "Add new block" project tree feature. Double-click on the parameter field, then click on the helper icon to see the available OBs.
DTIME	IN	Time	Time delay value (1 to 60000 ms) You can create longer delay times, for example, by using a counter inside a time delay interrupt OB.
SIGN	IN	Word	Not used by the S7-1200; any value is accepted
RET_VAL	OUT	Int	Execution condition code

CAN_DINT parameters

Parameter	Parameter type	Data type	Description
OB_NR	IN	Int	Time delay interrupt OB identifier. You can use an OB number or symbolic name.
RET_VAL	OUT	Int	Execution condition code

Operation

The SRT_DINT instruction specifies a time delay, starts the internal time delay timer, and associates a time delay interrupt OB subprogram with the time delay timeout event. When the specified time delay has elapsed, a program interrupt is generated that triggers the execution of the associated time delay interrupt OB. You can cancel an in-process time delay interrupt before the specified time delay occurs by executing the CAN_DINT instruction. The total number of active time delay and time cyclic interrupt events must not exceed four.

Adding time delay interrupt OB subprograms to your project

Only time delay interrupt OBs can be assigned to the SRT_DINT and CAN_DINT instructions. No time delay interrupt OB exists in a new project. You must add time delay interrupt OBs to your project. To create a time-delay interrupt OB, follow these steps:

1. Double-click the "Add new block" item in the "Program blocks" branch of the project tree, select "Organization block (OB)", and choose "Time delay interrupt".
2. You have the option to rename the OB, select the programming language, or select the block number. Switch to manual numbering if you want to assign a different block number than the number that was assigned automatically.
3. Edit the time delay interrupt OB subprogram and create programmed reaction that you want to execute when the time delay timeout event occurs. You can call other FC and FB code blocks from the time delay interrupt OB, with a maximum nesting depth of four.
4. The newly assigned time delay interrupt OB names will be available when you edit the OB_NR parameter of the SRT_DINT and CAN_DINT instructions.

Condition codes

RET_VAL (W#16#...)	Description
0000	No error occurred
8090	Incorrect parameter OB_NR
8091	Incorrect parameter DTIME
80A0	Time delay interrupt has not started

6.2.6.3 Disable and Enable alarm interrupt instructions

Use the DIS_AIRT and EN_AIRT instructions to disable and enable alarm interrupt processing.



DIS_AIRT delays the processing of new interrupt events. You can execute DIS_AIRT more than once in an OB. The DIS_AIRT executions are counted by the operating system. Each of these remains in effect until it is cancelled again specifically by an EN_AIRT instruction, or until the current OB has been completely processed.

Once they are enabled again, the interrupts that occurred while DIS_AIRT was in effect are processed, or the interrupts are processed as soon as the current OB has been executed.



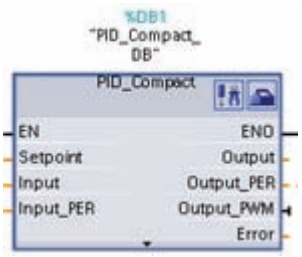
EN_AIRT enables the processing of interrupt events that you previously disabled with the DIS_AIRT instruction. Each DIS_AIRT execution must be cancelled by an EN_AIRT execution. If, for example, you have disabled interrupts five times with five DIS_AIRT executions, you must cancel these with five EN_AIRT executions.

The EN_AIRT executions must occur within the same OB, or any FC or FB called from the same OB, before interrupts are enabled again for this OB.

Parameter RET_VAL indicates the number of times that interrupt processing was disabled, which is the number of queued DIS_AIRT executions. Interrupt processing is only enabled again when parameter RET_VAL = 0.

Parameter	Parameter type	Data type	Description
RET_VAL	OUT	Int	Number of delays = number of DIS_AIRT executions in the queue.

6.2.7 PID control



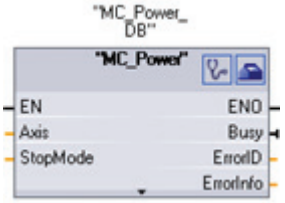
The "PID_Compact" statement makes a PID controller with optimizing self tuning for automatic and manual mode available.

For information about the PID_Compact instruction, refer to the online help of the TIA portal.

6.2.8 Motion control instructions

The motion control instructions use an associated technology data block and the dedicated PTO (pulse train outputs) of the CPU to control the motion on an axis. For information about the motion control instructions, refer to the online help of STEP 7 Basic.

NOTICE
The maximum pulse frequency of the pulse output generators is 100 KHz for the digital outputs of the CPU and 20 KHz for the digital outputs of the signal board. However, STEP 7 Basic does not alert you when you configure an axis that with a maximum speed or frequency that exceeds this hardware limitation. This could cause problems with your application, so always ensure that you do not exceed the maximum pulse frequency of the hardware.



MC_Power enables and disables a motion control axis.



MC_Reset resets all motion control errors. All motion control errors that can be acknowledged are acknowledged.



MC_Home establishes the relationship between the axis control program and the axis mechanical positioning system.



MC_Halt cancels all motion processes and causes the axis motion to stop. The stop position is not defined.



MC_MoveJog executes jog mode for testing and startup purposes.



MC_MoveAbsolute starts motion to an absolute position. The job ends when the target position is reached.



MC_MoveRelative starts a positioning motion relative to the start position.



MC_MoveVelocity causes the axis to travel with the specified speed.

Note

Pulse-train outputs cannot be used by other instructions in the user program

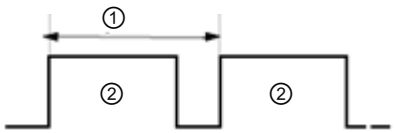
When you configure the outputs of the CPU or signal board as pulse generators (for use with the PWM or basic motion control instructions), the corresponding outputs addresses (Q0.0, Q0.1, Q4.0, and Q4.1) are removed from the Q memory and cannot be used for other purposes in your user program. If your user program writes a value to an output used as a pulse generator, the CPU does not write that value to the physical output.

6.2.9 Pulse instruction

6.2.9.1 CTRL_PWM instruction

The CTRL_PWM Pulse Width Modulation (PWM) instruction provides a fixed cycle time output with a variable duty cycle. The PWM output runs continuously after being started at the specified frequency (cycle time).

The pulse width is varied as required to effect the desired control.



① Cycle time
② Pulse width

Pulse width can be expressed as hundreths of the cycle time (0 – 100), as thousandths (0 – 1000), as ten thousandths (0 – 10000), or as S7 analog format. The pulse width can vary from 0 (no pulse, always off) to full scale (no pulse, always on).

Since the PWM output can be varied from 0 to full scale, it provides a digital output that in many ways is the same as an analog output. For example, the PWM output can be used to control the speed of a motor from stop to full speed, or it can be used to control position of a valve from closed to fully opened.

Two pulse generators are available for controlling high-speed pulse output functions: PWM and Pulse train output (PTO). PTO is used by the motion control instructions. You can assign each pulse generator to either PWM or PTO, but not both at the same time.

The two pulse generators are mapped to specific digital outputs as shown in the following table. You can use onboard CPU outputs, or you can use the optional signal board outputs. The output point numbers are shown in the following table (assuming the default output configuration). If you have changed the output point numbering, then the output point numbers will be those you assigned. Regardless, PTO1/PWM1 uses the first two digital outputs, and PTO2/PWM2 uses the next two digital outputs, either on the CPU or on the attached signal board. Note that PWM requires only one output, while PTO can optionally use two outputs per channel. If an output is not required for a pulse function, it is available for other uses.

Description	Default output assignment		
		Pulse	Direction
PTO 1	Onboard CPU	Q0.0	Q0.1
	Signal board	Q4.0	Q4.1
PWM 1	Onboard CPU	Q0.0	--
	Signal board	Q4.0	--
PTO 2	Onboard CPU	Q0.2	Q0.3
	Signal board	Q4.2	Q4.3
PWM 2	Onboard CPU	Q0.2	--
	Signal board	Q4.2	--

Configuring a pulse channel for PWM

To prepare for PWM operation, first configure a pulse channel in the device configuration by selecting the CPU, then Pulse Generator (PTO/PWM), and choose either PWM1 or PWM2. Enable the pulse generator (check box). If a pulse generator is enabled, a unique default name is assigned to this particular pulse generator. You can change this name by editing it in the "Name:" edit box, but it must be a unique name. Names of enabled pulse generators will become tags in the "constant" tag table, and will be available for use as the PWM parameter of the CTRL_PWM instruction.

NOTICE

The maximum pulse frequency of the pulse output generators is 100 KHz for the digital outputs of the CPU and 20 KHz for the digital outputs of the signal board. However, STEP 7 Basic does not alert you when you configure an axis that with a maximum speed or frequency that exceeds this hardware limitation. This could cause problems with your application, so always ensure that you do not exceed the maximum pulse frequency of the hardware.

You have the option to rename the pulse generator, add a comment, and assign parameters as follows:

- Pulse generator used as follows: PWM or PTO (choose PWM)
- Output source: onboard CPU or Signal Board
- Time base: milliseconds or microseconds

- Pulse width format:
  - Hundreths (0 to 100)
  - Thousandths (0 to 1000)
  - Ten-thousandths (0 to 10000)
  - S7 analog format (0 to 27648)
- Cycle time: Enter your cycle time value. This value can only be changed in Device configuration.
- Initial pulse width: Enter your initial pulse width value. The pulse width value can be changed during runtime.

Output addresses



Start address: Enter the Q word address where you want to locate the pulse width value. The default location is QW1000 for PWM1, and QW1002 for PWM2. The value at this location controls the width of the pulse and is initialized to the "Initial pulse width:" value specified above each time the CPU transitions from STOP to RUN mode. You change this Q-word value during run time to cause a change in the pulse width.

Parameter	Parameter type	Data type	Initial value	Description
PWM	IN	Word	0	PWM identifier: Names of enabled pulse generators will become tags in the "constant" tag table, and will be available for use as the PWM parameter.
ENABLE	IN	Bool		1=start pulse generator 0 = stop pulse generator
BUSY	OUT	Bool	0	Function busy
STATUS	OUT	Word	0	Execution condition code

Operation

A data block (DB) is used by the CTRL_PWM instruction to store parameter information. When placing a CTRL_PWM instruction into the program editor, a DB will be assigned. The data block parameters are not separately changed by the user, but are controlled by the CTRL_PWM instruction.

Specify the enabled pulse generator to use, by using its tag name for the PWM parameter.

When the EN input is TRUE, the PWM_CTRL instruction starts or stops the identified PWM based on the value at the ENABLE input. Pulse width is specified by the value in the associated Q word output address.

Because the S7-1200 processes the request when the CTRL_PWM instruction is executed, parameter BUSY will always report FALSE on S7-1200 CPU models.

If an error is detected, then ENO is set to FALSE, and parameter STATUS contains a condition code.

The pulse width will be set to the initial value configured in device configuration when the PLC first enters the RUN mode. You write values to the Q-word location specified in device configuration ("Output addresses" / "Start address:") as needed to change the pulse width. You use an instruction such as a move, convert, math, or PID box to write the desired pulse width to the appropriate Q word. You must use the valid range for the Q-word value (percent, thousandths, ten-thousandths, or S7 analog format).

Condition codes

STATUS value	Description
0	No error
80A1	PWM identifier does not address a valid PWM

Digital I/O points assigned to PWM and PTO cannot be forced

The digital I/O points used by the pulse-width modulation (PWM) and pulse-train output (PTO) devices are assigned during device configuration. When digital I/O point addresses are assigned to these devices, the values of the assigned I/O point addresses cannot be modified by the Watch table force function.

Pulse-train outputs cannot be used by other instructions in the user program

When you configure the outputs of the CPU or signal board as pulse generators (for use with the PWM or basic motion control instructions), the corresponding outputs addresses (Q0.0, Q0.1, Q4.0, and Q4.1) are removed from the Q memory and cannot be used for other purposes in your user program. If your user program writes a value to an output used as a pulse generator, the CPU does not write that value to the physical output.

6.3 Global library instructions

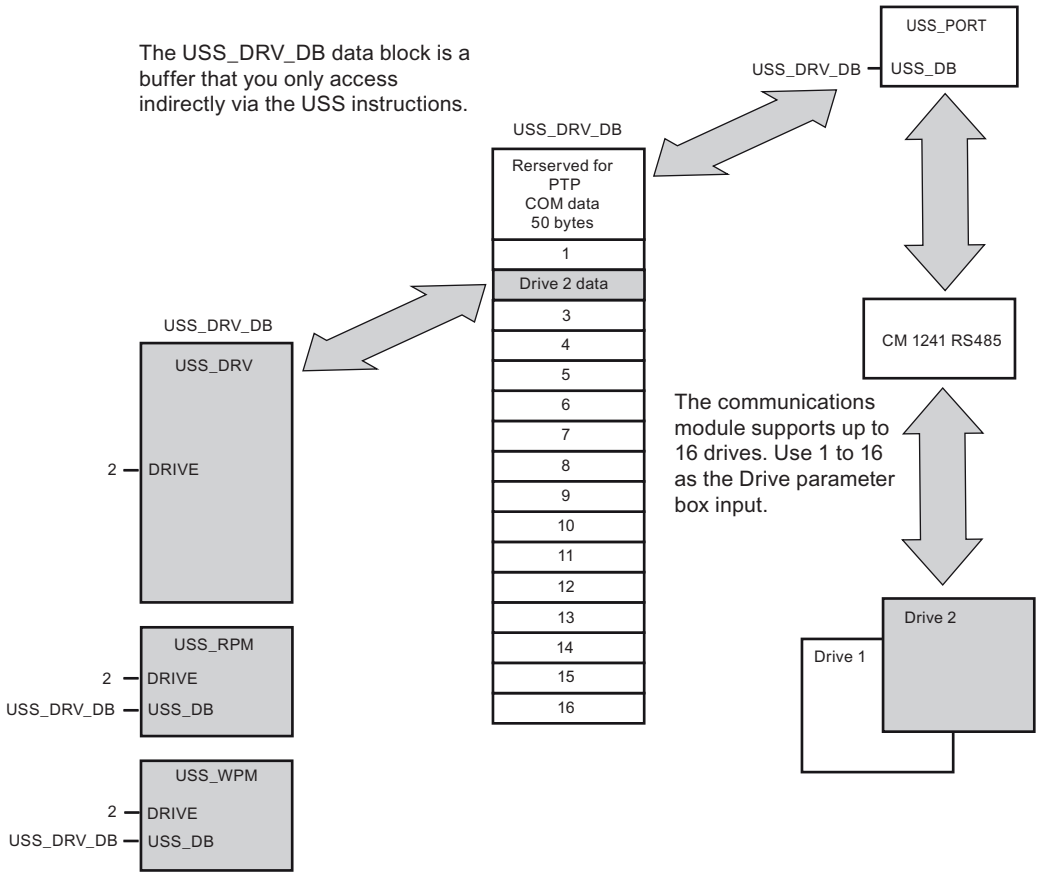
6.3.1 USS

The USS Protocol library makes controlling Siemens drives which support USS protocol. The instructions include functions that are specifically designed for using the USS protocol to communicate with the drive. The CM 1241 RS485 module communicates with the drives on RS485 ports. You can control the physical drive and the read/write drive parameters with the USS library.

6.3.1.1 Requirements for using the USS protocol

The library provides 1 FB and 3 FCs to support the USS protocol. Each CM 1241 RS485 communications module supports a maximum of 16 drives.

A single Instance Data Block contains temporary storage and buffers for all drives on the USS network connected to each PtP communication module you install. The USS functions for these drives share the information in this data block.



All drives (up to 16) connected to a single CM 1241 RS485 are part of the same USS network. All drives connected to a different CM 1241 RS485 are part of a different USS network. Because the S7-1200 supports up to three CM 1241 RS485 devices, you can have up to three USS networks, with up to 16 drives on each network, for a total of 48 USS drives supported.

Each USS network is managed using a unique data block (three data blocks are required for three USS networks using three CM 1241 RS485 devices). All instructions associated with a single USS network must share this data block. This includes all USS_DRV, USS_PORT, USS_RPM, and USS_WPM instructions used to control all drives on a single USS network.

The USS_DRV instruction is a Function Block (FB). When you place the USS_DRV instruction into the editor, you will be prompted by the "Call options" dialog for which DB to assign for this FB. If this is the first USS_DRV instruction in this program for this USS network, then you can accept the default DB assignment (or change the name if you wish), and the new DB will be created for you. If however this is not the first USS_DRV instruction for this channel, then you must use the drop-down list in the "Call options" dialog to select the appropriate DB that was previously assigned for this USS network.

Instructions USS_PORT, USS_RPM, and USS_WPM are all Functions (FC's). No DB is assigned when you place these FC's in the editor. Instead, you must assign the appropriate DB to the "USS_DB" input of these instructions (double-click on the parameter field, then click on the helper icon to see the available DB's).

The USS_PORT function handles actual communication between the CPU and the drives via the PtP communication module. Each call to this function handles one communication with one drive. Your program must call this function fast enough to prevent a communication timeout by the drives. You may call this function in the Main or any interrupt OB.

The USS_DRV function block provides your program access to a specified drive on the USS network. Its inputs and outputs are the status and controls for the drive. If there are 16 drives on the network, your program must have at least 16 USS_DRV calls, one for each drive. These blocks should be called at the rate that is required to control the functions of the drive.

You may only call the USS_DRV function block from the main OB.

⚠ CAUTION

Only call USS_DRV, USS_RPM, USS_WPM from the Main OB. The USS_PORT function can be called from any OB, usually from a Time delay interrupt.

Failure to prevent interruption of USS_PORT may produce unexpected errors.

The USS_RPM and USS_WPM functions read and write the remote drive operating parameters. These parameters control the internal operation of the drive. See the drive manual for the definition of these parameters. Your program can contain as many of these functions as necessary, but only one read or write request can be active per drive, at any given time. You may only call the USS_RPM and USS_WPM functions from a Main OB.

Calculating the time required for communicating with the drive

Communications with the drive are asynchronous to the S7-1200 scan. The S7-1200 typically completes several scans before one drive communications transaction is completed.

The USS_PORT interval is the time required for one drive transaction. The table below shows the minimum USS_PORT interval for each baud rate. Calling the USS_PORT function more frequently than the USS_PORT interval will not increase the number of transactions. The drive timeout interval is the amount of time that might be taken for a transaction, if communications errors caused 3 tries to complete the transaction. By default, the USS protocol library automatically does up to 2 retries on each transaction.

Baud rate	Calculated minimum USS_PORT call Interval (milliseconds)	Drive message interval timeout per drive (milliseconds)
1200	790	2370
2400	405	1215
4800	212.5	638
9600	116.3	349
19200	68.2	205
38400	44.1	133
57600	36.1	109
115200	28.1	85

6.3.1.2 USS_DRV instruction

The USS_DRV instruction exchanges data with the drive by creating request messages and interpreting the drive response messages. A separate function block should be used for each drive, but all USS functions associated with one USS network and PtP communication module must use the same Instance Data Block. You must create the DB name when you place the first USS_DRV instruction and you reuse that DB that was created by the initial instruction usage.

When the initial USS_DRV execution is made, the drive indicated by the USS address (parameter DRIVE) is initialized in the Instance DB. After this initialization, subsequent executions of USS_PORT can then begin communication to the drive at this drive number.

Changing the Drive number requires a PLC STOP to RUN mode transition that initializes the Instance DB. Input parameters are configured into the USS TX message buffer and outputs are read from a "previous" valid response buffer if any exists. There is no data transmission during USS_DRV execution. Drives are communicated with when USS_PORT is executed. USS_DRV only configures the messages to be sent and interprets data that might have been received from a previous request.

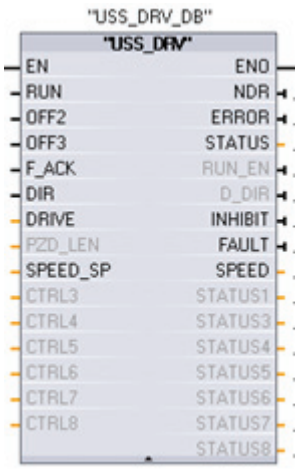
You can control the drive direction of rotation using either the DIR input (BOOL) or using the sign (positive or negative) with the SPEED_SP input (REAL). The following table indicates how these inputs work together to determine the drive direction, assuming the motor is wired for forward rotation.

SPEED_SP	DIR	Drive Direction
Value > 0	0	Reverse
Value > 0	1	Forward
Value < 0	0	Forward
Value < 0	1	Reverse

LAD (default view)



LAD (expanded view)



Expand the box to reveal all the parameters by clicking the bottom of the box.

The parameter pins that are grayed are optional and do not need to be assigned.

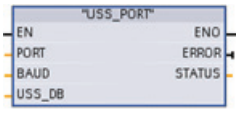
Parameter	Parameter type	Data type	Description
RUN	IN	Bool	Drive start bit: When true, this input enables the drive to run at the preset speed.
OFF2	IN	Bool	Electrical stop bit: When false, this bit cause the drive to coast to a stop with no braking.
OFF3	IN	Bool	Fast stop bit – When false, this bit causes a fast stop by causing braking the drive rather than just allowing the drive to coast to a stop.
F_ACK	IN	Bool	Fault acknowledge bit – This bit is set to reset the fault bit on a drive. This bit is set after the fault is cleared to indicate to the drive it no longer needs to indicate the previous fault.
DIR	IN	Bool	Drive direction control – This bit is set to indicate that the direction is forward (for positive SPEED_SP).
DRIVE	IN	USInt	Drive address: This input is the address of the USS drive. The valid range is drive 1 to drive 16.
PZD_LEN	IN	USInt	Word length – This is the number of words of PZD data. The valid values are 2, 4, 6, or 8 words. Default is 2.
SPEED_SP	IN	Real	Speed set point – This is the speed of the drive as a percentage of configured frequency. A positive value specifies forward direction (when DIR is true).
CTRL3	IN	UInt	Control word 3 – A value written to a user-configurable parameter on the drive. The user must configure this on the drive. Optional parameter.
CTRL4	IN	UInt	Control word 4 – A value written to a user-configurable parameter on the drive. The user must configure this on the drive. Optional parameter.
CTRL5	IN	UInt	Control word 5 – A value written to a user-configurable parameter on the drive. The user must configure this on the drive. Optional parameter.
CTRL6	IN	UInt	Control word 6 – A value written to a user-configurable parameter on the drive. The user must configure this on the drive.
CTRL7	IN	UInt	Control word 7 – A value written to a user-configurable parameter on the drive. The user must configure this on the drive. Optional parameter.
CTRL8	IN	UInt	Control word 8 – A value written to a user-configurable parameter on the drive. The user must configure this on the drive. Optional parameter.
NDR	OUT	Bool	New data ready – When true the bit indicates that the outputs contain data from a new communication request.
ERROR	OUT	Bool	Error occurred – When true, this indicates that an error has occurred and the STATUS output is valid. All other outputs are set to zero on an error. Communication errors are only reported on the USS_PORT instruction ERROR and STATUS outputs.
STATUS	OUT	UInt	The status value of the request. It indicates the result of the scan. This is not a status word returned from the drive.

Parameter	Parameter type	Data type	Description
RUN_EN	OUT	Bool	Run enabled – This bit indicates whether the drive is running.
D_DIR	OUT	Bool	Drive direction – This bit indicates whether the drive is running forward.
INHIBIT	OUT	Bool	Drive inhibited – This bit indicates the state of the inhibit bit on the drive.
FAULT	OUT	Bool	Drive fault – This bit indicates that the drive has registered a fault. The user must fix the problem and then set the F_ACK bit to clear this bit when set.
SPEED	OUT	REAL	Drive Current Speed (scaled value of drive status word 2) – The value of the speed of the drive as a percentage of configured speed.
STATUS1	OUT	UInt	Drive Status Word 1 – This value contains fixed status bits of a drive.
STATUS3	OUT	UInt	Drive Status Word 3 – This value contains a user-configurable status word on the drive.
STATUS4	OUT	UInt	Drive Status Word 4 – This value contains a user-configurable status word on the drive.
STATUS5	OUT	UInt	Drive Status Word 5 – This value contains a user-configurable status word on the drive.
STATUS6	OUT	UInt	Drive Status Word 6 – This value contains a user-configurable status word on the drive.
STATUS7	OUT	UInt	Drive Status Word 7 – This value contains a user-configurable status word on the drive.
STATUS8	OUT	UInt	Drive Status Word 8 – This value contains a user-configurable status word on the drive.

6.3.1.3 USS_PORT instruction

The USS_PORT instruction handles communication over the USS network. Typically there is only one USS_PORT function per PtP communication module in the program, and each call of this function handles a transmission to or from a single drive. Your program must execute the USS_PORT function often enough to prevent drive timeouts. All USS functions associated with one USS network and PtP communication module must use the same Instance Data Block. USS_PORT is usually called from a time delay interrupt OB to prevent drive timeouts and keep the most recent USS data updates available for USS_DRV calls.

LAD



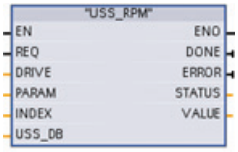
FBD



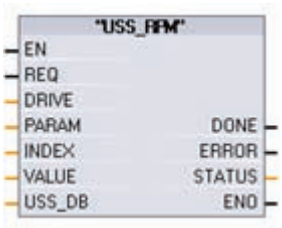
Parameter	Parameter type	Data type	Description
PORT	IN	Port	PtP communications module. Identifier: This a constant which can be referenced within the "Constants" tab of the default tag table.
BAUD	IN	DInt	The Baud Rate to be used for USS communication.
USS_DB	IN	DInt	This is a reference to the instance DB that is created and initialized when a USS_DRV instruction is placed in your program.
ERROR	OUT	Bool	When true, this pin indicates that an error has occurred and the STATUS output is valid.
STATUS	OUT	UInt	The status value of the request. It indicates the result of the scan or initialization. Additional information is available in the "USS_Extended_Error" variable for some status codes.

6.3.1.4 USS_RPM instruction

LAD



FBD



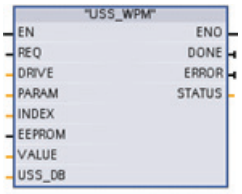
The USS_RPM instruction reads a parameter from the drive. All USS functions associated with one USS network and PtP communication module must use the same data block. USS_RPM must be called from the main OB.

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Send request: When true, it indicates that a new read request is desired. This is ignored if the request for this parameter is already pending.
DRIVE	IN	USInt	Drive address: This input is the address of the USS drive. The valid range is drive 1 to drive 16.
PARAM	IN	UInt	Parameter number: This input designates which drive parameter is written. The range of this parameter is 0 to 2047. See your drive manual for details on how to access any parameters above this range.
INDEX	IN	UInt	Parameter index: This input designates which Drive Parameter index is to be written. A 16-bit value where the Least Significant Byte is the actual index value with a range of (0 to 255). The Most Significant Byte may also be used by the drive and is drive specific. See your drive manual for details.
USS_DB	IN	Variant	This is a reference to the instance DB that is created and initialized when a USS_DRV instruction is placed in your program.

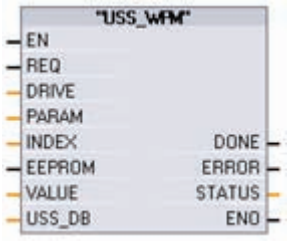
Parameter	Parameter type	Data type	Description
VALUE	IN	Word, Int, UInt, DWord, DInt, UDInt, Real	This is the value of the parameter that was read and is valid only when the DONE bit is true.
DONE	OUT	Bool	Done: When TRUE indicates that the VALUE output holds the previously requested read parameter value. This bit is set when USS_DRV sees the read response data from the drive. This bit is reset when either: • you request the response data via another USS_RPM poll Or • On the second of the next two calls to USS_DRV
ERROR	OUT	Bool	Error occurred – When true, this indicates that an error has occurred and the STATUS output is valid. All other outputs are set to zero on an error. Communication errors are only reported on the USS_PORT instruction ERROR and STATUS outputs.
STATUS	OUT	UInt	This is the status value of the request. It indicates the result of the read request. Additional information is available in the "USS_Extended_Error" variable for some status codes.

6.3.1.5 USS_WPM instruction

LAD



FBD



The USS_WPM instruction modifies a parameter in the drive. All USS functions associated with one USS network and PtP communication module must use the same data block. USS_WPM must be called from the main OB.

Note

EEPROM write operations

Beware of overusing the EEPROM permanent write operation. Minimize the number of EEPROM write operations to extend the EEPROM life.

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Send request: When true, it indicates that a new write request is desired. This is ignored if the request for this parameter is already pending.
DRIVE	IN	USInt	Drive address: This input is the address of the USS drive. The valid range is drive 1 to drive 16.
PARAM	IN	UInt	Parameter number: This input designates which drive parameter is written. The range of this parameter is 0 to 2047. See your drive manual for details on how to access any parameters above this range.
INDEX	IN	UInt	Parameter index: This input designates which Drive Parameter index is to be written. A 16-bit value where the Least Significant Byte is the actual index value with a range of (0 to 255). The Most Significant Byte may also be used by the drive and is drive specific. See your drive manual for details.
EEPROM	IN	Bool	Store To Drive EEPROM: When true, writes to the drive parameter will be stored in the drive EEPROM. If false, the write is temporary and will not be retained if drive is power cycled.
VALUE	IN	Word, Int, UInt, DWord, DInt, UDInt, Real	The value of the parameter that is to be written. It must be valid on the transition of REQ.
USS_DB	IN	Variant	This is a reference to the instance DB that is created and initialized when a USS_DRV instruction is placed in your program.
DONE	OUT	Bool	Done: When TRUE indicates that the input VALUE has been written to the drive. This bit is set when USS_DRV sees the write response data from the drive. This bit is reset when either: You request the drive's confirmation that the write is complete via another USS_WPM poll or on the second of the next two calls to USS_DRV.
ERROR	OUT	Bool	Error occurred: When true, this indicates that an error has occurred and the STATUS output is valid. All other outputs are set to zero on an error. Communication errors are only reported on the USS_PORT instruction ERROR and STATUS outputs.
STATUS	OUT	UInt	This is the status value of the request. It indicates the result of the write request. Additional information is available in the "USS_Extended_Error" variable for some status codes.

6.3.1.6 USS status codes

USS instruction status codes are returned at the STATUS output of the USS functions.

STATUS value (W#16#....)	Description
0000	No error
8180	The length of the drive response did not match the characters received from the drive. The drive number where the error occurred is returned in the "USS_Extended_Error" variable. See the extended error description below this table.
8181	VALUE parameter was not a Word, Real or DWord data type
8182	User supplied a Word for a parameter value and received a DWord or Real from the drive in the response
8183	User supplied a DWord or Real for a parameter value and received a Word from the drive in the response
8184	Response telegram from drive had a bad checksum. The drive number where the error occurred is returned in the "USS_Extended_Error" variable. See the extended error description below this table.
8185	Illegal drive address (valid drive address range: 1-16)
8186	Speed set point out of valid range (valid speed SP range: -200% to 200%)
8187	Wrong drive number responded to the request sent. The drive number where the error occurred is returned in the "USS_Extended_Error" variable. See the extended error description below this table.
8188	Illegal PZD word length specified (valid range = 2, 4, 6 or 8 words)
8189	Illegal Baud Rate was specified
818A	Parameter request channel is in use by another request for this drive
818B	Drive has not responded to requests and retries. The drive number where the error occurred is returned in the "USS_Extended_Error" variable. See the extended error description below this table.
818C	Drive returned an extended error on a parameter request operation. See the extended error description below this table.
818D	Drive returned an illegal access error on a Parameter request operation. See your drive manual for information of why parameter access may be limited
818E	Drive has not been initialized: This error code is returned to USS_RPM or USS_WPM when USS_DRV for that drive has not been called at least once. This keeps the initialization of first scan of USS_DRV from overwriting a pending Parameter Read or Write request since it initializes the Drive as a new entry. To fix this error, call USS_DRV for this drive number.
80Ax-80Fx	Specific errors returned from PtP (Point-to-Point) communication FBs called by the USS Library: These error code values are not modified by the USS library and are defined in the PtP instruction descriptions.

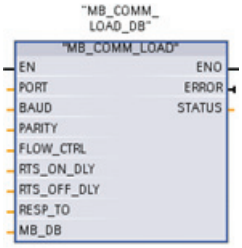
USS drive extended error codes

USS Drives support read and write access to a drive's internal parameters. This feature allows remote control and configuration of the drive. Drive parameter access operations can fail due to errors like values out of range or illegal requests for a drive's current mode. The drive generates an error code value that is returned in the "USS_Extended_Error" variable of the USS_DRV Instance DB. This error code value is only valid for the last execution of a USS_RPM or USS_WPM instruction. The drive error code is put into the "USS_Extended_Error" variable when the STATUS code value is hexadecimal 818C. The error code value of "USS_Extended_Error" depends on the drive model. See the drive's manual for a description of the extended error codes for read and write parameter operations.

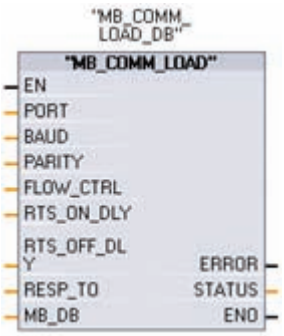
6.3.2 MODBUS

6.3.2.1 MB_COMM_LOAD

LAD



FBD



The MB_COMM_LOAD instruction configures a port on the Point-to-Point (PtP) CM 1241 RS485 or CM 1241 RS232 module for Modbus RTU protocol communications.

Parameter	Parameter type	Data type	Description
PORT	IN	UInt	Communications port identifier: After you install the CM module in the Device configuration, the port identifier appears in the helper drop-list available at the PORT box connection. This constant can also be referenced within the "Constants" tab of the default tag table.
BAUD	IN	UDInt	Baud Rate Selection: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200 All other values are invalid
PARITY	IN	UInt	Parity selection: • 0 – None • 1 – Odd • 2 – Even
FLOW_CTRL	IN	UInt	Flow control selection: • 0 – (default) No Flow Control • 1 – Hardware Flow control with RTS always ON (does not apply to RS485 ports) • 2 - Hardware Flow control with RTS switched
RTS_ON_DLY	IN	UInt	RTS ON Delay Selection: • 0 – (default) No delay from RTS active until the first character of the message is transmitted • 1 to 65535 – Delay in milliseconds from RTS active until the first character of the message is transmitted (does not apply to RS-485 ports). RTS delays shall be applied independent of the FLOW_CTRL selection.

Parameter	Parameter type	Data type	Description
RTS_OFF_DLY	IN	UInt	RTS OFF Delay Selection: • 0 – (default) No delay from the last character transmitted until RTS goes inactive • 1 to 65535 – Delay in milliseconds from the last character transmitted until RTS goes inactive (does not apply to RS-485 ports). RTS delays shall be applied independent of the FLOW_CTRL selection.
RESP_TO	IN	UInt	Response Timeout: Time in milliseconds allowed by MB_MASTER for the slave to respond. If the slave does not respond in this time period, MB_MASTER will retry the request or terminate the request with an error, if the specified number of retries has been sent. 5 ms to 65535 ms (default value = 1000ms).
MB_DB	IN	Variant	A reference to the Instance Data Block used by the MB_MASTER or MB_SLAVE instructions. After MB_SLAVE or MB_MASTER is placed in your program, the DB identifier appears in the helper drop-list available at the MB_DB box connection.
ERROR	OUT	Bool	Error: • 0 – No error detected • 1 – Indicates that an error was detected and the error code at parameter STATUS is valid
STATUS	OUT	Word	Port configuration error code

MB_COMM_LOAD is executed to configure a port for the Modbus RTU protocol. After the port is configured, you communicate on the Modbus by executing either MB_SLAVE or MB_MASTER instructions.

MB_COMM_LOAD should be called one time to initialize the port. MB_COMM_LOAD only needs to be called again if one of the communication parameters must change. You can call MB_COMM_LOAD from a startup OB and execute it one time, or use the first scan system flag to initiate the call to execute it one time.

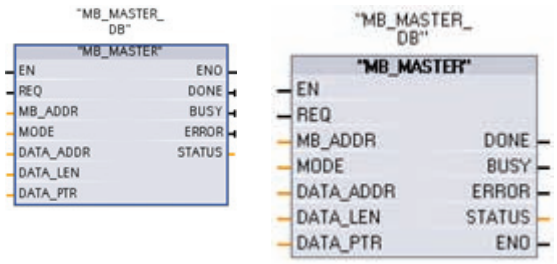
One instance of the MB_COMM_LOAD must be used to configure each port of each communication module that is used for Modbus communication. You must assign a unique MB_COMM_LOAD Instance Data Block for each port that you use. The S7-1200 CPU is limited to 3 communication modules.

An Instance Data Block is assigned when you place the MB_MASTER or MB_SLAVE instructions. This Instance Data Block is referenced when you specify the MB_DB parameter on the MB_COMM_LOAD instruction.

STATUS value (W#16#....)	Description
0000	No error
8180	Invalid port ID value
8181	Invalid baud rate value
8182	Invalid parity value
8183	Invalid flow control value
8184	Invalid response timeout value
8185	Incorrect MB_DB pointer to the instance DB for an MB_MASTER or MB_SLAVE

6.3.2.2 MB_MASTER

LAD **FBD**



The MB_MASTER instruction allows your program to communicate as a Modbus master using a port on the Point-to-Point (PtP) CM 1241 RS485 or CM 1241 RS232 module. You can access data in one or more Modbus slave devices.

An Instance Data Block is assigned when you place the MB_MASTER instruction in your program. This MB_MASTER Instance Data Block name is used when you specify the MB_DB parameter on the MB_COMM_LOAD instruction.

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Request Input: • 0 – No request • 1 – Request to transmit data to Modbus Slave(s)
MB_ADR	IN	USInt	Modbus RTU station address: Valid address range: 0 to 247 The value of 0 is reserved for broadcasting a message to all Modbus slaves. Modbus function codes 05, 06, 15 and 16 are the only function codes supported for broadcast.
MODE	IN	USInt	Mode Selection: Specifies the type of request: read, write, or diagnostic See the following Modbus functions table for details.
DATA_ADDR	IN	UDInt	Starting Address in the Slave: Specifies the starting address of the data to be accessed in the Modbus slave. See the Modbus functions table below for valid addresses.
DATA_LEN	IN	UInt	Data Length: Specifies the number of bits or words to be accessed in this request. See the Modbus functions table below for valid lengths.
DATA_PTR	IN	Variant	Data Pointer: Points to the CPU DB address for the data being written or read. The DB must be a "NOT symbolic access only" DB type. See the DATA_PTR note below.
NDR	OUT	Bool	New Data Ready: • 0 – Transaction not complete • 1 – Indicates that the MB_MASTER instruction has completed the requested transaction with Modbus slave(s)
BUSY	OUT	Bool	Busy: • 0 – No MB_MASTER transaction in progress • 1 – MB_MASTER transaction in progress
ERROR	OUT	Bool	Error: • 0 – No error detected • 1 – Indicates that an error was detected and the error code supplied at parameter STATUS is valid
STATUS	OUT	Word	Execution condition code

Modbus master communication rules

- MB_COMM_LOAD must be executed to configure a port before a MB_MASTER instruction can communicate with that port.
- If a port is to be used to initiate Modbus master requests, that port cannot be used by MB_SLAVE . One or more instances of MB_MASTER execution can be used with that port.
- The Modbus instructions do not use communication interrupt events to control the communication process. Your program must poll the MB_MASTER instruction for transmit and receive complete conditions.
- If your program operates a Modbus master and uses MB_MASTER to send a request to a slave, then you must continue to poll (execute MB_MASTER) until the response from the slave is returned.
- Call all MB_MASTER execution for a given port from the same OB (or OB priority level).

REQ parameter

REQ value FALSE = No request

REQ value TRUE = Request to transmit data to Modbus Slave(s).

You must supply this input through an positive edge triggered contact on the first call for MB_MASTER execution. The edge triggered pulse will invoke the transmission request once. All inputs are captured and held unchanged for one request and response triggered by this input.

Internally the MB_MASTER will start a state machine to make sure that no other MB_MASTER instruction is allowed to issue a request until this request has been completed.

In addition, if the same instance of the call to the MB_MASTER FB is executed again with the REQ input TRUE before the completion of the request, then no subsequent transmissions will be made. However, as soon as the request has been completed, a new request will be issued if MB_MASTER is executed with the REQ input set to true.

DATA_ADDR and MODE parameters select the Modbus function type

DATA_ADDR (starting Modbus address in the Slave): Specifies the starting address of the data to be accessed in the Modbus slave.

MB_MASTER uses a MODE input rather than a Function Code input. The combination of MODE and Modbus address range determine the Function Code that is used in the actual Modbus message. The following table shows the correspondence between MBUS_MASTER parameter MODE, Modbus function code, and Modbus address range.

MB_MASTER Modbus functions				
	Modbus address parameter DATA_ADDR	Address type	Modbus data length parameter DATA_LEN	Modbus function
Mode 0				
Read	00001 to 09999	Output bits	1 to 2000	01H
	10001 – 19999	Input bits	1 to 2000	02H
	30001 - 39999	Input registers	1 to 125	04H
	40001 to 49999 400001 to 465536(Extended)	Holding registers	1 to 125	03H
Mode 1				
Write	00001 to 09999	Output bits	1 (single bit)	05H
	40001 to 49999 400001 to 465536(Extended)	Holding registers	1 (single word)	06H
	00001 to 09999	Output bits	2 to 1968	15H
	40001 to 49999 400001 to 465536(Extended)	Holding registers	2 to 123	16H
Mode 2				
Some Modbus slaves do not support single bit or word writes with Modbus functions 05H and 06H. In these cases, Mode 2 is used to force single bit and word writes using Modbus functions 15H and 16H.				
Write	00001 to 09999	Output bits	1 to 1968	15H
	40001 to 49999 400001 to 465536(Extended	Holding registers	1 to 123	16H
Mode 11 • Reads an event counter word from the Modbus slave that is referenced as an input to MB_ADDR • On a Siemens S7-1200 Modbus slave, this counter is incremented every time that the slave receives a valid read or write (non-broadcast) request from a Modbus master. • The returned value is stored in the word location specified as the input to DATA_PTR. • A valid DATA_LEN is not required for this mode.				
Mode 80 • Checks the communication status of the Modbus slave that is referenced as an input to MB_ADDR • The setting of the NDR output bit on the MB_MASTER instruction indicates that the addressed Modbus slave responded with the appropriate response data. • No data is returned to your program. • A valid DATA_LEN is not required for this mode.				
Mode 81 • Resets the event counter (as returned by Mode 11) on the Modbus slave that is referenced as an input to MB_ADDR • The setting of the NDR output bit on the MB_MASTER instruction indicates that the addressed Modbus slave responded with the appropriate response data. • No data is returned to your program. • A valid DATA_LEN is not required for this mode.				

DATA_PTR parameter

The DATA_PTR parameter points to the local source or destination address (the address in the S7-1200 CPU) of the data that is written to or read from, respectively. When you use the MB_MASTER instruction to create a Modbus master, you must create a global data block that provides data storage for reads and writes to Modbus slaves.

Note

The DATA_PTR parameter must reference a global data block which was created with the Symbolic Access Only attribute box unchecked.

You must uncheck the "Symbolic address only" box when you add a new Data block to create a classic global DB type.

Data block structures for the DATA_PTR parameter

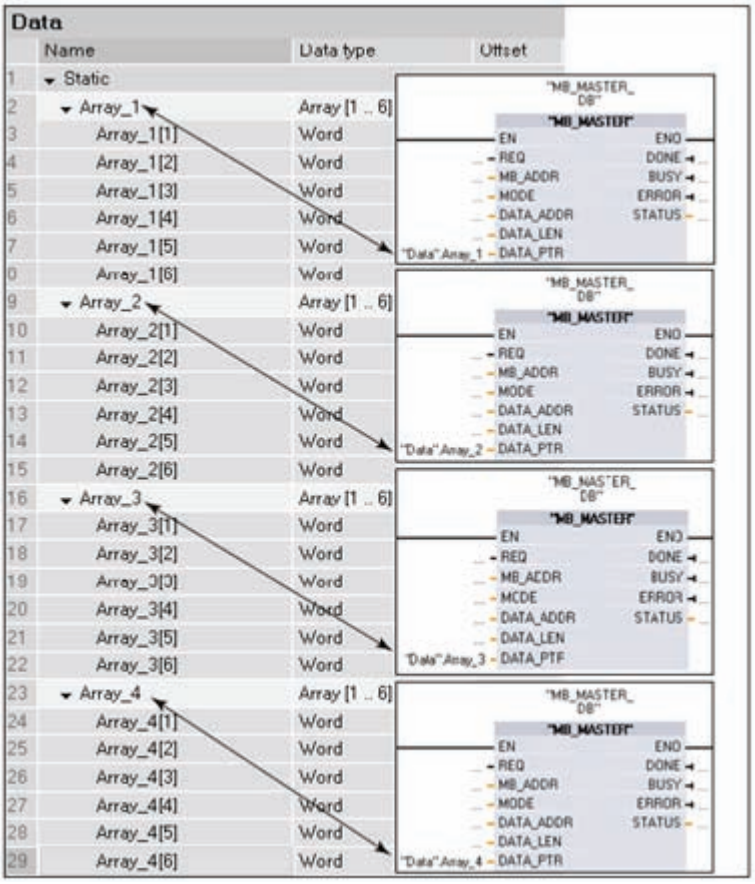
- These data types are valid for **word reads** of Modbus addresses 30001 to 39999, 40001 to 49999, and 400001 to 465536 and also for **word writes** to Modbus addresses 40001 to 49999 and 400001 to 465536.
  - Standard array of WORD, UINT, or INT data types, as shown below.
  - Named WORD, UINT, or INT structure where each element has a unique name and 16 bit data type.
  - Named complex structure where each element has a unique name and a 16 or 32 bit data type.
- For bit reads and writes of Modbus addresses 00001 to 09999 and 10001 to 19999.
  - Standard array of Boolean data types.
  - Named Boolean structure of uniquely named Boolean variables..
- Although not required, it is recommended that each MB_MASTER instruction have its own separate area in a global data block. The reason for this recommendation is that there is a greater possibility of data corruption if multiple MB_MASTER instructions are reading and writing to the same area of a global data block.
- There is no requirement that the DATA_PTR data areas be in the same global data block. You can create one data block with multiple areas for Modbus reads, one data block for Modbus writes, or one data block for each slave station.
- All of the arrays in the example below are created as base 1 arrays [1 … ##]. The arrays could have been created as base 0 arrays [0 … ###] or a mix of base 0 and base 1.

Example MB_MASTER instructions accessing DATA_PTR global data blocks

The example global data block shown below uses 4 uniquely named, 6 word arrays for Modbus request data storage. Although the data arrays in this example are the same size, the arrays can be of any size and are shown as the same size to simplify the examples. Each array could also be replaced with a data structure that includes more descriptive tag names and mixed data types. Examples of alternative data structures are provided in the HR_DB parameter description of the MB_SLAVE instruction (Page 199).

The MB_MASTER instruction examples below show only the DATA_PTR parameter and not the other required parameters. The purpose of the examples is to show how the MB_MASTER instruction uses the DATA_PTR data block.

The arrows indicate how each array is associated to different MB_MASTER instructions.



The first element of any array or structure is always the first source or destination of any Modbus read or write activity. All the scenarios below are based on the diagram above.

Scenario 1: If the first MB_MASTER instruction reads 3 words of data from Modbus address 40001 on any valid Modbus slave, then the following occurs.

The word from address 40001 is stored in "Data".Array_1[1].

The word from address 40002 is stored in "Data".Array_1[2].

The word from address 40003 is stored in "Data".Array_1[3].

Scenario 2: If the first MB_MASTER instruction reads 4 words of data from Modbus address 40015 on any valid Modbus slave, then the following occurs.

The word from address 40015 is stored in "Data".Array_1[1].

The word from address 40016 is stored in "Data".Array_1[2].

The word from address 40017 is stored in "Data".Array_1[3].

The word from address 40018 is stored in "Data".Array_1[4].

Scenario 3: If the second MB_MASTER instruction reads 2 words of data from Modbus address 30033 on any valid Modbus slave, then the following occurs.

The word from address 30033 is stored in "Data".Array_2[1].

The word from address 30034 is stored in "Data".Array_2[2].

Scenario 4: If the third MB_MASTER instruction writes 4 words of data to Modbus address 40050 on any valid Modbus slave, then the following occurs.

The word from "Data".Array_3[1] is written to Modbus address 40050.

The word from "Data".Array_3[2] is written to Modbus address 40051.

The word from "Data".Array_3[3] is written to Modbus address 40052.

The word from "Data".Array_3[4] is written to Modbus address 40053.

Scenario 5: If the third MB_MASTER instruction writes 3 words of data to Modbus address 40001 on any valid Modbus slave, then the following occurs.

The word from "Data".Array_3[1] is written to Modbus address 40001.

The word from "Data".Array_3[2] is written to Modbus address 40002.

The word from "Data".Array_3[3] is written to Modbus address 40003.

Scenario 6: If the fourth MB_MASTER instruction uses a Mode 11 (retrieve valid message count) from any valid Modbus slave, the following occurs.

The count word is stored in "Data".Array_4[1].

Example bit reads and writes using word locations as DATA_PTR input

Table 6- 1 Scenario 7: Read 4 output bits starting at Modbus address 00001

MB_MASTER input values			Slave Modbus values	
MB_ADDR	27 (Slave example)		**00001**	**ON**
MODE	0 (Read)		**00002**	**ON**
DATA_ADDR	00001 (Outputs)		**00003**	**OFF**
DATA_LEN	4		**00004**	**ON**
DATA_PTR	"Data".Array_4		00005	ON
			00006	OFF
			00007	ON
			00008	OFF

"Data".Array_4[1] values after Modbus request	
MS (Most significant) Byte	LS (Least significant) Byte
xxxx-1011	xxxx-xxxx
x indicates that data is not changed	

Table 6- 2 Scenario 8: Read 12 output bits starting at Modbus address 00003

MB_MASTER input values			**Slave Modbus values**				
MB_ADDR	27 (Slave example)		00001	ON		**00010**	**ON**
MODE	0 (Read)		00002	ON		**00011**	**OFF**
DATA_ADDR	00003 (Outputs)		**00003**	**OFF**		**00012**	**OFF**
DATA_LEN	12		**00004**	**ON**		**00013**	**ON**
DATA_PTR	"Data".Array_4		**00005**	**ON**		**00014**	**OFF**
			00006	**OFF**		00015	ON
			00007	**ON**		00016	ON
			00008	**ON**		00017	OFF
			00009	**OFF**		00018	ON

"Data".Array_4[1] values after Modbus request	
MS Byte	LS Byte
1011-0110	xxxx-0100-
x indicates that data is not changed	

Table 6- 3 Scenario 9: Write 5 output bits starting at Modbus address 00001

MB_MASTER input values			**Slave outputs before**			**Slave outputs after**
MB_ADDR	27 (Slave example)		**00001**	**ON**		**OFF**
MODE	1 (Write)		**00002**	**ON**		ON
DATA_ADDR	00001 (Outputs)		**00003**	**OFF**		ON
DATA_LEN	5		**00004**	**ON**		**OFF**
DATA_PTR	"Data".Array_4		**00005**	**ON**		ON
			00006	OFF		Unchanged
			00007	ON		Unchanged
			00008	ON		Unchanged
			00009	OFF		Unchanged

"Data".Array_4[1] values for Modbus write request	
MS Byte	LS Byte
xxx1-0110	xxxxx-xxxx
x indicates that data is not used in the Modbus request	

Table 6- 4 Scenario 10: Read 22 output bits starting at Modbus address 00003

MB_MASTER input values			**Slave Modbus values**				
MB_ADDR	27 (Slave example)		00001	ON		**00014**	**ON**
MODE	0 (Read)		00002	ON		**00015**	**OFF**
DATA_ADDR	00003 (Outputs)		**00003**	**OFF**		**00016**	**ON**
DATA_LEN	22		**00004**	**ON**		**00017**	**ON**
DATA_PTR	"Data".Array_4		**00005**	**ON**		**00018**	**OFF**
			00006	**OFF**		**00019**	**ON**
			00007	**ON**		**00020**	**ON**
			00008	**ON**		**00021**	**OFF**
			00009	**ON**		**00022**	**ON**
			00010	**OFF**		**00023**	**ON**
			00011	**OFF**		**00024**	**OFF**
			00012	**ON**		00025	OFF
			00013	**OFF**		00026	ON

"Data".Array_4[1] values after Modbus request	
MS Byte	LS Byte
0111-0110	0110-1010

"Data".Array_4[2] values after Modbus request	
MS Byte	LS Byte
xx01-1011	xxxx-xxxx
x indicates that data is not changed	

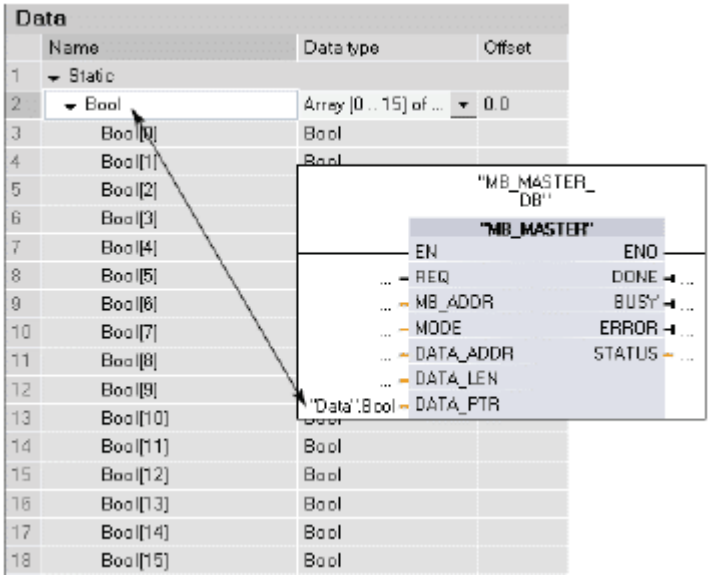
Example bit reads and writes using BOOL locations as DATA_PTR input

Although Modbus reads and writes to bit address locations can be handled through the use of word locations, DATA_PTR areas can also be configured as Boolean data types, structures or arrays to provide a direct one to one correlation for the first bit that is read or written by using a MB_MASTER instruction.

If you use Boolean arrays or structures, it is recommended that you make the data size a multiple of 8 bits (on byte boundaries). For example, when you create a Boolean array of 10 bits the STEP 7 Basic software will allocate 16 bits (2 bytes) in the global Data block for the 10 bits. Inside the data block, these would be stored as byte1 [xxxx xxxx] byte2 [---- --xx] where x indicates accessible data locations and – indicates locations that are inaccessible. Modbus requests of up to a length of 16 bits are allowed, but the upper 6 bits would be placed into byte 2 memory locations that are not referenced and are not accessible by your program.

Boolean areas can be created as an array of Boolean values or as a structure of Boolean variables. Both methods operate in an identical manner and differ only in how they are created and accessed in your program.

The global data block editor view below shows a single array of 16 Boolean values created with base 0. The array could also have been created as a base 1 array. The arrow shows how this array is associated with a MB_MASTER instruction.



Scenarios 11 and 12 show the correspondence of Modbus addresses to Boolean array addresses.

Table 6- 5 Scenario 11: Write 5 output bits starting at Modbus address 00001

MB_MASTER input values			Slave outputs before		DATA_PTR data	Slave outputs after
MB_ADDR	27 (Slave example)		00001	ON	"Data".Bool[0]=FALSE	OFF
MODE	1 (Write)		00002	ON	"Data".Bool[1]=TRUE	ON
DATA_ADDR	00001 (Outputs)		00003	OFF	"Data".Bool[2]=TRUE	ON
DATA_LEN	5		00004	ON	"Data".Bool[3]-FALSE	OFF
DATA_PTR	"Data".Bool		00005	ON	"Data".Bool[4]=FALSE	OFF
			00006	OFF		Unchanged
			00007	ON		Unchanged
			00008	OFF		Unchanged

Table 6- 6 Scenario 12: Read 15 output bits starting at Modbus address 00004

MB_MASTER input values			Slave Modbus value		DATA_PTR data after
MB_ADDR	27 (Slave example)		00001	ON	
MODE	0 (Read)		00002	ON	
DATA_ADDR	00003 (Outputs)		**00003**	**OFF**	"Data".Bool[0]=FALSE
DATA_LEN	15		**00004**	**ON**	"Data".Bool[1]=TRUE
DATA_PTR	"Data".Bool		**00005**	**ON**	"Data".Bool[2]=TRUE
			00006	**OFF**	"Data".Bool[3]-FALSE
			00007	**ON**	Data".Bool[4]=TRUE
			00008	**ON**	Data".Bool[5]=TRUE
			00009	**ON**	Data".Bool[6]=TRUE
			00010	**OFF**	Data".Bool[7]=FALSE
			00011	**OFF**	Data".Bool[8]=FALSE
			00012	**ON**	Data".Bool[9]=TRUE
			00013	**OFF**	Data".Bool[10]=FALSE
			00014	**ON**	Data".Bool[11]=TRUE
			00015	**OFF**	Data".Bool[12]=FALSE
			00016	**ON**	Data".Bool[13]=TRUE
			00017	**ON**	Data".Bool[14]=TRUE
			00018	OFF	
			00019	ON	

Condition codes

STATUS value (W#16#....)	Description
0000	No error
80C8	The specified response timeout (refer to RCVTIME or MSGTIME) is 0.
80D1	The receiver issued a flow control request to suspend an active transmission and never re-enabled the transmission during the specified wait time. This error is also generated during hardware flow control when the receiver does not assert CTS within the specified wait time.
80D2	The transmit request was aborted because no DSR signal is received from the DCE.
80E0	The message was terminated because the receive buffer is full.
80E1	The message was terminated as a result of a parity error.
80E2	The message was terminated as a result of a framing error.
80E3	The message was terminated as a result of an overrun error.
80E4	The message was terminated as a result of the specified length exceeding the total buffer size.
8180	Invalid port ID value
8186	Invalid Modbus station address

STATUS value (W#16#....)	Description
8188	Invalid Mode value or write mode to read only slave address area
8189	Invalid Data Address value
818A	Invalid Data Length value
818B	• Invalid pointer to the local data source/destination: Size not correct
818C	Pointer to a type safe DB type DATA_PTR (must be a Classic DB type)
8200	Port is busy processing a transmit request

6.3.2.3 MB_SLAVE

The MB_SLAVE instruction allows your program to communicate as a Modbus slave using a port on the Point-to-Point (PtP) CM 1241 RS485 or CM 1241 RS232 module. A Modbus RTU master can issue a request and then your program responds via MB_SLAVE execution.

You must assign a unique Instance Data Block when you place the MB_SLAVE instruction in your program. This MB_SLAVE Instance Data Block name is used when you specify the MB_DB parameter on the MB_COMM_LOAD instruction.

Modbus communication function codes (1, 2, 4, 5, and 15) can read and write bits and words directly in the PLC Input Process Image and Output process Image. The following table shows the mapping of modbus addresses to the process image in the CPU.

MB_SLAVE Modbus functions						S7-1200	
Codes	Function	Data area	Address range			Data area	CPU address
01	Read bits	Output	1	to	8192	Output Process Image	Q0.0 to Q1023.7
02	Read bits	Input	10001	to	18192	Input Process Image	I0.0 to I1023.7
04	Read words	Input	30001	to	30512	Input Process Image	IW0 to IW1022
05	Write bit	Output	1	to	8192	Output Process Image	Q0.0 to Q1023.7
15	Write bits	Output	1	to	8192	Output Process Image	Q0.0 to Q1023.7

Modbus communication function codes (3, 6, 16) use a separate and unique Modbus holding register data block that you must create, before you can specify the MB_HOLD_REG parameter on the MB_SLAVE instruction. The following table shows the mapping of Modbus holding register to the MB_HOLD_REG DB address in the PLC.

MB_SLAVE Modbus functions				S7-1200	
Codes	Function	Data area	Address range	CPU DB data area	CPU DB address
03	Read words	Holding Register	40001 to 49999	MB_HOLD_REG	Words 1 to 9999
			400001 to 465535		Words 1 to 65535
06	Write word	Holding Register.	40001 to 49999	MB_HOLD_REG	Words 1 to 9999
			400001 to 465535		Words 1 to 65535
16	Write words	Holding Register	40001 to 49999	MB_HOLD_REG	Words 1 to 9999
			400001 to 465535		Words 1 to 65535

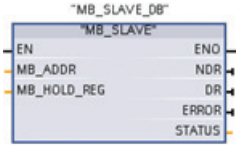
The following table shows the supported Modbus diagnostic functions.

S7-1200 MB_SLAVE Modbus diagnostic functions		
Codes	Sub-function	Description
08	0000H	Return query data echo test: The MB_SLAVE will echo back to a Modbus master a word of data that is received.
08	000AH	Clear communication event counter: The MB_SLAVE will clear out the communication event counter that is used for Modbus function 11.
11		Get communication event counter: The MB_SLAVE uses an internal communication event counter for recording the number of successful Modbus read and write requests that are sent to the Modbus slave. The counter does not increment on any Function 8, Function 11, or broadcast requests. It is also not incremented on any requests that result in a communication error (for example, parity or CRC errors).

The MB_SLAVE supports broadcast write requests from any Modbus master as long as the request is for accessing valid locations.

Regardless of the validity of a request, the MB_SLAVE gives no response to a Modbus master as the result of a broadcast request.

LAD



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Parameter	Parameter type	Data type	Description
MB_ADDR	IN	USINT	Modbus RTU Address (1 to 247): The station address of the Modbus slave.
MB_HOLD_REG	IN	VARIANT	Pointer to the Modbus Holding Register DB. The Holding Register DB must be a classic, global DB See the MB_HOLD_REG note below.
NDR	OUT	BOOL	New Data Ready: • 0 – No new data • 1 – Indicates that new data has been written by the Modbus master
DR	OUT	BOOL	Data Read: • 0 – No data read • 1 – Indicates that data has been read by the Modbus master

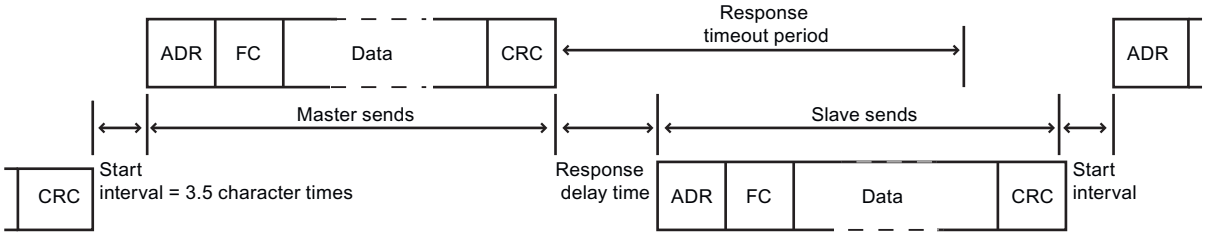
Parameter	Parameter type	Data type	Description
ERROR	OUT	BOOL	Error: • 0 – No error detected • 1 – Indicates that an error was detected and the error code supplied at parameter STATUS is valid.
STATUS	OUT	WORD	Error code

Modbus slave communication rules

- MB_COMM_LOAD must be executed to configure a port, before a MB_SLAVE instruction can communicate with that port.
- If a port is to respond as a slave to a Modbus master, then that port cannot be used by MB_MASTER. Only one instance of MB_SLAVE execution can be used with a given port.
- The Modbus instructions do not use communication interrupt events to control the communication process. Your program must control the communication process by polling the MB_SLAVE instruction for transmit and receive complete conditions.
- The MB_SLAVE must execute periodically at a rate that allows it to make a timely response to incoming requests from a Modbus master.
- You should call MB_SLAVE every scan from a program cycle OB.

Operation

MB_SLAVE must be executed periodically to receive each request from the Modbus master and then respond as required. The frequency of execution for MB_SLAVE is dependent upon the response timeout period of the Modbus master. This is illustrated in the following diagram.



The response timeout period is the amount of time a Modbus master waits for the start of a response from a Modbus slave. This time period is not defined by the Modbus protocol, but is a parameter of each Modbus master. The frequency of execution (time between one execution and the next execution) of MB_SLAVE must be based on the particular parameters of your Modbus master. At a minimum, you should execute MB_SLAVE twice within the response timeout period of the Modbus master.

MB_HOLD_REG parameter examples

MB_HOLD_REG is a pointer to the Modbus holding register Data block. This DB is used to hold data values that a Modbus master is allowed to access (read or write). You must create

the data block and assign the data type structure that will be read from and written to, before it can be used with the MB_SLAVE instruction.

Note

The Modbus Holding Register data block must reference a global data block which was created with the Symbolic Access Only attribute box unchecked.

You must uncheck the "Symbolic address only" box when you add a new Data block to create a classic global DB type.

The holding registers can use these DB data structures:

- Standard array of words
- Named word structure
- Named complex structure

The following program examples show how to use the MB_HOLD_REG parameter to handle these DB data structures.

Example 1 - Standard array of words

This example holding register is an array of words. The data type assignments can be changed to other word size types (INT and UINT).

Advantages:

- This type of holding register structure is very fast and simple to create.
- The program logic to access a data element is simplified.
-

Disadvantages:

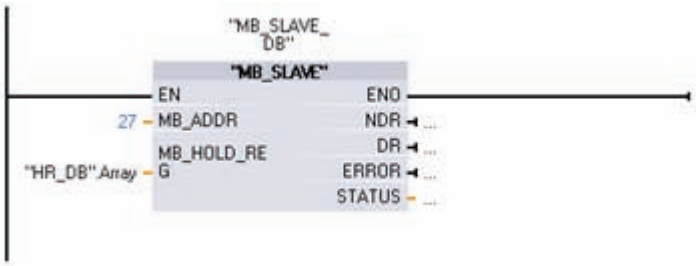
- Although you can programmatically reference each array element by the symbolic names ("HR_DB"."Array"[1] through "HR_DB"."Array"[10]), the names do not describe the internal function of the data.
- The array can consist of only one data type. Type conversions may be required in a user program with rigid type control.

This is how an array of words structure would appear in the data block editor.

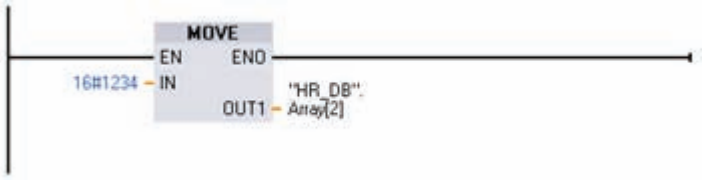
HR_DB

	Name	Data type	Offset	Default value	Initial value	Retain	Comment
1	Static						
2	Array	Array [1..10] of W..	0.0			☐	40001 to 40010
3	Array[1]	Word		W#16#0000	W#16#0000		
4	Array[2]	Word		W#16#0000	W#16#0000		
5	Array[3]	Word		W#16#0000	W#16#0000		
6	Array[4]	Word		W#16#0000	W#16#0000		
7	Array[5]	Word		W#16#0000	W#16#0000		
8	Array[6]	Word		W#16#0000	W#16#0000		
9	Array[7]	Word		W#16#0000	W#16#0000		
10	Array[8]	Word		W#16#0000	W#16#0000		
11	Array[9]	Word		W#16#0000	W#16#0000		
12	Array[10]	Word		W#16#0000	W#16#0000		

The image below shows how the array would be assigned to the MB_HOLD_REG input of an MB_SLAVE instruction.



Each element of the array can be accessed by symbolic name, as shown below. In this example, a new value is moved into the second element of the array which corresponds to Modbus address 40002.



Each of the words in the array, as defined in the data block, provides the MB_SLAVE instruction with Modbus holding register addresses. In this instance, since there are only 10 elements in the array, there are only 10 available Modbus holding register addresses usable by this MB_SLAVE instruction and accessible by a Modbus master.

The correlation of the array element names to Modbus addresses is shown below.

"HR_DB".Array[1]	Modbus address 40001
" HR_DB ". Array[2]	Modbus address 40002
" HR_DB ". Array[3]	Modbus address 40003
...	...
" HR_DB ". Array[9]	Modbus address 40009
" HR_DB ".Array [10]	Modbus address 40010

Example 2 - Named word structure

This example holding register is a series of words with descriptive symbolic names.

Advantages:

- Each structure element has a descriptive name with a specific data type assigned to it.

Disadvantages:

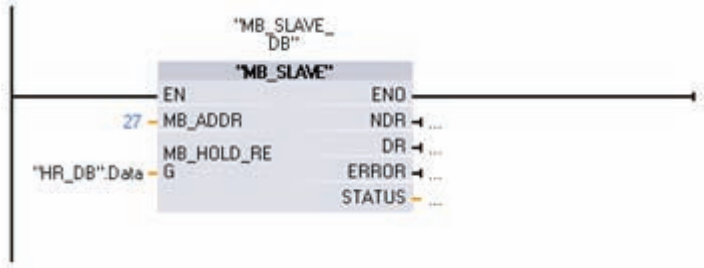
- It takes longer to create this type of structure than the standard array of words.
- The elements require additional symbolic referencing when used in a user program. Where the first element of the simple array is referenced as "HR_DB".Array[0] the first element of this type is referenced "HR_DB".Data.Temp_1.

This is how a named word structure would appear in the data block editor. Each element has a unique name and can be a WORD, UINT, or INT.

HR_DB

	Name	Data type	Offset	Initial value	Retain	Comment
1	Static					
2	Data	Struct	0.0			
3	Temp_1	Int	0.0	0		40001
4	Temp_2	Int	2.0	0		40002
5	Temp_3	Int	4.0	0		40003
6	Good_Count	UInt	6.0	0		40004
7	Bad_Count	UInt	8.0	0		40005
8	Rework_Count	UInt	10.0	0		40006
9	Line_Stops	UInt	12.0	0		40007
10	Avg_Time	UInt	14.0	0		40008
11	Code_1	Word	16.0	0		40009
12	Code_2	Word	18.0	0		40010

The image below shows how the data structure above would be assigned to the MB_HOLD_REG input of an MB_SLAVE instruction in your program.



Each element of the array can be accessed by its symbolic name as shown below. In this example, a new value is moved into the second element of the array which corresponds to Modbus address 40002.



The correlation of the data element names to Modbus addresses is shown below.

"HR_DB".Data.Temp_1	Modbus address 40001
"HR_DB".Data.Temp_2	Modbus address 40002
"HR_DB".Data.Temp_3	Modbus address 40003
"HR_DB".Data.Good_Count	Modbus address 40004
"HR_DB".Data.Bad_Count	Modbus address 40005
"HR_DB".Data.Rework_Count	Modbus address 40006
"HR_DB".Data.Line_Stops	Modbus address 40007
"HR_DB".Data.Avg_Time	Modbus address 40008
"HR_DB".Data.Code_1	Modbus address 40009
"HR_DB".Data.Code_2	Modbus address 40010

Example 3 - Named complex structure

This example holding register is a series of series of mixed data types with descriptive symbolic names.

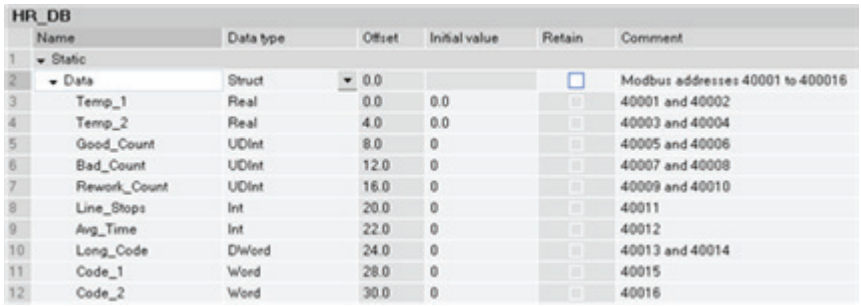
Advantages:

- Each structure element has a descriptive name with a specific data type assigned to it.
- It allows for the direct transfer of non-word based data types.

Disadvantages:

- It takes longer to create this type of structure than the standard array of words.
- The Modbus master needs to be configured to accept the data that it will be receiving from the Modbus slave. As shown in the image below, Temp_1 is a 4 byte real value. The receiving master needs to be able to reassemble the 2 received words back into the real value that is expected.
- The elements require additional symbolic referencing in your program. Where the first element of the simple array is referenced as "HR_DB".Array[0], the first element of this type is referenced as "HR_DB".Data.Temp_1.

This is how a named complex structure would appear in the data block editor. Each element has a unique name with multiple sizes and data types.



HR_DB

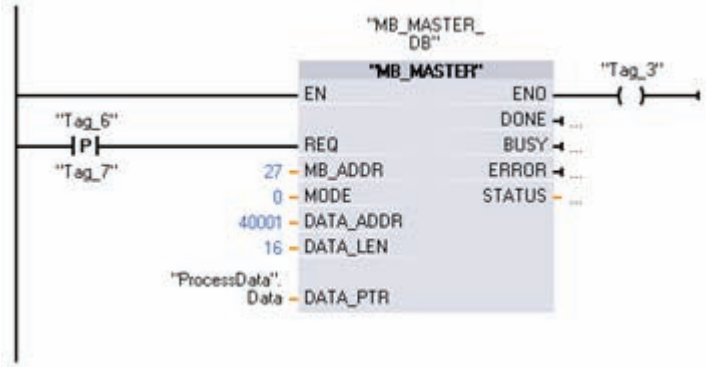
	Name	Data type	Offset	Initial value	Retain	Comment
1	Static					
2	Data	Struct	0.0			Modbus addresses 40001 to 400016
3	Temp_1	Real	0.0	0.0		40001 and 40002
4	Temp_2	Real	4.0	0.0		40003 and 40004
5	Good_Count	UDInt	8.0	0		40005 and 40006
6	Bad_Count	UDInt	12.0	0		40007 and 40008
7	Rework_Count	UDInt	16.0	0		40009 and 40010
8	Line_Stops	Int	20.0	0		40011
9	Avg_Time	Int	22.0	0		40012
10	Long_Code	DWord	24.0	0		40013 and 40014
11	Code_1	Word	28.0	0		40015
12	Code_2	Word	30.0	0		40016

The correlation of the data element names to Modbus addresses is shown below.

"HR_DB".Data.Temp_1	Modbus addresses 40001 and 40002
"HR_DB".Data.Temp_2	Modbus addresses 40003 and 40004
"HR_DB".Data.Good_Count	Modbus addresses 40005 and 40006
"HR_DB".Data.Bad_Count	Modbus addresses 40007 and 40008
"HR_DB".Data.Rework_Count	Modbus addresses 40009 and 40010
"HR_DB".Data.Line_Stops	Modbus address 400011
"HR_DB".Data.Avg_Time	Modbus address 400012
"HR_DB".Data.Long_Code	Modbus address 40013 and 40014
"HR_DB".Data.Code_1	Modbus address 40015
"HR_DB".Data.Code_2	Modbus address 40016

Another S7-1200 CPU operating as a Modbus master can use the MB_Master instruction and an identical data structure to receive the block of data from the S7-1200 CPU operating as a Modbus slave. This Modbus Master instruction will copy all 16 words of data directly

from the slave's HR_DB data block into the master's ProcessData data block, as shown below.



ProcessData

	Name	Data type	Offset	Initial value	Retain	Comment
1	Static					
2	Data	Struct	0.0			Modbus addresses 40001 to 400016
3	Temp_1	Real	0.0	0.0		40001 and 40002
4	Temp_2	Real	4.0	0.0		40003 and 40004
5	Good_Count	UDInt	8.0	0		40005 and 40006
6	Bad_Count	UDInt	12.0	0		40007 and 40008
7	Rework_Count	UDInt	16.0	0		40009 and 40010
8	Line_Stops	Int	20.0	0		40011
9	Avg_Time	Int	22.0	0		40012
10	Long_Code	DWord	24.0	0		40013 and 40014
11	Code_1	Word	28.0	0		40015
12	Code_2	Word	30.0	0		40016

A series of Modbus master Data_PTR data block locations can be used to transfer the same or different structures from multiple Modbus slaves.

Condition codes

STATUS value (W#16#....)	Description
80C8	The specified response timeout (refer to RCVTIME or MSGTIME) is 0
80D1	The receiver issued a flow control request to suspend an active transmission and never re-enabled the transmission during the specified wait time. This error is also generated during hardware flow control when the receiver does not assert CTS within the specified wait time.
80D2	The transmit request was aborted because no DSR signal is received from the DCE
80E0	The message was terminated because the receive buffer is full
80E1	The message was terminated as a result of a parity error
80E2	The message was terminated as a result of a framing error
80E3	The message was terminated as a result of an overrun error
80E4	The message was terminated as a result of the specified length exceeding the total buffer size
8180	Invalid port ID value
8186	Invalid Modbus station address
8187	Invalid pointer to MB_HOLD_REG DB
818C	Pointer to a type safe DB type MB_HOLD_REG DB (must be a Classic DB type)

STATUS value (W#16#....)	Description	
	Response code sent to Modbus master (B#16#..)	
8380	No response	CRC error
8381	01	Function code not supported
8382	No response	Data length error
8383	02	Data address error
8384	03	Data value error
8385	03	Data diagnostic code value not supported (function code 08)

PROFINET

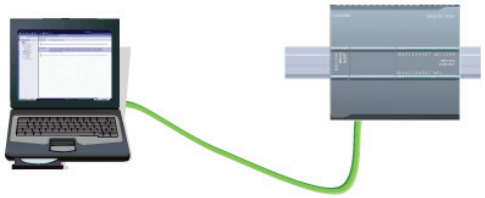
7

The S7-1200 CPU has an integrated PROFINET port which supports both Ethernet and TCP/IP-based communications standards. The following application protocols are supported by the S7-1200 CPU:

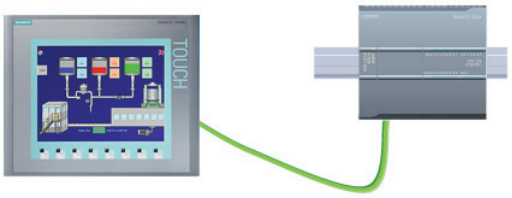
- Transport Control Protocol (TCP)
- ISO on TCP (RFC 1006)

The S7-1200 CPU can communicate with other S7-1200 CPUs, with the STEP 7 Basic programming device, with HMI devices, and with non-Siemens devices using standard TCP communications protocols. There are two ways to communicate using PROFINET:

- Direct connection: Use direct communication when you are using a programming device, HMI, or another CPU connected to a single CPU.
- Network connection: Use network communications when you are connecting more than two devices (for example, CPUs, HMIs, programming devices, and non-Siemens devices).



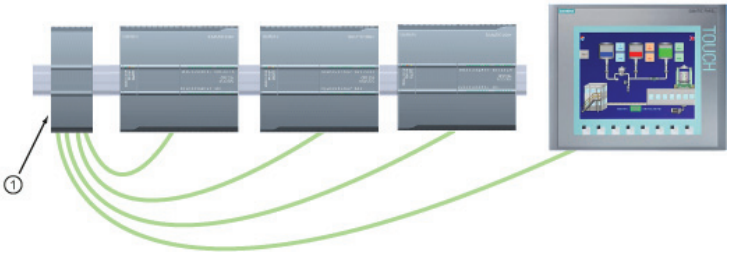
Direct connection: Programming device connected to S7-1200 CPU



Direct connection: HMI connected to S7-1200 CPU



Direct connection: An S7-1200 CPU connected to another S7-1200 CPU



Network connection: More than two devices connected together, using a CSM1277 Ethernet switch ①

An Ethernet switch is not required for a direct connection between a programming device or HMI and a CPU. An Ethernet switch is required for a network with more than two CPUs or HMI devices. The rack-mounted Siemens CSM1277 4-port Ethernet switch can be used to connect your CPUs and HMI devices. The PROFINET port on the S7-1200 CPU does not contain an Ethernet switching device.

Maximum number of connections for the PROFINET port

The PROFINET port on the CPU supports the following simultaneous communication connections.

- 3 connections for HMI to CPU communication
- 1 connection for programming device (PG) to CPU communication
- 8 connections for S7-1200 program communication using the T-block instructions (TSEND_C, TRCV_C, TCON, TDISCON, TSEN, TRCV)
- 3 connections for a passive S7-1200 CPU communicating with an active S7 CPU
  - The active S7 CPU uses GET and PUT instructions (S7-300 and S7-400) or ETHx_XFER instructions (S7-200).
  - An active S7-1200 communication connection is only possible with the T-block instructions.

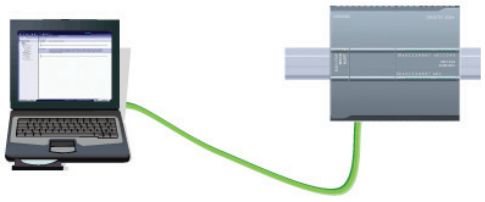
Restricted TSAPs or port numbers for passive ISO and TCP communication

If you use the "TCON" instruction to set up and establish a passive communications connection, the following port addresses are restricted and should not be used:

- ISO TSAP (passive): 01.00, 01.01, 02.00, 02.01, 03.00, 03.01
- TCP port (passive): 5001, 102, 123, 20, 21, 25, 34962, 34963, 34964, 80

7.2 Communication with a programming device

A CPU can communicate with a STEP 7 Basic programming device on a network.



Consider the following when setting up communications between a CPU and a programming device:

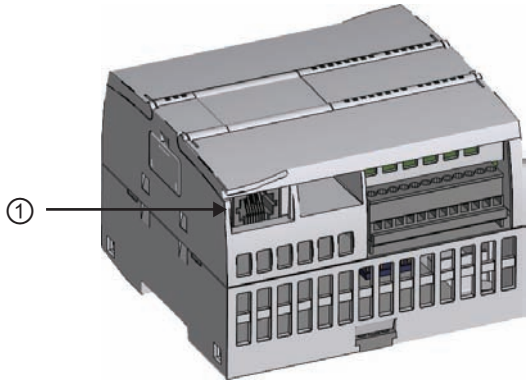
- Configuration/Setup: Hardware configuration is required.
- No Ethernet switch is required for one-to-one communications; an Ethernet switch is required for more than two devices in a network.

7.2.1 Establishing the hardware communications connection

The PROFINET interfaces establish the physical connections between a programming device and a CPU. Since Auto-Cross-Over functionality is built into the CPU, either a standard or crossover Ethernet cable can be used for the interface. An Ethernet switch is not required to connect a programming device directly to a CPU.

Follow the steps below to create the hardware connection between a programming device and a CPU:

1. Install the CPU (Page 26).
2. Plug the Ethernet cable into the PROFINET port shown below.
3. Connect the Ethernet cable to the programming device.



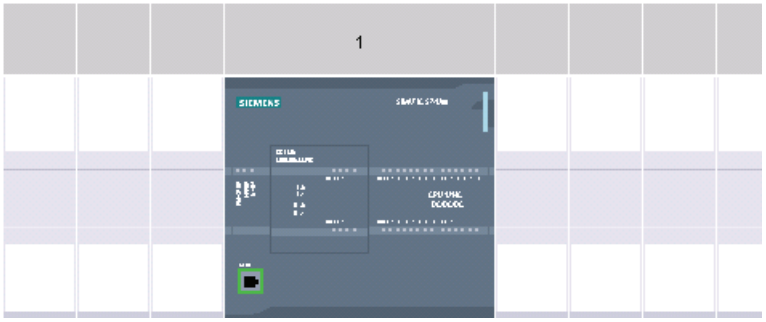
① PROFINET port

An optional strain relief is available to strengthen the PROFINET connection.

7.2.2 Configuring the devices

If you have already created a project with a CPU, open your project in the TIA Portal.

If not, create a project and insert a CPU (Page 70) into the rack. In the project below, a CPU is shown in the "Device View" of the TIA Portal.



7.2.3 Assigning Internet Protocol (IP) addresses

7.2.3.1 Assigning IP addresses to programming and network devices

If your programming device is using an on-board adapter card connected to your plant LAN (and possibly the world-wide web), the IP Address Network ID and subnet mask of your CPU and the programming device's on-board adapter card must be exactly the same. The Network ID is the first part of the IP address (first three octets) (for example, **211.154.184**.16) that determines what IP network you are on. The subnet mask normally has a value of **255.255.255.0**; however, since your computer is on a plant LAN, the subnet mask may have various values (for example, **255.255.254.0**) in order to set up unique subnets. The subnet mask, when combined with the device IP address in a mathematical AND operation, defines the boundaries of an IP subnet.

Note

In a world-wide web scenario, where your programming devices, network devices, and IP routers will communicate with the world, unique IP addresses must be assigned to avoid conflict with other network users. Contact your company IT department personnel, who are familiar with your plant networks, for assignment of your IP addresses.

If your programming device is using an Ethernet-to-USB adapter card connected to an isolated network, the IP Address Network ID and subnet mask of your CPU and the programming device's Ethernet-to-USB adapter card must be exactly the same. The Network ID is the first part of the IP address (first three octets) (for example, **211.154.184**.16) that determines what IP network you are on. The subnet mask normally has a value of **255.255.255.0**. The subnet mask, when combined with the device IP address in a mathematical AND operation, defines the boundaries of an IP subnet.

Note

An Ethernet-to-USB adapter card is useful when you do not want your CPU on your company LAN. During initial testing or commissioning tests, this arrangement is particularly useful.

Programming Device Adapter Card	Network Type	Internet Protocol (IP) Address	Subnet Mask
On-board adapter card	Connected to your plant LAN (and possibly the world-wide web)	Network ID of your CPU and the programming device's on-board adapter card must be exactly the same. The Network ID is the first part of the IP address (first two octets) (for example, 211.154.184.16) that determines what IP network you are on.)	The subnet mask of your CPU and the on-board adapter card must be exactly the same. The subnet mask normally has a value of **255.255.255.0**; however, since your computer is on a plant LAN, the subnet mask may have various values (for example, **255.255.254.0**) in order to set up unique subnets. The subnet mask, when combined with the device IP address in a mathematical AND operation, defines the boundaries of an IP subnet.
Ethernet-to-USB adapter card	Connected to an isolated network	Network ID of your CPU and the programming device's Ethernet-to-USB adapter card must be exactly the same. The Network ID is the first part of the IP address (first two octets) (for example, 211.154.184.16) that determines what IP network you are on.)	The subnet mask of your CPU and the Ethernet-to-USB adapter card must be exactly the same. The subnet mask normally has a value of **255.255.255.0**. The subnet mask, when combined with the device IP address in a mathematical AND operation, defines the boundaries of an IP subnet.

Assigning or checking the IP address of your programming device using "My Network Places" (on your desktop)

You can assign or check your programming device's IP address with the following menu selections:

- (Right-click) "My Network Places"
- "Properties"
- (Right-click) "Local Area Connection"
- "Properties"

In the "Local Area Connection Properties" dialog, in the "This connection uses the following items:" field, scroll down to "Internet Protocol (TCP/IP)". Click "Internet Protocol (TCP/IP)", and click the "Properties" button. Select "Obtain an IP address automatically (DHCP)" or "Use the following IP address" (to enter a static IP address).

Note

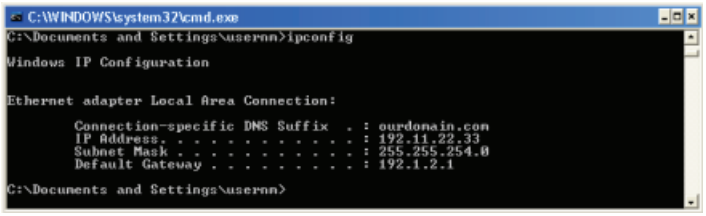
Dynamic Host Configuration Protocol (DHCP) automatically assigns an IP address to your programming device upon power up from the DHCP server.

Checking the IP address of your programming device using the "ipconfig" and "ipconfig /all" commands

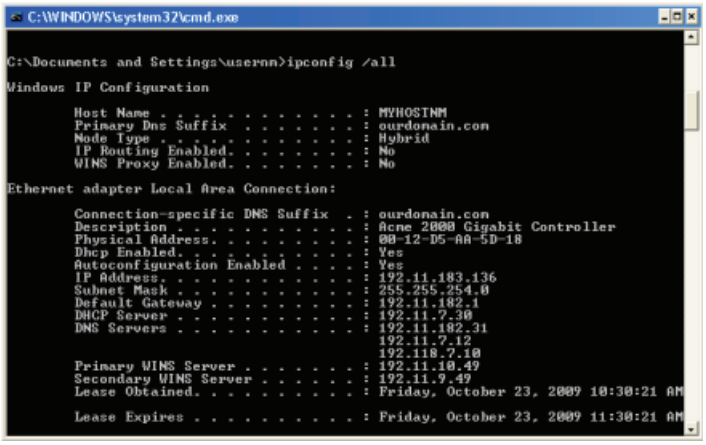
You can also check the IP address of your programming device, and, if applicable, the IP address of your IP router (Gateway) with the following menu selections:

- "Start" button (on your desktop)
- "Run"

In the "Run" dialog, in the "Open" field, enter "cmd" and click the "OK" button. In the "C:\WINDOWS\system32\cmd.exe" dialog that is displayed, enter the command "ipconfig". An example result is shown below:



Further information can be displayed with an "ipconfig /all" command. Your programming device's adapter card type and Ethernet (MAC) address can be found here:



Assigning an IP address to a CPU

You can use one of the following two methods to assign IP addresses to a CPU:

- Assign an IP address online
- Configure an IP address in your project

7.2.3.2 Assigning an IP address online

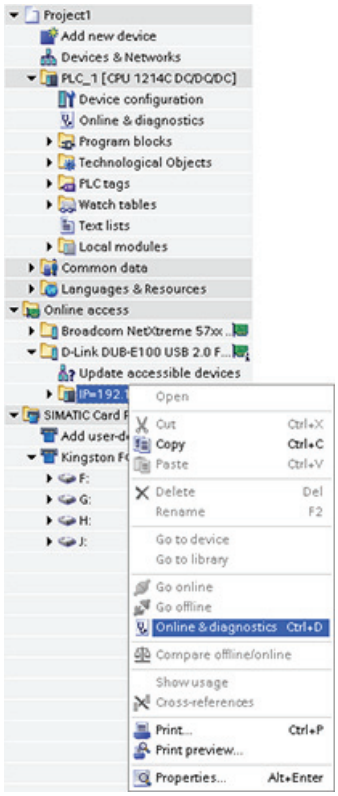
You can assign an IP address to a network device online. This is particularly useful in an initial device configuration.

Use the following procedure to assign an IP address online:

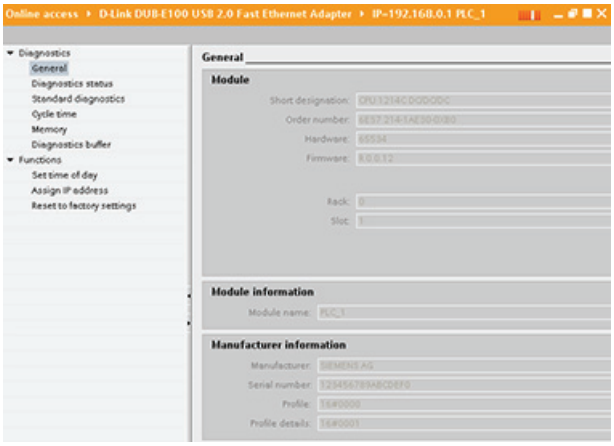
1. In the "Project tree," verify that no IP address is assigned to the CPU, with the following menu selections:
   - "Online access"
   - <Adapter card for the network in which the device is located>
   - "Update accessible devices"



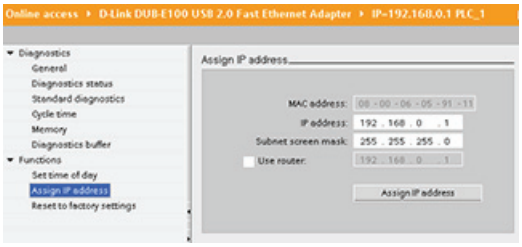
2. In the "Project tree," make the following menu selections:
   - "Online access"
   - <Adapter card for the network in which the device is located>
   - "Update accessible devices"
   - <device address>
   - "Online & diagnostics"



3. In the "Online & diagnostics" dialog, make the following menu selections:
   - "Functions"
   - "Assign IP address"



4. In the "IP address" field, enter your new IP address.



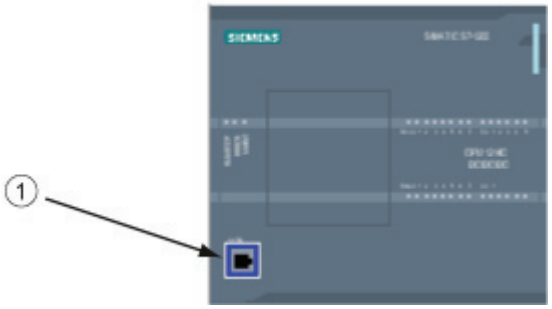
5. In the "Project tree," verify that your new IP address has been assigned to the CPU, with the following menu selections:
   - "Online access"
   - <Adapter for the network in which the device is located>
   - "Update accessible devices"



7.2.3.3 Configuring an IP address in your project

Configuring the PROFINET interface

After you configure the rack with the CPU (Page 211) , you can configure parameters for the PROFINET interface. To do so, click the green PROFINET box on the CPU to select the PROFINET port. The "Properties" tab in the inspector window displays the PROFINET port.



① PROFINET port

Configuring the IP address

Ethernet (MAC) address: In a PROFINET network, each device is assigned a Media Access Control address (MAC address) by the manufacturer for identification. A MAC address consists of six groups of two hexadecimal digits, separated by hyphens (-) or colons (:), in transmission order, (for example, 01-23-45-67-89-AB or 01:23:45:67:89:AB).

IP address: Each device must also have an Internet Protocol (IP) address. This address allows the device to deliver data on a more complex, routed network.

Each IP address is divided into four 8-bit segments and is expressed in a dotted, decimal format (for example, 211.154.184.16). The first part of the IP address is used for the Network ID (What network are you on?), and the second part of the address is for the Host ID (unique for each device on the network). An IP address of 192.168.x.y is a standard designation recognized as part of a private network that is not routed on the Internet.

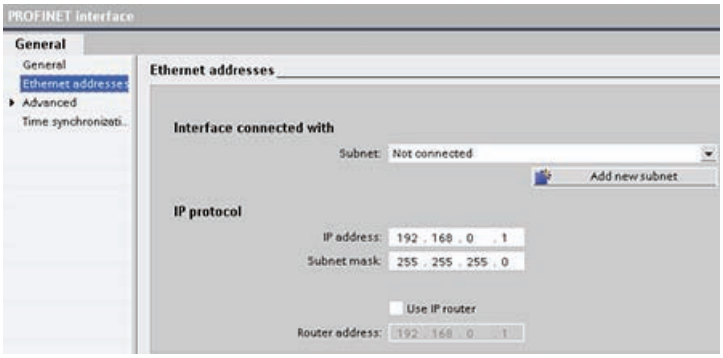
Subnet mask: A subnet is a logical grouping of connected network devices. Nodes on a subnet tend to be located in close physical proximity to each other on a Local Area Network (LAN). A mask (known as the subnet mask or network mask) defines the boundaries of an IP subnet.

A subnet mask of 255.255.255.0 is generally suitable for a small local network. This means that all IP addresses on this network should have the same first 3 octets, and the various devices on this network are identified by the last octet (8-bit field). An example of this is to assign a subnet mask of 255.255.255.0 and an IP addresses of 192.168.2.0 through 192.168.2.255 to the devices on a small local network.

The only connection between different subnets is via a router. If subnets are used, an IP router must be employed.

IP router: Routers are the link between LANs. Using a router, a computer in a LAN can send messages to any other networks, which might have other LANs behind them. If the destination of the data is not within the LAN, the router forwards the data to another network or group of networks where it can be delivered to its destination.

Routers rely on IP addresses to deliver and receive data packets.



IP addresses properties:
In the Properties window, select the "Ethernet address" configuration entry. The TIA Portal displays the Ethernet address configuration dialog, which associates the software project with the IP address of the CPU that will receive that project.

Note

The CPU does not have a pre-configured IP address. You must manually assign an IP address for the CPU. If your CPU is connected to a router on a network, you must also enter the router's IP address. All IP addresses are configured when you download the project.

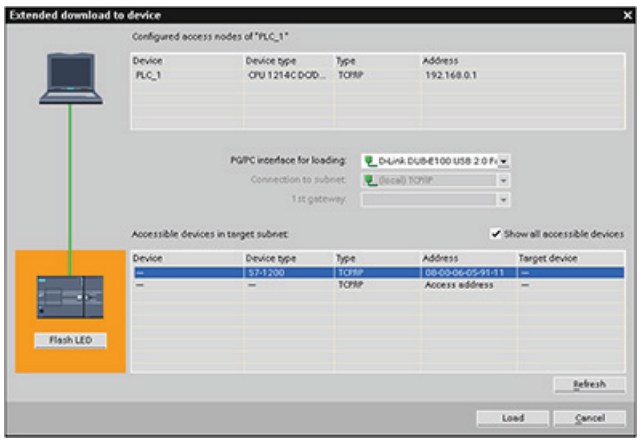
Refer to "Assigning IP addresses to programming and network devices" for more information.

The following table defines the parameters for the IP address:

Parameter		Description
Subnet	Name of the Subnet to which the device is connected. Click the "Add new subnet" button to create a new subnet. "Not connected" is the default. Two connection types are possible: • The "Not connected" default provides a local connection. • A subnet is required when your network has two or more devices.	
IP protocol	IP address	Assigned IP address for the CPU
	Subnet mask	Assigned subnet mask
	Use IP router	Click the checkbox to indicate the use of an IP router
	Router address	Assigned IP address for the router, if applicable

7.2.4 Testing the PROFINET network

After completing the configuration, download the project to the CPU. All IP addresses are configured when you download the project.



Assigning an IP address to a device online

The S7-1200 CPU does not have a pre-configured IP address. You must manually assign an IP address for the CPU.

To assign an IP address to a device online, refer to "Assigning an IP address online" for this step-by-step procedure.

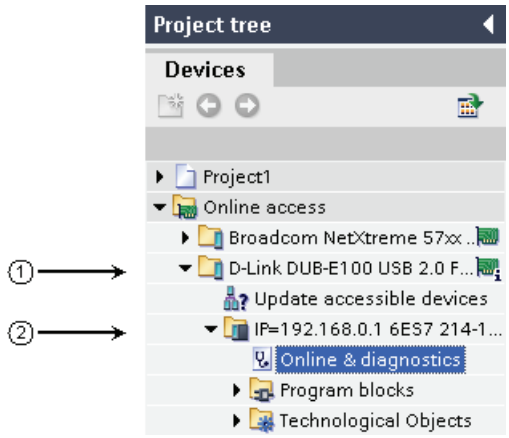
To assign an IP address in your project, you must configure the IP address in the Device configuration, save the configuration, and download it to the PLC. Refer to "Configuring an IP address for your project" for more information.

Note

If you have assigned IP addresses online you can change online-assigned IP addresses using the online or offline hardware configuration method.

If you have assigned IP addresses in offline hardware configuration, you can only change project-assigned IP addresses using the offline hardware configuration method.

Use "Online access" to display the connected CPU's IP address as shown below.



① Second of two Ethernet networks on this programming device

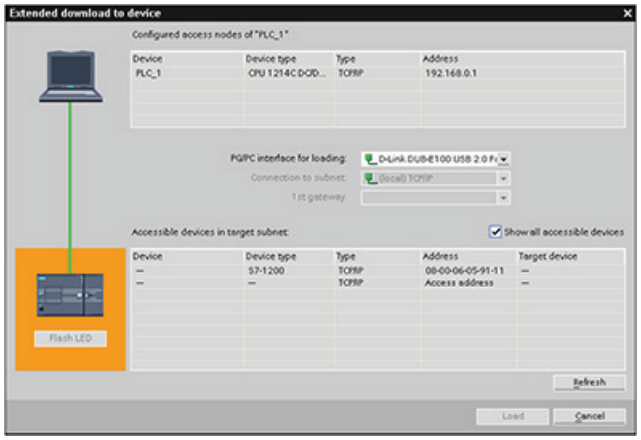
② IP address of the only S7-1200 CPU on this Ethernet network

Note

All configured networks of the programming device are displayed. You must select the correct network to display the required S7-1200 CPU's IP address.

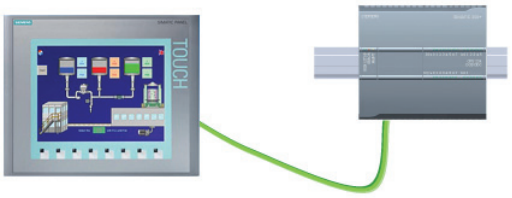
Using the "Extended download to device" dialog to test for connected network devices

The S7-1200 CPU "Download to device" function and its "Extended download to device" dialog can show all accessible network devices and whether or not unique IP addresses have been assigned to all devices. To display all accessible and available devices with their assigned MAC and IP addresses, check the "Show all accessible devices" checkbox.



If the required network device is not in this list, communications to that device have been interrupted for some reason. The device and network must be investigated for hardware and/or configuration errors.

7.3 HMI-to-PLC communication



The CPU supports PROFINET communications connections to HMIs. The following requirements must be considered when setting up communications between CPUs and HMIs:

Configuration/Setup:

- The PROFINET port of the CPU must be configured to connect with the HMI.
- The HMI must be setup and configured.
- The HMI configuration information is part of the CPU project and can be configured and downloaded from within the project.
- No Ethernet switch is required for one-to-one communications; an Ethernet switch is required for more than two devices in a network.

Note

The rack-mounted Siemens CSM1277 4-port Ethernet switch can be used to connect your CPUs and HMI devices. The PROFINET port on the CPU does not contain an Ethernet switching device.

Supported functions:

- The HMI can read/write data to the CPU.
- Messages can be triggered, based upon information retrieved from the CPU.
- System diagnostics

Note

WinCC Basic and STEP 7 Basic are components of the TIA Portal. Refer to WinCC Basic for more information on configuring the HMI.

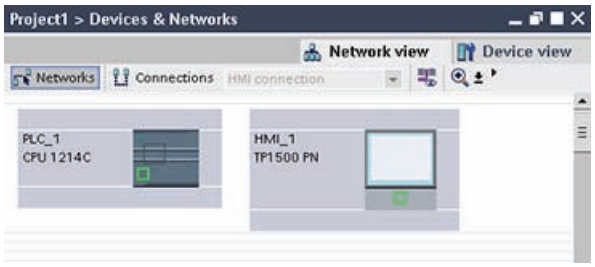
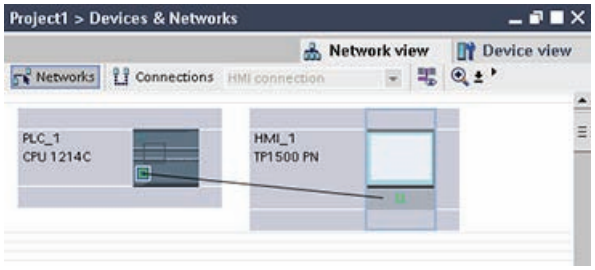
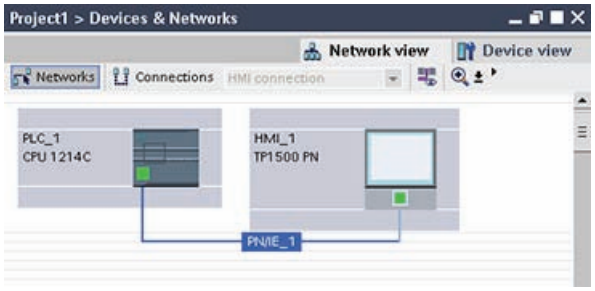
Required steps in configuring communications between an HMI and a CPU

Step	Task
1	Establishing the hardware communications connection A PROFINET interface establishes the physical connection between an HMI and a CPU. Since Auto-Cross-Over functionality is built into the CPU, you can use either a standard or crossover Ethernet cable for the interface. An Ethernet switch is not required to connect an HMI and a CPU. Refer to "Communication with a programming device: Establishing the hardware communications connection" (Page 211) for more information.
2	Configuring the devices Refer to "Communication with a programming device: Configuring the devices" (Page 211) for more information.
3	Configuring the logical network connections between an HMI and a CPU Refer to "HMI to PLC communication: Configuring the logical network connections between an HMI and a CPU" (Page 222) for more information.
4	Configuring an IP address in your project Use the same configuration process; however, you must configure IP addresses for the HMI and the CPU. Refer to "Communication with a programming device: Configuring an IP address in your project" (Page 217) for more information.
5	Testing the PROFINET network You must download the configuration for each CPU. Refer to "Communication with a programming device: Testing the PROFINET network (Page 219) for more information.

7.3.1 Configuring the logical network connections between an HMI and a CPU

After you configure the rack with the CPU, you are now ready to configure your network connections.

In the Devices and Networks portal, use the "Network view" to create the network connections between the devices in your project. To create the Ethernet connection, select the green (Ethernet) box on the CPU. Drag a line to the Ethernet box on the HMI device. Release the mouse button and your Ethernet connection is joined.

Action	Result
Select "Network view" to display the devices to be connected.	
Select the port on one device and drag the connection to the port on the second device.	
Release the mouse button to create the network connection.	

7.4 PLC-to-PLC communication



A CPU can communicate with another CPU on a network by using the TSEND_C and TRCV_C instructions.

Consider the following when setting up communications between two CPUs:

- Configuration/Setup: Hardware configuration is required.
- Supported functions: Reading/Writing data to a peer CPU
- No Ethernet switch is required for one-to-one communications; an Ethernet switch is required for more than two devices in a network.

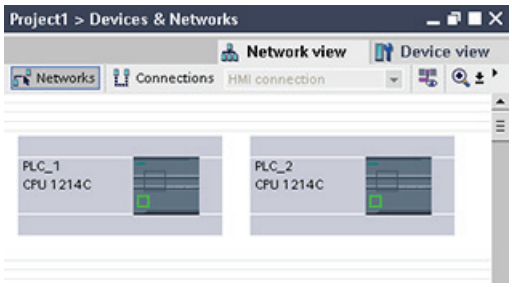
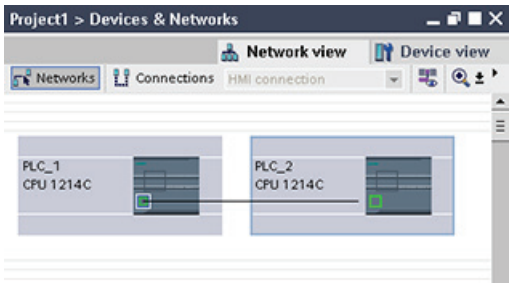
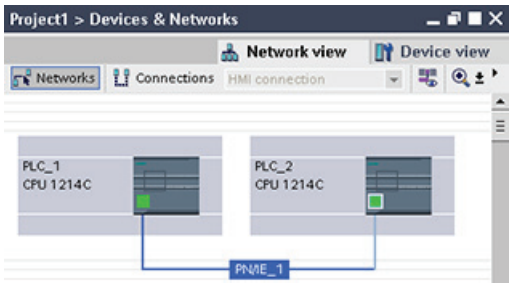
Required steps in configuring communications between two CPUs

Step	Task
1	Establishing the hardware communications connection A PROFINET interface establishes the physical connection between two CPUs. Since Auto-Cross-Over functionality is built into the CPU, you can use either a standard or crossover Ethernet cable for the interface. An Ethernet switch is not required to connect the two CPUs. Refer to "Communication with a programming device: Establishing the hardware communications connection" for more information.
2	Configuring the devices You must configure two projects with a CPU in each project. Refer to "Communication with a programming device: Configuring the devices" for more information.
3	Configuring the logical network connections between two CPUs Refer to "Configuring communications between two CPUs: Configuring the logical network connections between two CPUs" (Page 224) for more information.
4	Configuring an IP address in yourproject Use the same configuration process; however, you must configure IP addresses for two CPUs (for example, PLC_1 and PLC_2). Refer to "Communication with a programming device: Configuring an IP address in your project" for more information.
5	Configuring transmit (send) and receive parameters You must configure TSEND_C and TRCV_C instructions in both CPUs to enable communications between them. Refer to "Configuring communications between two CPUs: Configuring transmit (send) and receive parameters" (Page 225) for more information.
6	Testing the PROFINET network You must download the configuration for each CPU. Refer to "Configuring communications between a programming device and a CPU: Testing the PROFINET network" for more information.

7.4.1 Configuring the logical network connections between two CPUs

After you configure the rack with the CPU, you are now ready to configure your network connections.

In the Devices and Networks portal, use the "Network view" to create the network connections between the devices in your project. To create the PROFINET connection, select the green (PROFINET) box on the first PLC. Drag a line to the PROFINET box on the second PLC. Release the mouse button and your PROFINET connection is joined.

Action	Result
Select "Network view" to display the devices to be connected.	
Select the port on one device and drag the connection to the port on the second device.	
Release the mouse button to create the network connection.	

7.4.2 Configuring transmit (send) and receive parameters

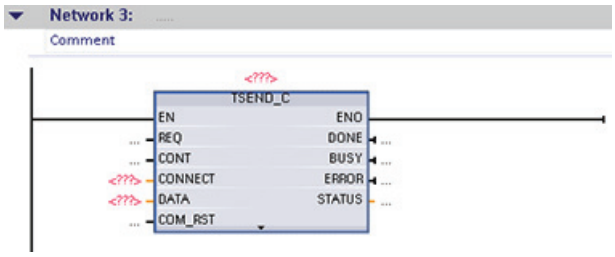
Transmission block (T-block) communications are used to establish connections between two CPUs. Before the CPUs can engage in PROFINET communications, you must configure parameters for transmitting (or sending) messages and receiving messages. These parameters dictate how communications operate when messages are being transmitted to or received from a target device.

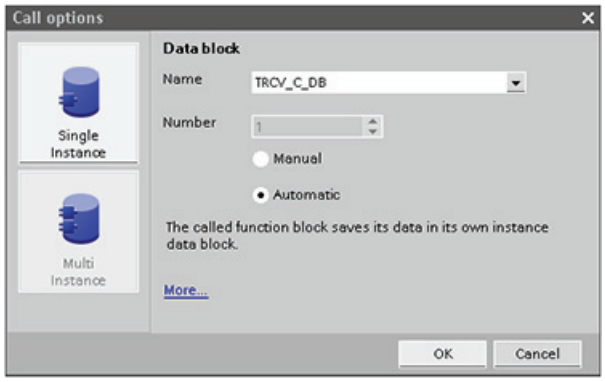
7.4.2.1 Configuring the TSEND_C instruction transmit (send) parameters

TSEND_C instruction

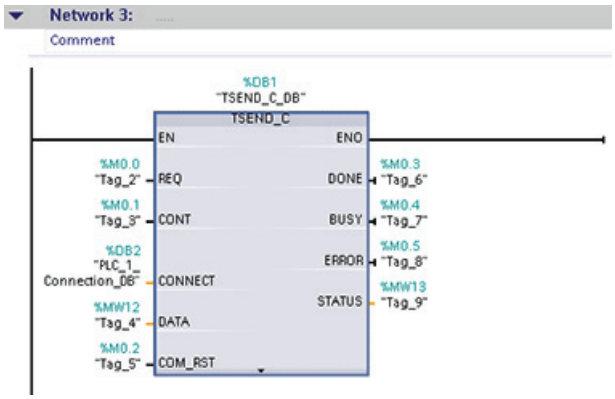
The TSEND_C instruction (Page 154) creates a communications connection to a partner station. The connection is set up, established, and automatically monitored until it is commanded to disconnect by the instruction. The TSEND_C instruction combines the functions of the TCON, TDISCON and TSEND instructions.

From the Device configuration in STEP 7 Basic, you can configure how a TSEND_C instruction transmits data. To begin, you insert the instruction into the program from the "Communications" folder in the "Extended Instructions". The instruction is displayed, along with the Call options dialog where you assign a DB for storing the parameters of the TSEND_C instruction.





You can assign tag memory locations to the inputs and outputs, as shown in the following figure.



Configuring General parameters

You specify the communication parameters in the Properties configuration dialog of the TSEND_C instruction. This dialog appears near the bottom of the page whenever you have selected any part of the TSEND_C instruction.

Configuring Connection parameters

Every CPU has an integrated PROFINET port, which supports standard PROFINET communications. The supported Ethernet protocols are described in the following two connection types:

Protocol	Protocol Name	Usage
RFC 1006	ISO on TCP	Message fragmentation and re-assembly
TCP	Transport Controool Protocol	Transport of frames

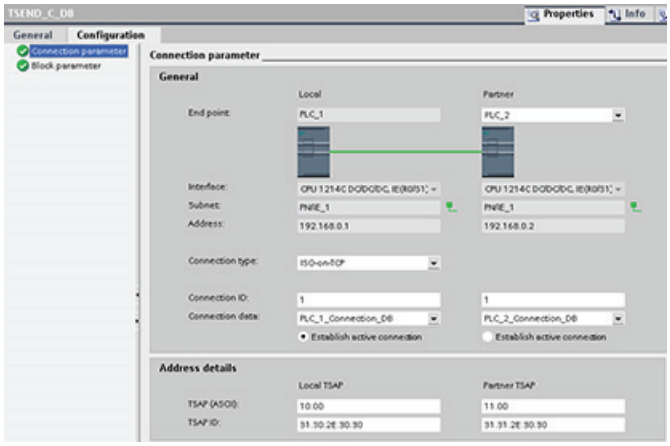
ISO on TCP (RFC 1006)

ISO on TCP is a mechanism that enables ISO applications to be ported to the TCP/IP network. This protocol has the following features:

- An efficient communications protocol closely tied to the hardware
- Suitable for medium-sized to large data amounts (up to 8192 bytes)
- In contrast to TCP, the messages feature an end-of-data identification and are message-oriented.
- Routing-capable; can be used in WAN
- Dynamic data lengths are possible.
- Programming effort is required for data management due to the SEND / RECEIVE programming interface.

UsingTransport Service Access Points (TSAPs), TCP protocol allows multiple connections to a single IP address (up to 64K connections). With RFC 1006, TSAPs uniquely identify these communication end point connections to an IP address.

In the "Address Details" section of the Connection Parameters dialog, you define the TSAPs to be used. The TSAP of a connection in the CPU is entered in the "Local TSAP" field. The TSAP assigned for the connection in your partner CPU is entered under the "Partner TSAP" field.



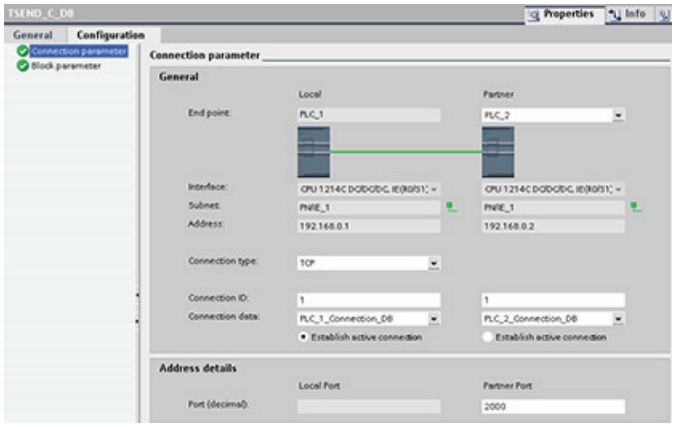
Parameter	Definition
General	
End point: Partner	Name assigned to the partner (receiving) CPU
Interface	Name assigned to the interfaces
Subnet	Name assigned to the subnets
Address	Assigned IP Addresses
Connection type	Type of Ethernet protocol
Connection ID	ID number
Connection data	Local and Partner CPU data storage location
Active connection setup	Radio button to select Local or Partner CPU as the active connection
Address details	
TSAP[1] (ASCII)	Local and Partner CPU TSAPs in ASCII format
TSAP ID	Local and Partner CPU TSAPs in hexadecimal format

[1] When configuring a connection with an S7-1200 CPU for ISO on TCP, use only ASCII characters in the TSAP extension for the passive communication partners.

Transport Control Protocol (TCP)

TCP is a standard protocol described by RFC 793: Transmission Control Protocol. The primary purpose of TCP is to provide reliable, secure connection service between pairs of processes. This protocol has the following features:

- An efficient communications protocol since it is closely tied to the hardware
- Suitable for medium-sized to large data amounts (up to 8192 bytes)
- Provides considerably more facilities for applications, notably:
  - Error recovery
  - Flow control
  - Reliability
- A connection-oriented protocol
- Can be used very flexibly with third-party systems which exclusively support TCP
- Routing-capable
- Only static data lengths are applicable.
- Messages are acknowledged.
- Applications are addressed using port numbers.
- Most of the user application protocols, such as TELNET and FTP, use TCP.
- Programming effort is required for data management due to the SEND / RECEIVE programming interface.



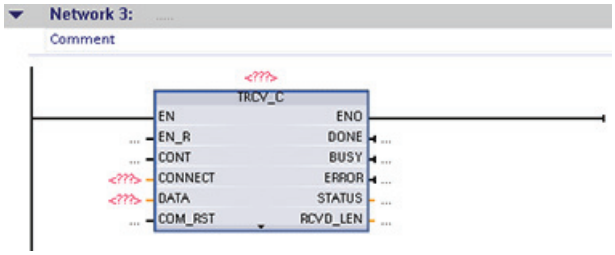
Parameter	Definition
General	
End point: Partner	Name assigned to the partner (receiving) CPU
Interface	Name assigned to the interfaces
Subnet	Name assigned to the subnets
Address	Assigned IP Addresses
Connection type	Type of Ethernet protocol
Connection ID	ID number
Connection data	Local and Partner CPU data storage location
Active connection setup	Radio button to select Local or Partner CPU as the active connection
Address details	
Port (decimal)	Partner CPU Port in decimal format

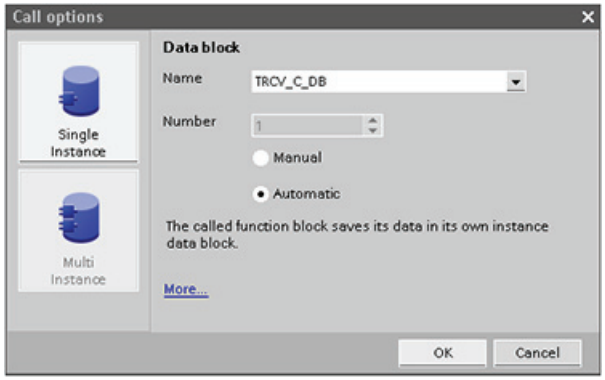
7.4.2.2 Configuring the TRCV_C instruction receive parameters

TRCV_C instruction

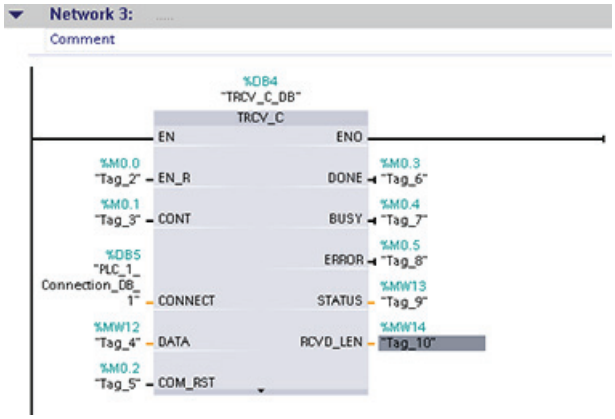
The TRCV_C instruction (Page 154) creates a communications connection to a partner station. The connection is set up, established, and automatically monitored until it is commanded to disconnect by the instruction. The TRCV_C instruction combines the functions of the TCON, TDISCON, and TRCV instructions.

From the CPU configuration in STEP 7 Basic, you can configure how a TRCV_C instruction receives data. To begin, insert the instruction into the program from "Communications" folder in the "Extended Instructions". The instruction is displayed, along with the Call options dialog where you assign a DB for storing the parameters of the TRCV_C instruction.





You can assign tag memory locations to the inputs and outputs, as shown as in the following figure.



Configuring the General parameters

You specify the communication parameters in the Properties configuration dialog of the TRCV_C instruction. This dialog appears near the bottom of the page whenever you have selected any part of the TRCV_C instruction.

Configuring the Connection parameters

Every CPU has an integrated PROFINET port, which supports standard PROFINET communications. The supported Ethernet protocols are described in the following two connection types:

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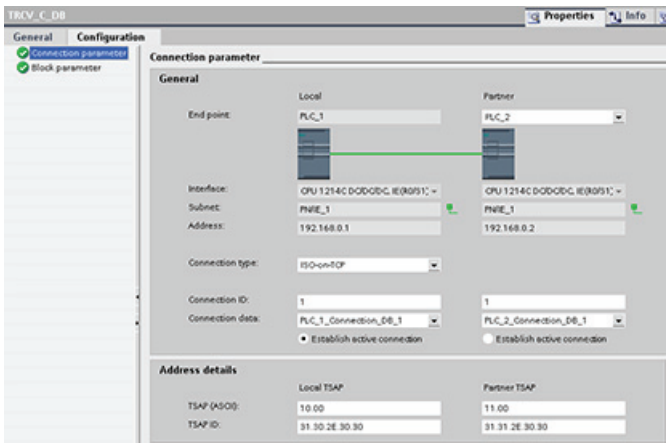
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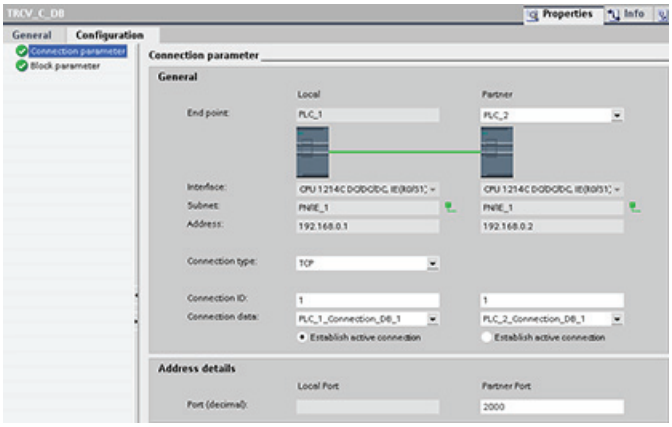
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Active connection setup	Radio button to select Local or Partner CPU as the active connection
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TSAP[1] (ASCII)	Local and Partner CPU TSAPs in ASCII format
TSAP ID	Local and Partner CPU TSAPs in hexadecimal format

[1] When configuring a connection with an S7-1200 CPU for ISO on TCP, use only ASCII characters in the TSAP extension for the passive communication partners.

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- Provides considerably more facilities for applications, notably:
  - Error recovery
  - Flow control
  - Reliability
- A connection-oriented protocol
- Can be used very flexibly with third-party systems which exclusively support TCP
- Routing-capable
- Only static data lengths are applicable.
- Messages are acknowledged.
- Applications are addressed using port numbers.
- Most of the user application protocols, such as TELNET and FTP, use TCP.
- Programming effort is required for data management due to the SEND / RECEIVE programming interface.



Parameter	Definition
General	
End point: Partner	Name assigned to the partner (receiving) CPU
Interface	Name assigned to the interfaces
Subnet	Name assigned to the subnets
Address	Assigned IP Addresses
Connection type	Type of Ethernet protocol
Connection ID	ID number
Connection data	Local and Partner CPU data storage location
Active connection setup	Radio button to select Local or Partner CPU as the active connection
Address details	
Port (decimal)	Local CPU Port in decimal format

7.5 Reference Information

7.5.1 Locating the Ethernet (MAC) address on the CPU

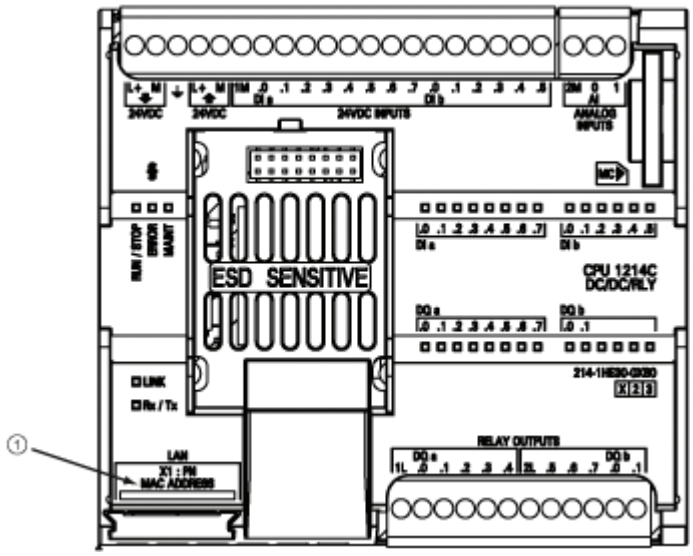
In PROFINET networking, a Media Access Control address (MAC address) is an identifier assigned to adapter cards by the manufacturer for identification. A MAC address usually encodes the manufacturer's registered identification number.

The standard (IEEE 802.3) format for printing MAC addresses in human-friendly form is six groups of two hexadecimal digits, separated by hyphens (-) or colons (:), in transmission order, (for example, 01-23-45-67-89-ab or 01:23:45:67:89:ab).

Note

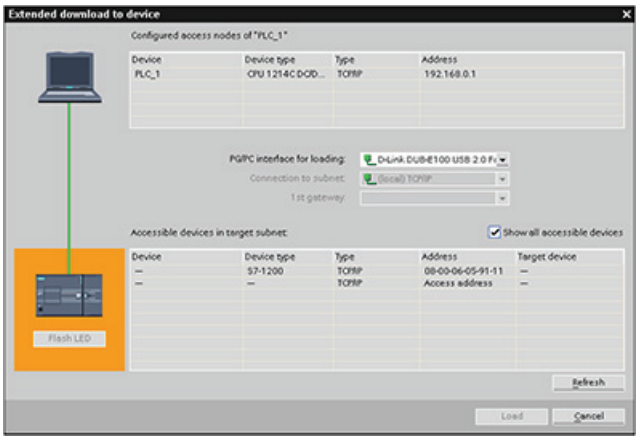
Each CPU is loaded at the factory with a permanent, unique MAC address. You cannot change the MAC address of a CPU.

The MAC address is printed on the front, lower-left corner of the CPU. Note that you have to lift the lower TB doors to see the MAC address information.



① MAC address

Initially, the CPU has no IP address, only a factory-installed MAC address. PROFINET communications requires that all devices be assigned a unique IP address.



Use the CPU "Download to device" function and the "Extended download to device" dialog to show all accessible network devices and ensure that unique IP addresses have been assigned to all devices. This dialog displays all accessible and available devices with their assigned MAC and IP addresses. MAC addresses are all-important in identifying devices that are missing the required unique IP address.

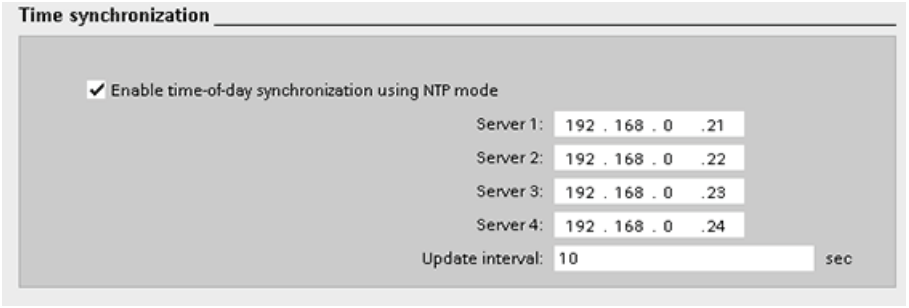
7.5.2 Configuring Network Time Protocol synchronization

The Network Time Protocol (NTP) is widely used to synchronize the clocks of computer systems to Internet time servers. It provides accuracies typically less than a millisecond on LANs and up to a few milliseconds on WANs. Typical NTP configurations utilize multiple redundant servers and diverse network paths in order to achieve high accuracy and reliability.

The NTP subnet operates with a hierarchy of levels, where each level is assigned a number called the stratum. Stratum 1 (primary) servers at the lowest level are directly synchronized to national time services. Stratum 2 (secondary) servers at the next higher level are synchronized to stratum 1 servers and so on.

Time synchronization parameters

In the Properties window, select the "Time synchronization" configuration entry. The TIA Portal displays the Time synchronization configuration dialog:



Note

All IP addresses are configured when you download the project.

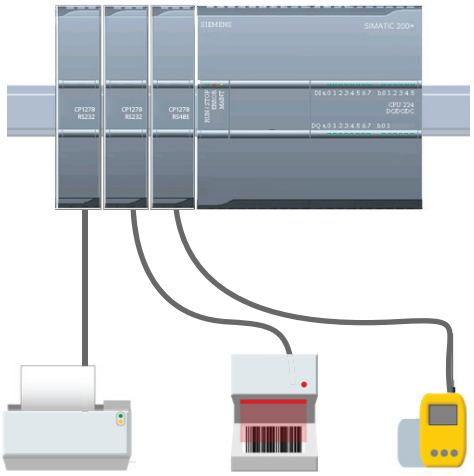
The following table defines the parameters for time synchronization:

Parameter	Definition
Enable time-of-day synchronization using Network Time Protocol (NTP) servers	Click the checkbox to enable time-of-day synchronization using NTP servers.
Server 1	Assigned IP Address for network time server 1
Server 2	Assigned IP Address for network time server 2
Server 3	Assigned IP Address for network time server 3
Server 4	Assigned IP Address for network time server 4
Time synchronization interval	Interval value (sec)

Point-to-Point (PtP) communications

8

The CPU supports the Point-to-Point protocol (PtP) for character-based serial communication, in which the user application completely defines and implements the protocol of choice. PtP provides maximum freedom and flexibility, but requires extensive implementation in the user program.



PtP enables a wide variety of possibilities:

- The ability to send information directly to an external device such as a printer
- The ability to receive information from other devices such as barcode readers, RFID readers, third-party camera or vision systems, and many other types of devices
- The ability to exchange information, sending and receiving data, with other devices such as GPS devices, third-party camera or vision systems, radio modems, and many more

PtP communication is serial communication that uses standard UARTs to support a variety of baud rates and parity options. The RS232 or RS485 communication module (CM) provides the electrial interface for performing the PtP communications.

STEP 7 Basic provides libraries of instructions that you can use in programming your application. These libraries provide PtP communication functions for the following protocols:

- USS drive protocol
- Modbus RTU Master Protocol
- Modbus RTU Slave Protocol

8.2 Using the RS232 and RS485 communication modules

Two communication modules (CMs) provide the interface for PtP communications: CM 1241 RS485 (Page 317) and CM 1241 RS232 (Page 318). You can connect up to three CMs (of any type). Install the CM to the left of the CPU or another CM. Refer to the "Installation" chapter (Page 29) for detailed instructions on module installation and removal.

The RS232 and RS485 communication modules have the following characteristics:

- Isolated port
- Supports Point-to-Point protocols
- Configured and programmed through extended instructions and library functions

- Displays transmit and receive activity by means of LEDs
- Displays a diagnostic LED
- Powered by the CPU. No external power connection is needed.

Refer to the Technical Specifications for Communication Modules (Page 317).

8.3 Configuring the communication ports

The communication modules can be configured by two methods:

- Use the device configuration in STEP 7 Basic to configure the port parameters (baud and parity), the send parameters and the receive parameters. The device configuration settings are stored permanently in the CPU. These settings are applied after a power cycle and a RUN to STOP transition.
- Use the PORT_CFG, SEND_CFG and RCV_CFG instructions to set the parameters. The port settings set by the instructions are valid while the CPU is in RUN mode. The port settings revert to the device configuration settings after a STOP transition or power cycle.

After configuring the hardware devices (Page 69), you configure parameters for the communication interfaces by selecting one of the CMs in your rack.

The "Properties" tab of the inspector window displays the parameters of the selected CM. Select "Port configuration" to edit the following parameters:

- Baud rate
- Parity
- Number of stop bits
- Flow control (RS232 only)
- Wait time





Except for flow control, the port configuration parameters are the same regardless of whether you are configuring an RS232 or an RS485 communication module. The parameter values may differ.

The port can also be configured (or the existing configuration can be changed) from the user program with the PORT_CFG (Page 250) instruction.

Note

Parameter values set from the PORT_CFG instruction in the user program override port configuration settings set from the STEP 7 Basic. Note that the S7-1200 does not retain parameters set from the PORT_CFG instruction in the event of power down.

Baud rate: The default value for the baud rate is 9.6 kbits per second. Valid choices are:

300 baud	2.4 kbits	19.2 kbits	76.8 kbits
600 baud	4.8 kbits	28.4 kbits	115.2 kbits
1.2 kbits	9.6 kbits	57.6 kbits	

Parity: The default value for parity is no parity. Valid choices are:

- No parity
- Even
- Odd
- Mark (parity bit always set to 1)
- Space (parity bit always set to 0)

Number of stop bits: The number of stop bits can be either one or two. The default is one.

Flow control: For the RS232 communication module, you can select either hardware or software flow control, as described in the section "Managing flow control (Page 239)". If you select hardware flow control, you can select whether the RTS signal is always on, or RTS is switched. If you select software flow control, you can define the ASCII characters for the XON and XOFF characters.

The RS485 communication module does not support flow control.

Wait time: The wait time specifies the time that the communication module waits to receive CTS after asserting RTS, or for receiving an XON after receiving an XOFF, depending on the type of flow control. If the wait time expires before the communication module receives an expected CTS or XON, the communication module aborts the transmit operation and returns an error to the user program. You specify the wait time in milliseconds. The range is 0 to 65535 milliseconds.

8.4 Managing flow control

Flow control refers to a mechanism for balancing the sending and receiving of data transmissions so that no data is lost. Flow control ensures that a transmitting device is not sending more information than a receiving device can handle. Flow control can be accomplished through either hardware or software. The RS232 CM supports both hardware and software flow control. The RS485 CM does not support flow control. You specify the type of flow control either when you configure the port (Page 238) or with the PORT_CFG instruction.

Hardware flow control works through the Request-to-send (RTS) and Clear-to-send (CTS) communication signals. With the RS232 CM, the RTS signal is output from pin 7 and the CTS signal is received through pin 8. The CM 1241 is a DTE (Data Terminal Equipment) device which asserts RTS as an output and monitors CTS as an input.

Hardware flow control: RTS switched

If you enable RTS switched hardware flow control for an RS232 CM, the module sets the RTS signal active to send data. It monitors the CTS signal to determine whether the receiving device can accept data. When the CTS signal is active, the module can transmit data as long as the CTS signal remains active. If the CTS signal goes inactive, then the transmission must stop.

Transmission resumes when the CTS signal becomes active. If the CTS signal does not become active within the configured wait time, the module aborts the transmission and returns an error to the user program. You specify the wait time in the port configuration (Page 238).

The RTS switched flow control is useful for devices that require a signal that the transmit is active. An example would be a radio modem that uses RTS as a "Key" signal to energize the radio transmitter. The RTS switched flow control will not function with standard telephone modems. Use the RTS always on selection for telephone modems.

Hardware flow control: RTS always on

In RTS always on node, the CM 1241 sets RTS active by default. A device such as a telephone modem monitors the RTS signal from the CM and utilizes this signal as a clear-to-send. The modem only transmits to the CM when RTS is active, that is, when the telephone modem sees an active CTS. If RTS is inactive, the telephone module does not transmit to the CM.

To allow the modem to send data to the CM at any time, configure "RTS always on" hardware flow control. The CM thus sets the RTS signal active all the time. The CM will not set RTS inactive even if the module cannot accept characters. The transmitting device must ensure that it does not overrun the receive buffer of the CM.

Data Terminal Block Ready (DTR) and Data Set Ready (DSR) signal utilization

The CM sets DTR active for either type of hardware flow control. The module transmits only when the DSR signal becomes active. The state of DSR is only evaluated at the start of the send operation. If DSR becomes inactive after transmission has started, the transmission will not be paused.

Software flow control

Software flow control uses special characters in the messages to provide flow control. These characters are ASCII characters that represent XON and XOFF.

XOFF indicates that a transmission must stop. XON indicates that a transmission can resume.

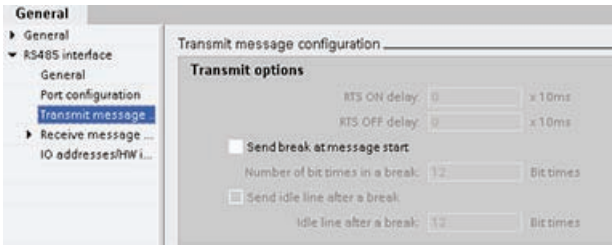
When the transmitting device receives an XOFF character from the receiving device, it stops transmitting. Transmitting resumes when the transmitting device receives an XON character. If it does not receive an XON character within the wait time that is specified in the port configuration (Page 238) , the CM aborts the transmission and returns an error to the user program.

Software flow control requires full-duplex communication, as the receiving partner must be able to send XOFF to the transmitting partner while a transmission is in progress. Software flow control is only possible with messages that contain only ASCII characters. Binary protocols cannot utilize sofware flow control.

8.5 Configuring the transmit (send) and receive parameters

Before the PLC can engage in PtP communications, you must configure parameters for transmitting (or sending) messages and receiving messages. These parameters dictate how communications operate when messages are being transmitted to or received from a target device.

Configuring the transmit (send) parameters



During the configuration of the CM, you configure how a communication interface transmits data by specifying the "Transmit message configuration" property for the selected CM.

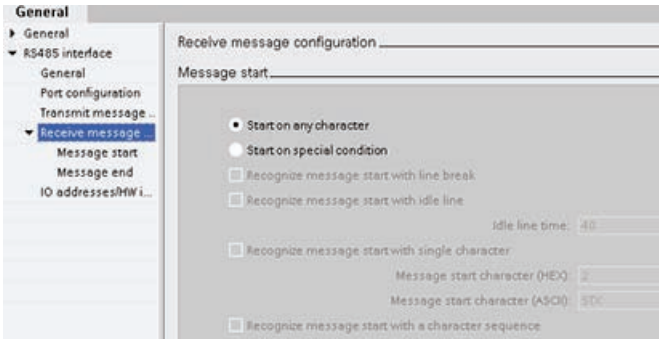
You can also dynamically configure or change the transmit message parameters from the user program by using the SEND_CFG (Page 251) instruction.

Note

Parameter values set from the SEND_CFG instruction in the user program override the port configuration settings. Note that the CPU does not retain parameters set from the SEND_CFG instruction in the event of power down.

Parameter	Definition
RTS On delay	Specifies the amount of time to wait after activating RTS before transmission is initiated. The range is 0 to 65535 ms, with a default value of 0. This parameter is valid only when the port configuration (Page 238) specifies hardware flow control. CTS is evaluated after the RTS On delay time has expired. This parameter is applicable for RS232 modules only.
RTS Off delay	Specifies the amount of time to wait before de-activating RTS after completion of transmission. The range is 0 to 65535 ms, with a default value of 0. This parameter is valid only when the port configuration (Page 238) specifies hardware flow control. This parameter is applicable for RS232 modules only.
Send break at message start Number of bit times in a break	Specifies that upon the start of each message, a break will be sent after the RTS On delay (if configured) has expired and CTS is active. You specify how many bit times constitute a break where the line is held in a spacing condition. The default is 12 and the maximum is 65535, up to a limit of eight seconds.
Send idle line after a break Idle line after a break	Specifies that an idle line will be sent after a break at message start. The "Idle line after a break" parameter specifies how many bit times constitute an idle line where the line is held in a marking condition. The default is 12 and the maximum is 65535, up to a limit of eight seconds.

Configuring the Receive parameters



From the device configuration, you configure how a communication interface receives data, and how it recognizes both the start of and the end of a message. Specify these parameters in the Receive message configuration for the selected CM.

You can also dynamically configure or change the receive message parameters from the user program by using the RCV_CFG (Page 253) instruction.

Note

Parameter values set from the RCV_CFG instruction in the user program override the port configuration settings. Note that the CPU does not retain parameters set from the RCV_CFG instruction in the event of power down.

For more information, see the RCV_CFG instruction.

Message start parameters

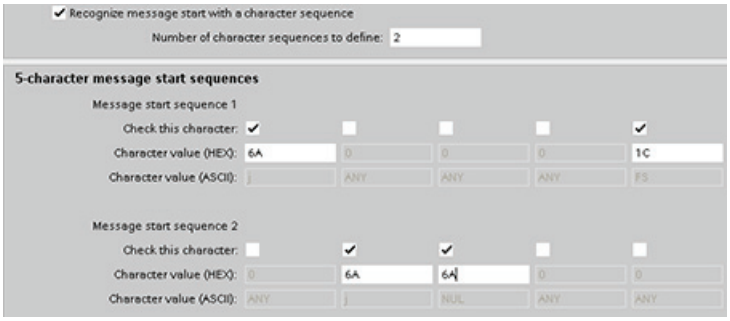
You can determine how the communication module recognizes the start of a message. The start characters and characters comprising the message go into the receive buffer until a configured end condition is met.

Multiple start conditions can be specified. All of the start conditions must be met before the message is considered started. For example, if you configure an idle line time and a specific start character, the CM will first look for the idle line time requirement to be met and then the CM will look for the specified start character. If some other character is received (not the specified start character), the CM will restart the start of message search by again looking for an idle line time.

The order of checking start conditions is:

- Idle line
- Line break
- Characters or character sequences

While checking for multiple start conditions, if one of the conditions is not met, the CM will restart the checking with the first required condition.

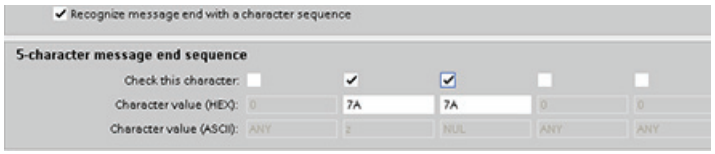
Parameter	Definition
Start Character character	The Start Character condition specifies that successfully receiving a particular character will begin a message. This character will be the first character within a message. Any character that is received before this specific character will be discarded.
Start on Any Character	The Any Character condition specifies any successfully received character will begin the start of a message. This character will be the first character within a message.
Line Break	The Line Break conditions specifies that a message receive operation should start after a break character is received.
Idle Line	The Idle Line condition specifies that a message reception should start once the receive line has been idle or quiet for the number of specified bit times. Once this condition occurs, the start of a message will begin.
Special condition: Recognize message start with single	Specifies that a particular character indicates the start of a message. The default is STX.
Special condition: Recognize message start with a character sequence	Specifies that a particular character sequence indicates the start of a message. For each sequence, you can specify up to five characters. For each character position, you specify either a specific hex character, or that the character is ignored in sequence matching. Incoming sequences will be evaluated against the configured start conditions until a start condition has been satisfied. Once the start sequence has been satisfied, evaluation of end conditions begins. You can configure up to five specific character sequences, which you can enable or disable as needed. The start condition is satisfied when any one of the configured character sequences occurs.
Sample configuration	 With this configuration, the start condition is satisfied when either pattern occurs: • When a five-character sequence is received where the first character is 0x6A and the fifth character is 0x1C. The characters at positions 2, 3, and 4 can be any character with this configuration. After the fifth character is received, evaluation of end conditions begins. • When two consecutive 0x6A characters are received, preceded by any character. In this case, evaluation of end conditions begins after the second 0x6A is received (3 characters). The character preceding the first 0x6A is included in the start condition. Example sequences that would satisfy this start condition: • <any character> 6A 6A • 6A 12 14 18 1C • 6A 44 A5 D2 1C

Message end parameters

You can also configure how the communication interface recognizes the end of a message. You can configure multiple message end conditions. If any one of the configured conditions occurs, the message ends.

Multiple end conditions can be specified at the same time. The message will end when any one of the end conditions has been satisfied. For example, you could specify an end condition with an end of message timeout of 300 milliseconds, an inter-character timeout of 40 bit times, and a maximum length of 50 bytes. The message will end if the message takes longer than 300 milliseconds to receive, or if the gap between any two characters exceeds 40 bit times, or if 50 bytes are received.

Parameter	Definition
Recognize message end by message timeout	The message end occurs when the configured amount of time to wait for message end has expired. The message timeout period begins when the first character is received according to the message start criteria. The default is 200 ms and the range is 0 to 65535 ms.
Recognize message end by response timeout	The message end occurs when the configured amount of time to wait for a response expires before a valid start sequence is received. The response timeout period begins when a transmission ends. The default response timeout is 200 ms and the range is 0 to 65535 ms. You must configure another end condition to indicate the actual end of a message.
Recognize message end by inter-character gap	The message end occurs when the maximum configured timeout between consecutive characters of a message has expired. The default value for the inter-character gap is 12 bit times and the maximum number is 65535 bit times, up to a maximum of eight seconds.
Recognize message end by max length	The message end occurs when the configured maximum number of characters has been received. The default is 0 bytes and the maximum is 1024 bytes.
Read message length from message	The message itself specifies the length of the message. The message end occurs when a message of the specified length has been received. The method for specifying and interpreting the message length is described below.
Recognize message end with a character	The message end occurs when a specified character is received.
Recognize message end with a character sequence	The message end occurs when a specified character sequence is received. You can specify a sequence of up to five characters. For each character position, you specify either a specific hex character, or that the character is ignored in sequence matching. Leading characters that are ignored characters are not part of the end condition. Trailing characters that are ignored characters are part of the end condition.

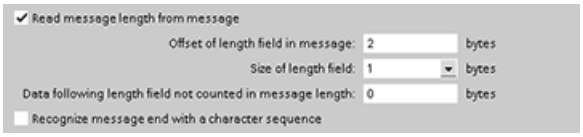
Parameter	Definition
Sample configuration	 In this case, the end condition is satisfied when two consecutive 0x7A characters are received, followed by any two characters. The character preceding the 0x7A 0x7A pattern is not part of the end character sequence. Two characters following the 0x7A 0x7A pattern are required to terminate the end character sequence. The values at character positions 4 and 5 are irrelevant, but they must be received to satisfy the end condition.

Specification of message length within the message

When you select the special condition where the message length is included in the message, you must provide three parameters that define information about the message length.

The actual message structure varies according to the protocol in use. The three parameters are as follows:

- n: the character position (1-based) within the message that starts the length specifier
- Length size: The number of bytes (one, two, or four) of the length specifier
- Length m: the number of characters following the length specifier that are not included in the length count



These fields appear in the Receive message configuration of the device properties.

Example 1: Consider a message structured according to the following protocol:

STX	Len (n)	Characters 3 to 14 counted by the length											
		ADR	PKE		INDEX		PWD		STW		HSW		BCC
1	2	3	4	5	6	7	8	9	10	11	12	13	14
STX	0x0C	xx	xxxx		xxxx		xxxx		xxxx		xxxx		xx

Configure the receive message length parameters for this message as follows:

- n = 2 (The message length starts with byte 2.)
- Length size = 1 (The message length is defined in one byte.)
- Length m = 0 (There are no additional characters following the length specifier that are not counted in the length count. Twelve characters follow the length specifier.)

In this example, the characters from 3 to 14 inclusive are the characters counted by Len (n).

Example 2: Consider another message structured according to the following protocol:

SD1	Len (n)	Len (n)	SD2	Characters 5 to 10 counted by length						FCS	ED
				DA	SA	FA	Data unit=3 bytes				
1	2	3	4	5	6	7	8	9	10	11	12
xx	0x06	0x06	xx	xx	xx	xx	xx	xx	xx	xx	xx

Configure the receive message length parameters for this message as follows:

- n = 3 (The message length starts at byte 3.)
- Length size = 1 (The message length is defined in one byte.)
- Length m = 3 (There are three characters following the length specifier that are not counted in the length. In the protocol of this example, the characters SD2, FCS, and ED are not counted in the length count. The other six characters are counted in the length count; therefore the total number of characters following the length specifier is nine.)

In this example, the characters from 5 to 10 inclusive are the characters counted by Len (n).

8.6 Programming the PtP communications

STEP 7 Basic provides extended instructions that enable the user program to perform Point-to-Point communications with a protocol designed and specified in the user program. These instructions can be considered in two categories:

- Configuration instructions
- Communication instructions

Configuration instructions

Before your user program can engage in PtP communication, you must configure the communication interface port and the parameters for sending data and receiving data.

You can perform the port configuration and message configuration for each communication module through the device configuration or through these instructions in your user program:

- PORT_CFG
- SEND_CFG
- RCV_CFG

Communication instructions

The PtP communication instructions enable the user program to send messages to and receive messages from the communication modules. For information transferring data with these instructions, see the section on data consistency (Page 86).

All of the PtP functions operate asynchronously. The user program can use a polling architecture to determine the status of transmissions and receptions. SEND_PTP and RCV_PTP can execute concurrently. The communication modules buffer the transmit and receive messages as necessary up to a maximum buffer size of 1024 bytes.

The communication modules send messages to and receive messages from the actual point-to-point devices. The message protocol is in a buffer that is either received from or sent to a specific communication port.	• SEND_PTP • RCV_PTP
Additional instructions provide the capability to reset the receive buffer, and to get and set specific RS232 signals.	• RCV_RST • SGN_GET • SGN_SET

8.6.1 Polling architecture

The S7-1200 point-to-point instructions must be called cyclically/periodically to check for received messages. Polling the send will tell the user program when the transmit has completed.

Polling architecture: master

The typical sequence for a master is as follows:

1. A SEND_PTP instruction initiates a transmission to the communication module.
2. The SEND_PTP instruction is executed on subsequent scans to poll for the transmit complete status.
3. When the SEND_PTP instruction indicates that the transmission is complete, the user code can prepare to receive the response.
4. The RCV_PTP instruction is executed repeatedly to check for a response. When the CM has collected a response message, the RCV_PTP instruction will copy the response to the CPU and indicate that new data has been received.
5. The user program can process the response.
6. Go to step 1 and repeat the cycle.

Polling architecture: slave

The typical sequence for a slave is as follows:

1. The user program should execute the RCV_PTP instruction every scan.
2. When the CM has received a request, the RCV_PTP instruction will indicate that new data is ready and the request will be copied into the CPU.
3. The user program should service the request and generate a response.
4. Use a SEND_PTP instruction to send the response back to the master.
5. Repeatedly execute SEND_PTP to be sure the transmit occurs.
6. Go to step 1 and repeat the cycle.

The slave must be responsible for calling RCV_PTP frequently enough to receive a transmission from the master before the master times out while waiting for a response. To accomplish this task, the user program can call RCV_PTP from a cyclic OB, where the cycle time is sufficient to receive a transmission from the master before the timeout period expires.

If you set the cycle time for the OB to provide for two executions within the timeout period of the master, the user program should receive transmissions without missing any.

8.7 Point-to-Point instructions

8.7.1 Common parameters for Point-to-Point instructions

Communication module LED behaviors

There are three LED indicators on the Communication module (CM):

- Diagnostic LED: This LED flashes red until it is addressed by the CPU. After the CPU powers up, it will check for modules and address the CM module. The Diagnostic LED will begin to flash green. This means that the CPU has addressed the CM, but has not yet provided configuration to the CM. The configuration is downloaded to the module when the program is downloaded to the CPU. After a download to the CPU, the Diagnostic LED on the communication module should be a steady green.
- Transmit LED: This LED is located above the receive LED. The transmit LED illuminates when data is being transmitted out the communication port.
- Receive LED: This LED illuminates when data is being received by the communication port.

Bit time resolution

Several parameters are specified in a number of bit times at the configured baud rate. Specifying the parameter in bit times allows the parameter to be independent of baud rate. All parameters that are in units of bit times can be specified to a maximum number of 65535. However, the maximum of amount of time that can be measured by a S7-1200 is 8 seconds.

REQ input parameter

Many of the Point-to-Point (PtP) instructions use a REQ input that initiates the operation on a low to high transition. The REQ input must be high (TRUE) for one execution of an instruction, but the REQ input can remain TRUE for as long as desired. The instruction will not initiate another operation until it is called with the REQ input FALSE so that the instruction can reset the history state of the REQ input. This is required so that the instruction can detect the low to high transition to initiate the next operation.

When you place a PtP instruction, you are prompted to identify the instance DB. Use a unique DB for each type of PtP instruction. That is, all SEND_PTP instructions for a given port should have the same instance DB, but SEND_PTP and RCV_PTP must have different instance DBs. This ensures that inputs such as the REQ are properly handled by each instruction.

PORT input parameter

Select from the drop down menu (associated with the PORT input) the port identifier for the CM that you want this instance of the instruction to operate. This number is also found as the "hardware identifier" in the configuration information for the CM.

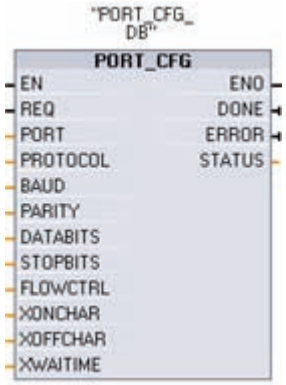
NDR, DONE, ERROR, and STATUS output parameters

- The output DONE indicates that the requested operation has completed without error. This output will be set for one scan.
- The output NDR (New Data Ready) indicates that the requested action has completed without error and new data has been received. This output will be set for one scan.
- The output ERROR indicates that the requested action has completed with an error. This output will be set for one scan.
- The output STATUS is used to report errors or intermediate status results.
  - If the DONE or NDR bit is set, then STATUS will be set to 0 or to an informational code.
  - If the ERROR bit is set, then STATUS will be set to an error code.
  - If none of the above bits are set, then the instruction returns status results that describe the current state of the function, such as a busy status.

Common condition codes

STATUS (W#16#....)	Description
0000	No error
8x3A	Illegal pointer in parameter x
8070	All internal instance memory in use
8080	Port number is illegal
8081	Timeout, module error, or other internal error
8082	Parameterization failed because parameterization is in progress in background
8083	Buffer overflow: The CM returned a received message with a length greater than the length parameter allowed.
8090	Wrong message length, wrong submodule, or illegal message
8091	Wrong version in parameterization message
8092	Wrong record length in parameterization message

8.7.2 PORT_CFG instruction



PORT_CFG (Port Configuration) allows you to change port parameters such as baud rate from your program.

You can set up the initial static configuration of the port in the device configuration properties, or just use the default values. You can execute the PORT_CFG instruction in your program to change the configuration. The PORT_CFG configuration changes are not permanently stored in the CPU. The parameters configured in the device configuration are restored when the CPU transitions from RUN to STOP mode and after a power cycle.

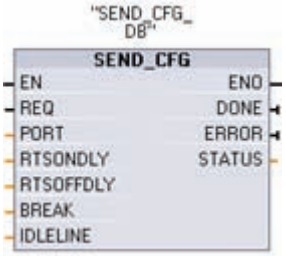
See Configuring the communication ports (Page 238) and Managing flow control (Page 239) for more information.

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Activate the configuration change on rising edge of this input.
PORT	IN	PORT	Communication port identifier: This logical address is a constant which can be referenced within the "Constants" tab of the default tag table.
PROTOCOL	IN	UInt	0 - Point-to-Point communication protocol 1..n - future definition for specific protocols
BAUD	IN	UInt	Port baud rate: 1 - 300 baud 2 - 600 baud 3 - 1200 baud 4 - 2400 baud 5 - 4800 baud 6 - 9600 baud 7 - 19200 baud 8 - 38400 baud 9 - 57600 baud 10 - 76800 baud 11 - 115200 baud
PARITY	IN	UInt	Port parity: 1 - No parity 2 - Even parity 3 - Odd parity 4 - Mark parity 5 - Space parity
DATABITS	IN	UInt	Bits per character: 1 - 8 data bits 2 - 7 data bits
STOPBITS	IN	UInt	Stop bits: 1 - 1 stop bit 2 - 2 stop bits

Parameter	Parameter type	Data type	Description
FLOWCTRL	IN	UInt	Flow control: 1 - No flow control 2 - XON/XOFF 3 - Hardware RTS always ON 4 - Hardware RTS switched
XONCHAR	IN	Char	Specify the character that is used as the XON character. This is typically a DC1 character (11H). This parameter is only evaluated if flow control is enabled.
XOFFCHAR	IN	Char	Specify the character that is used as the XOFF character. This is typically a DC3 character (13H). This parameter is only evaluated if flow control is enabled.
XWAITIME	IN	UInt	Specify how long to wait for a XON character after receiving a XOFF character, or how long to wait for the CTS signal after enabling RTC (0 to 65535 ms). This parameter is only evaluated if flow control is enabled.
DONE	OUT	Bool	TRUE for one scan, after the last request was completed with no error
ERROR	OUT	Bool	TRUE for one scan, after the last request was completed with an error
STATUS	OUT	Word	Execution condition code

STATUS (W#16#....)	Description
80A0	Specific protocol does not exist.
80A1	Specific baud rate does not exist.
80A2	Specific parity option does not exist.
80A3	Specific number of data bits does not exist.
80A4	Specific number of stop bits does not exist.
80A5	Specific type of flow control does not exist.
80A6	Wait time is 0 and flow control enabled
80A7	XON and XOFF are illegal values

8.7.3 SEND_CFG instruction



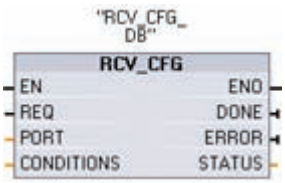
SEND_CFG (Send Configuration) allows the dynamic configuration of serial transmission parameters for a Point-to-Point communication port. Any queued messages within a communication module (CM) will be discarded once SEND_CFG is executed.

You can set up the initial static configuration of the port in the device configuration properties, or just use the default values. You can execute the SEND_CFG instruction in your program to change the configuration. The SEND_CFG configuration changes are not permanently stored in the PLC. The parameters configured in the device configuration are restored when the CPU transitions from RUN to STOP mode and after a power cycle. See Configuring the transmit (send) and receive parameters (Page 241).

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Activate the configuration change on the rising edge of this input.
PORT	IN	PORT	Communication port identifier: This logical address is a constant which can be referenced within the "Constants" tab of the default tag table.
RTSONDLY	IN	UInt	Number of milliseconds to wait after enabling RTS before any Tx data transmission occurs. This parameter is only valid when hardware flow control is enabled. 0 - 65535 ms. 0 will disable the feature.
RTSOFFDLY	IN	UInt	Number of milliseconds to wait after the Tx data transmission occurs before RTS is disabled: This parameter is only valid when hardware flow control is enabled. 0 - 65535 ms. 0 will disable the feature.
BREAK	IN	UInt	This parameter specifies that a break will be sent upon the start of each message for the specified number of bit times. The maximum is 65535 bit times. 0 will disable the feature. 8 second maximum
IDLELINE	IN	UInt	This parameter specifies that the line will remain idle for the specified number of bit times before the start of each message. The maximum is 65535 bit times. 0 will disable the feature. 8 second maximum
DONE	OUT	Bool	TRUE for one scan, after the last request was completed with no error
ERROR	OUT	Bool	TRUE for one scan, after the last request was completed with an error
STATUS	OUT	Word	Execution condition code

STATUS (W#16#....)	Description
80B0	Transmit interrupt configuration is not allowed
80B1	Break time is greater than the allowed value (2500 bit times)
80B2	Idle time is greater than the allowed value (2500 bit times)

8.7.4 RCV_CFG instruction



RCV_CFG (Receive Configuration) performs dynamic configuration of serial receiver parameters for a Point-to-Point communication port. This instruction configures the conditions that signal the start and end of a received message. Any queued messages within a CM will be discarded when RCV_CFG is executed.

You can set up the initial static configuration of the CM port in the device configuration properties, or just use the default values. You can execute the RCV_CFG instruction in your program to change the configuration. The RCV_CFG configuration changes are not permanently stored in the PLC. The parameters configured in the device configuration are restored when the CPU transitions from RUN to STOP mode and after a power cycle. See Configuring the Receive parameters (Page 241) for more information.

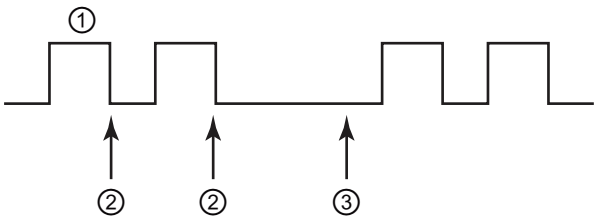
Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Activate the configuration change on the rising edge of this input.
PORT	IN	PORT	Communication port identifier: This logical address is a constant which can be referenced within the "Constants" tab of the default tag table.
CONDITIONS	IN	CONDITIONS	The Conditions data structure specifies the starting and ending message conditions. These are described below.
DONE	OUT	Bool	TRUE for one scan, after the last request was completed with no error
ERROR	OUT	Bool	TRUE for one scan, after the last request was completed with an error
STATUS	OUT	Word	Execution condition code

Start conditions for the RCV_PTP instruction

The RCV_PTP instruction uses the configuration specified by the RCV_CFG instruction to determine the beginning and ending of point-to-point communication messages. The start of a message is determined by the start conditions. The start of a message can be determined by one or a combination of start conditions. If more than one start condition is specified, all the conditions must be satisfied before the message is started. Possible start conditions:

- Start Character specifies that successfully receiving a particular character will begin a message. This character will be the first character within a message. Any character that is received before this specific character will be discarded.
- Any Character specifies that any successfully received character will begin the start of a message. This character will be the first character within a message.
- Line Break specifies that a message receive operation should start after a break character is received.

- Idle Line specifies that a message reception should start once the receive line has been idle or quiet for the number of specified bit times. Once this condition occurs, the start of a message will begin.



① Characters

② Restarts the idle line timer

③ Idle line is detected and message receive is started

- Variable Sequences: Start conditions can be constructed that are based upon a variable number of character sequences (up to a maximum of 4) consisting of a varying number of characters (up to a maximum of 5). Each character position within each sequence may be selected as a specific character, or selected as a wild-card character, meaning any character will qualify. This start condition can be used when different sequences of characters indicate the start of a message.

  Consider the following received hexadecimal coded message: "**68** 10 aa **68** bb 10 aa 16" and the configured start sequences shown in the table below. Start sequences begin to be evaluated when the first 68H character is successfully received. Upon successfully receiving the fourth character (the second 68H), then start condition 1 is satisfied. Once the start conditions are satisfied, the evaluation of the end conditions begins.

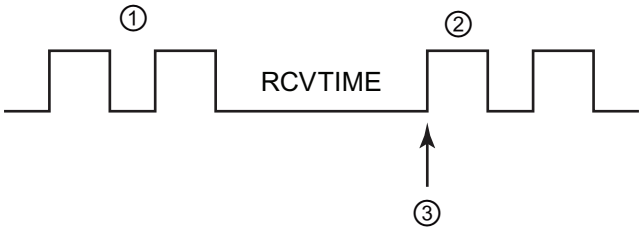
  The start sequence processing can be terminated due to various parity, framing, or inter-character timing errors. These errors result in no received message, because the start condition was not satisfied.

Start condition	First Character	First Character +1	First Character +2	First Character +3	First Character +4
1	**68**H	xx	xx	**68**H	xx
2	10H	aaH	xx	xx	xx
3	dcH	aaH	xx	xx	xx
4	e5H	xx	xx	xx	xx

End conditions for the RCV_PTP instruction

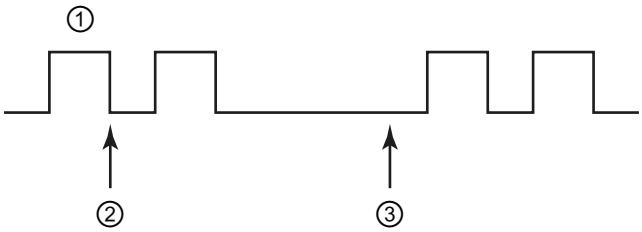
The end of a message is determined by the specification of end conditions. The end of a message is determined by the first occurrence of one or more configured end conditions. Possible message end conditions:

- Response Timeout specifies that a character of the response should be successfully received within the time specified by RCVTIME. The timer begins as soon as the transmission completes successfully and the module begins the receive operation. If a character is not received within the RCVTIME period, then an error is returned to the corresponding RCV_PTP instruction. The response timeout does not define a specific end condition. It only specifies that a character should be successfully received within the specified time. A distinct end condition must be used to define the end condition for the response messages.



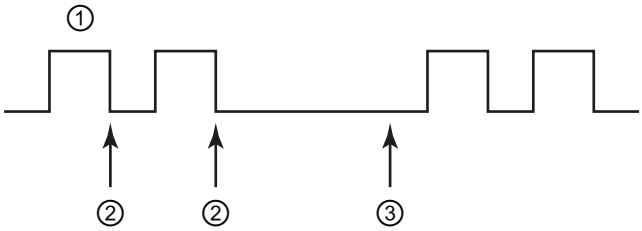
① Transmitted characters
② Received characters
③ The first character must be successfully received by this time

- Message Timeout specifies that a message should be received within the time specified by MSGTIME. The timer begins as soon as the specified start condition has been satisfied.



① Received characters
② Start Message condition satisfied: message timer starts
③ Message timer expires and terminates the message

- Intercharacter Gap is the time measured from the end of one character (the last stop bit) until the end of the next character. If the time between any two characters exceeds the number of configured bit times, the message will be terminated.



① Received characters

② Restarts the intercharacter timer

③ The intercharacter timer expires and terminates the message with errors

- Maximum Length: The receive operation will stop once the specified number of characters have been received. This condition can be used to prevent a message buffer overrun error.

  When this end condition is combined with timeout end conditions and the timeout condition occurs, any valid received characters are provided even if the maximum length is not reached. This allows support for varying length protocols when only the maximum length is known.

- Combination Condition of "N + Length Size + Length M". This end condition can be used to process a varying sized message that contains a length field.
  - N specifies the position (number of characters into the message) where the length field begins. (1 based)
  - Length Size specifies the size of the length field. Valid values are 1, 2, or 4 bytes.
  - Length M specifies the number of ending characters (following the length field) that are not included within the length of the message. This value can be used to specify the length of a checksum field whose size is not included in the length field.
  - As an example, consider a message format that consists of a start character, an address character, a one-byte length field, message data, checksum characters, and an end character. The entries identified with "Len" correspond with the N parameter. The value of N would be 3, specifying that the length byte is positioned 3 bytes into the message. The value of Length Size would be 1, specifying that the value for the length of the message is contained in 1 byte. The checksum and end char fields correspond with the "Length M" parameter. The value of "Length M" would be 3, specifying the number of bytes of the checksum and character fields.

Start char (1)	Address (2)	Len (N) (3)	Message ... (x)		Checksum and End char Length M x+1 x+2 x+3		
xx	xx	xx	xx	xx	xx	xx	xx

- Variable Characters: This end condition can be used to end receiving based upon different character sequences. The sequences can consist of a varying number of characters (up to a maximum of 5). Each character position within each sequence can be selected as a specific character, or selected as a wild-card character, meaning any character will satisfy the condition. Any leading characters that are configured to be

ignored are not required to be part of the message. Any trailing characters that are ignored are required to be part of the message.

Parameter CONDITIONS data type structure part 1 (start conditions)

Parameter	Parameter type	Data type	Description
STARTCOND	IN	UInt	Specify the start condition: • 01H - Start Char • 02H - Any Char • 04H - Line Break • 08H - Idle Line • 10H - Sequence 1 • 20H - Sequence 2 • 40H - Sequence 3 • 80H - Sequence 4
IDLETIME	IN	UInt	The number of bit times required for idle line timeout. Only used with an idle line condition. 0 to 65535
STARTCHAR	IN	Byte	The start character used with the start character condition.
STRSEQ1CTL	IN	Byte	Sequence 1 ignore/compare control for each character: These are the enabling bits for each character in start sequence • 01H - Character 1 • 02H - Character 2 • 04H - Character 3 • 08H - Character 4 • 10H - Character 5 Disabling the bit associated with a character means any character will match, in this sequence position.
STRSEQ1	IN	Char[5]	Sequence 1 start characters (5 characters)
STRSEQ2CTL	IN	Byte	Sequence 2 ignore/compare control for each character
STRSEQ2	IN	Char[5]	Sequence 2 start characters (5 characters)
STRSEQ3CTL	IN	Byte	Sequence 3 ignore/compare control for each character
STRSEQ3	IN	Char[5]	Sequence 3 start characters (5 characters)
STRSEQ4CTL	IN	Byte	Sequence 4 ignore/compare control for each character
STRSEQ4	IN	Char[5]	Sequence 4 start characters (5 characters)

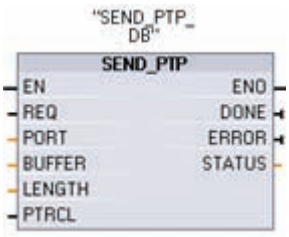
Parameter CONDITIONS data type structure part 2 (end conditions)

Parameter	Parameter type	Data type	Description
ENDCOND	IN	UInt	This parameter specifies message end condition: • 01H - Response time • 02H - Message time • 04H - Inter-character gap • 08H - Maximum length • 10H - N + LEN + M • 20H - Sequence
MAXLEN	IN	UInt	Maximum message length: Only used when the maximum length end condition is selected. 0 to 1023 bytes
N	IN	UInt	Byte position within the message of the length field. Only used with the N + LEN + M end condition. 1 to 1023 bytes
LENGTHSIZE	IN	UInt	Size of the byte field (1, 2, or 4 bytes). Only used with the N + LEN + M end condition.
LENGTHM	IN	UInt	Specify the number of characters following the length field that are not included in the value of the length field. This is only used with the N + LEN + M end condition. 0 to 255 bytes
RCVTIME	IN	UInt	Specify how long to wait for the first character to be received. The receive operation will be terminated with an error if a character is not successfully received within the specified time. This is only used with the response time condition. 0 to 65535 bit time, 8 second maximum This parameter is not really evaluated as an end condition since it only evaluates start conditions. A distinct end condition must be selected.
MSGTIME	IN	UInt	Specify how long to wait for the entire message to be completely received once the first character has been received. This parameter is only used when the message timeout condition is selected. 0 - 65535 milliseconds
CHARGAP	IN	UInt	Specify the number of bit times between characters. If the number of bit times between characters exceeds the specified value, then the end condition will be satisfied. This is only used with the inter-character gap condition. 0 to 65535 milliseconds
ENDSEQ1CTL	IN	Byte	Sequence 1 ignore/compare control for each character: These are the enabling bits for each character for the end sequence. Character 1 is bit 0, character 2 is bit 1, …, character 5 is bit 4. Disabling the bit associated with a character means any character will match, in this sequence position.
ENDSEQ1	IN	Char[5]	Sequence 1 start characters (5 characters)

Condition codes

STATUS (W#16#....)	Description
80C0	Illegal start condition selected
80C1	Illegal end condition selected, no end condition selected
80C2	Receive interrupt enabled and this is not possible
80C3	Max length end condition is enabled and max length is 0 or > 1024
80C4	Calculated length is enabled and N is >= 1023
80C5	Calculated length is enabled and length is not 1, 2 or 4
80C6	Calculated length is enabled and M value is > 255
80C7	Calculated length is enabled and calculated length is > 1024
80C8	Response timeout is enabled and response timeout is zero
80C9	Inter-character gap timeout is enabled and it is zero or > 2500
80CA	Idle line timeout is enabled and it is zero or > 2500
80CB	End sequence is enabled but all chars are "don't care"
80CC	Start sequence (any one of 4) is enabled but all chars are "don't care"

8.7.5 SEND_PTP instruction



SEND_PTP (Send Point-to-Point data) initiates the transmission of the data. SEND_PTP transfers the specified buffer to the CM. The CPU program continues while the CM sends the data at the specified baud rate. Only one send operation can be pending at a given time. The CM returns an error if a second SEND_PTP is executed while the CM is already transmitting a message.

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Activates the requested transmission on the rising edge of this transmission enable input. This initiates transfer of the contents of the buffer to the Point-to-Point communication module (CM).
PORT	IN	PORT	Communication port identifier: This logical address is a constant which can be referenced within the "Constants" tab of the default tag table.
BUFFER	IN	Variant	This parameter points to the starting location of the transmit buffer. Boolean data or Boolean arrays are not supported.
LENGTH	IN	UInt	Transmitted frame length from bytes When transmitting a complex structure, always use a length of 0.

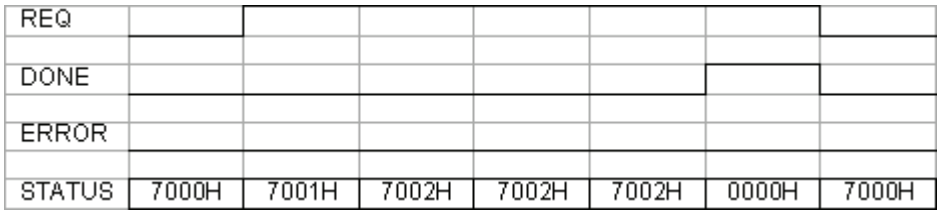
Parameter	Parameter type	Data type	Description
PTRCL	IN	Bool	This parameter selects the buffer as normal point-to-point or specific Siemens-provided protocols that are implemented within the attached CM. FALSE = user program controlled point-to-point operations. (only valid option)
DONE	OUT	Bool	TRUE for one scan, after the last request was completed with no error
ERROR	OUT	Bool	TRUE for one scan, after the last request was completed with an error
STATUS	OUT	Word	Execution condition code

While a transmit operation is in progress, the DONE and ERROR outputs are FALSE. When a transmit operation is complete, either the DONE or the ERROR output will be set TRUE for one scan cycle to show the status of the transmit operation. While DONE or ERROR is TRUE, the STATUS output is valid.

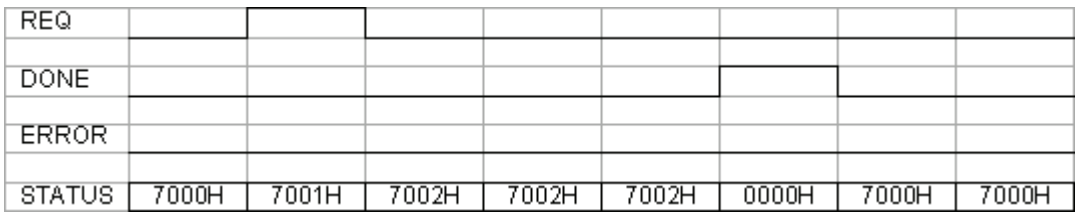
The instruction returns a status of 16#7001 if the communication module (CM) accepts the transmit data. Subsequent SEND_PTP executions return a 16#7002 if the CM is still busy transmitting. When the transmit operation is complete, the CM will return the status of the transmit operation, 16#0000, if no errors occurred. Subsequent executions of SEND_PTP with REQ low return a status of 16#7000 (not busy).

Relationship of the output values to REQ:

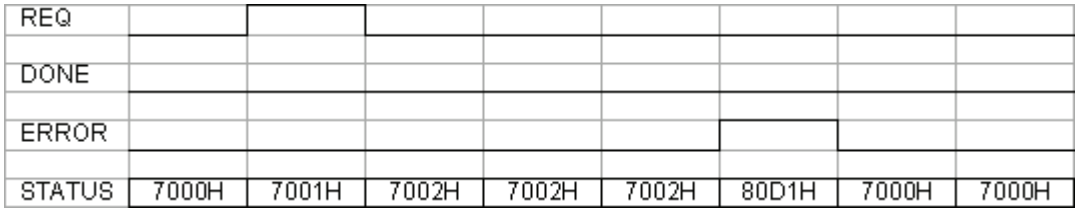
This assumes that the instruction is called periodically to check for the status of the transmission process. In the diagram below, it is assumed that the instruction is called every scan (represented by the STATUS values).



The following diagram shows how the DONE and STATUS parameters are valid for only one scan if the REQ line is pulsed (for one scan) to initiate the transmit operation.



The following diagram shows the relationship of DONE, ERROR and STATUS parameters when there is an error.



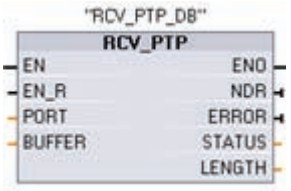
STATUS (W#16#....)	Description
80D0	New request while transmitter active
80D1	Transmit aborted because of no CTS within wait time
80D2	Transmit aborted because of no DSR from the DCE device
80D3	Transmit aborted because of queue overflow (transmit more than 1024 bytes)
7000	Not busy
7001	Busy when accepting request (first call)
7002	Busy on a poll (nth call)

Interaction of the LENGTH and DATA parameters for PTP_SEND

The minimum size of data that can be transmitted by the PTP_SEND instruction is a byte. The DATA parameter determines the size of the data to be transmitted. You cannot use BOOL or arrays of BOOL for the DATA parameter.

LENGTH parameter	DATA parameter	Description
LENGTH = 0	Not used	The complete data is sent as defined at the DATA parameter. You do not need to specify the number of transmitted bytes when LENGTH = 0.
LENGTH > 0	Elementary data type	The LENGTH value must contain the byte count of this data type. Otherwise, nothing is transferred and the error 8088H is returned.
	Structure	The LENGTH value may contain a byte count less than the complete byte length of the structure. In this case, only the first LENGTH bytes are transferred.
	Array	The LENGTH value may contain a byte count that is less than the complete byte length of the array. In this case, only array elements which fit completely in LENGTH bytes are transferred. The LENGTH value must be a multiple of the data element byte count. Otherwise, STATUS = 8088H, ERROR = 1, and no transmit occurs.
	String	The complete memory layout of the string format is transferred. The LENGTH value must include bytes for maximum length, actual length, and the string characters. For the STRING data type, all lengths and characters have a byte size. If a string is used as actual parameter at the DATA parameter, the LENGTH value must also include two bytes for the two length fields.

8.7.6 RCV_PTP instruction



RCV_PTP (Receive Point-to-Point) checks for messages that have been received in the CM. If a message is available, it will be transferred from the CM to the CPU. An error returns the appropriate STATUS value.

The STATUS value is valid when either NDR or ERROR is TRUE. The STATUS value provides the reason for termination of the receive operation in the CM. This will typically be a positive value, indicating that the receive operation was successful and that the receive process terminated normally. If the STATUS value is negative (the Most Significant Bit of the hexadecimal value is set), that indicates the receive operation was terminated for an error condition such as parity, framing, or overrun errors.

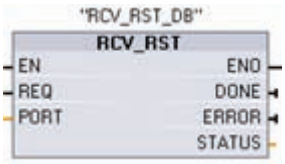
Each Point-to-Point CM module can buffer up to a maximum of 1K bytes. This could be one large message or several smaller messages.

Parameter	Parameter type	Data type	Description
EN_R	IN	Bool	When this input is TRUE, check the CM module for received messages. If a message was successfully received, it will be transferred from the module to the CPU. When EN_R is FALSE, the CM is checked for received messages and the STATUS output is set, but the message is not transferred to the CPU.
PORT	IN	PORT	Communication port identifier: This logical address is a constant that can be referenced within the "Constants" tab of the default tag table.
BUFFER	IN	Variant	This parameter points to the starting location of the receive buffer. This buffer should be large enough to receive the maximum length message. Boolean data or Boolean arrays are not supported.
NDR	OUT	Bool	TRUE for one scan, when new data is ready and operation is complete with no errors.
ERROR	OUT	Bool	TRUE for one scan, after the operation was completed with an error
STATUS	OUT	Word	Execution condition code
LENGTH	OUT	UInt	Length of the returned message (in bytes)

STATUS (W#16#...)	Description
0000	No buffer present
80E0	Message terminated because the receive buffer is full
80E1	Message terminated due to parity error
80E2	Message terminated due to framing error
80E3	Message terminated due to overrun error

STATUS (W#16#...)	Description
80E4	Message terminated because calculated length exceeds buffer size
0094	Message terminated due to received maximum character length
0095	Message terminated because of message timeout
0096	Message terminated because of inter-character timeout
0097	Message terminated because of response timeout
0098	Message terminated because the "N+LEN+M" length condition was satisfied
0099	Message terminated because of end sequence was satisfied

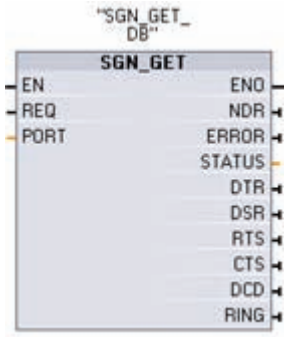
8.7.7 RCV_RST instruction



RCV_RST (Receiver Reset) clears the receive buffers in the CM.

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Activates the receiver reset on the rising edge of this enable input
PORT	IN	PORT	Communication port identifier: The port must be specified using the module's logical address.
DONE	OUT	Bool	When TRUE for one scan, indicates that the last request was completed without errors.
ERROR	OUT	Bool	When TRUE, shows that the last request was completed with errors. Also, when this output is TRUE, the STATUS output will contain related error codes.
STATUS	OUT	Word	Error code

8.7.8 SGN_GET instruction



SGN_GET (Get RS232 Signals) reads the current states of RS232 communication signals. This function is only valid for the RS232 CM (communication module).

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Get RS232 signal state values on the rising edge of this input
PORT	IN	PORT	Communication port identifier: This logical address is a constant which can be referenced within the "Constants" tab of the default tag table.
NDR	OUT	Bool	TRUE for one scan, when new data is ready and the operation is complete with no errors
ERROR	OUT	Bool	TRUE for one scan, after the operation was completed with an error
STATUS	OUT	Word	Execution condition code
DTR	OUT	Bool	Data terminal ready, module ready (output)
DSR	OUT	Bool	Data set ready, communication partner ready (input)
RTS	OUT	Bool	Request to send, module ready to send (output)
CTS	OUT	Bool	Clear to send, communication partner can receive data (input)
DCD	OUT	Bool	Data carrier detect, receive signal level (always false, not supported)
RING	OUT	Bool	Ring indicator, indication of incoming call (always false, not supported)

STATUS (W#16#....)	Description
80F0	CM is RS485 module and no signals are available
80F1	Signals cannot be set because of Hardware flow control
80F2	Cannot set DSR because module is DTE
80F3	Cannot set DTR because module is DCE

8.7.9 SGN_SET instruction



SGN_SET (Set RS232 Signals) sets the states of RS232 communication signals. This function is only valid for the RS232 CM (communication module).

Parameter	Parameter type	Data type	Description
REQ	IN	Bool	Start the set RS232 signals operation, on the rising edge of this input
PORT	IN	PORT	Communication port identifier: This logical address is a constant that can be referenced within the "Constants" tab of the default tag table.
SIGNAL	IN	Byte	Selects which signal to set: (multiple allowed) • 01H = Set RTS • 02H = Set DTR • 04H = Set DSR
RTS	IN	Bool	Request to send, module ready to send value to set (true or false)
DTR	IN	Bool	Data terminal ready, module ready to send value to set (true or false)
DSR	IN	Bool	Data set ready (only applies to DCE type interfaces) (not used)
DONE	OUT	Bool	TRUE for one scan, after the last request was completed with no error
ERROR	OUT	Bool	TRUE for one scan, after the last request was completed with an error
STATUS	OUT	Word	Execution condition code

STATUS (W#16#....)	Description
80F0	CM is RS485 module and no signals are settable
80F1	Signals cannot be set because of Hardware flow control
80F2	Cannot set DSR because module is DTE
80F3	Cannot set DTR because module is DCE

8.8 Errors

Return values of PtP instructions

Each PtP instruction has three outputs that provide the completion status:

Parameter	Data type	Default	Description
DONE	Boolean	FALSE	TRUE for one scan indicates that the last request completed without errors.
ERROR	Boolean	FALSE	TRUE indicates that the last request completed with errors, with the applicable error code in STATUS.
STATUS	Word	0	Two bytes that contain the error class and error number, if applicable. STATUS retains its value for the duration of the execution of the function.

Common error classes and errors

Class description	Error classes	Description
Port configuration	80Ax	Used to define common port configuration errors
Transmit configuration	80Bx	Used to define common transmit configuration errors
Receive configuration	80Cx	Used to define common receive configuration errors
Transmission runtime	80Dx	Used to define common transmission runtime errors
Reception runtime	80Ex	Used to define common reception runtime errors
Signal handling	80Fx	Used to define common errors associated with all signal handling

Port configuration errors

Event / error ID	Description
0x80A0	The specific protocol does not exist
0x80A1	The specific baud rate does not exist
0x80A2	The specific parity does not exist
0x80A3	The specific number of data bits does not exist
0x80A4	The specific number of stop bits does not exist
0x80A5	The specific type of flow control does not exist

Transmit configuration errors

Event / error ID	Description
0x80B0	The specific protocol does not exist
0x80B1	The specific baud rate does not exist
0x80B2	The specific parity does not exist
0x80B3	The specific number of data bits does not exist
0x80B4	The specific number of stop bits does not exist
0x80B5	The specific type of flow control does not exist

Receive configuration errors

Event / error ID	Description
0x80C0	Start condition error
0x80C1	End condition error
0x80C3	Maximum length error
0x80C4	N value error (refer to N+LEN+M)
0x80C5	Length size error (refer to MAXLEN or N+LEN+M)
0x80C6	M value error (refer to N+LEN+M)
0x80C7	N-Length-M value error (refer to N+LEN+M)
0x80C8	Response timeout error, no message was received during the specified receive period. (refer to RCVTIME or MSGTIME)
0x80C9	Inter-character timeout error (refer to CHARGAP)
0x80CA	Idle line timeout error (refer to Idle Line)
0x80CB	A specified end sequence is configured with all "don't care" characters
0x80CC	A specified start sequence is configured with all "don't care" characters

Signal errors

Event / error ID	Description
0x80F0	The communication module is an RS485 module and no signals are available
0x80F1	The communication module is an RS232 module, but no signals are settable because H/W flow control is enabled
0x80F2	The DSR signal can not be set since the module is a DTE device

Transmission runtime errors

Event / error ID	Description
Buffer Limit	The total available transmit buffer of the CP has been exceeded
0x80D0	A new request was received while the transmitter was active

Event / error ID	Description
0x80D1	The receiver issued a flow control request to suspend an active transmission and never re-enabled the transmission during the specified wait time This error is also generated during hardware flow control when the receiver does not assert CTS within the specified wait time
0x80D2	The transmit request was aborted because no DSR signal is received from the DCE
0x80D3	The total available transmit buffer of the CP has been exceeded
0x7000	The transmit function is not busy
0x7001	The transmit function is busy with the first call
0x7002	The transmit function is busy with subsequent calls (polls after the first call)

Reception runtime return values

Event / error ID	Description
0x80E0	The message was terminated because the receive buffer is full
0x80E1	The message was terminated as a result of a parity error
0x80E2	The message was terminated as a result of a framing error
0x80E3	The message was terminated as a result of an overrun error
0x80E4	The message was terminated as a result of the specified length exceeding the total buffer size
0x0094	The message was terminated because the maximum character length was received (MAXLEN)
0x0095	The message was terminated because the complete message was not received in the specified time (MSGTIME)
0x0096	The message was terminated because the next character was not received in the within the duration of the inter-character time (CHARGAP)
0x0097	The message was terminated because the first character was not received in the specified time (RCVTIME)
0x0098	The message was terminated because the "n+len+m" length condition has been satisfied (N+LEN+M)
0x0099	The message was terminated because the end sequence has been satisfied (ENDSEQ)

Miscellaneous parameter errors

Event / error ID	Description
0x8n3A	An illegal pointer was provided on parameter n
0x8070	All internal instance memory is in use
0x8080	The port number is invalid
0x8082	Parameterization failed because parameterization is already in progress in the background
0x8083	Buffer overflow. CM returned more data than allowed.
0x8085	LEN parameter has the value of 0 or is greater than the largest value allowed
0x8088	LEN parameter is larger than the memory area specified in DATA

Online and diagnostic tools

9

9.1 Status LEDs

The CPU and the I/O modules use LEDs to provide information about either the operational status of the module or the I/O. The CPU provides the following status indicators:

- STOP/RUN
  - Solid orange indicates STOP mode
  - Solid green indicates RUN mode
  - Flashing (alternating green and orange) indicates that the CPU is starting up
- ERROR
  - Flashing red indicates an error, such as an internal error in the CPU, a error with the memory card, or a configuration error (mismatched modules)
  - Solid red indicates defective hardware
- MAINT (Maintenance) flashes whenever you insert a memory card. The CPU then changes to STOP mode. After the CPU has changed to STOP mode, perform one of the following functions to initiate the evaluation of the memory card:
  - Change the CPU to RUN mode
  - Perform a memory reset (MRES)
  - Power-cycle the CPU

Description	STOP/RUN Orange / Green	ERROR Red	MAINT Orange
Power is off	Off	Off	Off
Startup, self-test, firmware update	Flashing (alternating orange and green)	-	Off
Stop mode	On (orange)	-	-
Run mode	On (orange)	-	-
Remove the memory card	On (orange)	-	Flashing
Error	On (either orange or green)	Flashing	-
Maintenance requested	On (either orange or green)	-	On
Defective hardware	On (orange)	On	Off
LED test or defective CPU firmware	Flashing (alternating orange and green)	Flashing	Flashing

The CPU also provides two LEDs that indicate the status of the PROFINET communications. Open the bottom terminal block cover to view the PROFINET LEDs.

- Link (green) turns on to indicate a successful connection
- Rx/Tx (yellow) turns on to indicate transmission activity

The CPU and each digital signal module (SM) provide an I/O Channel LED for each of the digital inputs and outputs. The I/O Channel (green) turns on or off to indicate the state of the individual input or output.

In addition, each digital SM provides a DIAG LED that indicates the status of the module:

- Green indicates that the module is operational
- Red indicates that the module is defective or non-operational

Each analog SM provides an I/O Channel LED for each of the analog inputs and outputs.

- Green indicates that the channel has been configured and is active
- Red indicates an error condition of the individual analog input or output

In addition, each analog SM provides a DIAG LED that indicates the status of the module:

- Green indicates that the module is operational
- Red indicates that the module is defective or non-operational

The SM detects the presence or absence of power to the module (field-side power, if required).

Description	DIAG (Red / Green)	I/O Channel (Red / Green)
Field-side power is off	Flashing red	Flashing red
Not configured or updated in progress	Flashing green	Off
Module configured with no errors	On (green)	On (green)
Error condition	Flashing red	-
I/O error (with diagnostics enabled)	-	Flashing red
I/O error (with diagnostics disabled)	-	On (green)

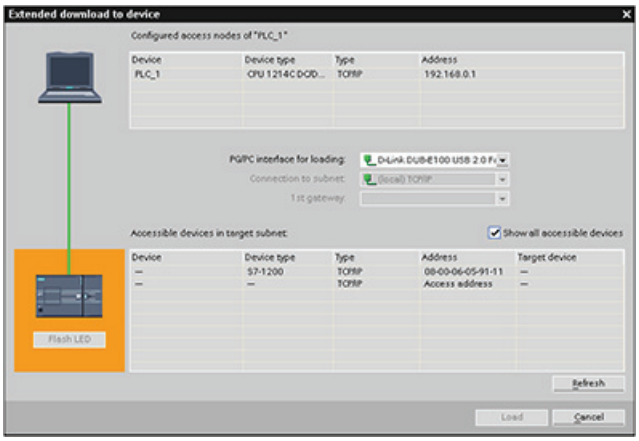
9.2 Going online and connecting to a CPU

An online connection between the programming device and a target system is required for loading programs and project engineering data to the target system as well as for activities such as the following:



- Testing user programs
- Displaying and changing the operating mode of the CPU
- Displaying and setting the date and time of day of the CPU
- Displaying the module information
- Comparing online and offline blocks
- Diagnosing hardware

You can then access the data on the target system in the online or diagnostics view using the "Online tools" task card.



The current online status of a device is indicated by an icon to the right next to the device in the project navigation.

The orange color indicates an online connection.

Select "Accessible Nodes" to find a CPU on the network.



Click "Go online" to connect to a CPU on the network.

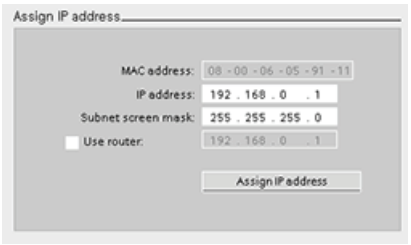
9.3 Setting the IP address and time of day

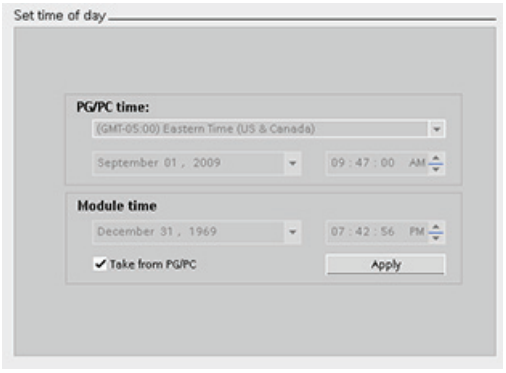
You can set the IP address and time of day in the online CPU.

After connecting to an online CPU from the "Online & diagnostics" area, you can display or change the IP address.

Refer to the section on the IP address (Page 76) for more information.

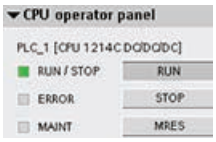
You can also display or set the time and date parameters of the online CPU.





9.4 CPU operator panel for the online CPU

The "CPU operator panel" task card displays the operating mode (STOP or RUN) of the online CPU: The panel also shows whether the CPU has an error or if values are being forced. Use the CPU operating panel to change the operating mode of an online CPU.

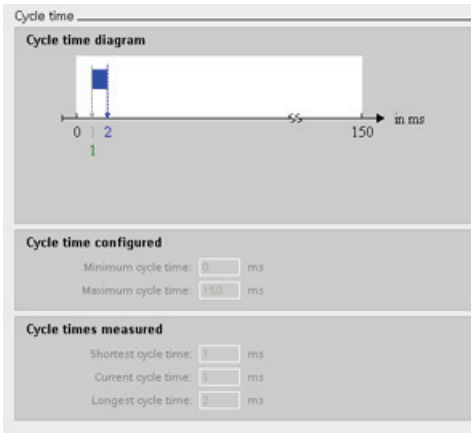


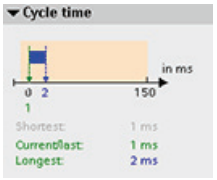
9.5 Monitoring the cycle time and memory usage

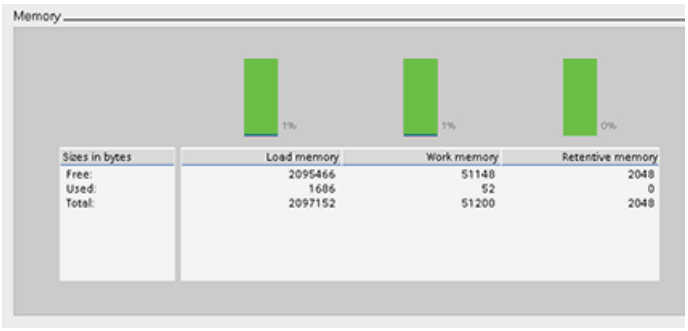
You can monitor the cycle time and memory usage of an online CPU.

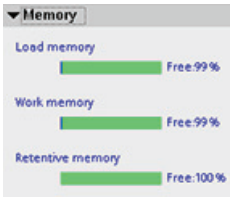
After connecting to the online CPU, you can view the following measurements:

- Cycle time
- Memory usage





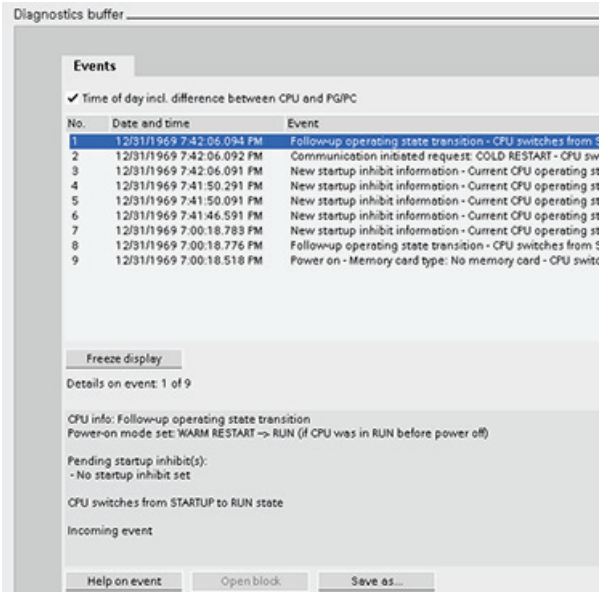




9.6 Displaying diagnostic events in the CPU

Use the diagnostics buffer to review the recent activity in the CPU. The diagnostics buffer contains the following entries:

- Diagnostic events
- Changes in the CPU operating mode (transitions to STOP or RUN mode)



The first entry contains the latest event. Each entry in the diagnostic buffer contains the date and time the event was logged, and a description.

The maximum number of entries is dependent on the CPU. A maximum of 50 entries is supported.

Only the 10 most recent events in the diagnostic buffer are stored permanently. Resetting the CPU to the factory settings resets the diagnostic buffer by deleting the entries.

9.7 Watch tables for monitoring the user program

A watch table allows you to perform monitoring and control functions on data points as the CPU executes your program. These data points can be process image (I or Q), physical (I_:P or Q_:P), M, or DB depending on the monitor or control function.

The Monitoring function does not change the program sequence. It presents you with information about the program sequence and the data of the program in the CPU.

Control functions enable the user to control the sequence and the data of the program. Caution must be exercised when using control functions. These functions can seriously influence the execution of the user/system program. The three control functions are Modify, Force and Enable Outputs in STOP.

With the watch table, you can perform the following online functions:

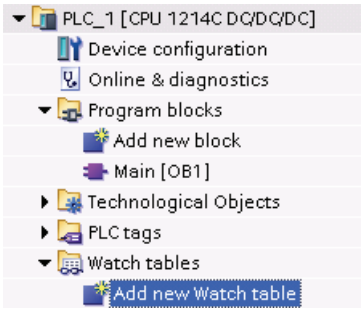
- Monitoring the status of the tags
- Modifying values for the individual tags
- Forcing a tag to a specific value

You select when to monitor or modify the tag:

- Beginning of scan cycle: Reads or writes the value at the beginning of the scan cycle
- End of scan cycle: Reads or writes the value at the end of the scan cycle
- Switch to stop

To create a watch table:

1. Double-click "Add new watch table" to open a new watch table.
2. Enter the tag name to add a tag to the watch table.



The following options are available for monitoring tags:

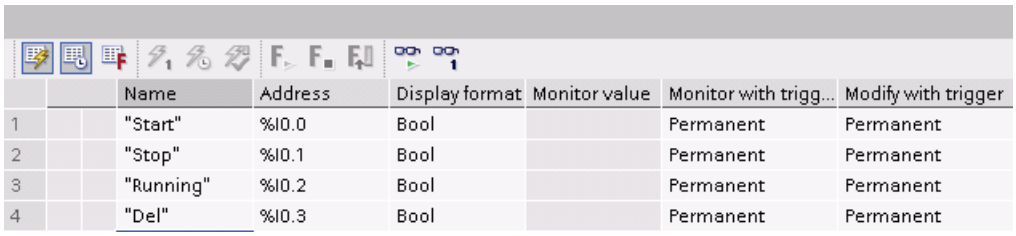
- Monitor all: This command starts the monitoring of the visible tags in the active watch table.
- Monitor now: This command starts the monitoring of the visible tags in the active watch table. The watch table monitors the tags immediately and once only.

The following options are available for modifying tags:

- "Modify to 0" sets the value of a selected address to "0".
- "Modify to 1" sets the value of a selected address to "1".
- "Modify now" immediately changes the value for the selected addresses for one scan cycle.
- "Modify with trigger" changes the values for the selected addresses.

  This function does not provide feedback to indicate that the selected addresses were actually modified. If feedback of the change is required, use the "Modify now" function.
- "Enable peripheral outputs" disables the command output disable and is available only when the CPU is in STOP mode.

To monitor the tags, you must have an online connection to the CPU.



		Name	Address	Display format	Monitor value	Monitor with trigg...	Modify with trigger
1		"Start"	%I0.0	Bool		Permanent	Permanent
2		"Stop"	%I0.1	Bool		Permanent	Permanent
3		"Running"	%I0.2	Bool		Permanent	Permanent
4		"Del"	%I0.3	Bool		Permanent	Permanent

The various functions can be selected using the buttons at the top of the watch table.

Enter the tag name to monitor and select a display format from the dropdown selection. With an online connection to the CPU, clicking the "Monitor" button displays the actual value of the data point in the "Monitor value" field.

Using a trigger when monitoring or modifying PLC tags

Triggering determines at what point in the scan cycle the selected address will be monitored or modified.

Trigger Type	Description
Permanent	Continuously collects the data
At scan cycle start	Permanent: Continuously collects the data at the start of the scan cycle, after the CPU reads the inputs
	Once: Collects the data at the start of the scan cycle, after the CPU reads the inputs
At scan cycle end	Permanent: Continuously collects the data at the end of the scan cycle, before the CPU writes the outputs
	Once: Collects the data once at the end of the scan cycle, before the CPU writes the outputs
At transition to STOP	Permanent: Continuously collects data when the CPU transitions to STOP
	Once: Collects the data once after the CPU transitions to STOP

For modifying a PLC tag at a given trigger, select either the start or the end of cycle.

- Modifying an output: The best trigger event for modifying an output is at the end of the scan cycle, immediately before the CPU writes the outputs.

  Monitor the value of the outputs at the beginning of the scan cycle to determine what value is written to the physical outputs. Also, monitor the outputs before the CPU writes the values to the physical outputs in order to check program logic and to compare to the actual I/O behavior.

- Modifying an input: The best trigger event for modifying an input is at the start of the cycle, immediately after the CPU reads the inputs and before the user program uses the input values.

  If you are modifying inputs the start of the scan cycle, you should also monitor the value of the inputs at the end of the scan cycle to ensure that the value of the input at the end the scan cycle has not changed from the start of the scan cycle. If there is a difference in the values, your user program may be writing to an input in error.

To diagnose why the CPU might have gone to STOP, use the "Transition to STOP" trigger to capture the last process values.

Enabling outputs in STOP mode

The watch table allows you to write to the outputs when the CPU is in STOP mode. This functionality allows you to check the wiring of the outputs and verify that the wire connected to an output pin initiates a high or low signal to the terminal of the process device to which it is connected.

⚠ WARNING

Even though the CPU is in STOP mode, enabling a physical output can activate the process point to which it is connected.

You can change the state of the outputs in STOP mode when the outputs are enabled. If the outputs are disabled, you cannot modify the outputs in STOP mode.

- To enable the modification of the outputs in STOP, select the "Enable peripheral outputs" option of the "Modify" command of the "Online" menu, or by right-clicking the row of the Watch table.
- Setting the CPU to RUN mode disables "Enable peripheral outputs" option.
- If any inputs or outputs are forced, the CPU is not allowed to enable outputs while in STOP mode. The force function must first be cancelled.

Forcing values in the CPU

The CPU allows you to force input and output point(s) by specifying the physical input or output address (I_:P or Q_:P) in the watch table and starting force.

In the program, reads of physical inputs are overwritten by the forced value. The program uses the forced value in processing. When the program writes a physical output, the output value is overwritten by the force value. The forced value appears at the physical output and is used by the process.

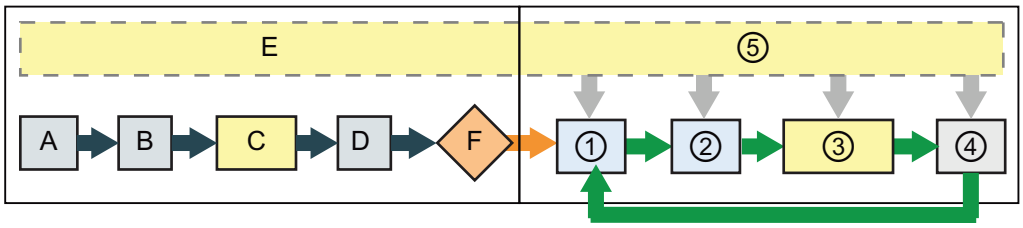
When an input or output is forced in the watch table, the force actions become part of the user program. Even though the programming software has been closed, the force selections remain active in the operating CPU program until they are cleared by going online with the programming software and stopping the force function. Programs with forced points loaded on another CPU from a memory card will continue to force the points selected in the program.

If the CPU is executing the user program from a write-protected memory card, you cannot initiate or change the forcing of I/O from a watch table because you cannot override the values in the write-protected user program. Any attempt to force the write-protected values generates an error. If you use a memory card to transfer a user program, any forced elements on that memory card will be transferred to the CPU.

Note

Digital I/O points assigned to HSC, PWM, and PTO cannot be forced

The digital I/O points used by the high-speed counter (HSC), pulse-width modulation (PWM), and pulse-train output (PTO) devices are assigned during device configuration. When digital I/O point addresses are assigned to these devices, the values of the assigned I/O point addresses cannot be modified by the force function of the watch table.



Startup

A	The clearing of the I memory area is not affected by the Force function.
B	The initialization of the outputs values is not affected by the Force function.
C	During the execution of the startup OBs, the CPU applies the force value when the user program accesses the physical input.
D	The storing of interrupt events into the queue is not affected.
E	The enabling of the writing to the outputs is not affected.

RUN

①	While writing Q memory to the physical outputs, the CPU applies the force value as the outputs are updated.
②	When reading the physical inputs, the CPU applies the force values just prior to copying the inputs into I memory.
③	During the execution of the user program (program cycle OBs), the CPU applies the force value when the user program accesses the physical input or writes the physical output.
④	Handling of communication requests and self-test diagnostics are not affected by the Force function.
⑤	The processing of interrupts during any part of the scan cycle is not affected.

Technical specifications

A

A.1 General Technical Specifications

Standards compliance

The S7-1200 automation system complies with the following standards and test specifications. The test criteria for the S7-1200 automation system are based on these standards and test specifications.

CE approval

CE

The S7-1200 Automation System satisfies requirements and safety related objectives according to the EC directives listed below, and conforms to the harmonized European standards (EN) for the programmable controllers listed in the Official Journals of the European Community.

- EC Directive 2006/95/EC (Low Voltage Directive) "Electrical Equipment Designed for Use within Certain Voltage Limits"
  - EN 61131-2:2007 Programmable controllers - Equipment requirements and tests
- EC Directive 2004/108/EC (EMC Directive) "Electromagnetic Compatibility"
  - Emission standard
    EN 61000-6-4:2007: Industrial Environment
  - Immunity standard
    EN 61000-6-2:2005: Industrial Environment
- EC Directive 94/9/EC (ATEX) "Equipment and Protective Systems Intended for Use in Potentially Explosive Atmosphere
  - EN 60079-15:2005: Type of Protection 'n'

The CE Declaration of Conformity is held on file available to competent authorities at:

Siemens AG
IA AS RD ST PLC Amberg
Werner-von-Siemens-Str. 50
D92224 Amberg
Germany

cULus approval

Underwriters Laboratories Inc. complying with

- Underwriters Laboratories, Inc.: UL 508 Listed (Industrial Control Equipment)
- Canadian Standards Association: CSA C22.2 Number 142 (Process Control Equipment)

NOTICE
The SIMATIC S7-1200 series meets the CSA standard. The cULus logo indicates that the S7-1200 has been examined and certified by Underwriters Laboratories (UL) to standards UL 508 and CSA 22.2 No. 142.

FM approval

Factory Mutual Research (FM):
Approval Standard Class Number 3600 and 3611
Approved for use in:
Class I, Division 2, Gas Group A, B, C, D, Temperature Class T4A Ta = 40° C
Class I, Zone 2, IIC, Temperature Class T4 Ta = 40° C

ATEX approval

EN 60079-0:2006: Explosive Atmospheres - General Requirements

EN 60079-15:2005: Electrical Apparatus for potentially explosive atmospheres;
Type of protection 'n'

II 3 G Ex nA II T4

The following special conditions for safe use of the S7-1200 must be followed:

- Install modules in a suitable enclosure providing a minimum degree of protection of IP54 according to EN 60529 and take into account the environmental conditions under which the equipment will be used.
- When the temperature under rated conditions exceeds 70° C at the cable entry point, or 80° C at the branching point of the conductors, the temperature specification of the selected cable should be in compliance with the actual measured temperature.
- Provisions should be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40%.

C-Tick approval

The S7-1200 automation system satisfies requirements of standards to AS/NZS 2064 (Class A)

Maritime approval

The S7-1200 products are periodically submitted for special agency approvals related to specific markets and applications. Consult your local Siemens representative if you need additional information related to the latest listing of exact approvals by part number.

Classification societies:

- ABS (American Bureau of Shipping)
- BV (Bureau Veritas)
- DNV (Det Norske Veritas)
- GL (Germanischer Lloyd)
- LRS (Lloyds Register of Shipping)
- Class NK (Nippon Kaiji Kyokai)

Industrial environments

The S7-1200 automation system is designed for use in industrial environments.

Application Field	Noise Emission Requirements	Noise Immunity Requirements
Industrial	EN 61000-6-4:2007	EN 61000-6-2:2005

Electromagnetic compatibility

Electromagnetic Compatibility (EMC) is the ability of an electrical device to operate as intended in an electromagnetic environment and to operate without emitting levels of electromagnetic interference (EMI) that may disturb other electrical devices in the vicinity.

Electromagnetic Compatibility - Immunity per EN 61000-6-2	
EN 61000-4-2 Electrostatic discharge	8 kV air discharge to all surfaces 6 kV contact discharge to exposed conductive surfaces
EN 61000-4-3 Radiated electromagnetic field	80 to 1000 MHz, 10 V/m, 80% AM at 1 kHz 1-4 to 2.0 GHz, 3 V/m, 80% AM a 1 kHz 2.0 to 2.7 GHz, 1 V/m, 80% AM at 1 kHz
EN 61000-4-4 Fast transient bursts	2 kV, 5 kHz with coupling network to AC and DC system power 2 kV, 5 kHz with coupling clamp to I/O
EN 6100-4-5 Surge immunity	AC systems - 2 kV common mode, 1kV differential mode DC systems - 2 kV common mode, 1kV differential mode For DC systems (I/O signals, DC power systems) external protection is required.

Electromagnetic Compatibility - Immunity per EN 61000-6-2	
EN 61000-4-6 Conducted disturbances	150 kHz to 80 MHz, 10 V RMS, 80% AM at 1kHz
EN 61000-4-11 Voltage dips	AC systems 0% for 1 cycle, 40% for 12 cycles and 70% for 30 cycles at 60 Hz

Electromagnetic Compatibility - Conducted and Radiated Emissions per EN 61000-6-4	
Conducted Emissions EN 55011, Class A, Group 1 0.15 MHz to 0.5 MHz 0.5 MHz to 5 MHz 5 MHz to 30 MHz	 <79dB (µV) quasi-peak; <66 dB (µV) average <73dB (µV) quasi-peak; <60 dB (µV) average <73dB (µV) quasi-peak; <60 dB (µV) average
Radiated Emissions EN 55011, Class A, Group 1 30 MHz to 230 MHz 230 MHz to 1 GHz	 <40dB (µV/m) quasi-peak; measured at 10m <47dB (µV/m) quasi-peak; measured at 10m

Environmental conditions

Environmental Conditions - Transport and Storage	
EN 60068-2-2, Test Bb, Dry heat and EN 60068-2-1, Test Ab, Cold	-40° C to +70° C
EN 60068-2-30, Test Db, Damp heat	25° C to 55° C, 95% humidity
EN 60068-2-14, Test Na, temperature shock	-40° C to +70° C, dwell time 3 hours, 2 cycles
EN 60068-2-32, Free fall	0.3 m, 5 times, product packaging
Atmospheric pressure	1080 to 660h Pa (corresponding to an altitude of -1000 to 3500m)

Environmental Conditions - Operating	
Ambient temperature range (Inlet Air 25 mm below unit)	0° C to 55° C horizontal mounting 0° C to 45° C vertical mounting 95% non-condensing humidity
Atmospheric pressure	1080 to 795 hPa (Corresponding to an altitude of -1000 to 2000m)
Concentration of contaminants	$S0_2$: < 0.5 ppm; H_2S: < 0.1 ppm; RH < 60% non-condensing
EN 60068-2-14, Test Nb, temperature change	5° C to 55° C, 3° C/minute
EN 60068-2-27 Mechanical shock	15 G, 11 ms pulse, 6 shocks in each of 3 axis
EN 60068-2-6 Sinusoidal vibration	DIN rail mount: 3.5 mm from 5-9 Hz, 1G from 9 - 150 Hz Panel Mount: 7.0 mm from 5-9 Hz, 2G from 9 to 150 Hz 10 sweeps each axis, 1 octave per minute

High Potential Isolation Test	
24 V/5 V nominal circuits 115/230 V circuits to ground 115/230 V circuits to 115/230 V circuits 115 V/230V circuits to 24 V/5 V circuits	520 VDC (type test of optical isolation boundaries) 1,500 VAC routine test/1950 VDC type test 1,500 VAC routine test/1950 VDC type test 1,500 VAC routine test/3250 VDC type test

Protection Class

- Protection Class II according to EN 61131-2 (Protective conductor not required)

Degree of protection

- IP20 Mechanical Protection, EN 60529
- Protects against finger contact with high voltage as tested by standard probe. External protection required for dust, dirt, water and foreign objects of < 12.5mm in diameter.

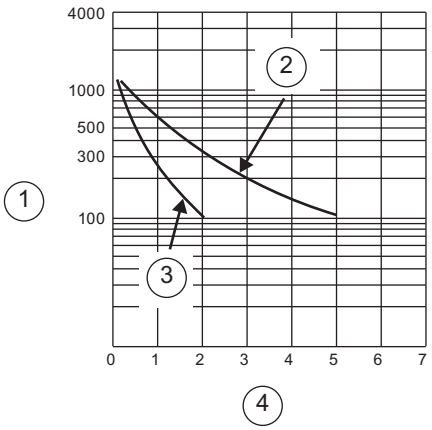
Rated voltages

Rated Voltage	Tolerance
24 VDC	20.4 VDC to 28.8 VDC
120/230 VAC	85 VAC to 264 VAC, 47 to 63 Hz

NOTICE
When a mechanical contact turns on output power to the S7-1200 CPU, or any digital signal module, it sends a "1" signal to the digital outputs for approximately 50 microseconds. You must plan for this, especially if you are using devices which respond to short duration pulses.

Relay electrical service life

The typical performance data supplied by relay vendors is shown below. Actual performance may vary depending upon your specific application. An external protection circuit that is adapted to the load will enhance the service life of the contacts.



① Service life (x 10^3 operations)

② 250 VAC resistive load,
30 VDC resistive load

③ 250 VAC inductive load (p.f=0.4)
30 VDC inductive load (L/R=7ms)

④ Rated Operating Current (A)

A.2 CPUs

A.2.1 CPU 1211C Specifications

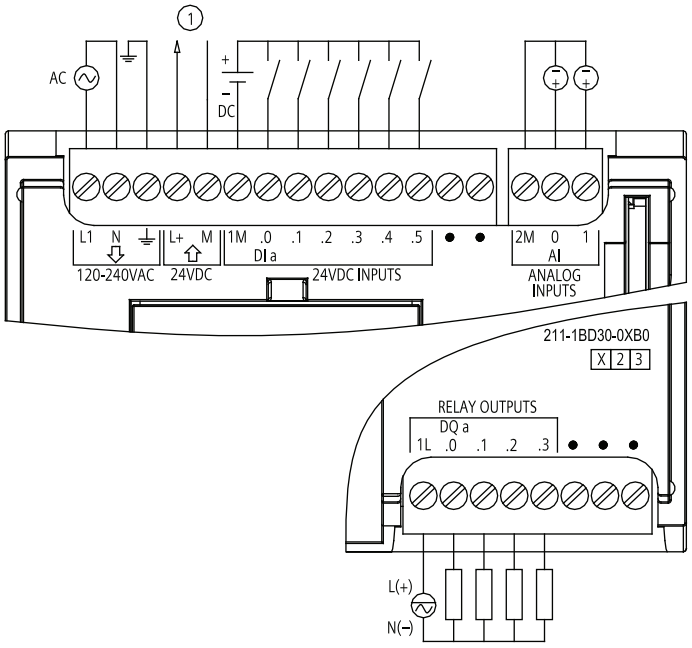
Technical Specifications			
Model	**CPU 1211C AC/DC/Relay**	**CPU 1211C DC/DC/Relay**	**CPU 1211C DC/DC/DC**
Order number (MLFB)	6ES7 211-1BD30-0XB0	6ES7 211-1HD30-0XB0	6ES7 211-1AD30-0XB0
General			
Dimensions W x H x D (mm)	90 x 100 x 75		
Weight	420 grams	380 grams	370 grams
Power dissipation	10 W	8 W	
Current available (CM bus)	750 mA max. (5 VDC)		
Current available (24 VDC)	300 mA max. (sensor power)		
Digital input current consumption (24VDC)	4 mA/input used		
CPU Features			
User memory	25 Kbytes Work memory / 1 Mbytes Load memory / 2 Kbytes Retentive memory		
On-board digital I/O	6 inputs/4 outputs		
On-board analog I/O	2 inputs		
Process image size	1024 bytes of inputs (I) /1024 bytes of outputs (Q)		
Bit memory (M)	4096 bytes		
Signal modules expansion	none		
Signal board expansion	1 SB max.		
Communication module expansion	3 CMs max.		
High-speed counters	3 total Single phase: 3 at 100 kHz Quadrature phase: 3 at 80 kHz		
Pulse outputs	2		
Pulse catch inputs	6		
Time delay / cyclic interrupts	4 total with 1 ms resolution		
Edge interrupts	6 rising and 6 falling (10 and 10 with optional signal board)		
Memory card	SIMATIC Memory Card (optional)		
Real time clock accuracy	+/- 60 seconds/month		
Real time clock retention time	10 days typ./6 days min. at 40°C (maintenance-free Super Capacitor)		
Performance			
Boolean execution speed	0.1 µs/instruction		
Move Word execution speed	12 µs/instruction		
Real Math execution speed	18 µs/instruction		
Communication			
Number of ports	1		
Type	Ethernet		

Technical Specifications			
Model	**CPU 1211C AC/DC/Relay**	**CPU 1211C DC/DC/Relay**	**CPU 1211C DC/DC/DC**
Connections	• 3 for HMI • 1 for programming device • 8 for Ethernet instructions in the user program • 3 for CPU-to-CPU		
Data rates	10/100 Mb/s		
Isolation (external signal to PLC logic)	Transformer isolated, 1500 VDC		
Cable type	CAT5e shielded		
Power supply			
Voltage range	85 to 264 VAC	20.4 to 28.8 VDC	
Line frequency	47 to 63 Hz	--	
Input current CPU only at max. load CPU with all expansion accessories at max. load	 60 mA at 120 VAC 30 mA at 240 VAC 180 mA at 120 VAC 90 mA at 240 VAC	 300 mA at 24 VDC 900 mA at 24 VDC	
Inrush current (max.)	20 A at 264 VAC	12 A at 28.8 VDC	
Isolation (input power to logic)	1500 VAC	Not isolated	
Ground leakage, AC line to functional earth	0.5 mA max.	-	
Hold up time (loss of power)	20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	
Internal fuse, not user replaceable	3 A, 250 V, slow blow		
Sensor power			
Voltage range	20.4 to 28.8 VDC	L+ minus 4 VDC min.	
Output current rating (max.)	300 mA (short circuit protected)		
Maximum ripple noise (<10 MHz)	< 1 V peak to peak	Same as input line	
Isolation (CPU logic to sensor power)	Not isolated		
Digital inputs			
Number of inputs	6		
Type	Sink/Source (IEC Type 1 sink)		
Rated voltage	24 VDC at 4 mA, nominal		
Continuous permissible voltage	30 VDC, max.		
Surge voltage	35 VDC for 0.5 sec.		
Logic 1 signal (min.)	15 VDC at 2.5 mA		
Logic 0 signal (max.)	5 VDC at 1 mA		
Isolation (field side to logic)	500 VAC for 1 minute		
Isolation groups	1		
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)		
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz Quadrature phase: 80 KHz		
Number of inputs on simultaneously	6		

Technical Specifications			
Model	**CPU 1211C AC/DC/Relay**	**CPU 1211C DC/DC/Relay**	**CPU 1211C DC/DC/DC**
Cable length (meters)	500 shielded, 300 unshielded, 50 shielded for HSC inputs		
Analog inputs			
Number of inputs	2		
Type	Voltage (single-ended)		
Range	0 to 10 V		
Full-scale range (data word)	0 to 27648 (refer to Analog input representation for voltage (Page 306))		
Overshoot range (data word)	27,649 to 32,511 (refer to Analog input representation for voltage (Page 306))		
Overflow (data word)	32,512 to 32767 (refer to Analog input representation for voltage (Page 306))		
Resolution	10 bits		
Maximum withstand voltage	35 VDC		
Smoothing	None, Weak, Medium, or Strong (refer to Analog input response times (Page 306) for step response times)		
Noise rejection	10, 50, or 60 Hz (refer to Analog input response times (Page 306) for sample rates)		
Impedance	≥100 KΩ		
Isolation (field side to logic)	None		
Accuracy (25°C / 0 to 55°C)	3.0% / 3.5% of full-scale		
Common mode rejection	40 dB, DC to 60 Hz		
Operational signal range	Signal plus common mode voltage must be less than +12 V and greater than -12 V		
Cable length (meters)	100 m, shielded twisted pair		
Digital outputs			
Number of outputs	4		
Type	Relay, dry contact		Solid state - MOSFET
Voltage range	5 to 30 VDC or 5 to 250 VAC		20.4 to 28.8 VDC
Logic 1 signal at max. current	--		20 VDC min.
Logic 0 signal with 10 KΩ load	--		0.1 VDC max.
Current (max.)	2.0 A		0.5 A
Lamp load	30 W DC / 200 W AC		5 W
ON state resistance	0.2 Ω max. when new		0.6 Ω max.
Leakage current per point	--		10 µA max.
Surge current	7 A with contacts closed		8 A for 100 ms max.
Overload protection	No		
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)		500 VAC for 1 minute
Isolation resistance	100 MΩ min. when new		--
Isolation between open contacts	750 VAC for 1 minute		--
Isolation groups	1		1
Inductive clamp voltage	--		L+ minus 48 VDC, 1 W dissipation
Switching delay (Qa.0 to Qa.3)	10 ms max.		1.0 µs max., off to on 3.0 µs max., on to off

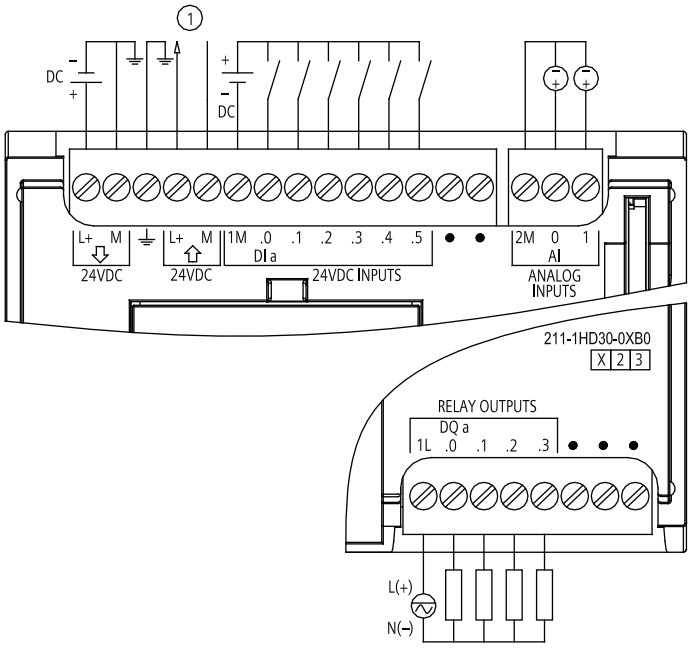
Technical Specifications			
Model	**CPU 1211C AC/DC/Relay**	**CPU 1211C DC/DC/Relay**	**CPU 1211C DC/DC/DC**
Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended		100 KHz max., 2 Hz min.
Lifetime mechanical (no load)	10,000,000 open/close cycles		--
Lifetime contacts at rated load	100,000 open/close cycles		--
Behavior on RUN to STOP	Last value or substitute value (default value 0)		
Number of Outputs On simultaneously	4		
Cable length (meters)	500 shielded, 150 unshielded		

Wiring Diagrams



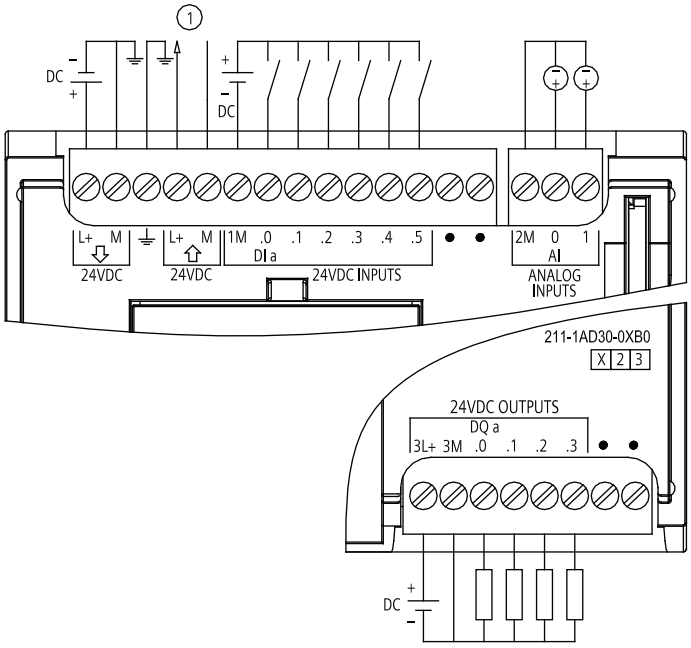
① 24 VDC Sensor Power Out

Figure A-1 CPU 1211C AC/DC/Relay (6ES7 211-1BD30-0XB0)



① 24 VDC Sensor Power Out

Figure A-2 CPU 1211C DC/DC/Relay (6ES7 211-1HD30-0XB0)



① 24 VDC Sensor Power Out

Figure A-3 CPU 1211C DC/DC/DC (6ES7 211-1AD30-0XB0)

A.2.2 CPU 1212C Specifications

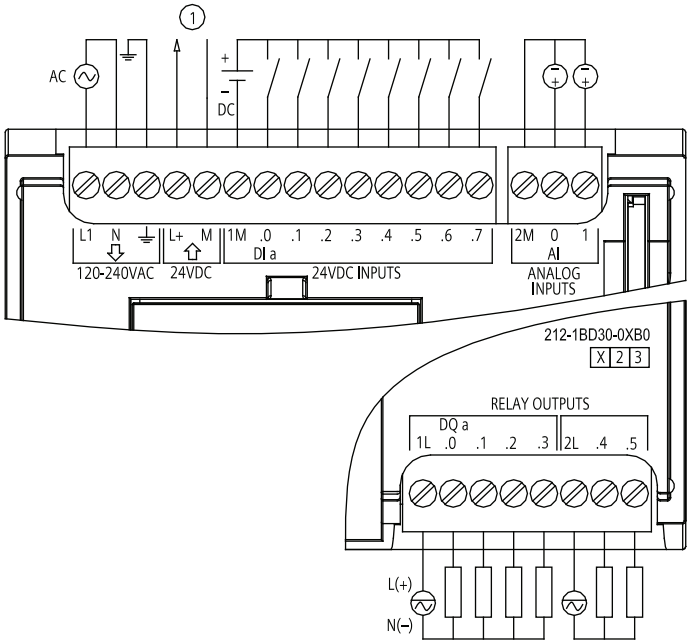
Technical Specifications			
Model	**CPU 1212C AC/DC/Relay**	**CPU 1212C DC/DC/Relay**	**CPU 1212C DC/DC/DC**
Order number (MLFB)	6ES7 212-1BD30-0XB0	6ES7 212-1HD30-0XB0	6ES7 212-1AD30-0XB0
General			
Dimensions W x H x D (mm)	90 x 100 x 75		
Weight	425 grams	385 grams	370 grams
Power dissipation	11 W	9 W	
Current available (SM and CM bus)	1000 mA max. (5 VDC)		
Current available (24 VDC)	300 mA max. (sensor power)		
Digital input current consumption (24 VDC)	4 mA/input used		
CPU Features			
User memory	25 Kbytes Work memory / 1 Mbytes Load memory/ 2 Kbytes Retentive memory		
On-board digital I/O	8 inputs/6 outputs		
On-board analog I/O	2 inputs		
Process image size	1024 bytes of inputs (I)/1024 bytes of outputs (Q)		
Bit memory (M)	4096 bytes		
Signal modules expansion	2 SMs max.		
Signal board expansion	1 SB max.		
Communication module expansion	3 CMs max.		
High-speed counters	4 total Single phase: 3 at 100 kHz and 1 at 30 kHz clock rate Quadrature phase: 3 at 80 kHz and 1 at 20 kHz clock rate		
Pulse outputs	2		
Pulse catch inputs	8		
Time delay / cyclic interrupts	4 total with 1 ms resolution		
Edge interrupts	8 rising and 8 falling (12 and 12 with optional signal board)		
Memory card	SIMATIC Memory Card (optional)		
Real time clock accuracy	+/- 60 seconds/month		
Real time clock retention time	10 days typ./6 days min. at 40°C (maintenance-free Super Capacitor)		
Performance			
Boolean execution speed	0.1 µs/instruction		
Move Word execution speed	12 µs/instruction		
Real Math execution speed	18 µs/instruction		
Communication			
Number of ports	1		
Type	Ethernet		
Connections	• 3 for HMI • 1 for programming device • 8 for Ethernet instructions in the user program • 3 for CPU-to-CPU		

Technical Specifications			
Model	**CPU 1212C AC/DC/Relay**	**CPU 1212C DC/DC/Relay**	**CPU 1212C DC/DC/DC**
Data rates	10/100 Mb/s		
Isolation (external signal to PLC logic)	Transformer isolated, 1500 VDC		
Cable type	CAT5e shielded		
Power supply			
Voltage range	85 to 264 VAC	20.4 to 28.8 VDC	
Line frequency	47 to 63 Hz	--	
Input current CPU only at max. load CPU with all expansion accessories at max. load	80 mA at 120 VAC 40 mA at 240 VAC 240 mA at 120 VAC 120 mA at 240 VAC	400 mA at 24 VDC 1200 mA at 24 VDC	
Inrush current (max.)	20 A at 264 VAC	12 A at 28.8 VDC	
Isolation (input power to logic)	1500 VAC	Not isolated	
Ground leakage, AC line to functional earth	0.5 mA max.	-	
Hold up time (loss of power)	20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	
Internal fuse, not user replaceable	3 A, 250 V, slow blow		
Sensor power			
Voltage range	20.4 to 28.8 VDC	L+ minus 4 VDC min.	
Output current rating (max.)	300 mA (short circuit protected)		
Maximum ripple noise (<10 MHz)	< 1 V peak to peak	Same as input line	
Isolation (CPU logic to sensor power)	Not isolated		
Digital inputs			
Number of inputs	8		
Type	Sink/Source (IEC Type 1 sink)		
Rated voltage	24 VDC at 4 mA, nominal		
Continuous permissible voltage	30 VDC, max.		
Surge voltage	35 VDC for 0.5 sec.		
Logic 1 signal (min.)	15 VDC at 2.5 mA		
Logic 0 signal (max.)	5 VDC at 1 mA		
Isolation (field side to logic)	500 VAC for 1 minute		
Isolation groups	1		
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)		
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz (Ia.0 to Ia.5) and 30 KHz (Ia.6 to Ia.7) Quadrature phase: 80 KHz (Ia.0 to Ia.5) and 20 KHz (Ia.6 to Ia.7)		
Number of inputs on simultaneously	8		
Cable length (meters)	500 shielded, 300 unshielded, 50 shielded for HSC inputs		
Analog inputs			
Number of inputs	2		
Type	Voltage (single-ended)		
Range	0 to 10 V		

Technical Specifications			
Model	**CPU 1212C AC/DC/Relay**	**CPU 1212C DC/DC/Relay**	**CPU 1212C DC/DC/DC**
Full-scale range (data word)	0 to 27648 (Refer to Analog input representation for voltage (Page 306))		
Overshoot range (data word)	27,649 to 32,511 (Refer to Analog input representation for voltage (Page 306))		
Overflow (data word)	32,512 to 32767 (Refer to Analog input representation for voltage (Page 306))		
Resolution	10 bits		
Maximum withstand voltage	35 VDC		
Smoothing	None, Weak, Medium, or Strong (refer to Analog input response times (Page 306) for step response times)		
Noise rejection	10, 50, or 60 Hz (refer to Analog input response times (Page 306) for sample rates)		
Impedance	≥100 KΩ		
Isolation (field side to logic)	None		
Accuracy (25°C / 0 to 55°C)	3.0% / 3.5% of full-scale		
Common mode rejection	40 dB, DC to 60 Hz		
Operational signal range	Signal plus common mode voltage must be less than +12 V and greater than -12 V		
Cable length (meters)	100 twisted and shielded		
Digital outputs			
Number of outputs	6		
Type	Relay, dry contact		Solid state - MOSFET
Voltage range	5 to 30 VDC or 5 to 250 VAC		20.4 to 28.8 VDC
Logic 1 signal at max. current	--		20 VDC min.
Logic 0 signal with 10 KΩ load	--		0.1 VDC max.
Current (max.)	2.0 A		0.5 A
Lamp load	30 W DC / 200 W AC		5 W
ON state resistance	0.2 Ω max. when new		0.6 Ω max.
Leakage current per point	--		10 µA max.
Surge current	7 A with contacts closed		8 A for 100 ms max.
Overload protection	No		
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)		500 VAC for 1 minute
Isolation resistance	100 MΩ min. when new		--
Isolation between open contacts	750 VAC for 1 minute		--
Isolation groups	2		1
Inductive clamp voltage	--		L+ minus 48 VDC, 1 W dissipation
Switching delay (Qa.0 to Qa.3)	10 ms max.		1.0 µs max., off to on 3.0 µs max., on to off
Switching delay (Qa.4 to Qa.5)	10 ms max.		50 µs max., off to on 200 µs max., on to off
Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended		100 KHz max., 2 Hz min.
Lifetime mechanical (no load)	10,000,000 open/close cycles		--
Lifetime contacts at rated load	100,000 open/close cycles		--
Behavior on RUN to STOP	Last value or substitute value (default value 0)		

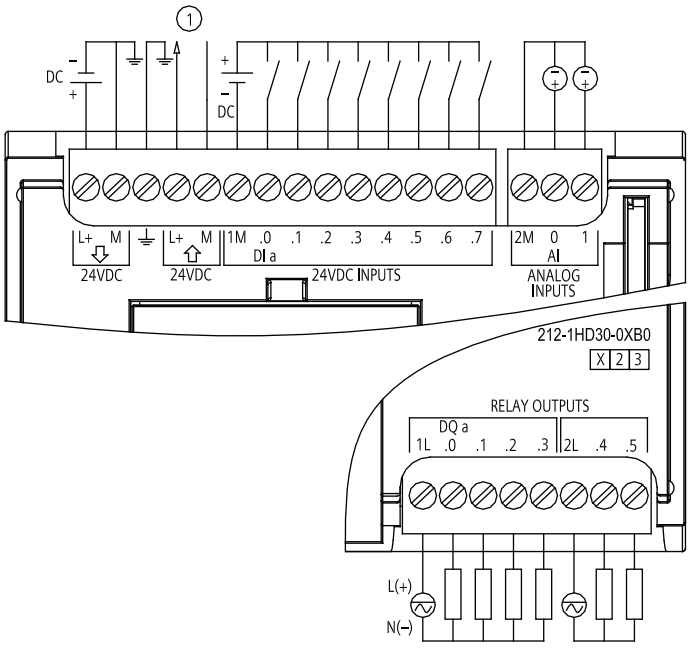
Technical Specifications			
Model	**CPU 1212C AC/DC/Relay**	**CPU 1212C DC/DC/Relay**	**CPU 1212C DC/DC/DC**
Number of Outputs On simultaneously	6		
Cable length (meters)	500 shielded, 150 unshielded		

Wiring Diagrams



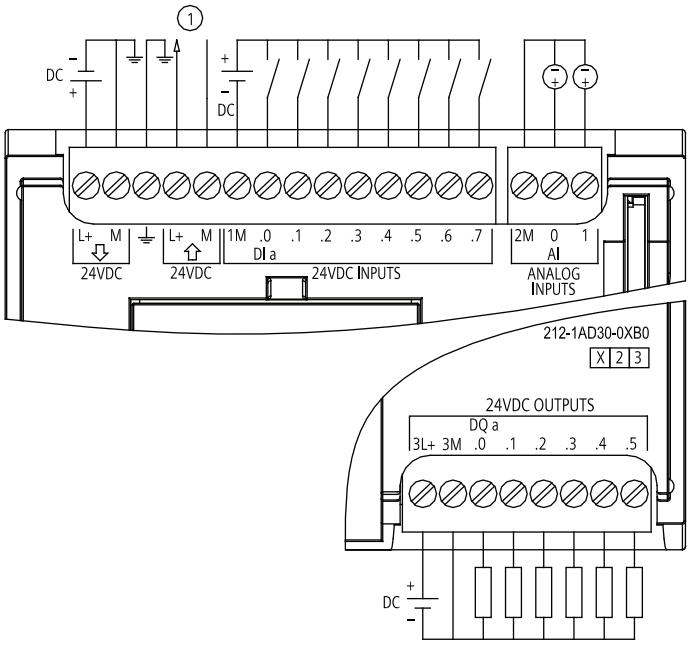
① 24 VDC Sensor Power Out

Figure A-4 CPU 1212C AC/DC Relay (6ES7 212-1BD30-0XB0)



① 24 VDC Sensor Power Out

Figure A-5 CPU 1212C DC/DC/Relay (6ES7 212-1HD30-0XB0)



① 24 VDC Sensor Power Out

Figure A-6 CPU 1212C DC/DC/DC (6ES7 212-1AD30-0XB0)

A.2.3 CPU 1214C Specifications

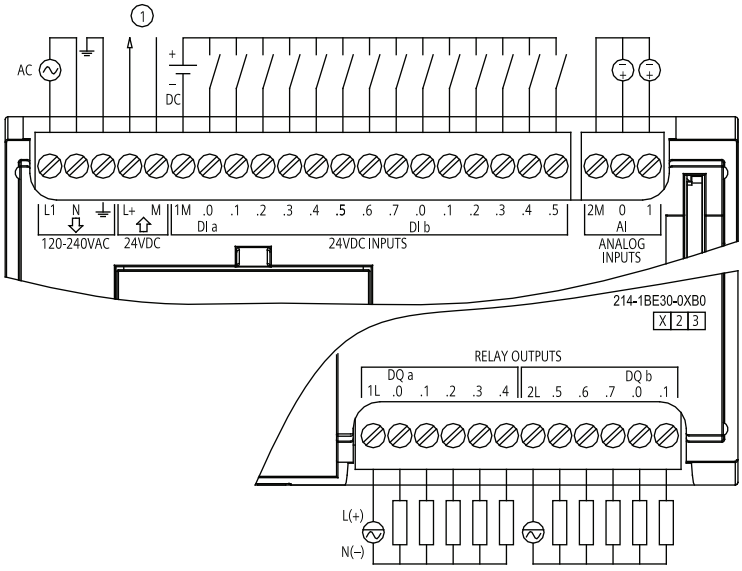
Technical Specifications			
Model	**CPU 1214C AC/DC/Relay**	**CPU 1214C DC/DC/Relay**	**CPU 1214C DC/DC/DC**
Order number (MLFB)	6ES7 214-1BE30-0XB0	6ES7 214-1HE30-0XB0	6ES7 214-1AE30-0XB0
General			
Dimensions W x H x D (mm)	110 x 100 x 75		
Weight	475 grams	435 grams	415 grams
Power dissipation	14 W	12 W	
Current available (SM and CM bus)	1600 mA max. (5 VDC)		
Current available (24 VDC)	400 mA max. (sensor power)		
Digital input current consumption (24VDC)	4 mA/input used		
CPU Features			
User memory	50 Kbytes Work memory / 2 Mbytes Load memory/ 2 Kbytes Retentive memory		
On-board digital I/O	14 inputs/10 outputs		
On-board analog I/O	2 inputs		
Process image size	1024 bytes of inputs (I)/1024 bytes of outputs (Q)		
Bit memory (M)	8192 bytes		
Signal modules expansion	8 SMs max.		
Signal board expansion	1 SB max.		
Communication module expansion	3 CMs max.		
High-speed counters	6 total Single phase: 3 at 100 kHz and 3 at 30 kHz clock rate Quadrature phase: 3 at 80 kHz and 3 at 20 kHz clock rate		
Pulse outputs	2		
Pulse catch inputs	14		
Time delay / cyclic interrupts	4 total with 1 ms resolution		
Edge interrupts	12 rising and 12 falling (14 and 14 with optional signal board)		
Memory card	SIMATIC Memory Card (optional)		
Real time clock accuracy	+/- 60 seconds/month		
Real time clock retention time	10 days typ./6 days min. at 40°C (maintenance-free Super Capacitor)		
Performance			
Boolean execution speed	0.1 µs/instruction		
Move Word execution speed	12 µs/instruction		
Real Math execution speed	18 µs/instruction		
Communication			
Number of ports	1		
Type	Ethernet		
Connections	• 3 for HMI • 1 for programming device • 8 for Ethernet instructions in the user program • 3 for CPU-to-CPU		

Technical Specifications			
Model	**CPU 1214C AC/DC/Relay**	**CPU 1214C DC/DC/Relay**	**CPU 1214C DC/DC/DC**
Data rates	10/100 Mb/s		
Isolation (external signal to PLC logic)	Transformer isolated, 1500 VDC		
Cable type	CAT5e shielded		
Power supply			
Voltage range	85 to 264 VAC	20.4 to 28.8 VDC	
Line frequency	47 to 63 Hz	--	
Input current CPU only at max. load CPU with all expansion accessories at max. load	 100 mA at 120 VAC 50 mA at 240 VAC 300 mA at 120 VAC 150 mA at 240 VAC	 500 mA at 24 VDC 1500 mA at 24 VDC	
Inrush current (max.)	20 A at 264 VAC	12 A at 28.8 VDC	
Isolation (input power to logic)	1500 VAC	Not isolated	
Ground leakage, AC line to functional earth	0.5 mA max.	-	
Hold up time (loss of power)	20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	
Internal fuse, not user replaceable	3 A, 250 V, slow blow		
Sensor power			
Voltage range	20.4 to 28.8 VDC	L+ minus 4 VDC min.	
Output current rating (max.)	400 mA (short circuit protected)		
Maximum ripple noise (<10 MHz)	< 1 V peak to peak	Same as input line	
Isolation (CPU logic to sensor power)	Not isolated		
Digital inputs			
Number of inputs	14		
Type	Sink/Source (IEC Type 1 sink)		
Rated voltage	24 VDC at 4 mA, nominal		
Continuous permissible voltage	30 VDC, max.		
Surge voltage	35 VDC for 0.5 sec.		
Logic 1 signal (min.)	15 VDC at 2.5 mA		
Logic 0 signal (max.)	5 VDC at 1 mA		
Isolation (field side to logic)	500 VAC for 1 minute		
Isolation groups	1		
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)		
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz (Ia.0 to Ia.5) and 30 KHz (Ia.6 to Ib.5) Quadrature phase: 80 KHz (Ia.0 to Ia.5) and 20 KHz (Ia.6 to Ib.5)		
Number of inputs on simultaneously	14		
Cable length (meters)	500 shielded, 300 unshielded, 50 shielded for HSC inputs		
Analog inputs			
Number of inputs	2		
Type	Voltage (single-ended)		

Technical Specifications			
Model	**CPU 1214C AC/DC/Relay**	**CPU 1214C DC/DC/Relay**	**CPU 1214C DC/DC/DC**
Range	0 to 10 V		
Full-scale range (data word)	0 to 27648 (Refer to Analog input representation for voltage (Page 306))		
Overshoot range (data word)	27,649 to 32,511 (Refer to Analog input representation for voltage (Page 306))		
Overflow (data word)	32,512 to 32767 (Refer to Analog input representation for voltage (Page 306))		
Resolution	10 bits		
Maximum withstand voltage	35 VDC		
Smoothing	None, Weak, Medium, or Strong (refer to Analog input response time (Page 306) for step response times)		
Noise rejection	10, 50, or 60 Hz (refer to Analog input response time (Page 306) for sample rates)		
Impedance	≥100 KΩ		
Isolation (field side to logic)	None		
Accuracy (25°C / 0 to 55°C)	3.0% / 3.5% of full-scale		
Common mode rejection	40 dB, DC to 60 Hz		
Operational signal range	Signal plus common mode voltage must be less than +12 V and greater than -12 V		
Cable length (meters)	100 twisted and shielded		
Digital outputs			
Number of outputs	10		
Type	Relay, dry contact		Solid state - MOSFET
Voltage range	5 to 30 VDC or 5 to 250 VAC		20.4 to 28.8 VDC
Logic 1 signal at max. current	--		20 VDC min.
Logic 0 signal with 10 KΩ load	--		0.1 VDC max.
Current (max.)	2.0 A		0.5 A
Lamp load	30 W DC / 200 W AC		5 W
ON state resistance	0.2 Ω max. when new		0.6 Ω max.
Leakage current per point	--		10 µA max.
Surge current	7 A with contacts closed		8 A for 100 ms max.
Overload protection	No		
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)		500 VAC for 1 minute
Isolation resistance	100 MΩ min. when new		--
Isolation between open contacts	750 VAC for 1 minute		--
Isolation groups	2		1
Inductive clamp voltage	--		L+ minus 48 VDC, 1 W dissipation
Switching delay (Qa.0 to Qa.3)	10 ms max.		1.0 µs max., off to on 3.0 µs max., on to off
Switching delay (Qa.4 to Qb.1)	10 ms max.		50 µs max., off to on 200 µs max., on to off
Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended		100 KHz max., 2 Hz min.
Lifetime mechanical (no load)	10,000,000 open/close cycles		--
Lifetime contacts at rated load	100,000 open/close cycles		--

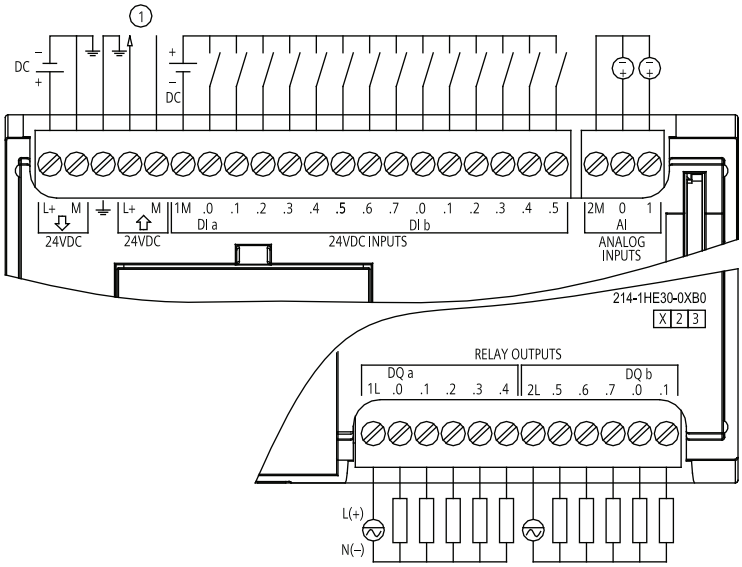
Technical Specifications			
Model	**CPU 1214C AC/DC/Relay**	**CPU 1214C DC/DC/Relay**	**CPU 1214C DC/DC/DC**
Behavior on RUN to STOP	Last value or substitute value (default value 0)		
Number of Outputs On simultaneously	10		
Cable length (meters)	500 shielded, 150 unshielded		

Wiring Diagrams



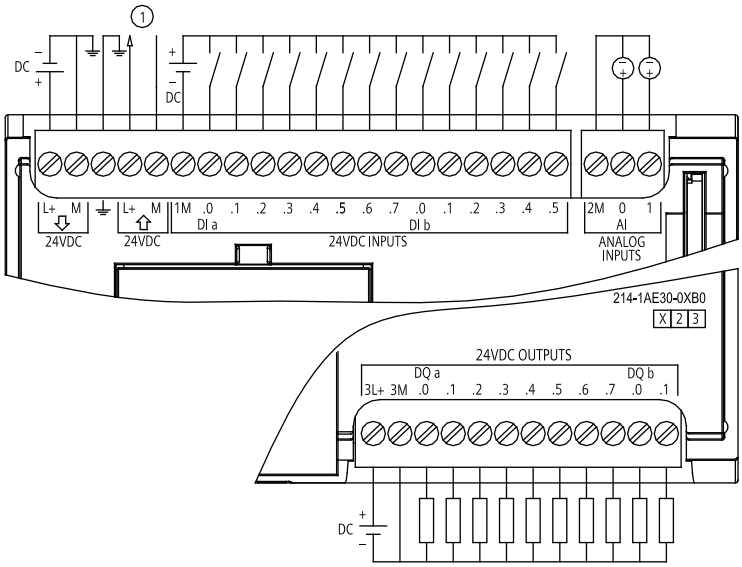
① 24 VDC Sensor Power Out

Figure A-7 CPU 1214C AC/DC/Relay (6ES7 214-1BE30-0XB0)



① 24 VDC Sensor Power Out

Figure A-8 CPU 1214C DC/DC/Relay (6ES7 214-1HE30-0XB0)



① 24 VDC Sensor Power Out

Figure A-9 CPU 1214C DC/DC/DC (6ES7 214-1AE30-0XB0)

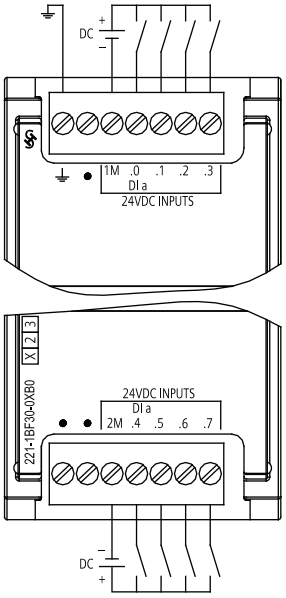
A.3 Digital signal modules (SMs)

A.3.1 SM 1221 Digital Input Specifications

Technical Specifications		
Model	**SM 1221 DI 8x24VDC**	**SM 1221 DI 16x24VDC**
Order number (MLFB)	6ES7 221-1BF30-0XB0	6ES7 221-1BH30-0XB0
General		
Dimensions W x H x D (mm)	45 x 100 x 75	
Weight	170 grams	210 grams
Power dissipation	1.5 W	2.5 W
Current consumption (SM Bus)	105 mA	130 mA
Current consumption (24 VDC)	4 mA / input used	4 mA / input used
Digital inputs		
Number of inputs	8	16
Type	Sink/Source (IEC Type 1 sink)	
Rated voltage	24 VDC at 4 mA, nominal	
Continuous permissible voltage	30 VDC, max.	
Surge voltage	35 VDC for 0.5 sec.	
Logic 1 signal (min.)	15 VDC at 2.5 mA	
Logic 0 signal (max.)	5 VDC at 1 mA	
Isolation (field side to logic)	500 VAC for 1 minute	
Isolation groups	2	4
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)	
Number of inputs on simultaneously	8	16
Cable length (meters)	500 shielded, 300 unshielded	

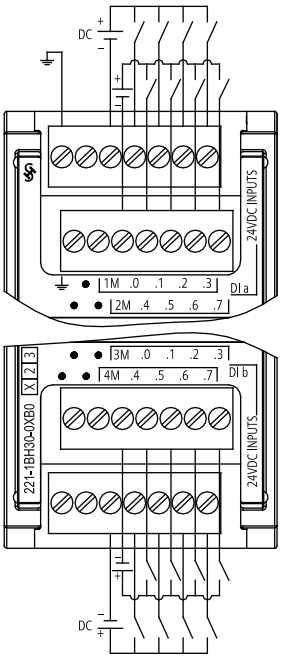
Wiring diagrams

SM 1221 DI 8 x 24 VDC



6ES7 221-1BF30-0XB0

SM 1221 DI 16 x 24 VDC



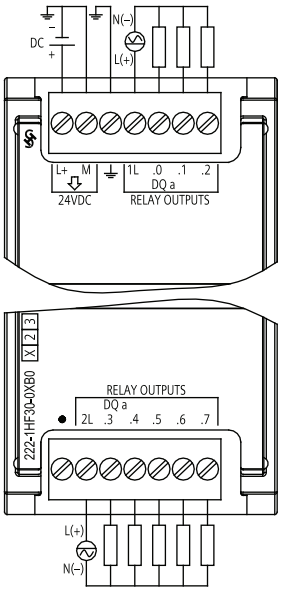
6ES7 221-1BH30-0XB0

A.3.2 SM 1222 Digital Output Specifications

Technical Specifications				
Model	**SM 1222 DQ 8xRelay**	**SM1222 DQ 16xRelay**	**SM1222 DQ 8x24VDC**	**SM1222 DQ 16x24VDC**
Order number (MLFB)	6ES7 222-1HF30-0XB0	6ES7 222-1HH30-0XB0	6ES7 222-1BF30-0XB0	6ES7 222-1BH30-0XB0
General				
Dimensions W x H x D (mm)	45 x 100 x 75			
Weight	190 grams	260 grams	180 grams	220 grams
Power dissipation	4.5 W	8.5 W	1.5 W	2.5 W
Current consumption (SM Bus)	120 mA	135 mA	120 mA	140 mA
Current consumption (24 VDC)	11 mA / Relay coil used		--	
Digital Outputs				
Number of outputs	8	16	8	16
Type	Relay, dry contact		Solid state - MOSFET	
Voltage range	5 to 30 VDC or 5 to 250 VAC		20.4 to 28.8 VDC	
Logic 1 signal at max. current	--		20 VDC min.	
Logic 0 signal with 10K Ω load	--		0.1 VDC max.	
Current (max.)	2.0 A		0.5 A	
Lamp load	30 W DC/200 W AC		5W	
On state contact resistance	0.2 Ω max. when new		0.6 Ω max.	
Leakage current per point	--		10 µA max.	
Surge current	7 A with contacts closed		8 A for 100 ms max.	
Overload protection	No			
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)		500 VAC for 1 minute	
Isolation resistance	100 MΩ min. when new		--	
Isolation between open contacts	750 VAC for 1 minute		--	
Isolation groups	2	4	1	1
Current per common (max.)	10 A		4 A	8 A
Inductive clamp voltage	--		L+ minus 48 V, 1 W dissipation	
Switching delay	10 ms max.		50 µs max. off to on 200 µs max. on to off	
Lifetime mechanical (no load)	10,000,000 open/close cycles		--	
Lifetime contacts at rated load	100,000 open/close cycles		--	
Behavior on RUN to STOP	Last value or substitute value (default value 0)			
Number of outputs on simultaneously	8	16	8	16
Cable length (meters)	500 shielded, 150 unshielded			

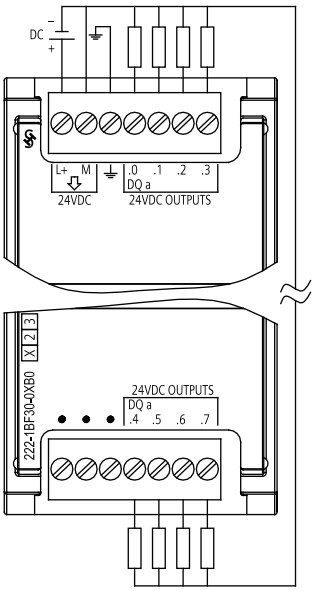
Wiring Diagrams

SM 1222 DQ 8 x Relay



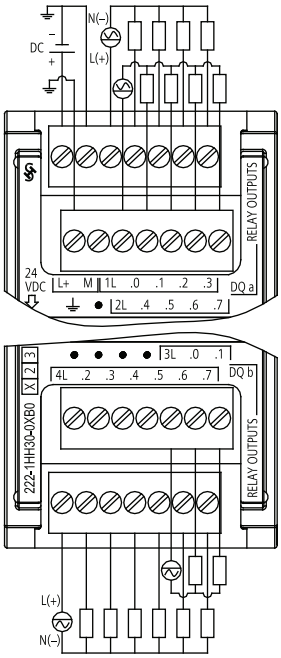
6ES7 222-1HF30-0XB0

SM 1222 DQ 8 x 24 VDC



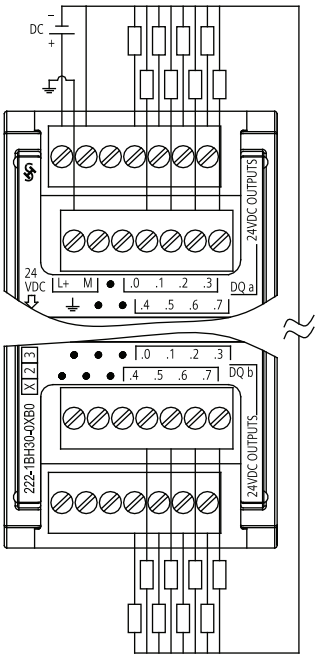
6ES7 222-1BF30-0XB0

SM 1222 DQ 16 x Relay



6ES7 222-1HH30-0XB0

SM 1222 DQ 16 x 24 VDC



6ES7 222-1BH30-0XB0

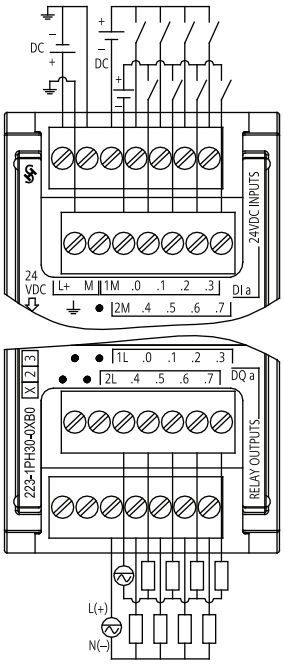
A.3.3 SM 1223 Digital Input/Output Specifications

Technical Specifications				
Model	**SM 1223 DI 8x24 VDC, DQ 8xRelay**	**SM 1223 DI 16x24 VDC, DQ 16xRelay**	**SM 1223 DI 8x24 VDC, DQ 8x24 VDC**	**SM 1223 DI 16x24 VDC, DQ16x24 VDC**
Order number (MLFB)	6ES7 223-1PH30-0XB0	6ES7 223-1PL30-0XB0	6ES7 223-1BH30-0XB0	6ES7 223-1BL30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	70 x 100 x 75	45 x 100 x 75	70 x 100 x 75
Weight	230 grams	350 grams	210 grams	310 grams
Power dissipation	5.5 W	10 W	2.5 W	4.5 W
Current consumption (SM Bus)	145 mA	180 mA	145 mA	185 mA
Current consumption (24 VDC)	4 mA / Input used 11 mA / Relay coil used		4 mA / Input used	
Digital Inputs				
Number of inputs	8	16	8	16
Type	Sink/Source (IEC Type 1 sink)			
Rated voltage	24 VDC at 4 mA, nominal			
Continuous permissible voltage	30 VDC max.			
Surge voltage	35 VDC for 0.5 sec.			
Logic 1 signal (min.)	15 VDC at 2.5 mA			
Logic 0 signal (max.)	5 VDC at 1 mA			
Isolation (field side to logic)	500 VAC for 1 minute			
Isolation groups	2	2	2	2
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms, selectable in groups of 4			
Number of inputs on simultaneously	8	16	8	16
Cable length (meters)	500 shielded, 300 unshielded			
Digital Outputs				
Number of outputs	8	16	8	16
Type	Relay, dry contact		Solid state - MOSFET	
Voltage range	5 to 30 VDC or 5 to 250 VAC		20.4 to 28.8 VDC	
Logic 1 signal at max. current	--		20 VDC, min.	
Logic 0 signal with 10 KΩ load	--		0.1 VDC, max.	
Current (max.)	2.0 A		0.5 A	
Lamp load	30 W DC / 200 W AC		5 W	
ON state contact resistance	0.2 Ω max. when new		0.6 Ω max.	
Leakage current per point	--		10 µA max.	
Surge current	7 A with contacts closed		8 A for 100 ms max.	
Overload protection	No			
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)		500 VAC for 1 minute	
Isolation resistance	100 MΩ min. when new		--	
Isolation between open contacts	750 VAC for 1 minute		--	

Technical Specifications				
Model	**SM 1223 DI 8x24 VDC, DQ 8xRelay**	**SM 1223 DI 16x24 VDC, DQ 16xRelay**	**SM 1223 DI 8x24 VDC, DQ 8x24 VDC**	**SM 1223 DI 16x24 VDC, DQ16x24 VDC**
Isolation groups	2	4	1	1
Current per common	10A	8 A	4 A	8 A
Inductive clamp voltage	--		L+ minus 48 V, 1 W dissipation	
Switching delay	10 ms max.		50 µs max. off to on 200 µs max. on to off	
Lifetime mechanical (no load)	10,000,000 open/close cycles		--	
Lifetime contacts at rated load	100,000 open/close cycles		--	
Behavior on RUN to STOP	Last value or substitute value (default value 0)			
Number of outputs on simultaneously	8	16	8	16
Cable length (meters)	500 shielded, 150 unshielded			

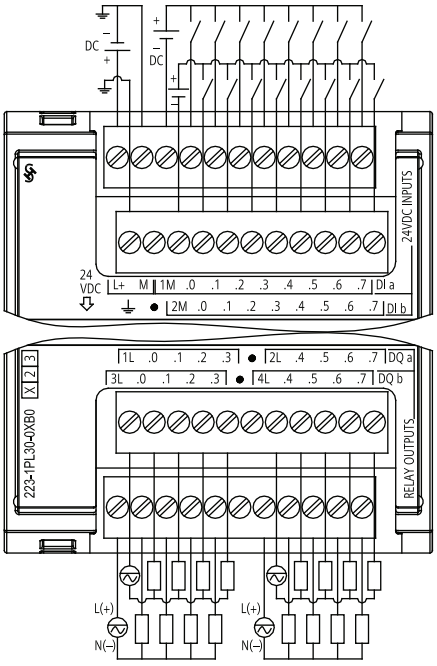
Wiring diagrams

SM 1223 DI 8 x 24 VDC, DQ 8 x Relay



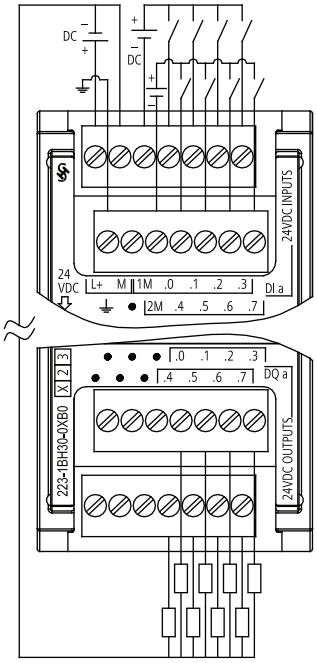
6ES7 223-1PH30-0XB0

SM1223 DI 16 x 24 VDC, DQ 16 x Relay



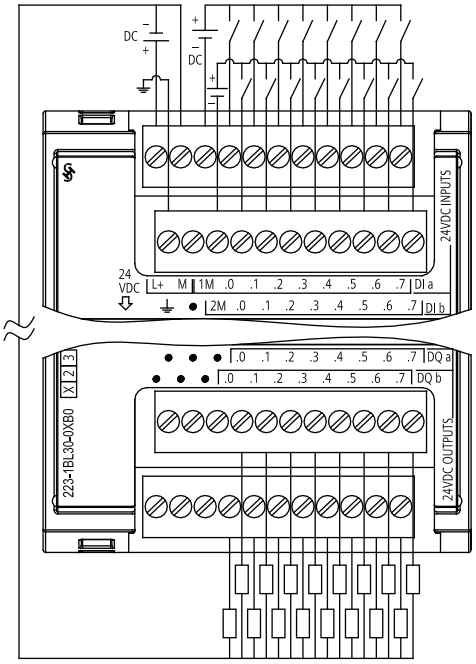
6ES7 223-1PL30-0XB0

SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC



6ES7 223-1BH30-0XB0

SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC



6ES7 223-1BL30-0XB0

A.4 Analog signal modules (SMs)

A.4.1 SM 1231, SM 1232, SM 1234 Analog Specifications

Technical Specifications			
Model	**SM 1231 AI 4x13bit**	**SM 1231 AI 8x13bit**	**SM 1234 AI 4x13bit AQ 2x14bit**
Order number (MLFB)	6ES7 231-4HD30-0XB0	6ES7 231-4HF30-0XB0	6ES7 234-4HE30-0XB0
General			
Dimensions W x H x D (mm)	45 x 100 x 75	45 x 100 x 75	45 x 100 x 75
Weight	180 grams	180 grams	220 grams
Power dissipation	1.5 W	1.5 W	2.0 W
Current consumption (SM Bus)	80 mA	90 mA	80 mA
Current consumption (24 VDC)	45 mA	45 mA	60 mA (no load)
Analog Inputs			
Number of inputs	4	8	4
Type	Voltage or Current (differential): Selectable in groups of 2		
Range	±10 V, ±5 V, ±2.5 V, or 0 to 20 mA		
Full scale range (data word)	-27,648 to 27,648		
Overshoot/undershoot range (data word)	Voltage: 32,511 to 27,649 / -27,649 to -32,512 Current: 32,511 to 27,649 / 0 to -4864 (Refer to Analog input representation for voltage, Analog input representation for current (Page 306))		
Overflow/underflow (data word)	Voltage: 32,767 to 32,512 / -32,513 to -32,768 Current: 32,767 to 32,512 / -4865 to -32,768 (Refer to Analog input representation for voltage, Analog input representation for current (Page 306))		
Resolution	12 bits + sign bit		
Maximum withstand voltage/current	±35 V / ±40 mA		
Smoothing	None, weak, medium, or strong (refer to Analog input response times (Page 306) for step response times)		
Noise rejection	400, 60, 50, or 10 Hz (refer to Analog input response times (Page 306) for sample rates)		
Impedance	≥ 9 MΩ (voltage) / 250 Ω (current)		
Isolation (field side to logic)	None		
Accuracy (25°C / 0 to 55°C)	±0.1% / ±0.2% of full scale		
Analog to digital conversion time	625 µs (400 Hz rejection)		
Common mode rejection	40 dB, DC to 60 Hz		
Operational signal range	Signal plus common mode voltage must be less than +12 V and greater than -12 V		
Cable length (meters)	100 meters, twisted and shielded		

Technical Specifications			
Model	**SM 1231 AI 4x13bit**	**SM 1231 AI 8x13bit**	**SM 1234 AI 4x13bit AQ 2x14bit**
Diagnostics			
Overflow/underflow	Yes[1]	Yes[1]	Yes[1]
Short to ground (voltage mode only)	Not applicable	Not applicable	Yes on outputs
Wire break (current mode only)	Not applicable	Not applicable	Yes on outputs
24 VDC low voltage	Yes	Yes	Yes

[1] If a voltage greater than +30 VDC or less than -15 VDC is applied to the input, the resulting value will be unknown and the corresponding overflow or underflow may not be active.

Technical Specifications			
Model	**SM 1232 AQ 2x14bit**	**SM 1232 AQ 4x14bit**	**SM 1234 AI 4x13bit AQ 2x14bit**
Order number (MLFB)	6ES7 232-4HB30-0XB0	6ES7 232-4HD30-0XB0	6ES7 234-4HE30-0XB0
General			
Dimensions W x H x D (mm)	45 x 100 x 75	45 x 100 x 75	45 x 100 x 75
Weight	180 grams	180 grams	220 grams
Power dissipation	1.5 W	1.5 W	2.0 W
Current consumption (SM Bus)	80 mA	80 mA	80 mA
Current consumption (24 VDC)	45 mA (no load)	45 mA (no load)	60 mA (no load)
Analog Outputs			
Number of outputs	2	4	2
Type	Voltage or current		
Range	±10 V or 0 to 20 mA		
Resolution	Voltage: 14 bits ; Current: 13 bits		
Full scale range (data word)	Voltage: -27,648 to 27,648 ; Current: 0 to 27,648 (Refer to Analog output representation for voltage and Analog output representation for current) (Page 306)		
Accuracy (25°C / 0 to 55°C)	±0.3% / ±0.6% of full scale		
Settling time (95% of new value)	Voltage: 300 µS (R), 750 µS (1 uF) ; Current: 600 µS (1 mH), 2 ms (10 mH)		
Load impedance	Voltage: ≥ 1000 Ω ; Current: ≤ 600 Ω		
Behavior on RUN to STOP	Last value or substitute value (default value 0)		
Isolation (field side to logic)	none		
Cable length (meters)	100 meters twisted and shielded		
Diagnostics			
Overflow/underflow	Yes	Yes	Yes[1]
Short to ground (voltage mode only)	Yes	Yes	Yes on outputs
Wire break (current mode only)	Yes	Yes	Yes on outputs
24 VDC low voltage	Yes	Yes	Yes

[1] If a voltage greater than +30 VDC or less than -15 VDC is applied to the input, the resulting value will be unknown and the corresponding overflow or underflow may not be active.

Analog input response time

SM Analog Modules Step Response (ms)				
0V to 10V measured at 95%				
Smoothing Selection	**Rejection Frequency**			
	400 Hz	**60 Hz**	**50 Hz**	**10 Hz**
None	4	18	22	100
Weak	9	52	63	320
Medium	32	203	241	1200
Strong	61	400	483	2410
Sample Rate				
• 4 channels • 8 channels	• 0.625 • 1.25	• 4.17 • 4.17	• 5 • 5	• 25 • 25

CPU Analog Input Step Response (ms)			
0V to 10V measured at 95%			
Smoothing Selection	**Rejection Frequency**		
	60 Hz	**50 Hz**	**10 Hz**
None	63	65	130
Weak	84	93	340
Medium	221	258	1210
Strong	424	499	2410
Sample Rate	**4.17**	**5**	**25**

Analog input representation for voltage

System	Voltage Measuring Range						
Decimal	**Hexadecimal**	**±10 V**	**±5 V**	**±2.5 V**		**0 to 10 V**	
32767	7FFF	11.851 V	5.926 V	2.963 V	Overflow	11.851V	Overflow
32512	7F00						
32511	7EFF	11.759 V	5.879 V	2.940 V	Overshoot range	11.759 V	Overshoot range
27649	6C01						
27648	6C00	10 V	5 V	2.5 V	Rated range	10 V	Rated range
20736	5100	7.5 V	3.75 V	1.875 V		7.5 V	
1	1	361.7 µV	180.8 µV	90.4 µV		361.7 µV	
0	0	0 V	0 V	0 V		0 V	
-1	FFFF					Negative values are not supported	
-20736	AF00	-7.5 V	-3.75 V	-1.875 V			
-27648	9400	-10 V	-5 V	-2.5 V			
-27649	93FF				Undershoot range		
-32512	8100	-11.759 V	-5.879 V	-2.940 V			
-32513	80FF				Underflow		
-32768	8000	-11.851 V	-5.926 V	-2.963 V			

Analog input representation for current

System	Current Measuring Range		
Decimal	**Hexadecimal**	**0 mA to 20 mA**	
32767	7FFF	23.70 mA	Overflow
32512	7F00		
32511	7EFF	23.52 mA	Overshoot range
27649	6C01		
27648	6C00	20 mA	Rated range
20736	5100	15 mA	
1	1	723.4 nA	
0	0	0 mA	
-1	FFFF		Undershoot range
-4864	ED00	-3.52 mA	
-4865	ECFF		Underflow
-32768	8000		

Analog output representation for voltage

System		Voltage Output Range	
Decimal	**Hexadecimal**	**± 10 V**	
32767	7FFF	See note 1	Overflow
32512	7F00	See note 1	
32511	7EFF	11.76 V	Overshoot range
27649	6C01		
27648	6C00	10 V	Rated range
20736	5100	7.5 V	
1	1	361.7 µ V	
0	0	0 V	
-1	FFFF	-361.7 µ V	
-20736	AF00	-7.5 V	
-27648	9400	-10 V	
-27649	93FF		Undershoot range
-32512	8100	-11.76 V	
-32513	80FF	See note 1	Underflow
-32768	8000	See note 1	

[1] . In an overflow or underflow condition, analog outputs will behave according to the device configuration properties set for the analog signal module. In the "Reaction to CPU STOP" parameter, select either: Use substitute value or Keep last value.

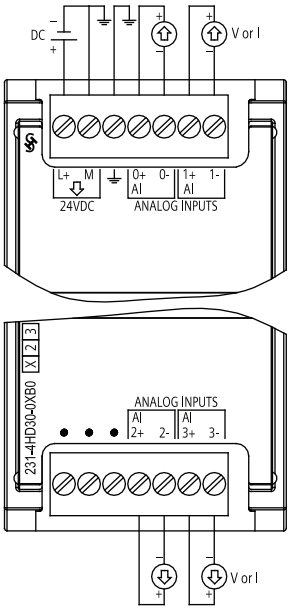
Analog output representation for current

System		Current Output Range	
Decimal	**Hexadecimal**	**± 20 mA**	
32767	7FFF	See note 1	Overflow
32512	7F00	See note 1	
32511	7EFF	23.52 mA	Overshoot range
27649	6C01		
27648	6C00	20 mA	Rated range
20736	5100	15 mA	
1	1	723.4 nA	
0	0	0 mA	
-1	FFFF		Undershoot range
-32512	8100		
-32513	80FF	See note 1	Underflow
-32768	8000	See note 1	

1. In an overflow or underflow condition, analog outputs will behave according to the device configuration properties set for the analog signal module. In the "Reaction to CPU STOP" parameter, select either: Use substitute value or Keep last value.

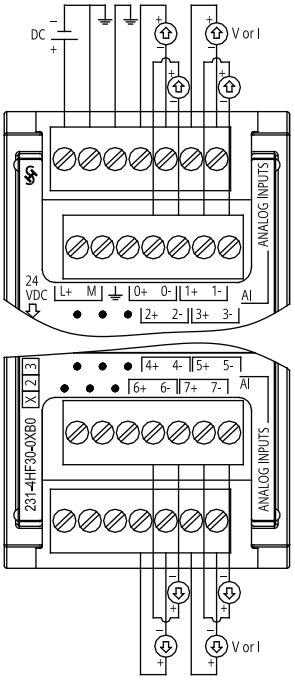
Wiring Diagrams

SM 1231 AI 4 x 13 bit



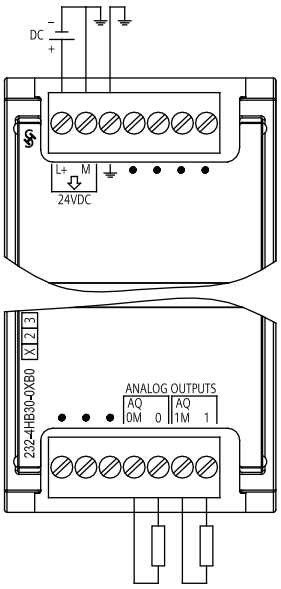
6ES7 231-4HD30-0XB0

SM 1231 AI 8 x 13 bit



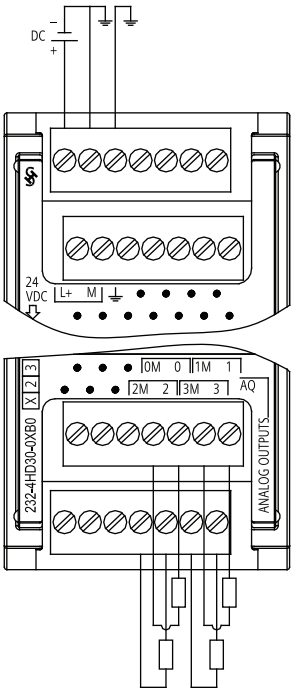
6ES7 231-4HF30-0XB0

SM 1232 AQ 2 x 14 bit



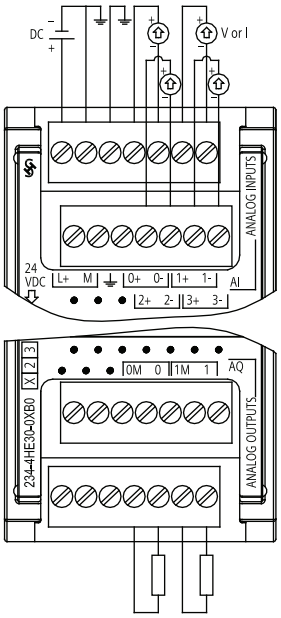
6ES7 232-4HB30-0XB0

SM 1232 AQ 4 x 14 bit



6ES7 232-4HD30-0XB0

SM 1234 AI 4 x 13 Bit / AQ 2 x 14 bit



6ES7 234-4HE30-0XB0

A.5 Signal boards (SBs)

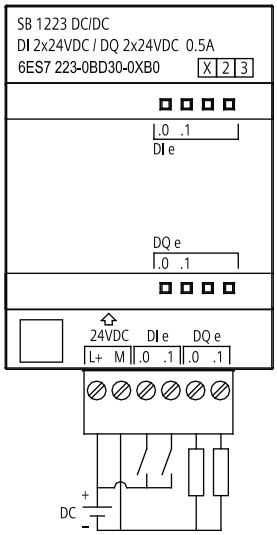
A.5.1 SB 1223 2 X 24 VDC Input / 2 X 24 VDC Output Specifications

Digital signal board specifications

Technical Data	
Model	**SB 1223 DI 2x24VDC, DQ 2x24VDC**
Order number (MLFB)	6ES7 223-0BD30-0XB0
General	
Dimensions W x H x D (mm)	38 x 62 x 21
Weight	40 grams
Power dissipation	1.0 W
Current consumption (SM Bus)	50 mA
Current consumption (24 VDC)	4 mA / Input used
Digital inputs	
Number of inputs	2
Type	IEC Type 1 sink
Rated voltage	24 VDC at 4 mA, nominal
Continuous permissible voltage	30 VDC, max.
Surge voltage	35 VDC for 0.5 sec.
Logic 1 signal (min.)	15 VDC at 2.5 mA
Logic 0 signal (max.)	5 VDC at 1 mA
HSC clock input rates (max.)	20 kHz (15 to 30 VDC) 30 kHz (15 to 26 VDC)
Isolation (field side to logic)	500 VAC for 1 minute
Isolation groups	1
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms Selectable in groups of 2
Number of inputs on simultaneously	2
Cable length (meters)	500 shielded, 300 unshielded
Digital Outputs	
Number of outputs	2
Output type	Solid state - MOSFET
Voltage range	20.4 to 28.8 VDC
Logic 1 signal at max. current	20 VDC min.
Logic 0 signal with 10K Ω load	0.1 VDC max.
Current (max.)	0.5 A
Lamp load	5 W
On state contact resistance	0.6 Ω max.
Leakage current per point	10 µA max.
Pulse Train Output rate	20 KHz max., 2 Hz min.

Technical Data	
Model	**SB 1223 DI 2x24VDC, DQ 2x24VDC**
Surge current	5 A for 100 ms max.
Overload protection	No
Isolation (field side to logic)	500 VAC for 1 minute
Isolation groups	1
Currents per common	1 A
Inductive clamp voltage	L+ minus 48 V, 1 W dissipation
Switching delay	2 µs max. off to on 10 µs max. on to off
Behavior on RUN to STOP	Last value or substitute value (default value 0)
Number of outputs on simultaneously	2
Cable length (meters)	500 shielded, 150 unshielded

SB 1223 2 x 24 VDC Input / 2 x 24 VDC Output wiring diagram

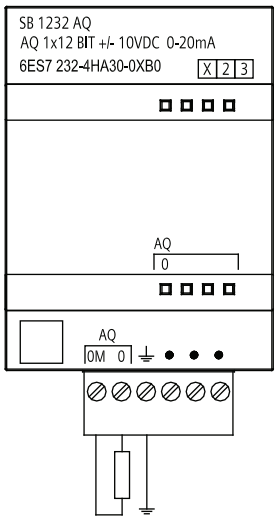


A.5.2 SB 1232 1 Analog Output Specifications

Analog signal board specifications

Technical Data	
Model	**SB 1223 AQ 1x12bit**
Order no. (MLFB)	6ES7 232-4HA30-0XB0
General	
Dimensions W x H x D (mm)	38 x 62 x 21 mm
Weight	40 grams
Power dissipation	1.5 W
Current consumption (SM Bus)	15 mA
Current consumption (24 VDC)	40 mA (no load)
Analog Outputs	
Number of outputs	1
Type	Voltage or current
Range	±10 V or 0 to 20 mA
Resolution	Voltage: 12 bits Current: 11 bits
Full scale range (data word)	Voltage: -27,648 to 27,648 Current: 0 to 27,648
Accuracy (25°C / 0 to 55°C)	±0.5% / ±1% of full scale
Settling time (95% of new value)	Voltage: 300 µS (R), 750 µS (1 uF) Current: 600 µS (1 mH), 2 ms (10 mH)
Load impedance	Voltage: ≥ 1000 Ω Current: ≤ 600 Ω
Behavior on RUN to STOP	Last value or substitute value (default value 0)
Isolation (field side to logic)	None
Cable length (meters)	100 meters, twisted and shielded
Diagnostics	
Overflow/underflow	Yes
Short to ground (voltage mode only)	Yes
Wire break (current mode only)	Yes

SB 1232 1 x Analog Output wiring diagram

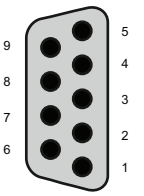


A.6 Communication modules (CMs)

A.6.1 CM 1241 RS485 Specifications

Table A- 1 Communication Module CM 1241 RS485

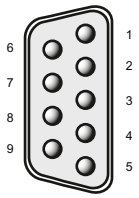
Technical Data	
Order no. (MLFB)	6ES7 241-1CH30-0XB0
Dimensions and weight	
Dimensions	30 x 100 x 75 mm
Weight	150 grams
Transmitter and Receiver	
Common mode voltage range	-7 V to +12 V, 1 second, 3 VRMS continuous
Transmitter differential output voltage	2 V min. at R_L = 100 Ω 1.5 V min. at R_L = 54 Ω
Termination and bias	10K Ω to +5 V on B, PROFIBUS Pin 3 10K Ω to GND on A, PROFIBUS Pin 8
Receiver input impedance	5.4K Ω min. including termination
Receiver threshold/sensitivity	+/- 0.2 V min., 60 mV typical hysteresis
Isolation RS485 signal to chassis ground RS485 signal to CPU logic common	500 VAC, 1 minute
Cable length, shielded	1000 m max.
Power supply specification	
Power loss (dissipation)	1.1 W
From +5 VDC	220 mA

Pin	Description	Connector (female)	Pin	Description
1 GND	Logic or communication ground		6 PWR	+5V with 100 ohm series resistor: Output
2	Not connected		7	Not connected
3 TxD+	Signal B (RxD/TxD+): Input/Output		8 TXD-	Signal A (RxD/TxD-): Input/Output
4 RTS	Request to send (TTL level): Output		9	Not connected
5 GND	Logic or communication ground		SHELL	Chassis ground

A.6.2 CM 1241 RS232 Specifications

Communication Module CM 1241 RS232

Technical Data	
Order no. (MLFB)	6ES7 241-1AH30-0XB0
Dimensions and weight	
Dimensions	30 x 100 x 75 mm
Weight	150 grams
Transmitter and Receiver	
Transmitter output voltage	+/- 5 V min. at R_L = 3K Ω
Transmit output voltage	+/- 15 VDC max.
Receiver input impedance	3 K Ω min.
Receiver threshold/sensitivity	0.8 V min. low, 2.4 max. high 0.5 V typical hysteresis
Receiver input voltage	+/- 30VDC max.
Isolation RS 232 signal to chassis ground RS 232 signal to CPU logic common	500 VAC, 1 minute
Cable length, shielded	10 m max.
Power supply specification	
Power loss (dissipation)	1.1 W
From +5 VDC	220 mA

Pin	Description	Connector (male)	Pin	Description
1 DCD	Data carrier detect: Input		6 DSR	Data set ready: Input
2 RxD	Received data from DCE: Input		7 RTS	Request to send: Output
3 TxD	Transmitted data to DCE: Output		8 CTS	Clear to send: Input
4 DTR	Data terminal ready: Output		9 RI	Ring indicator (not used)
5 GND	Logic ground		SHELL	Chassis ground

A.7 SIMATIC memory cards

Memory card specifications

Order Number	Capacity
6ES7 954-8LF00-0AA0	24 MB
6ES7 954-8LB00-0AA0	2 MB

A.8 Input simulators

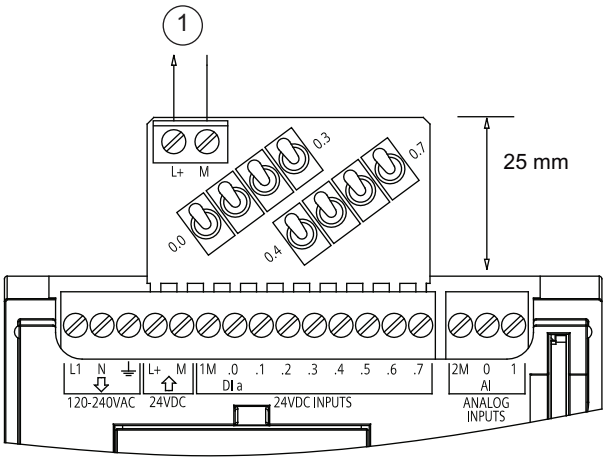
Model	8 Position Simulator	14 Position Simulator
Order number (MLFB)	6ES7 274-1XF30-0XA0	6ES7 274-1XH30-0XA0
Dimensions W x H x D (mm)	43 x 35 x 23	67 x 35 x 23
Weight	20 grams	30 grams
Points	8	14
Used with CPU	CPU 1211C, CPU 1212C	CPU 1214C

WARNING

These input simulators are not approved for use in Class I DIV 2 or Class I Zone 2 hazardous locations. The switches present a potential spark hazard/explosion hazard if used in a Class I DIV 2 or Class I Zone 2 location.

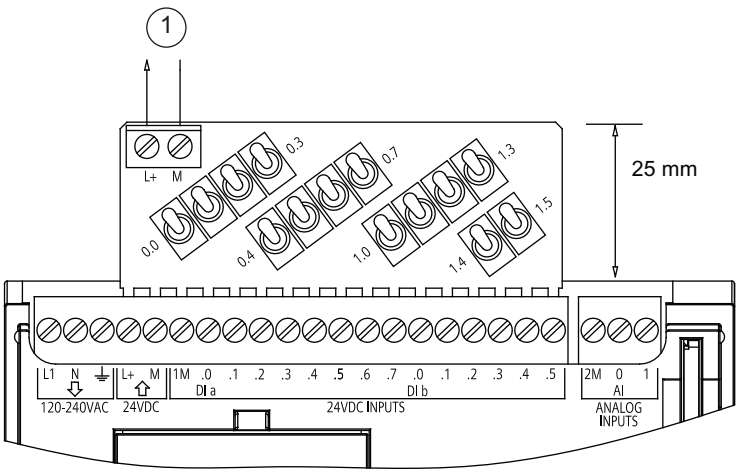
8 Position Simulator

① 24 VDC sensor power out



6ES7 274-1XF30-0XA0

14 Position Simulator



① 24 VDC sensor power out

6ES7 274-1XH30-0XA0

A.9 I/O expansion cable

Technical Data	
Order no (MLFB)	6ES7 290-6AA30-0XA0
Cable length	2 m
Weight	200 g

The I/O expansion cable has a male and female connector.

1. Connect the male connector to the bus connector on the right side of the signal module.
2. Connect the female connector to the bus connector on the left side of the signal module.
   - Slip the hook extension of the female connector into the housing at the bus connector
   - Push the female connector into the bus connector.

Calculating a power budget

B

The CPU has an internal power supply that provides power for the CPU itself, for any expansion modules, and for other 24 VDC user power requirements.

There are three types of expansion modules:

- Signal modules (SM) are installed on the right-side of the CPU. Each CPU allows a maximum number of signal modules possible without regard to the power budget.
  - CPU 1214 allows 8 signal modules
  - CPU 1212 allows 2 signal modules
  - CPU 1211 allows no signal modules
- Communication modules (CM) are installed on the left-side of the CPU. A maximum of 3 communication modules is allowed for any CPU without regard to the power budget.
- Signal boards (SB) are installed on top of the CPU. A maximum of 1 signal board is allowed for any CPU.

Use the following information as a guide for determining how much power (or current) the CPU can provide for your configuration.

Each CPU supplies both 5 VDC and 24 VDC power:

- The CPU provides 5 VDC power for the expansion modules when an expansion module is connected. If the 5 VDC power requirements for expansion modules exceed the power budget of the CPU, you must remove expansion modules until the requirement is within the power budget.
- Each CPU has a 24 VDC sensor supply that can supply 24 VDC for local input points or for relay coils on the expansion modules. If the power requirement for 24 VDC exceeds the power budget of the CPU, you can add an external 24 VDC power supply to provide 24 VDC to the expansion modules. You must manually connect the 24 VDC supply to the input points or relay coils.

⚠ WARNING

Connecting an external 24 VDC power supply in parallel with the DC sensor supply can result in a conflict between the two supplies as each seeks to establish its own preferred output voltage level.

The result of this conflict can be shortened lifetime or immediate failure of one or both power supplies, with consequent unpredictable operation of the PLC system. Unpredictable operation could result in death, severe personal injury and/or property damage.

The DC sensor supply on the CPU and any external power supply should provide power to different points. A single connection of the commons is allowed.

Some of the 24V power input ports in the PLC system are interconnected, with a logic common circuit connecting multiple M terminals. The CPU 24V power supply input, the SM relay coil power input, and a non-isolated analog power supply input are examples of circuits that are interconnected when designated as not isolated in the data sheets. All non-isolated M terminals must connect to the same external reference potential.

WARNING

Connecting non-isolated M terminals to different reference potentials will cause unintended current flows that may cause damage or unpredictable operation in the PLC and connected equipment.

Such damage or unpredictable operation could result in death, severe personal injury and/or property damage.

Always be sure that all non-isolated M terminals in a PLC system are connected to the same reference potential.

Information about the power budgets of the CPUs and the power requirements of the signal modules is provided in the technical specifications (Page 279).

Note

Exceeding the power budget of the CPU may result in not being able to connect the maximum number of modules allowed for your CPU.

B.2 Calculating a sample power requirement

The following example shows a sample calculation of the power requirements for a PLC that includes a CPU 1214C AC/DC/Relay, 3 x SM 1223 8 DC In/8 Relay Out, and 1 x SM 1221 8 DC In. This example has a total of 46 inputs and 34 outputs.

Note

The CPU has already allocated the power required to drive the internal relay coils. You do not need to include the internal relay coil power requirements in a power budget calculation.

The CPU in this example provides sufficient 5 VDC current for the SMs, but does not provide enough 24 VDC current from the sensor supply for all of the inputs and expansion relay coils. The I/O requires 448 mA and the CPU provides only 400 mA. This installation requires an additional source of at least 48 mA at 24 VDC power to operate all the included 24 VDC inputs and outputs.

CPU power budget	5 VDC	24 VDC
CPU 1214C AC/DC/Relay	1600 mA	400 mA
Minus		
System requirements	**5 VDC**	**24 VDC**
CPU 1214C, 14 inputs	-	14 * 4 mA = 56 mA
3 SM 1223, 5 V power	3 * 145 mA = 435 mA	-
1 SM 1221, 5 V power	1 * 105 mA = 105 mA	-
3 SM 1223, 8 inputs each	-	3 * 8 * 4 mA = 96 mA
3 SM 1223, 8 relay coils each	-	3 * 8 * 11 mA = 264 mA
1 SM 1221, 8 inputs	-	8 * 4 mA = 32 mA
Total requirements	540 mA	448 mA
Equals		
Current balance	**5 VDC**	**24 VDC**
Current balance total	1060 mA	(48 mA)

B.3 Calculating your power requirement

Use the following table to determine how much power (or current) the S7-1200 CPU can provide for your configuration. Refer to the technical specifications (Page 279) for the power budgets of your CPU model and the power requirements of your signal modules.

CPU power budget	5 VDC	24 VDC
Minus		
System requirements	**5 VDC**	**24 VDC**
Total requirements		
Equals		
Current balance	**5 VDC**	**24 VDC**
Current balance total		

Order numbers

C

CPUs		Order Number
CPU 1211C	CPU 1211C DC/DC/DC	6ES7 211-1AD30-0XB0
	CPU 1211C AC/DC/Relay	6ES7 211-1BD30-0XB0
	CPU 1211C DC/DC/Relay	6ES7 211-1HD30-0XB0
CPU 1212C	CPU 1212C DC/DC/DC	6ES7 212-1AD30-0XB0
	CPU 1212C AC/DC/Relay	6ES7 212-1BD30-0XB0
	CPU 1212C DC/DC/Relay	6ES7 212-1HD30-0XB0
CPU 1214C	CPU 1214C DC/DC/DC	6ES7 214-1AE30-0XB0
	CPU 1214C AC/DC/Relay	6ES7 214-1BE30-0XB0
	CPU 1214C DC/DC/Relay	6ES7 214-1HE30-0XB0

Signal modules, communication modules, and signal boards		Order Number
Signal modules	SM 1221 8 x 24 VDC Input	6ES7 221-1BF30-0XB0
	SM 1221 16 x 24 VDC Input	6ES7 221-1BH30-0XB0
	SM 1222 8 x 24 VDC Output	6ES7 222-1BF30-0XB0
	SM 1222 16 x 24 VDC Output	6ES7 222-1BH30-0XB0
	SM 1222 8 x Relay Output	6ES7 222-1HF30-0XB0
	SM 1222 16 x Relay Output	6ES7 222-1HH30-0XB0
	SM 1223 8 x 24 VDC Input / 8 x 24 VDC Output	6ES7 223-1BH30-0XB0
	SM 1223 16 x 24 VDC Input / 16 x 24 VDC Output	6ES7 223-1BL30-0XB0
	SM 1223 8 x 24 VDC Input / 8 x Relay Output	6ES7 223-1PH30-0XB0
	SM 1223 16 x 24 VDC Input / 16 x Relay Output	6ES7 223-1PL30-0XB0
	SM 1231 4 x Analog Input	6ES7 231-4HD30-0XB0
	SM 1231 8 x Analog Input	6ES7 231-4HF30-0XB0
	SM 1232 2 x Analog Output	6ES7 232-4HB30-0XB0
	SM 1232 4 x Analog Output	6ES7 232-4HD30-0XB0
	SM 1234 4 x Analog Input / 2 x Analog Output	6ES7 234-4HE30-0XB0
Communication modules	CM 1241 RS232	6ES7 241-1AH30-0XB0
	CM 1241 RS485	6ES7 241-1CH30-0XB0
Signal boards	SB 1223 2 x 24 VDC Input / 2 x 24 VDC Output	6ES7 223-0BD30-0XB0
	SB 1232 1 Analog Output	6ES7 232-4HA30-0XB0

HMI devices	Order Number
KTP400 Basic (Mono, PN)	6AV6 647-0AA11-3AX0
KTP600 Basic (Mono, PN)	6AV6 647-0AB11-3AX0
KTP600 Basic (Color, PN)	6AV6 647-0AD11-3AX0
KTP1000 Basic (Color, PN)	6AV6 647-0AF11-3AX0
TP1500 Basic (Color, PN)	6AV6 647-0AG11-3AX0

Programming package	Order Number
STEP 7 Basic v10.5	6ES7 822-0AA0-0YA0

Memory cards, other hardware, and spare parts		Order Number
Memory Cards	SIMATIC MC 2 MB	6ES7 954-8LB00-0AA0
	SIMATIC MC 24 MB	6ES7 954-8LF00-0AA0
Other hardware	PSU 1200 power supply	6EP1 332-1SH71
	CSM 1277 Ethernet switch - 4 ports	6GK7 277-1AA00-0AA0
	Simulator (1214C/1211C - 8 position)	6ES7 274-1XF30-0XA0
	Simulator (1214C - 14 position)	6ES7 274-1XH30-0XA0
	I/O Expansion cable, 2 m	6ES7 290-6AA30-0XA0
Spare Parts	Connector block, 7 terminal, Tin	6ES7 292-1AG30-0XA0
	Connector block, 8 terminal, Tin (4/pk)	6ES7 292-1AH30-0XA0
	Connector block, 11 terminal, Tin (4/pk)	6ES7 292-1AL30-0XA0
	Connector block, 12 terminal, Tin (4/pk)	6ES7 292-1AM30-0XA0
	Connector block, 14 terminal, Tin (4/pk)	6ES7 292-1AP30-0XA0
	Connector block, 20 terminal, Tin (4/pk)	6ES7 292-1AV30-0XA0
	Connector block, 3 terminal, Gold (4/pk)	6ES7 292-1BC0-0XA0
	Connector block, 6 terminal, Gold (4/pk)	6ES7 292-1BF30-0XA0
	Connector block, 7 terminal, Gold (4/pk)	6ES7 292-1BG30-0XA0
	Connector block, 11 terminal, Gold (4/pk)	6ES7 292-1BL30-0XA0

Documentation	Order Number
S7-1200 Programmable Controller System Manual	
• German	• 6ES7 298-8FA30-8AH0
• English	• 6ES7 298-8FA30-8BH0
• French	• 6ES7 298-8FA30-8CH0
• Spanish	• 6ES7 298-8FA30-8DH0
• Italian	• 6ES7 298-8FA30-8EH0
• Chinese	• 6ES7 298-8FA30-8KH0
S7-1200 Easy Book	
• German	• 6ES7 298-8FA30-8AQ0
• English	• 6ES7 298-8FA30-8BQ0
• French	• 6ES7 298-8FA30-8CQ0
• Spanish	• 6ES7 298-8FA30-8DQ0
• Italian	• 6ES7 298-8FA30-8EQ0
• Chinese	• 6ES7 298-8FA30-8KQ0

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