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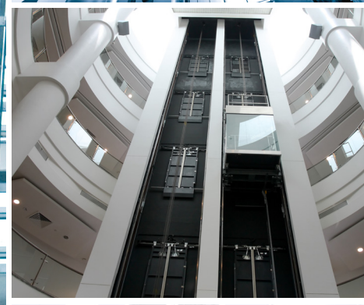
*We reserve the right to change the information in this manual without prior notice.


DELTA_IA_MDS_MH300-L_UM_EN_20210525


Delta High Performance Compact Drive - MH300-L Series (for Lift Application) User Manual



# Delta High Performance Compact Drive MH300-L Series (for Lift Application) User Manual

www.deltaww.com

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## *PLEASE READ PRIOR TO INSTALLATION FOR SAFETY.*

- ☑ Disconnect AC input power before connecting any wiring to AC motor drive.
- ☑ Even if the power has been turned off, a charge may still remain in the DC-link capacitors with hazardous voltages before the POWER LED is OFF. Do NOT touch the internal circuits and components.
- ☑ There are highly sensitive MOS components on the printed circuit boards. These components are especially sensitive to static electricity. Take anti-static measure before touching these components or the circuit boards.
- ☑ Never modify the internal components or wiring.
- ☑ Ground the AC motor drive by using the ground terminal. The grounding method must comply with the laws of the country where the AC motor drive is to be installed.
- ☑ Do NOT install the AC motor drive in a location with high temperature, direct sunlight or inflammable materials or gases.

- ☑ Never connect the AC motor drive output terminals U/T1, V/T2 and W/T3 directly to the AC mains circuit power supply.
- ☑ After finishing the wiring of the AC motor drive, check if U/T1, V/T2, and W/T3 are short-circuited to ground with a multimeter. Do NOT power the drive if short circuits occur. Eliminate the short circuits before the drive is powered.
- ☑ The rated voltage of power system to install motor drives is listed below. Ensure that the installation voltage is in the correct range when installing a motor drive.
  1. For 230V models, the range is between 170–264V.
  2. For 460V models, the range is between 323–528V.
- ☑ Refer to the table below for short circuit rating:

| Model (Power) | Short circuit rating |
|---|---|
| 230V | 5 kA |
| 460V | 5 kA |

- ☑ Only qualified persons are allowed to install, wire and maintain the AC motor drives.
- ☑ Even if the three-phase AC motor is stopped, a charge with hazardous voltages may still remain in the main circuit terminals of the AC motor drive.
- ☑ The performance of electrolytic capacitor will degrade if it is not charged for a long time. It is recommended to charge the drive which is stored in no charge condition every 2 years for 3–4 hours to restore the performance of electrolytic capacitor in the motor drive. Note: When power up the motor drive, use adjustable AC power source (e.g. AC autotransformer) to charge the drive at 70%–80% of rated voltage for 30 minutes (do not run the motor drive). Then charge the drive at 100% of rated voltage for an hour (do not run the motor drive). By doing these, restore the performance of electrolytic capacitor before starting to run the motor drive. Do NOT run the motor drive at 100% rated voltage right away.
- ☑ Pay attention to the following precautions when transporting and installing this package (including wooden crate and wood stave)
  1. If you need to deworm the wooden crate, do NOT use fumigation or you will damage the drive. Any damage to the drive caused by using fumigation voids the warranty.
  2. Use other methods, such as heat treatment or any other non-fumigation treatment, to deworm the wood packaging material.
  3. If you use heat treatment to deworm, leave the packaging materials in an environment of over 56°C for a minimum of thirty minutes.
- ☑ Connect the drive to a three-phase three-wire or three-phase four-wire Wye system to comply with UL standards.

| | |
|---|---|
| | ☑ If the motor drive generates leakage current over AC 3.5 mA or over DC 10 mA on a grounding conductor, compliance with local grounding regulations or IEC61800-5-1 standard is the minimum requirement for grounding. |

NOTE

The content of this manual may be revised without prior notice. Please consult our distributors or download the latest version at http://www.deltaww.com/iadownload_acmotordrive

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**Issued Edition: 01**
**Firmware Version: V1.02**
**(Refer to Parameter 00-06 on the product to get the firmware version.)**
**Issued Date: May, 2021**

# Chapter 1 Introduction

1-1 Nameplate Information

1-2 Model Name

1-3 Serial Number

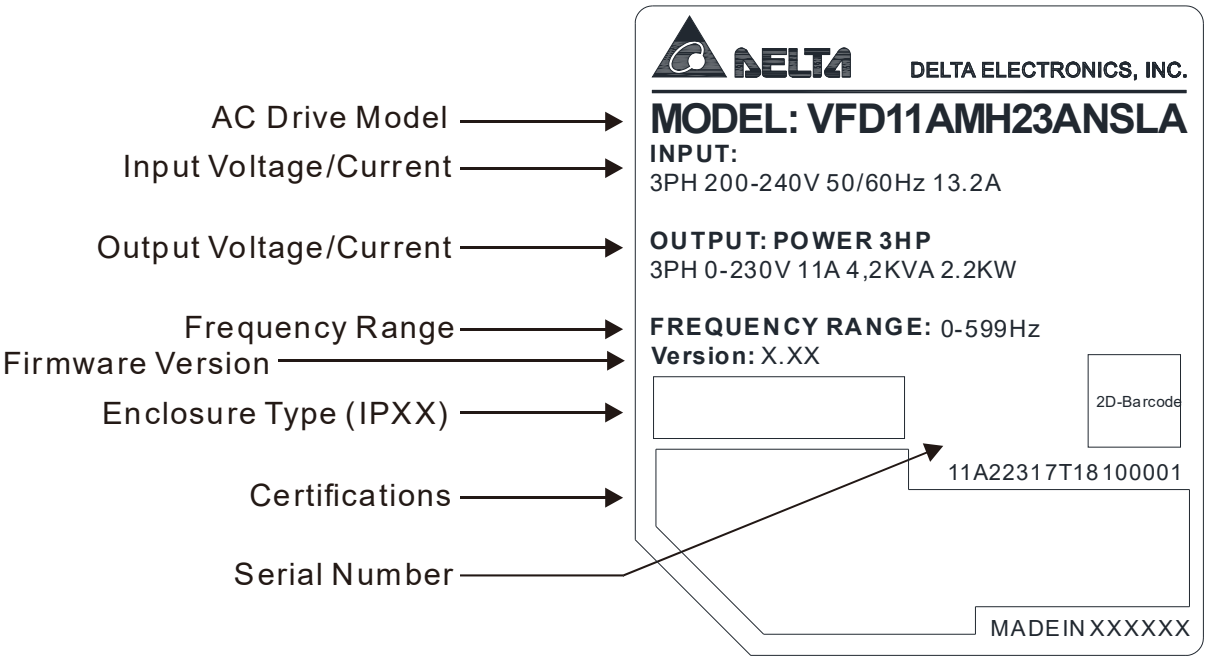
1-4 Apply After Service by Mobile Device

1-5 RFI Jumper

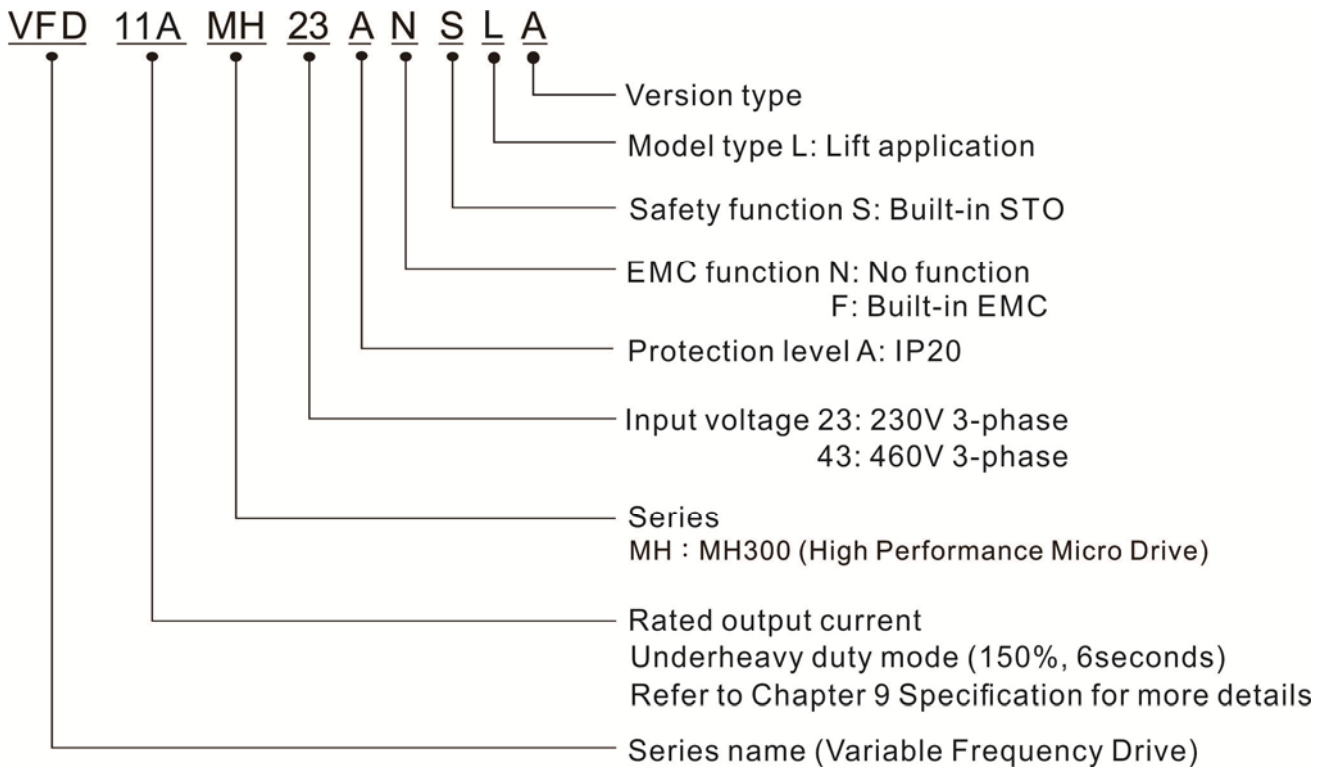
After receiving the AC motor drive, check for the following. Inspect the unit after unpacking to ensure that it was not damaged during shipment. Make sure that the part number printed on the package matches the part number indicated on the nameplate.

1. Make sure that the mains voltage is within the range indicated on the nameplate. Install the AC motor drive according to the instructions in this manual.
2. Before applying power, make sure that all devices, including mains power, motor, control board, and digital keypad are connected correctly.
3. When wiring the AC motor drive, make sure that the wiring for the input terminals “R/L1, S/L2, T/L3”, and the output terminals "U/T1, V/T2, W/T3” are correct to prevent damage to the drive.
4. When power is applied, use the digital keypad (KPMH-LC01) to select the language and set parameters. When executing a trial run, begin with a low speed and then gradually increase the speed to the desired speed.

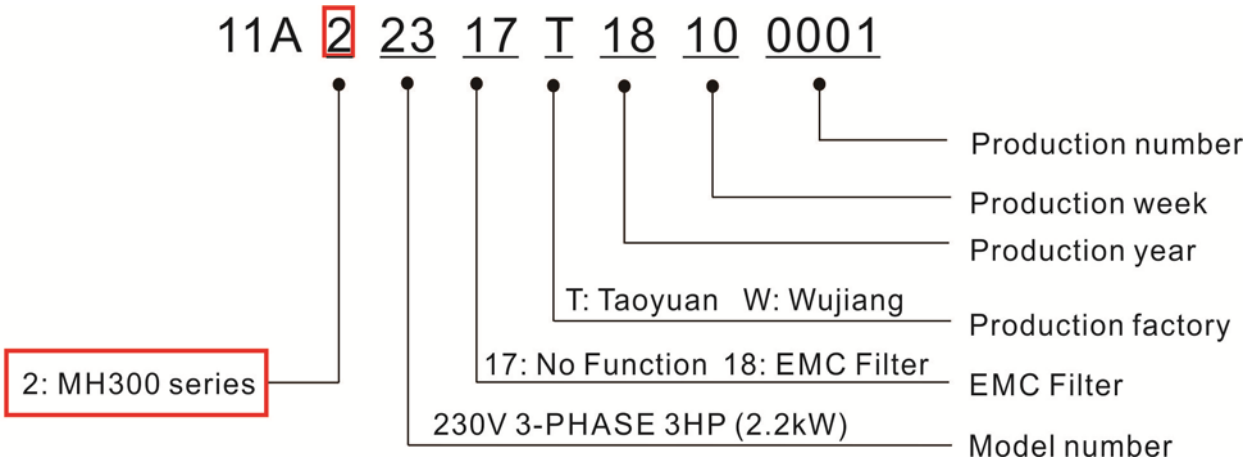
## 1-1 Nameplate Information



## 1-2 Model Name




## 1-3 Serial Number

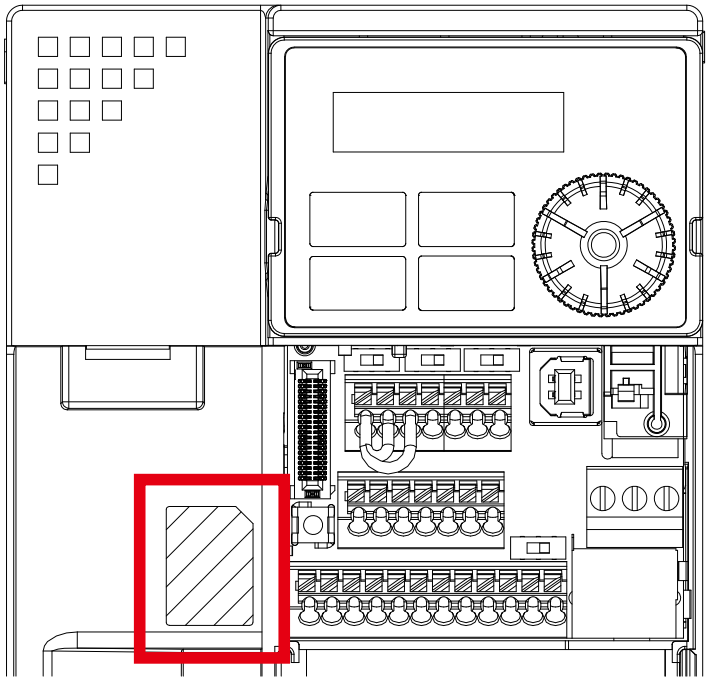


# 1-4 Apply After Service by Mobile Device

## 1-4-1 Location of Service Link Label

### Frame C–F

Service link label (Service Label) will be pasted on the area as below drawing shown.



## 1-4-2 Service Link Label

← QR code
http://service.deltaww.com/ia/repair?sn=serial number

← Serial number

← Web address of after-sales service

Scan QR Code to apply

1. Find out the QR code sticker (as above shown).
2. Use a Smartphone to run a QR Code reader APP.
3. Point your camera to the QR Code. Hold your camera steady so that the QR code comes into focus.
4. Access the Delta After Service website.
5. Fill your information into the column marked with an orange star.
6. Enter the CAPTCHA and click “Submit” to complete the application.

Cannot find QR Code?

1. Open a web browser on your computer or smart phone.
2. Key in https://service.deltaww.com/ia/repair in address bar and press enter.
3. Fill your information into the columns marked with an orange star.
4. Enter the CAPTCHA and click “Submit” to complete the application.

## 1-5 RFI Jumper

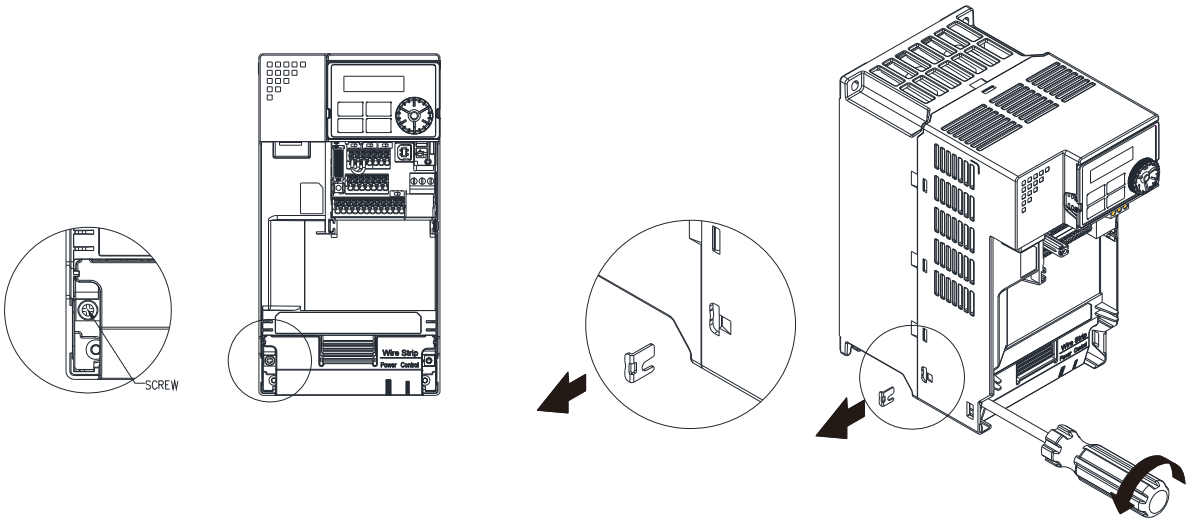
The drive contains Varistors/MOVs that are connected from phase to phase and from phase to ground to protect the drive against mains surges or voltage spikes.
Because the Varistors/MOVs from phase to ground are connected to ground with the RFI jumper, removing the RFI jumper disables the protection.

(1) In models with a built-in EMC filter, the RFI jumper connects the filter capacitors to ground to form a return path for high frequency noise in order to isolate the noise from contaminating the mains power. Removing the RFI jumper strongly reduces the effect of the built-in EMC filter.

(2) Although a single drive complies with the international standards for leakage current, an installation with several drives with built-in EMC filters can trigger the RCD. Removing the RFI jumper can help, but the EMC performance of each drive is no longer guaranteed.

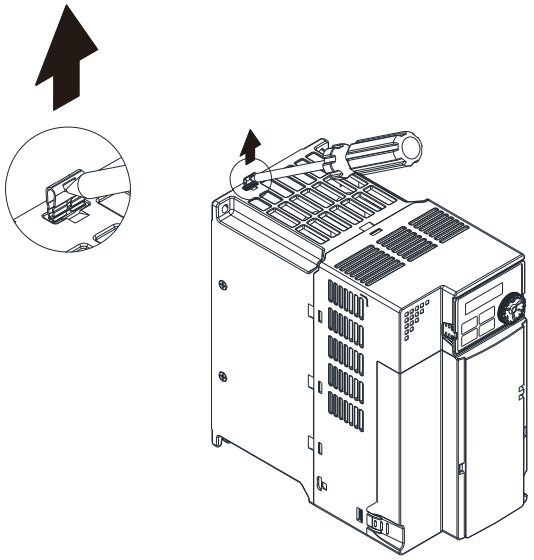
Frame C–F Screw Torque: 4–6 kg-cm / [3.5–5.2 lb-in.] / [0.39–0.59 Nm]

Loosen the screw and remove the RFI jumper (as shown below). Fasten the screw again after you remove the RFI jumper.




Frame C–F (model with built-in EMC filter)

Remove the RFI jumper with a screwdriver (as shown below).

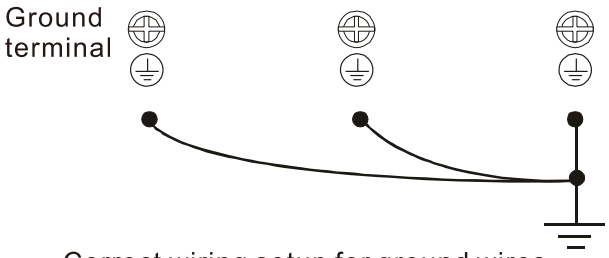


Isolating main power from ground:

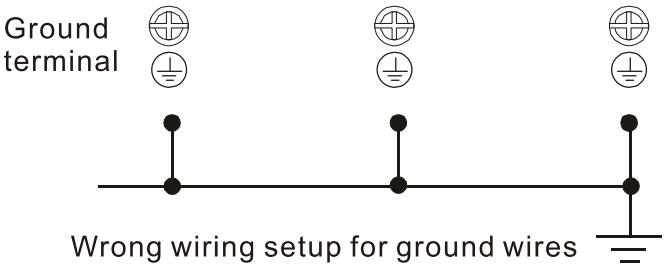
When the power distribution system of the drive is a floating ground system (IT Systems) or an asymmetric ground system (Corner Grounded TN Systems), you must remove the RFI jumper. Removing the RFI jumper disconnects the internal capacitors from ground to avoid damaging the internal circuits and to reduce the ground leakage current.

Important points regarding ground connection

- ☑ To ensure the safety of personnel, proper operation, and to reduce electromagnetic radiation, you must properly ground the drive during installation.
- ☑ The diameter of the cables must comply with the local safety regulations.
- ☑ The shield of shielded cables must be connected to the ground of the drive to meet safety regulations.
- ☑ The shield of shielded power cables can only be used as the ground for equipment when the aforementioned points are met.
- ☑ When installing more drives, do not connect the grounds of the drives in series but connect each drive to ground. The following pictures show the correct and wrong ways to connect the grounds.




Correct wiring setup for ground wires




Wrong wiring setup for ground wires

Pay particular attention to the following points:

- ☑ Do not remove the RFI jumper while the power is on.
- ☑ Removing the RFI jumper also disconnects the built-in EMC filter capacitors. Compliance with the EMC specifications is no longer guaranteed.
- ☑ Do not remove the RFI jumper if the mains power is a symmetrical grounded power system in order to maintain the efficiency for EMC circuit.
- ☑ Do not remove the RFI jumper while conducting high voltage tests. When conducting a high voltage test to the entire facility, you must disconnect the mains power and the motor if the leakage current is too high.

Floating Ground System (IT Systems)

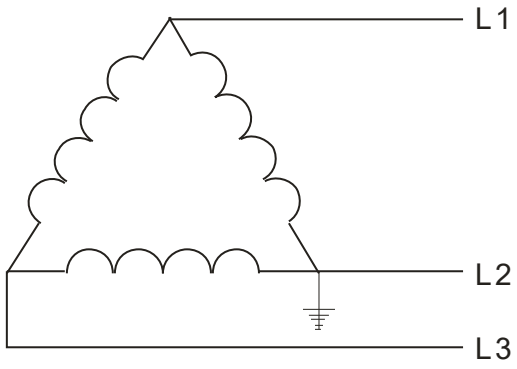
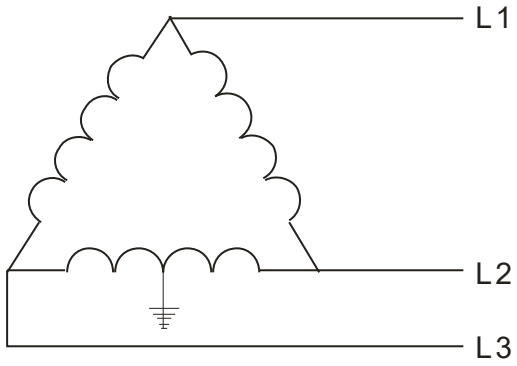
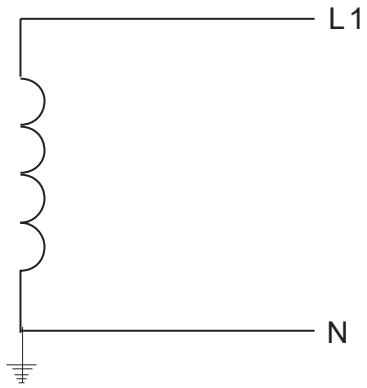
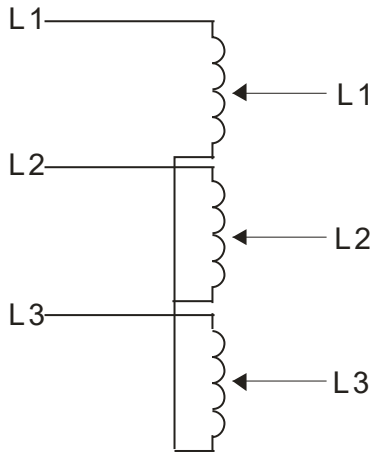
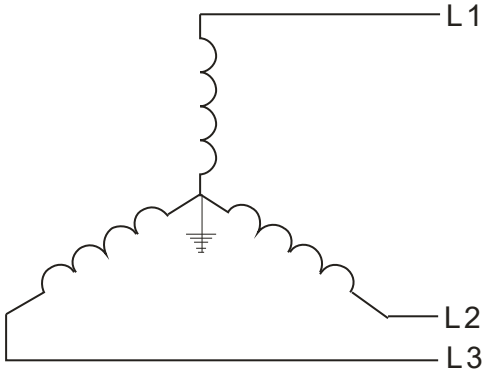
A floating ground system is also called an IT system, an ungrounded system, or a high impedance/resistance (greater than 30 Ω) grounded system.

- ☑ Disconnect the RFI jumper.
- ☑ Check whether there is excess electromagnetic radiation affecting nearby low-voltage circuits.
- ☑ In some situations, the transformer and cable naturally provide enough suppression. If in doubt, install an extra electrostatic shielded cable on the power supply side between the main circuit and the control terminals to increase suppression.
- ☑ Do not install an external EMC filter. The EMC filter is connected to ground through the filter capacitors, thus connecting the power input to ground. This is very dangerous and can easily damage the drive.

Asymmetric Ground System (Corner Grounded TN Systems)

**Caution:** Do not remove the RFI jumper while there is power to the input terminal of the drive.

In the following four situations, you must remove the RFI jumper. This is to prevent the system from grounding through the RFI and filter capacitors and damaging the drive.

<table>
<tr><th colspan="2">You must remove the RFI jumper</th></tr>
<tr><td>1. Grounding at a corner in a triangle configuration<br> 
</td><td>2. Grounding at a midpoint in a polygonal configuration<br> 
</td></tr>
<tr><td>3. Grounding at one end in a single-phase configuration<br> 
</td><td>4. No stable neutral grounding in a three-phase autotransformer configuration<br> 
</td></tr>
<tr><th colspan="2">You can use the RFI jumper</th></tr>
<tr><td colspan="2">Internal grounding through RFI capacitors, which reduces electromagnetic radiation. In a symmetrically grounding power system with higher EMC requirements, you can install an EMC filter. As a reference, the diagram on the right is a symmetrical grounding power system.<br> 
</td></tr>
</table>

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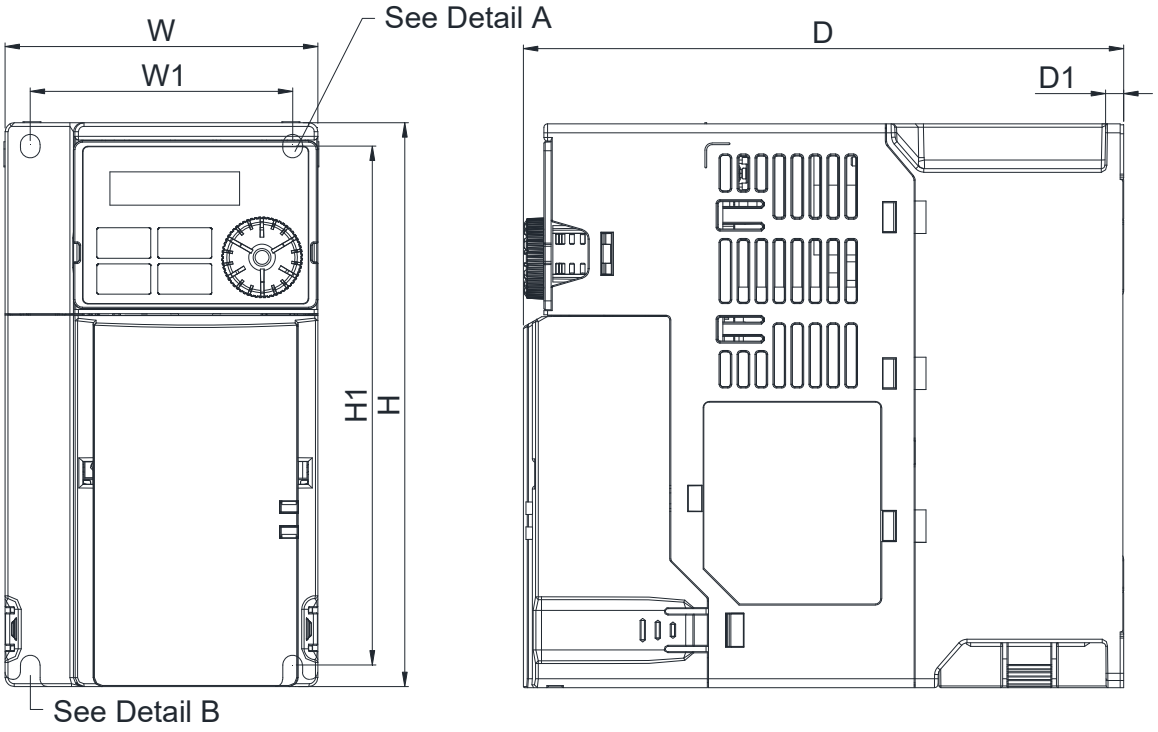
# Chapter 2 Dimension

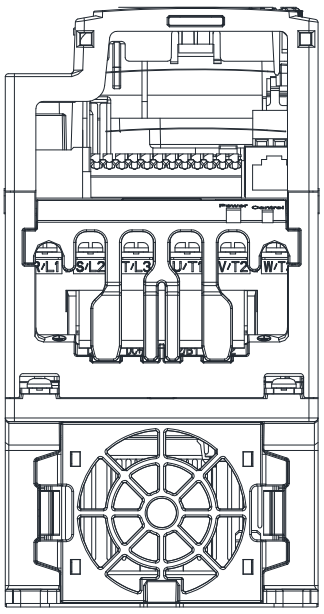
## Frame C

C1: VFD11AMH23ANSLA; VFD17AMH23ANSLA; VFD9A0MH43ANSLA;
C2: VFD9A0MH43AFSLA;

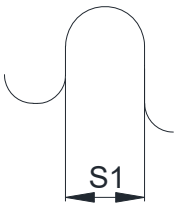
Unit: mm [inch]

| Frame | W | H | D | W1 | H1 | D1 | S1 |
|---|---|---|---|---|---|---|---|
| C1 | 87.0 [3.43] | 157.0 [6.18] | 167.0 [6.57] | 73.0 [2.87] | 144.5 [5.69] | 5.0 [0.20] | 5.5 [0.22] |
| C2 | 87.0 [3.43] | 157.0 [6.18] | 194.0 [7.64] | 73.0 [2.87] | 144.5 [5.69] | 5.0 [0.20] | 5.5 [0.22] |




Detail A (Mounting Hole)




Detail B (Mounting Hole)

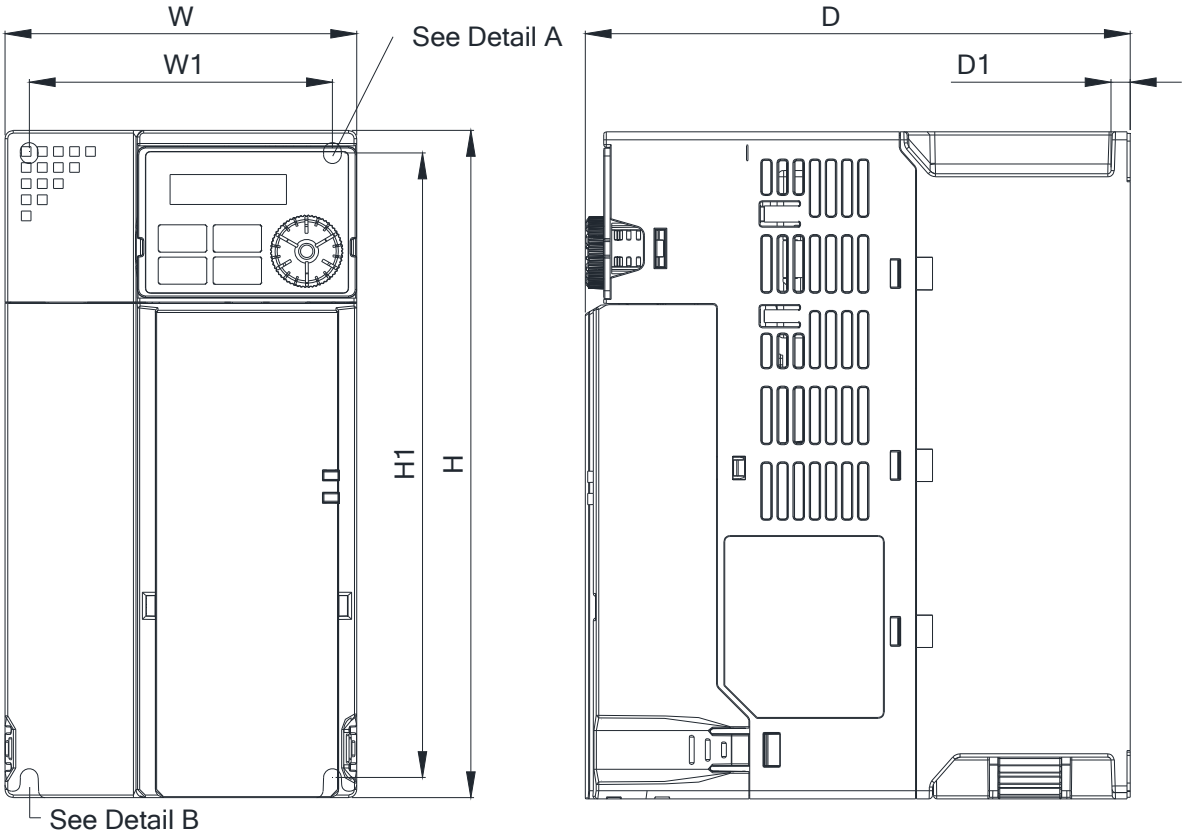
## Frame D

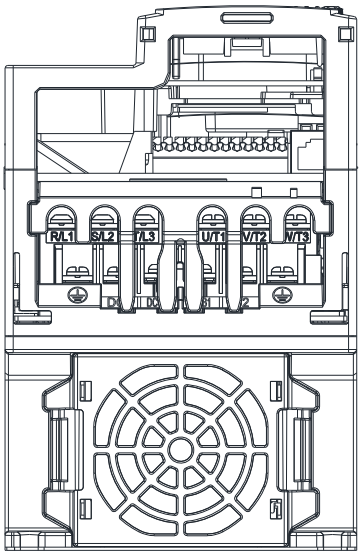
D1: VFD25AMH23ANSLA; VFD13AMH43ANSLA; VFD17AMH43ANSLA;

D2: VFD13AMH43AFSLA; VFD17AMH43AFSLA;

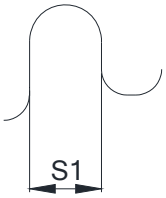
Unit: mm [inch]

| Frame | W | H | D | W1 | H1 | D1 | S1 |
|---|---|---|---|---|---|---|---|
| D1 | 109.0 [4.29] | 207.0 [8.15] | 169.0 [6.65] | 94.0 [3.70] | 193.8 [7.63] | 6.0 [0.24] | 5.5 [0.22] |
| D2 | 109.0 [4.29] | 207.0 [8.15] | 202.0 [7.95] | 94.0 [3.70] | 193.8 [7.63] | 6.0 [0.24] | 5.5 [0.22] |




Detail A (Mounting Hole)




Detail B (Mounting Hole)

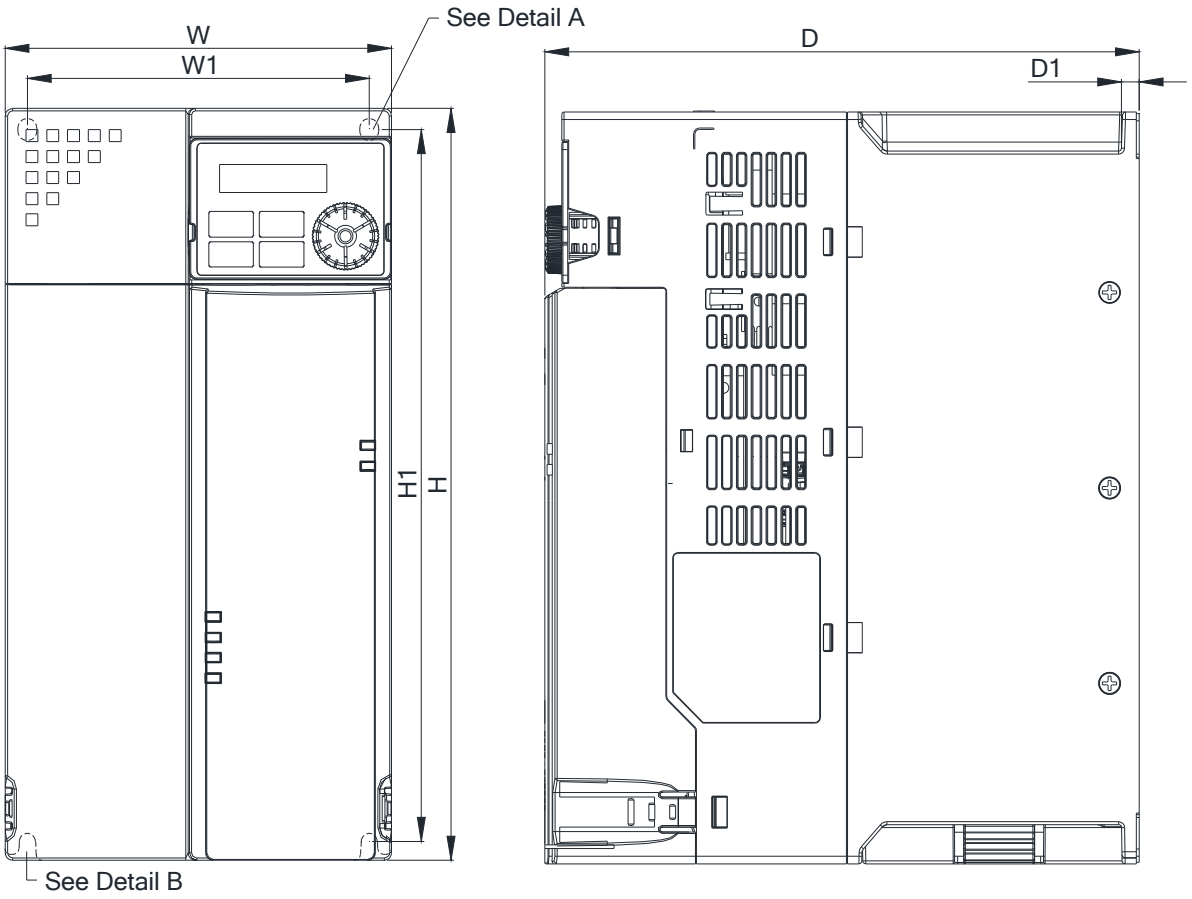
## Frame E

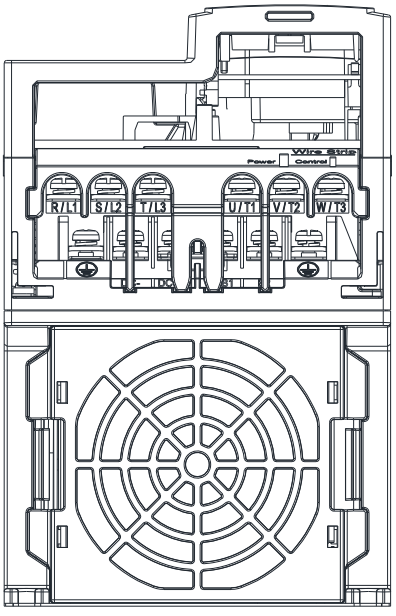
E1: VFD33AMH23ANSLA; VFD49AMH23ANSLA; VFD25AMH43ANSLA; VFD32AMH43ANSLA;

E2: VFD25AMH43AFSLA; VFD32AMH43AFSLA;

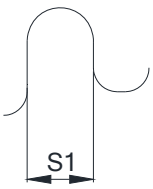
Unit: mm [inch]

| Frame | W | H | D | W1 | H1 | D1 | S1 |
|---|---|---|---|---|---|---|---|
| E1 | 130.0 [5.12] | 250.0 [9.84] | 200.0 [7.87] | 115.0 [4.53] | 236.8 [9.32] | 6.0 [0.24] | 5.5 [0.22] |
| E2 | 130.0 [5.12] | 250.0 [9.84] | 234.0 [9.21] | 115.0 [4.53] | 236.8 [9.32] | 6.0 [0.24] | 5.5 [0.22] |




Detail A (Mounting Hole)



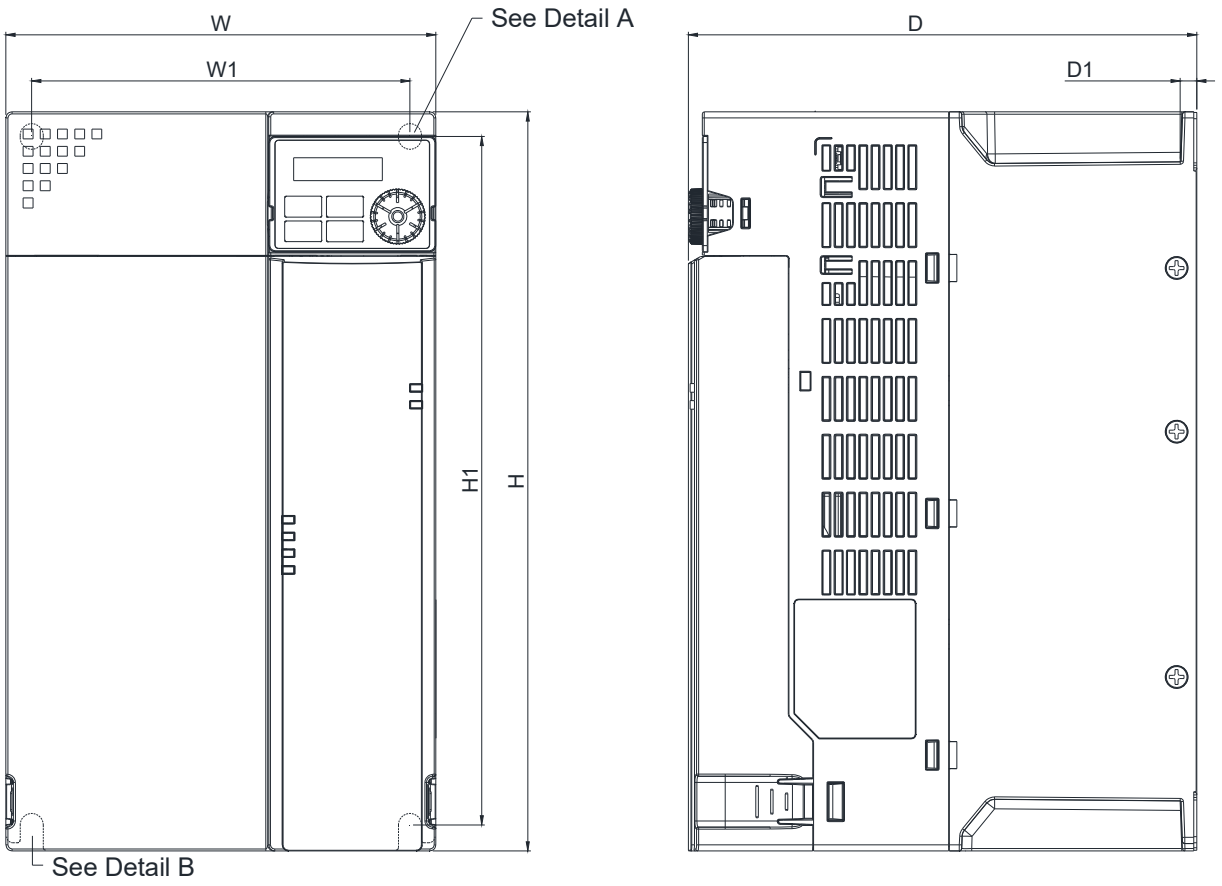

Detail B (Mounting Hole)

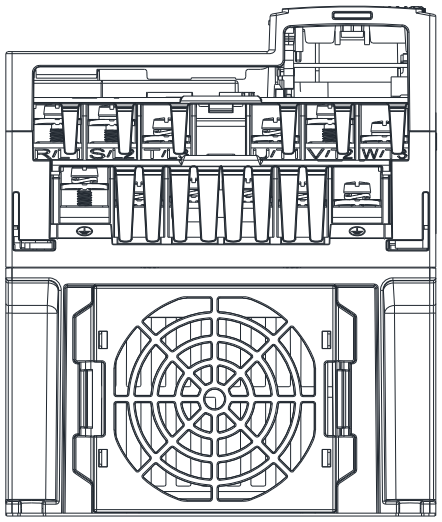
## Frame F

F1: VFD65AMH23ANSLA

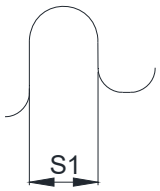
Unit: mm [inch]

| Frame | W | H | D | W1 | H1 | D1 | S1 |
|---|---|---|---|---|---|---|---|
| F1 | 175.0 [6.89] | 300.0 [11.81] | 207.0 [8.15] | 154.0 [6.06] | 279.5 [11.00] | 6.5 [0.26] | 8.4 [0.33] |




Detail A (Mounting Hole)




Detail B (Mounting Hole)

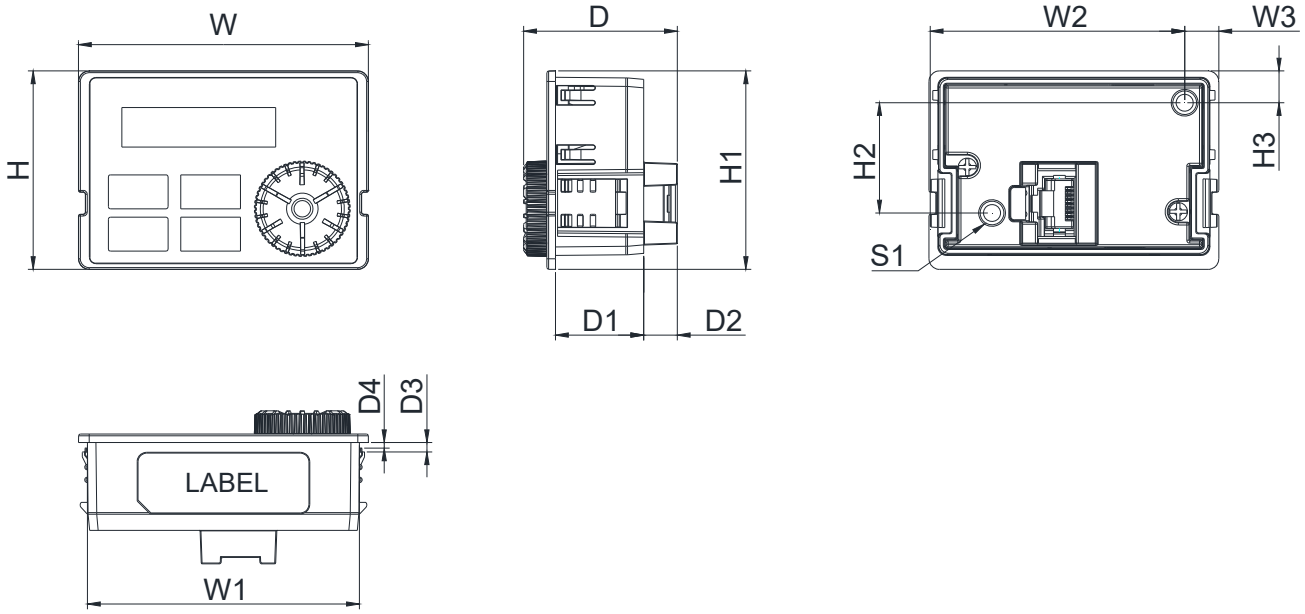
## Digital Keypad

KPMH-LC01

Unit: mm [inch]

| W | W1 | W2 | W3 | H | H1 | H2 |
|---|---|---|---|---|---|---|
| 68.0 [2.67] | 63.8 [2.51] | 45.2 [1.78] | 8.0 [0.31] | 46.8 [1.84] | 42.0 [1.65] | 26.0 [1.02] |

| H3 | D | D1 | D2 | D3 | D4 | S1 |
|---|---|---|---|---|---|---|
| 7.5 [0.30] | 36.1 [1.41] | 22.7 [0.89] | 7.9 [0.30] | 2.2 [0.09] | 1.3 [0.05] | M3*0.5(2X) |



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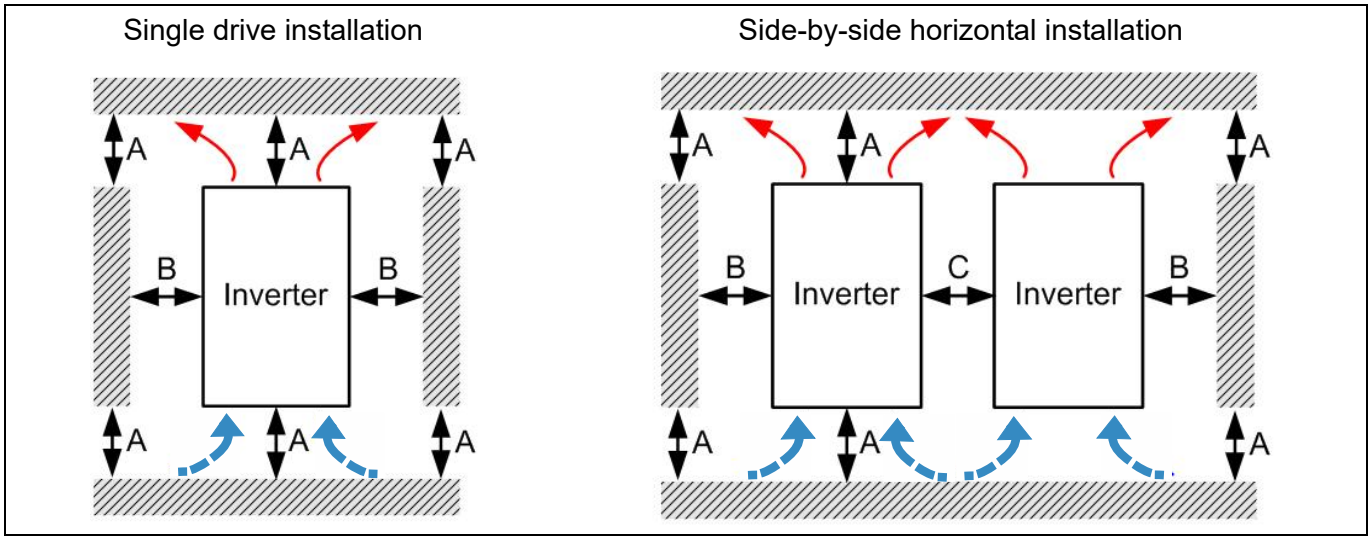
# Chapter 3 Installation

## Minimum Mounting Clearance and Installation

- ☑ Prevent fiber particles, scraps of paper, shredded wood, sawdust, metal particles, etc. from adhering to the heat sink.
- ☑ Install the AC motor drive in a metal cabinet. When installing one drive below another one, use a metal separator between the AC motor drives to prevent mutual heating and to prevent the risk of accidental fire.
- ☑ Install the AC motor drive in Pollution Degree 2 environments only: normally only non-conductive pollution occurs and temporary conductivity caused by condensation is expected.
- ☑ Mount the drive in an IP54 cabinet in order to maintain the Pollution Degree 2 or in a pollution-controlled environment.

The following figures are for reference only.

Airflow direction: inflow outflow distance



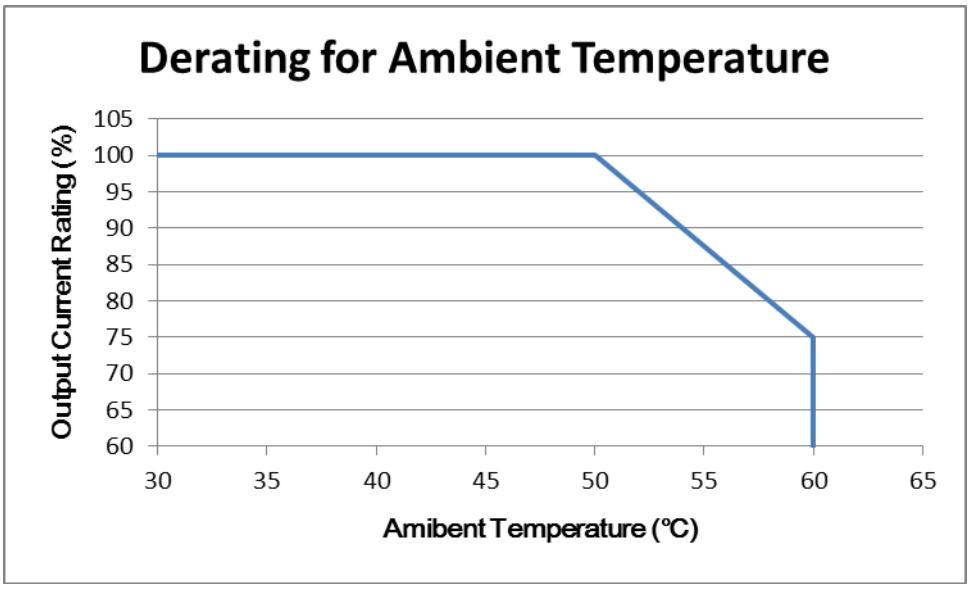

## Minimum mounting clearance

| Installation method | A (mm) | B (mm) | C (mm) | Ambient temperature (°C) | |
|---|---|---|---|---|---|
| | | | | Max. (Without derating) | Max. (Derating) |
| Single drive installation | 50 | 30 | - | 50 | 60 |
| Side-by-side horizontal installation | 50 | 30 | 30 | 50 | 60 |
| Zero stack installation | 50 | 30 | 0 | 40 | 50 |

NOTE

The minimum mounting clearances A–C in the table above apply to AC motor drives installation. Failing to follow the minimum mounting clearances may cause the fan to malfunction and cause heat dissipation problems.

| Frame | Airflow rate for cooling | | | Power Dissipation | | |
|---|---|---|---|---|---|---|
| | Model No. | Flow Rate (Unit: cfm) | Flow Rate (Unit: $m^3$ / hr) | Loss External (Heat sink, unit: W) | Internal (Unit: W) | Total (Unit: W) |
| C | VFD11AMH23ANSLA | 16.0 | 27.2 | 76.0 | 30.7 | 106.7 |
| | VFD17AMH23ANSLA | | | 108.2 | 40.1 | 148.3 |
| | VFD9A0MH43ANSLA<br>VFD9A0MH43AFSLA | | | 93.1 | 42 | 135.1 |
| D | VFD25AMH23ANSLA | 23.4 | 39.7 | 192.8 | 53.3 | 246.1 |
| | VFD13AMH43ANSLA<br>VFD13AMH43AFSLA | | | 132.8 | 39.5 | 172.3 |
| | VFD17AMH43ANSLA<br>VFD17AMH43AFSLA | | | 164.7 | 55.8 | 220.5 |
| E | VFD33AMH23ANSLA | 53.7 | 91.2 | 244.5 | 79.6 | 324.1 |
| | VFD49AMH23ANSLA | | | 374.2 | 86.2 | 460.4 |
| | VFD25AMH43ANSLA<br>VFD25AMH43AFSLA | | | 234.5 | 69.8 | 304.3 |
| | VFD32AMH43ANSLA<br>VFD32AMH43AFSLA | | | 319.8 | 74.3 | 394.1 |
| F | VFD65AMH23ANSLA | 67.9 | 115.2 | 492.0 | 198.2 | 690.2 |



# Chapter 4 Wiring

4-1 System Wiring Diagram

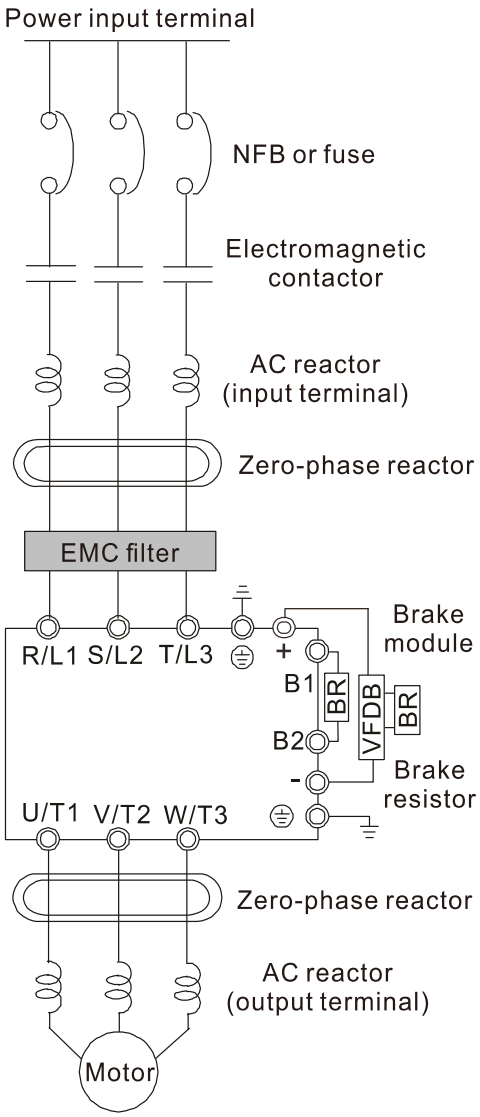
4-2 Wiring

After removing the front cover, verify that the power and control terminals are clearly visible. Read the following precautions to avoid wiring mistakes.

- ☑ It is crucial to **cut off the AC motor drive power** before doing any wiring. A charge with hazardous voltages may still remain in the DC BUS capacitors even after the power has been turned off for a short time. Measure the remaining voltage with a DC voltmeter on +1/DC+ and DC- before doing any wiring. For your safety, do not start wiring before the voltage drops to a safe level (less than 25 $V_{DC}$). Installing wiring with a residual voltage may cause injuries, sparks and short-circuits.
- ☑ Only qualified personnel familiar with AC motor drives are allowed to perform installation, wiring and commissioning. Make sure the power is turned off before wiring to prevent electric shocks.
- ☑ The terminals R/L1, S/L2, and T/L3 are for mains power input. If mains power is incorrectly connected to other terminals, it may result in damage to the equipment. The voltage and current must be in the range indicated on the nameplate (see Section 1-1).
- ☑ All units must be grounded directly to a common ground terminal to prevent electrical shocks or damage from lightning.
- ☑ Tighten the screw of the main circuit terminals to prevent sparks due to loosening of the terminals resulted from vibration.

- ☑ When wiring, choose wires that comply with local regulations for your safety.
- ☑ Check the following items after you finish the wiring:
  1. Are all connections correct?
  2. Are there any loose wires?
  3. Are there any short-circuits between the terminals or to ground?

# 4-1 System Wiring Diagram




| | |
|---|---|
| Power input terminal | Please refer to Chapter 9 Specification Table in the user manual for detail. |
| NFB or fuse | There may be a large inrush current during power on. Refer to Section 7-2 NFB to select a suitable NFB or Section 7-3 Fuse Specification Chart. |
| Electromagnetic contactor | Switching the power ON/OFF before the magnetic contactor more than one per hour can damage the drive. |
| AC reactor (input terminal) | When the mains power capacity is > 500kVA or when the drive is preceded by a capacitor bank, the instantaneous peaks voltage and current may destroy the drive. In that case it is recommended to install an AC input reactor that also improves the power factor and harmonics. The cable between reactor and drive should be < 10m.<br>Please refer to Section 7-4. |
| Zero-phase reactor | Used to reduce radiated emission, especially in environments with audio devices, and reduce input and output side interference.<br>The effective range is AM band to 10MHz.<br>Please refer to Section 7-5. |
| EMC filter | Can be used to reduce electromagnetic interference.<br>Please refer to Section 7-6. |
| Brake module & Brake resistor (BR) | Used to shorten the deceleration time of the motor.<br>Please refer to Section 7-1. |
| AC reactor (output terminal) | The wiring length of the motor affects switching current peaks. It is recommended to install an AC output reactor when the motor wiring length exceeds the value listed in Section 7-4. |

# 4-2 Wiring

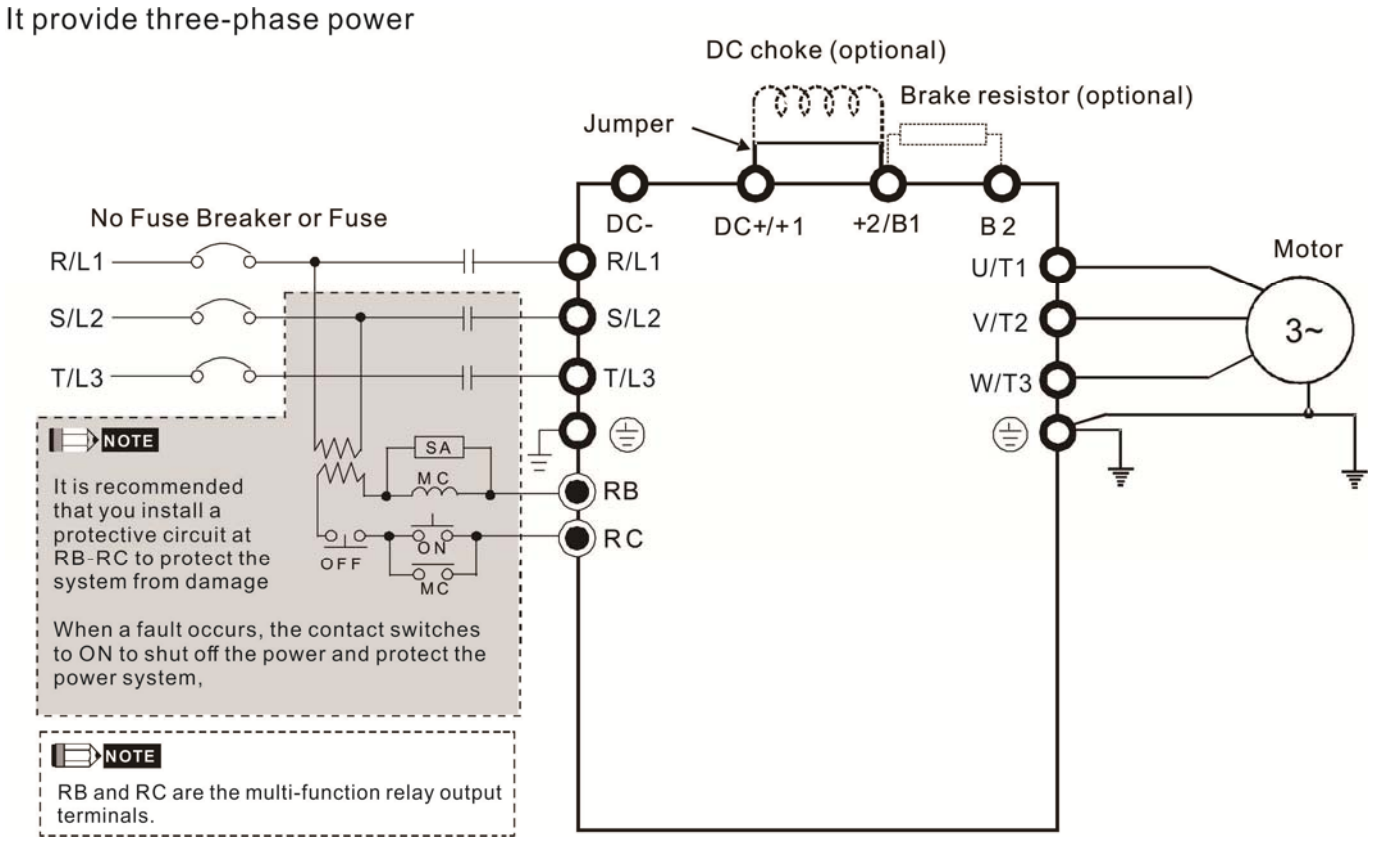

It provide three-phase power
DC choke (optional)
Brake resistor (optional)
Jumper
No Fuse Breaker or Fuse
R/L1
S/L2
T/L3
DC-
DC+/+1
+2/B1
B 2
R/L1
S/L2
T/L3
RB
RC
U/T1
V/T2
W/T3
Motor
3~
SA
MC
ON
OFF
MC
NOTE
It is recommended that you install a protective circuit at RB-RC to protect the system from damage
When a fault occurs, the contact switches to ON to shut off the power and protect the power system,
NOTE
RB and RC are the multi-function relay output terminals.

Figure 1

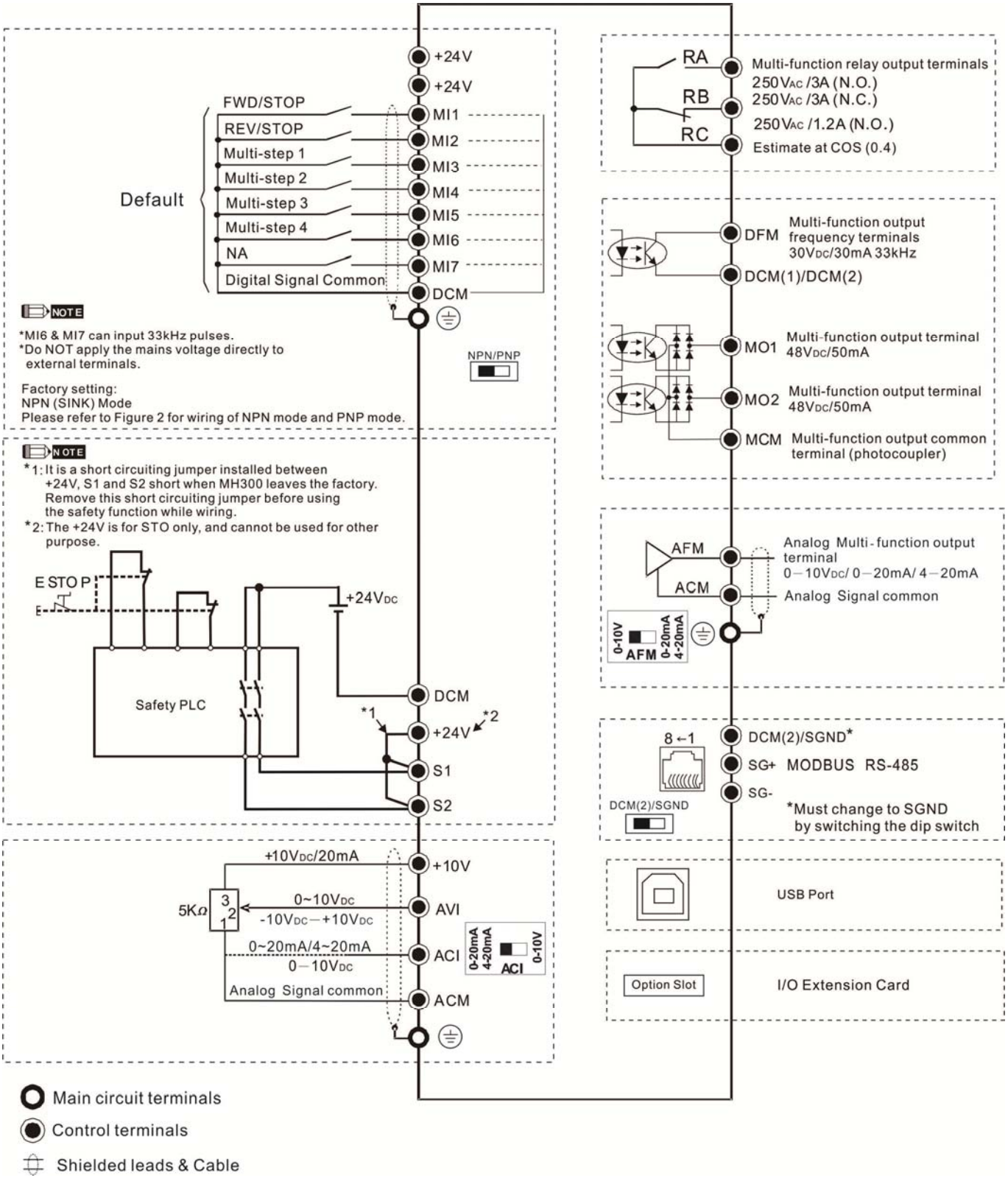

+24V
+24V
FWD/STOP
REV/STOP
Multi-step 1
Multi-step 2
Multi-step 3
Multi-step 4
NA
Digital Signal Common
Default
MI1
MI2
MI3
MI4
MI5
MI6
MI7
DCM
NOTE
*MI6 & MI7 can input 33kHz pulses.
*Do NOT apply the mains voltage directly to external terminals.
NPN/PNP
Factory setting:
NPN (SINK) Mode
Please refer to Figure 2 for wiring of NPN mode and PNP mode.
NOTE
*1: It is a short circuiting jumper installed between +24V, S1 and S2 short when MH300 leaves the factory. Remove this short circuiting jumper before using the safety function while wiring.
*2: The +24V is for STO only, and cannot be used for other purpose.
E STO P
+24VDC
Safety PLC
DCM
*1
*2
+24V
S1
S2
+10VDC/20mA
+10V
5KΩ
0~10VDC
-10VDC—+10VDC
AVI
0~20mA/4~20mA
0—10VDC
ACI
0-20mA
4-20mA
0-10V
ACI
Analog Signal common
ACM
RA
RB
RC
Multi-function relay output terminals
250VAC /3A (N.O.)
250VAC /3A (N.C.)
250VAC /1.2A (N.O.)
Estimate at COS (0.4)
DFM
Multi-function output frequency terminals
30VDC/30mA 33kHz
DCM(1)/DCM(2)
MO1
Multi-function output terminal
48VDC/50mA
MO2
Multi-function output terminal
48VDC/50mA
MCM
Multi-function output common terminal (photocoupler)
AFM
ACM
Analog Multi-function output terminal
0—10VDC/ 0—20mA/ 4—20mA
Analog Signal common
0-10V
AFM
0-20mA
4-20mA
8←1
DCM(2)/SGND*
SG+
MODBUS RS-485
SG-
DCM(2)/SGND
*Must change to SGND by switching the dip switch
USB Port
Option Slot
I/O Extension Card
Main circuit terminals
Control terminals
Shielded leads & Cable

Figure 2

SINK (NPN) / SOURCE (PNP) Mode

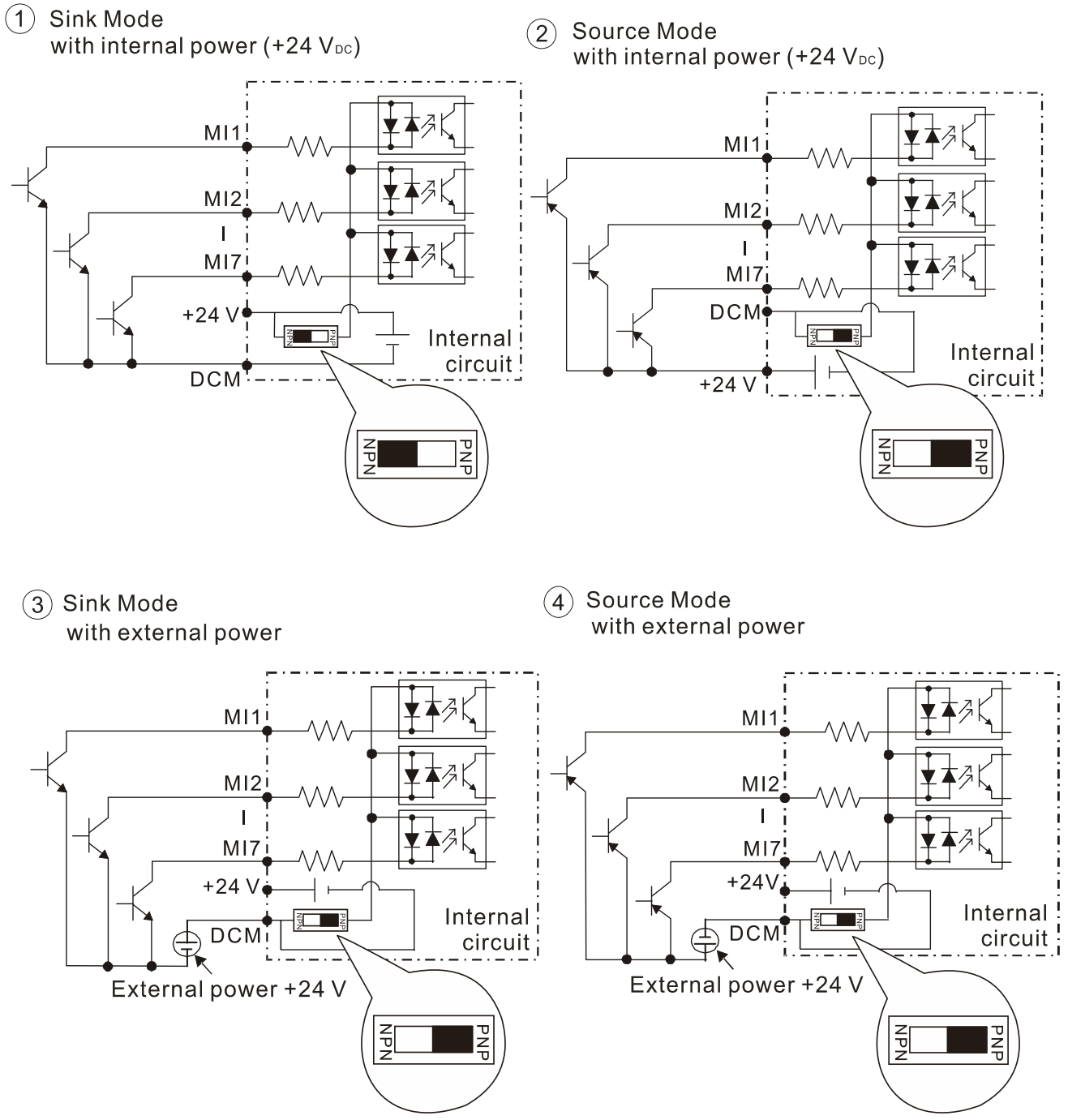
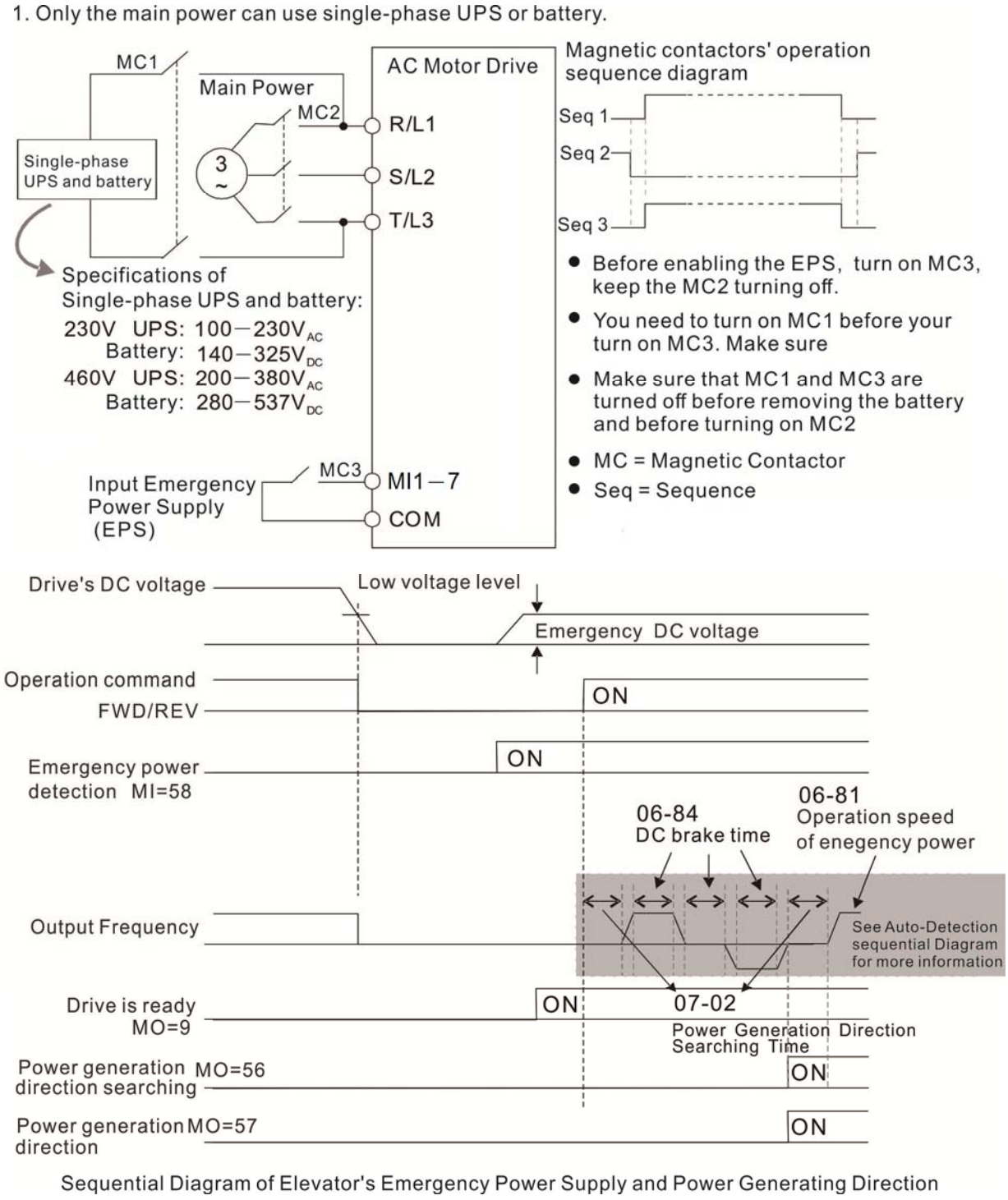


Figure 3

Applicable for frame C, D & E:




Sequential Diagram of Elevator's Emergency Power Supply and Power Generating Direction

Notes on Emergency Power Supply (EPS):

1. When the EPS is enabled (MI=58), the cooling fan stop running to prevent voltage decreasing of EPS.
2. When the EPS is enabled, the parameter setting cannot be saved. The system will lose its parameter setting after it is repower on.
3. When the EPS is enabled, the operating speed follows the setting of Pr.06-81.
4. When the EPS is enabled, low voltage protection and phase lose protection are disabled.
5. When the EPS is enabled, the DC-Bus voltage followa the setting of Pr.06-80.

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# Chapter 5 Main Circuit Terminals

5-1 Main Circuit Diagram

5-2 Main Circuit Terminals

**DANGER**

- ☑ Securely fasten the main circuit terminal screws to prevent sparking caused by loose screws due to vibration.
- ☑ When needed, only use an inductive filter at the motor output terminals U/T1, V/T2, W/T3 of the AC motor drive. DO NOT use phase-compensation capacitors or L-C (Inductance-Capacitance) or R-C (Resistance-Capacitance), unless approved by Delta.
- ☑ DO NOT connect brake resistors directly to +1/DC+ to DC-, +2/B1 to DC- to prevent damage to the drive.
- ☑ Ensure proper insulation of the main circuit wiring in accordance with the relevant safety regulations.

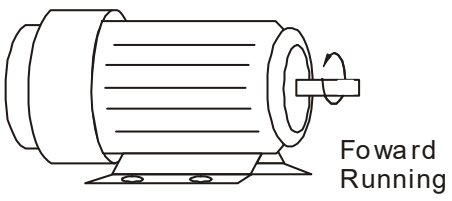
**CAUTION**

### Main power terminals

- ☑ R/L1, S/L2 and T/L3 have no phase-sequence requirement; they can be connected in any sequence.
- ☑ Add a magnetic contactor (MC) at the power input to quickly cut off power and reduce malfunction when activating the AC motor drive protection function. Both ends of the MC should have an R-C surge absorber.
- ☑ Ensure that voltages and currents are within specification.
- ☑ When using a general GFCI (Ground Fault Circuit Interrupter), select a sensitivity greater than or equal to 200 mA and greater than or equal to 0.1 sec. operation time to avoid nuisance tripping.
- ☑ Use conduits or shielded cables for the power wiring, and ground both ends of the conduit or shielded cables.
- ☑ DO NOT start or stop the drive by turning the power ON or OFF. Start and stop the drive with the RUN/STOP command. If you still need to run or stop the drive by turning the power ON or OFF, it is strongly recommended that you do so no more often than ONCE per hour.
- ☑ To comply with UL standards, connect the drive to a three-phase three-wire or three-phase four-wire Wye system type of mains power system.

### Output terminals for main circuit

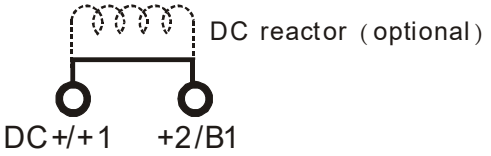
- ☑ Use a well-insulated motor that is suitable for operation with an inverter.
- ☑ When the AC drive output terminals U/T1, V/T2, and W/T3 are connected to the motor terminals U/T1, V/T2, and W/T3 respectively, the motor rotates counterclockwise (as viewed from the shaft end of the motor) when it receives a forward operation command. To permanently reverse the direction of rotation, exchange any two motor leads.



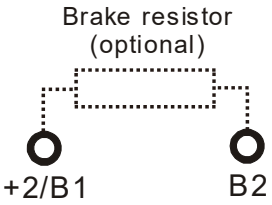
### Terminals for connecting DC reactor, external brake resistor and DC circuit

☑ These are the terminals for connecting the DC reactor to improve the power factor and harmonics. At delivery they are shorted by a jumper. Remove the jumper before connecting the DC reactor.

☑ You must tightly fasten the jumper when it does not connect the DC reactor, use DC+/+1, +2/B1 to execute common DC BUS, or connect with a brake resistor; otherwise the drive might lose power or break the terminals.




☑ Connect a brake resistor in applications with frequent deceleration, short deceleration time, too low braking torque, or increased braking torque.




☑ Connect the external brake resistor to the terminals [+2/B1], [B2] on AC motor drives.

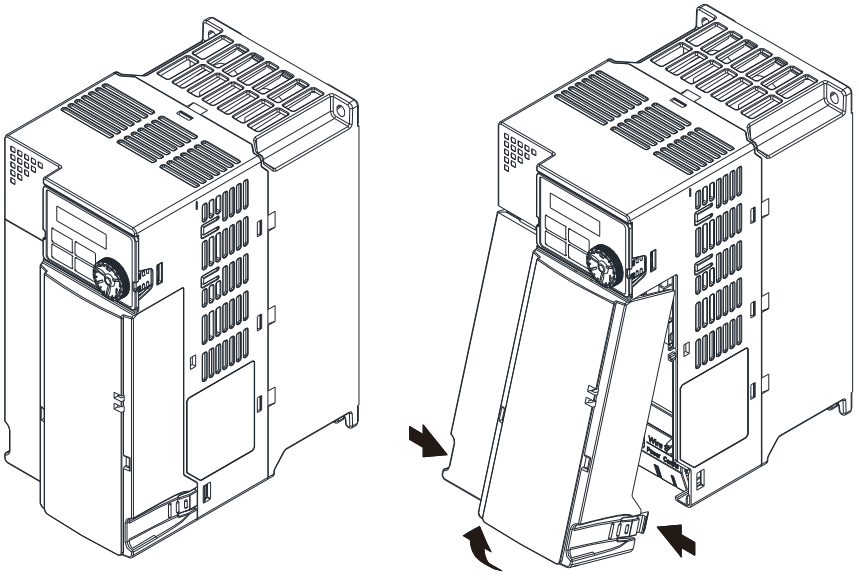
☑ DO NOT short-circuit or connect a brake resistor directly to DC+/+1 and DC-, +2/B1 to DC-; otherwise the drive will be damaged.

☑ Connect DC+ and DC- in common DC BUS applications. Refer to Section 5-2 (Main Circuit Terminal) for the wiring terminal specification and the wire gauge information.

## Remove the front cover

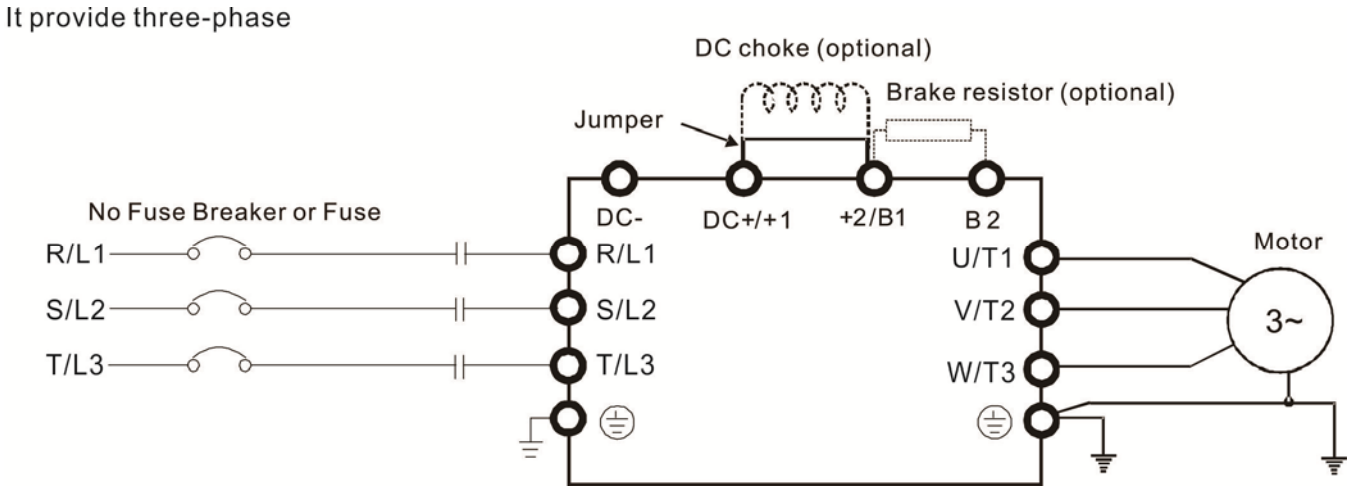
🕮 Remove the front cover before connecting the main circuit terminals and control circuit terminals. Remove the cover according to the figure below.

🕮 The figure below shows the Frame D model for example. Removing the cover on the other frame sizes is similar.



Press the clip on both sides, and take out by rotating.

# 5-1 Main Circuit Diagram




| Terminals | Descriptions |
|---|---|
| R/L1, S/L2, T/L3 | Mains input terminals three-phase |
| U/T1, V/T2, W/T3 | Motor output terminals for connecting three-phase IM and PM motors |
| +1, +2 | Connections for DC reactor to improve the power factor and harmonics.<br>Remove the jumper when using a DC reactor. |
| DC+, DC- | Connections for brake unit (VFDB series)<br>Common DC BUS |
| B1, B2 | Connections for brake resistor (optional) |
| ⏚ | Ground connection, comply with local regulations. |

## 5-2 Main Circuit Terminals

- The following additional terminals are needed when wiring. The additional terminal dimension should comply with Figure 1 below.
- After crimping the wire to the ring lug (must be UL approved), UL and CSA approved R/C (YDPU2), install heat shrink tubing rated at a minimum of 600 $V_{AC}$ insulation over the live part. Refer to Figure 2 below.

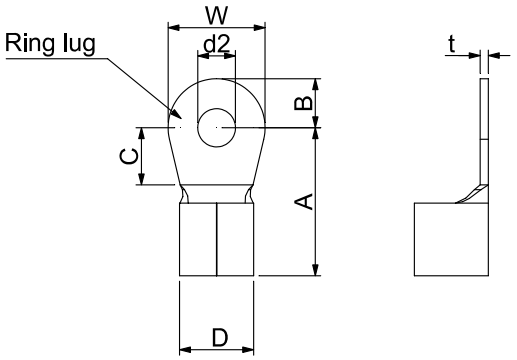



Figure 1.

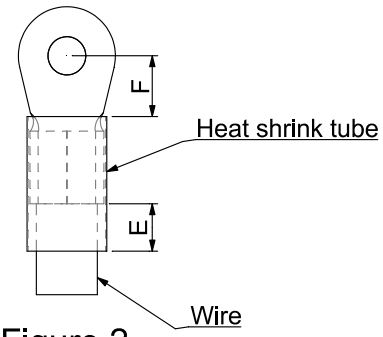



Figure 2.

### Dimensions of Ring Lug

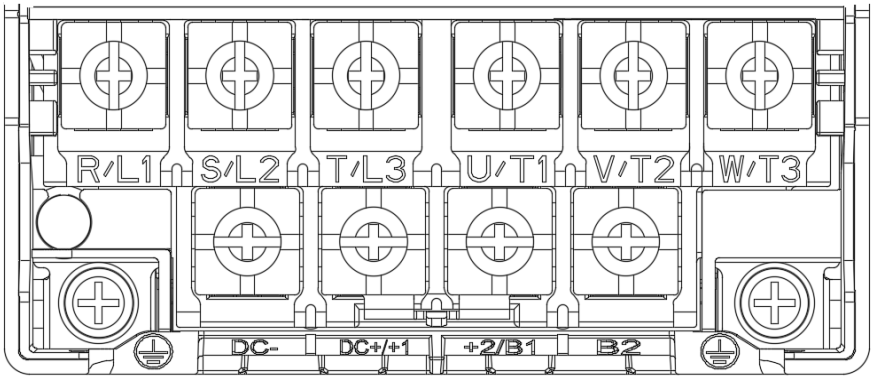
The part # of the ring terminals (produced by K.S. Terminals) in the table below are for reference only.

You can buy other ring terminals of your choice to match with different frame sizes.

| Frame | AWG | Vendor P/N | A (MAX) | B (MAX) | C (MIN) | D (MAX) | d2 (MIN) | E (MIN) | F (MIN) | W (MAX) | t (MAX) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 12 | RNBS5-4 | 17.8 | 5.0 | 6.1 | 7.2 | 4.3 | 13.0 | 5.5 | 10.5 | 1.2 |
| | 10 | RNBS5-4 | | | | | | | | | |
| | 8 | RNBS8-4 | | | | | | | | | |
| D | 10 | RNBS5-4 | 17.8 | 5.0 | 6.1 | 7.2 | 4.3 | 13.0 | 5.5 | 10.5 | 1.2 |
| | 8 | RNBS8-4 | | | | | | | | | |
| E | 6 | RNB14-5 | 27.1 | 6.1 | 10.5 | 11.5 | 5.3 | 13.0 | 6.5 | 12.6 | 1.7 |
| | 4 | RNBS22-5 | | | | | | | | | |
| F | 2 | RNBS38-6 | 35.0 | 9.0 | 13.3 | 14.0 | 6.2 | 13.0 | 10.0 | 19.5 | 1.8 |

Unit: mm

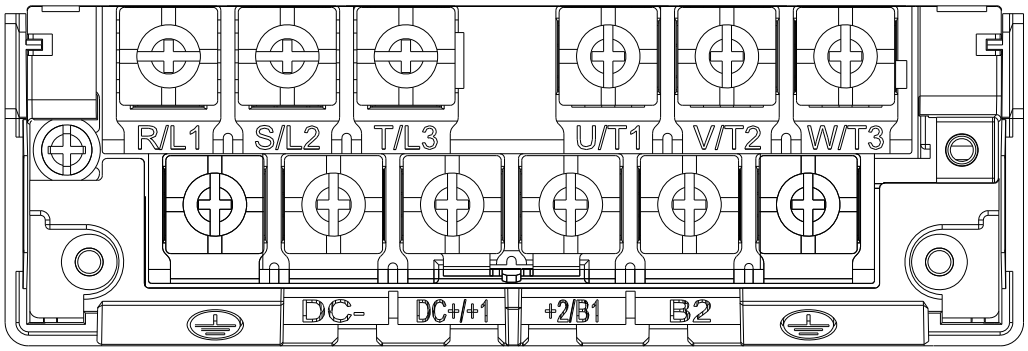
Frame C




- If you install at Ta 50°C above environment, please select copper wire which have voltage rating 600V and temperature resistant 75°C or 90°C or above.
- If you install at Ta 50°C environment, please select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- For UL installation compliant, you have to use copper wires when installation, the wire gauge is based on temperature resistant 75°C which is according to the requirements and recommendations from UL. Do not reduce the wire gauge when using high-temperature resistant wires.

| Models | Main circuit terminals R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, , DC-, DC+/+1, +2/B1, B2 | | | terminals ⏚ | | |
|---|---|---|---|---|---|---|
| | Max. Wire Gauge | Min. Wire Gauge | Torque (±10%) | Max. Wire Gauge | Min. Wire Gauge | Torque (±10%) |
| VFD11AMH23ANSLA | 10 $mm^2$ [8 AWG] | 6 $mm^2$ [10 AWG] | M4 20 Kg-cm [17.4 lb-in.] [1.96 Nm] | 6 $mm^2$ [10 AWG] | 6 $mm^2$ [10 AWG] | M4 20 Kg-cm [17.4 lb-in.] [1.96 Nm] |
| VFD17AMH23ANSLA | | 10 $mm^2$ [8 AWG] | | 10 $mm^2$ [8 AWG] | 10 $mm^2$ [8 AWG] | |
| VFD9A0MH43ANSLA | | 4 $mm^2$ [12 AWG] | | 4 $mm^2$ [12 AWG] | 4 $mm^2$ [12 AWG] | |
| VFD9A0MH43AFSLA | | | | | | |

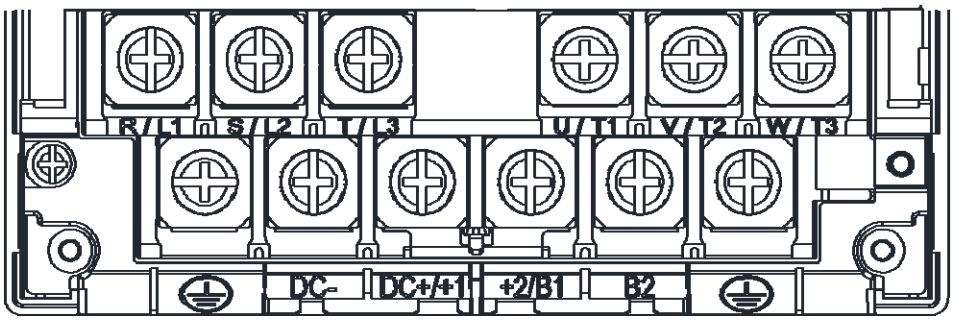
Frame D




- If you install at Ta 50°C above environment, please select copper wire which have voltage rating 600V and temperature resistant 75°C or 90°C or above.
- If you install at Ta 50°C environment, please select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- Model VFD25AMH23ANSLA install at Ta 45°C above environment, please select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- For UL installation compliant, you have to use copper wires when installation, the wire gauge is based on temperature resistant 75°C which is according to the requirements and recommendations from UL. Do not reduce the wire gauge when using high-temperature resistant wires.

| Models | Main circuit terminals R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, , DC-, DC+/+1, +2/B1, B2 | | | terminals ⏚ | | |
|---|---|---|---|---|---|---|
| | Max. Wire Gauge | Min. Wire Gauge | Torque (±10%) | Max. Wire Gauge | Min. Wire Gauge | Torque (±10%) |
| VFD25AMH23ANSLA | 10 $mm^2$ [8 AWG] | 10 $mm^2$ [8 AWG] | M4 20 Kg-cm [17.4 lb-in.] [1.96 Nm] | 10 $mm^2$ [8 AWG] | 10 $mm^2$ [8 AWG] | M4 20 Kg-cm [17.4 lb-in.] [1.96 Nm] |
| VFD13AMH43ANSLA | | 6 $mm^2$ [10 AWG] | | 6 $mm^2$ [10 AWG] | 6 $mm^2$ [10 AWG] | |
| VFD13AMH43AFSLA | | | | | | |
| VFD17AMH43ANSLA | | 10 $mm^2$ [8 AWG] | | 10 $mm^2$ [8 AWG] | 10 $mm^2$ [8 AWG] | |
| VFD17AMH43AFSLA | | | | | | |

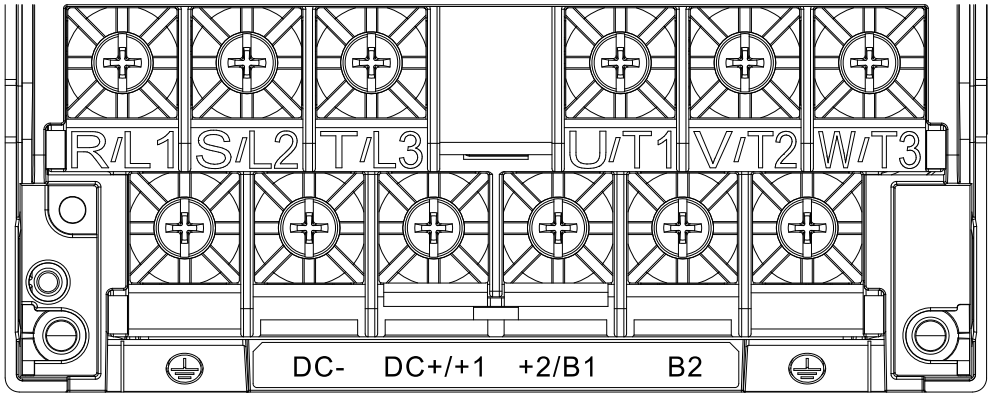
Frame E




- If you install at Ta 50°C above environment, please select copper wire which have voltage rating 600V and temperature resistant 75°C or 90°C or above.
- If you install at Ta 50°C environment, please select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- Model VFD33AMH23ANSLA install at Ta 40°C environment, please select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- Model VFD49AMH23ANSLA install at Ta 35°C environment, please select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- Model VFD32AMH43ANSLA and VFD32AMH43AFSLA install at Ta 45°C environment, please select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- For UL installation compliant, you have to use copper wires when installing. The wire gauge is based on temperature resistant 75°C which is according to the requirements and recommendations from UL. Do not reduce the wire gauge when using high-temperature resistant wires.
- ** These drives must be wired with the specified ring terminal dimensions.

<table>
<tr><th rowspan="2">Models</th><th colspan="3">Main circuit terminals<br>R/L1, S/L2, T/L3, U/T1, V/T2,<br>W/T3, , DC-, DC+/+1, +2/B1, B2</th><th colspan="3">terminals<br>⏚</th></tr>
<tr><th>Max. Wire Gauge</th><th>Min. Wire Gauge</th><th>Torque (±10%)</th><th>Max. Wire Gauge</th><th>Min. Wire Gauge</th><th>Torque (±10%)</th></tr>
<tr><td>VFD33AMH23ANSLA</td><td>16 mm$^2$ [6 AWG]</td><td>16 mm$^2$ [6 AWG]</td><td rowspan="6">M5<br>25 Kg-cm<br>[21.7 lb-in.]<br>[2.45 Nm]</td><td>16 mm$^2$ [6 AWG]</td><td rowspan="6">16 mm$^2$ [6 AWG]</td><td rowspan="6">M5<br>25 Kg-cm<br>[21.7 lb-in.]<br>[2.45 Nm]</td></tr>
<tr><td>VFD49AMH23ANSLA**</td><td>25 mm$^2$ [4 AWG]</td><td>25 mm$^2$ [4 AWG]</td><td>25 mm$^2$ [4 AWG]</td></tr>
<tr><td>VFD25AMH43ANSLA</td><td rowspan="4">16 mm$^2$ [6 AWG]</td><td rowspan="4">16 mm$^2$ [6 AWG]</td><td rowspan="4">16 mm$^2$ [6 AWG]</td></tr>
<tr><td>VFD25AMH43AFSLA</td></tr>
<tr><td>VFD32AMH43ANSLA</td></tr>
<tr><td>VFD32AMH43AFSLA</td></tr>
</table>

Frame F




- Model VFD65AMH23ANSLA install at Ta 35°C above environment, select copper wire which have voltage rating 600V and temperature resistant 90°C or 90°C.
- For UL installation compliant, you have to use copper wires when installation.
- The wire gauge is based on temperature resistant 75°C which is according to the requirements and recommendations from UL. Do not reduce the wire gauge when using high-temperature resistant wires.

| Models | Main circuit terminals R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, , DC-, DC+/+1, +2/B1, B2 | | | terminals ⏚ | | |
|---|---|---|---|---|---|---|
| | Max. Wire Gauge | Min. Wire Gauge | Torque (±10%) | Max. Wire Gauge | Min. Wire Gauge | Torque (±10%) |
| VFD65AMH23ANSLA | 35 $mm^2$ [2 AWG] | 35 $mm^2$ [2 AWG] | M6 40 Kg-cm [34.7 lb-in.] [3.92 Nm] | 35 $mm^2$ [2 AWG] | 16 $mm^2$ [6 AWG] | M6 40 Kg-cm [34.7 lb-in.] [3.92 Nm] |

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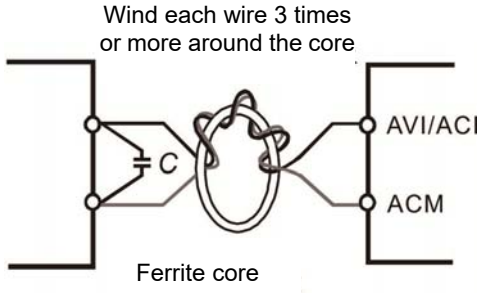
# Chapter 6 Control Terminals

CAUTION

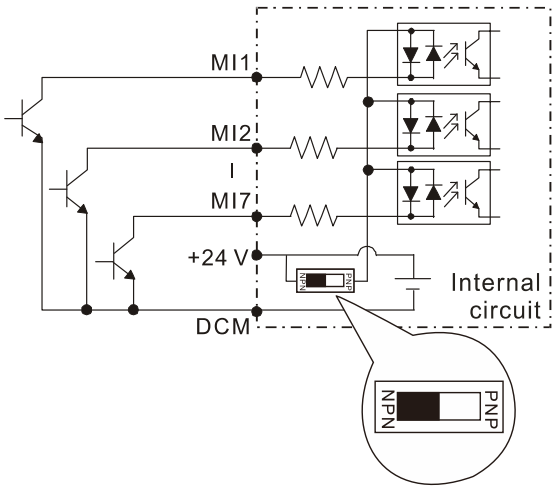
## Analog input terminals (AVI, ACI, ACM)

- ☑ Analog input signals are easily affected by external noise. Use shielded wiring and keep it as short as possible (less than 20 m) with proper grounding. If the noise is inductive, connecting the shield to the ACM terminal can reduce interference.
- ☑ Use twisted-pair wire for weak analog signals.
- ☑ If the analog input signals are affected by noise from the drive, connect a capacitor and ferrite core as shown in the following diagram.

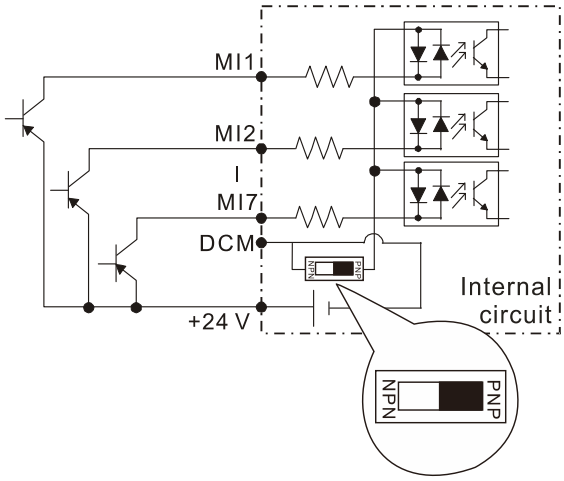



## Contact input terminals (MI1–MI7, DCM, +24V)

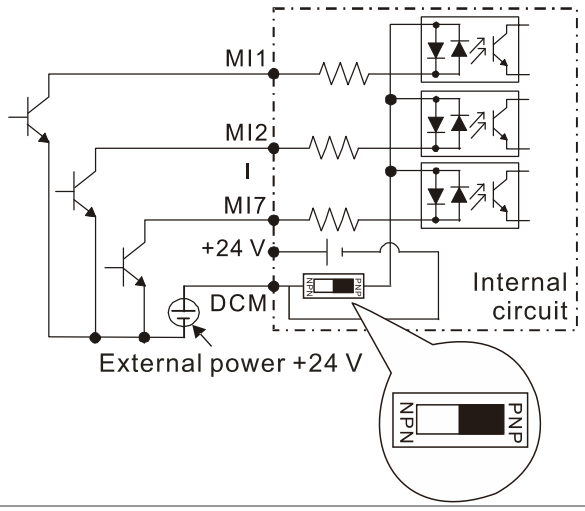
① Sink Mode
with internal power (+24 $V_{DC}$)



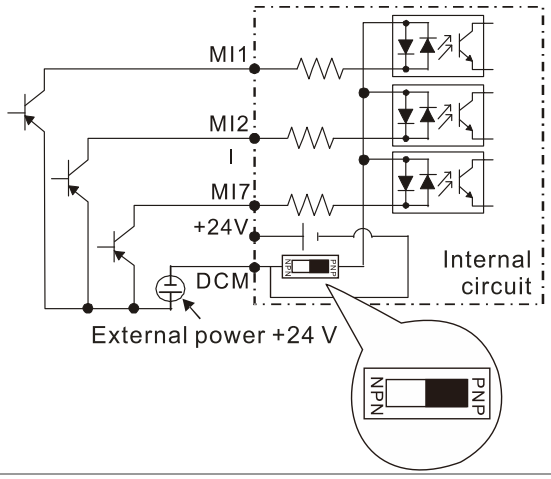

② Source Mode
with internal power (+24 $V_{DC}$)



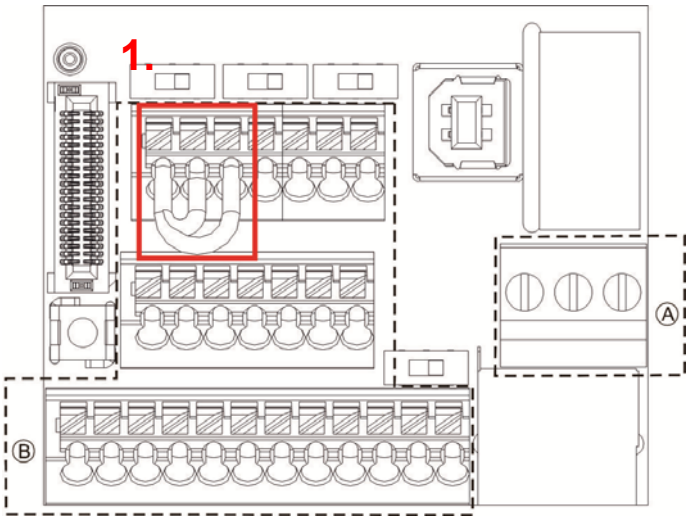

③ Sink Mode
with external power



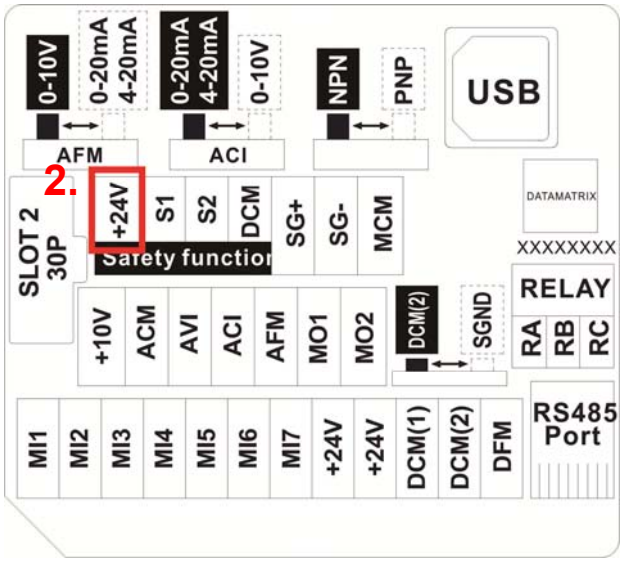

④ Source Mode
with external power



| | |
|---|---|
| | ☑ When the photo coupler is using the internal power supply, the switch connection for Sink and Source modes are as shown in the picture above: MI-DCM: Sink mode, MI-+24 V: Source mode. |
| | **Transistor output terminals (MO1, MO2, MCM)** |
| | ☑ Make sure to connect the digital outputs to the correct polarity. See the wiring diagram when connecting a relay to the digital output, connect a surge absorber across the coil, and check the polarity. |




Distribution Diagram of Control Terminal



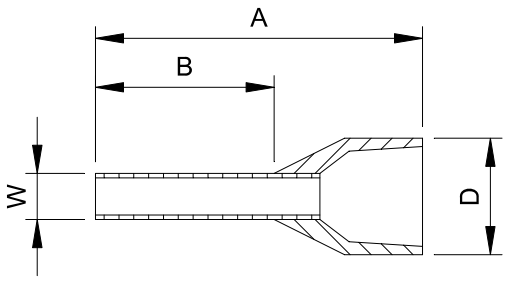

Location Map of Control Terminal

Wiring precautions:

- The default condition is +24V/S1/S2 shorted by jumper (as shown in figure 1. on upper left side), please refer to Chapter 4 WIRING for more details.
- Power source of the safety function: +24V (as shown in figure 2. on upper left side), STO use only.
- Relay terminals are on a screw clamp terminal block (See section A on the upper left side).
  1. Tighten the wiring with slotted screwdriver, which is 3.5 mm (wide) x 0.6mm (thick)
  2. The ideal length of stripped wire at the connection side is 6－7mm.
  3. When wiring bare wires, make sure they are perfectly arranged to go through the wiring holes.
- Control terminals are on a spring clamp terminal block (See section B on the upper left side).
  1. Tighten the wiring with slotted screwdriver, which is 2.5mm (wide) x 0.4mm (thick)
  2. The ideal length of stripped wire at the connection side is 9mm.
  3. When wiring bare wires, make sure they are perfectly arranged to go through the wiring holes.

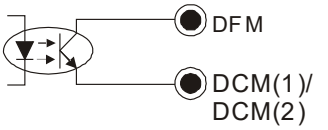
Control Terminals Wiring Specification

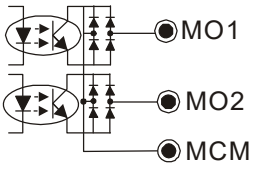
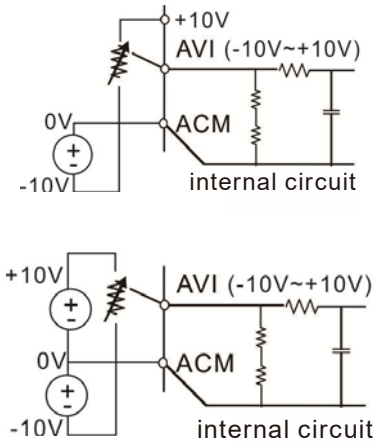
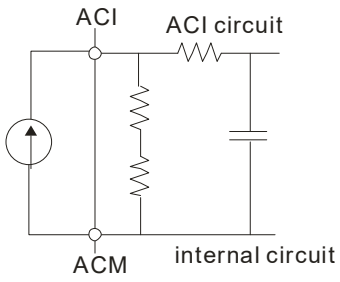
| Function name | Control Terminals Wiring Specification | Stripping Length(mm) | Max.Wire Size | Min. Wire Size | Torque |
|---|---|---|---|---|---|
| Repay Terminals | Solid | 6－7 | 1.5mm$^2$ [16AWG] | 0.2mm$^2$ [24AWG] | 5 Kg-cm [4.3 lb-in.] [0.49 Nm] |
| | Strand | | | | |
| Control Terminals | Solid | 9 | 0.75mm$^2$ [18AWG] | 0.25mm$^2$ [24AWG] | |
| | Strand | | | | |
| | Stranded with ferrules with plastic sleeve | 9 | 0.5mm$^2$ [20AWG] | | |

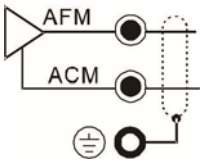



Unit: mm

| Models and Sizes of Non-Insulated Terminals | | | | | | |
|---|---|---|---|---|---|---|
| AWG | VENDOR | VENDOR P/N | A(MAX) | B(MAX) | D(MAX) | W(MAX) |
| 0.25mm$^2$ [24AWG] | PHOENIX CONTACT | AI 0,25- 8 YE | 12.5 | 8 | 2.6 | 1.1 |
| 0.34mm$^2$ [22AWG] | PHOENIX CONTACT | AI 0,34- 8 TQ | 12.5 | 8 | 3.3 | 1.3 |
| 0.5mm$^2$ [20AWG] | PHOENIX CONTACT | AI 0,5 - 8 WH | 14 | 8 | 3.5 | 1.4 |
| Models and Specifications of Crimping Tools:<br>CRIMPFOX 10S - 1212045, Manufacturer: PHOENIX CONTACT<br>DNT13-0101, Manufacturer: DINKLE | | | | | | |

| Terminals | Terminal Function | Description |
|---|---|---|
| +24V | Digital control signal common (Source) | +24V ±10% 100 mA |
| MI1<br>—<br>MI7 | Multi-function input 1–7 | Refer to Pr.02-01–Pr.02-07 to program the multi-function inputs MI1–MI7.<br>Source Mode<br>ON: the activation current is 3.3 mA ≥ 11 $V_{DC}$<br>OFF: cut-off voltage ≤ 5 $V_{DC}$<br>Sink Mode<br>ON: the activation current is 3.3 mA ≤ 13 $V_{DC}$<br>OFF: cut-off voltage ≥ 19 $V_{DC}$<br>■ When Pr.02-00 = 0, MI1 and MI2 can be programmed.<br>■ When Pr.02-00 ≠ 0, the function of MI1 and MI2 is acc. to Pr.02-00 setting.<br>■ When Pr.02-07 = 0, MI7 is pulse input with max. frequency 33kHz. |
| DFM | Digital frequency meter<br>  | DFM is a pulse-signal output; Duty-cycle: 50%<br>Min. load impedance $R_L$: 1kΩ/100pf<br>Max. current: 30mA<br>Max. capacitive load: 100pF<br>Max. voltage: 30 $V_{DC}$ ± 1 %<br>(when 30 $V_{DC}$ /30 mA /$R_L$ = 100 pf)<br>Max. output frequency: 33kHz |
| DCM (1) | Digital frequency signal common (Sink) | |

| Terminals | Terminal Function | Description |
|---|---|---|
| DCM (2) | Digital frequency signal common (Sink), it can switch to SGND | Internal current limiting resistor R: ≥ 1KΩ<br>Output load impedance $R_L$<br>Capacitive load ≤ 100 pf<br>Resistive load ≥ 1 kΩ，resistance determine the output voltage value.<br>DFM-DCM voltage = external voltage * ( $R_L$/ ($R_L$+R) ) |
| MO1 | Multi-function Output 1 (photo coupler) | Programmable open-collector outputs, see Pr. 02-16 and Pr. 02-17.<br>  <br>Max 48 $V_{DC}$ 50 mA |
| MO2 | Multi-function Output 2 (photo coupler) | |
| MCM | Multi-function Output Common | |
| RA | Multi-function relay output 1 (Relay N.O. a) | Programmable relay output, see Pr. 02-13.<br>Resistive Load<br>3 A (N.O.) / 3 A (N.C.) 250 $V_{AC}$<br>5 A (N.O.) / 3 A (N.C.) 30 $V_{DC}$<br>Inductive Load (COS 0.4)<br>1.2 A (N.O.)/ 1.2 A (N.C.) 250 $V_{AC}$<br>2.0 A (N.O.)/ 1.2 A (N.C.) 30 $V_{DC}$<br>Various kinds of monitor signals output, e.g.: operation, frequency attained, overload indication etc. |
| RB | Multi-function relay output 1 (Relay N.C. b) | |
| RC | Multi-function relay common (Relay) | |
| +10V | Potentiometer power supply | +10.5 ± 0.5 $V_{DC}$ / 20 mA |
| AVI | Analog voltage input<br>  | Programmable analog input, see Pr.03-00.<br>Impedance: 20kΩ<br>Range 0－Max. Output Frequency (Pr.01-00):<br>0– +10V/-10– +10V<br>Range switching by Pr.03-00, Pr.03-28. |
| ACI | Analog current input<br>  | Programmable analog input, see Pr.03-01.<br>Impedance: 250Ω<br>Range 0－Max. Output Frequency (Pr. 01-00):<br>0–20mA/4–20mA/0–10V<br>Range switching by Pr.03-01 , Pr.03-29. |

| Terminals | Terminal Function | Description |
|---|---|---|
| AFM | Multi-function analog voltage output   | Switch:<br>The AFM default is 0–10 V (voltage mode). Use the switch and Pr.03-31 to change to current mode (0–20 mA/4–20 mA). You must follow the indication on the back side of the front cover or page 6-1 of the user manual when using the switch.<br>Voltage mode<br>Range: 0–10 V (Pr. 03-31=0) corresponding to the max. operating range of the control object<br>Max. output current : 2 mA<br>Max. Load: 5 kΩ<br>Current mode<br>Range: 0–20 mA (Pr.03-31=1)/4–20 mA (Pr.03-31=2) corresponding to the maximum operating range of the control object<br>Max. load: 500 Ω |
| ACM | Analog Signal Common | Common for analog terminals |
| S1,S2 | Default: S1/S2 shorted for +24 V<br>Rated voltage: 24 $V_{DC}$ ±10%; Maximum voltage: 30 $V_{DC}$ ±10%<br>Activation current: 6.67 mA ±10%<br>STO activation mode<br>Input voltage level: S1-DCM > 0 $V_{DC}$ or S2-DCM < 5 $V_{DC}$<br>STO response time ≤ 20 ms. S1/S2 operates until the AC motor drive stops outputting current.<br>STO cut-off mode<br>Input voltage level: S1-DCM > 11 $V_{DC}$ and S2-DCM < 30 $V_{DC}$<br>Power removal safety function according to EN 954-1 and IEC/EN 61508<br>Note: refer to Chapter 17 SAFE TORQUE OFF FUNCTION for more information. | |
| DCM | | |
| SG+ | Modbus RS-485<br>Note: Please refer to Chapter 12 DESCRIPTION OF PARAMETER SETTINGS for more information. | |
| SG- | | |
| SGND | | |
| RJ-45 | Pin1: CAN_H<br>Pin2: CAN_L<br>Pin3, 7: SGND<br>Pin4: SG-<br>Pin5: SG+<br>Pin6: Reserved<br>Pin8: +10 VS | |

# Chapter 7 Optional Accessories

7-1 All Brake Resistors and Brake Units Used in AC Motor Drives

7-2 Non-fuse Circuit Breaker

7-3 Fuse Specification Chart

7-4 AC/DC Reactor

7-5 Zero Phase Reactors

7-6 EMC Filter

7-7 EMC Shield Plate

7-8 Capacitive Filter

7-9 NEMA Kit

7-10 Din-Rail Mounting

The optional accessories listed in this chapter are available upon request. Installing additional accessories to your drive substantially improves the drive's performance. Select accessories according to your need or contact your local distributor for suggestions.

# 7-1 All Brake Resistors and Brake Units Used in AC Motor Drives

230V three-phase

| Model | Applicable Motor | | *1 125% Braking Torque / 10% ED | | | | | | Max. Braking Torque | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | HP | kW | *2 Braking Torque (kg-m) | Resistor value spec. for each AC motor Drive | Braking Resistor for each Brake Unit | | | Braking Current (A) | Min. Resistor Value (Ω) | Max. Total Braking Current (A) | Peak Power (kW) |
| | | | | | *3 Part No. | Amount | Usage | | | | |
| VFD11AMH23ANSLA | 3 | 2.2 | 1.5 | 300W 70Ω | BR300W070 | 1 | - | 5.4 | 38.0 | 10 | 3.8 |
| VFD17AMH23ANSLA | 5 | 3.7 | 2.5 | 400W 40Ω | BR400W040 | 1 | - | 9.5 | 19.0 | 20 | 7.6 |
| VFD25AMH23ANSLA | 7.5 | 5.5 | 3.7 | 1000W 20Ω | BR1K0W020 | 1 | - | 19 | 16.5 | 23 | 8.7 |
| VFD33AMH23ANSLA | 10 | 7.5 | 5.1 | 1000W 20Ω | BR1K0W020 | 1 | - | 19 | 14.6 | 26 | 9.9 |
| VFD49AMH23ANSLA | 15 | 11 | 7.4 | 1500W 13Ω | BR1K5W013 | 1 | - | 29 | 12.6 | 29 | 11.0 |
| VFD65AMH23ANSLA | 20 | 15 | 10.2 | 2000W 8.6Ω | BR1K0W4P3 | 2 | 2 in series | 44 | 8.3 | 46 | 17.5 |

460V three-phase

| Model | Applicable Motor | | *1 125% Braking Torque /10% ED | | | | | | Max. Braking Torque | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | HP | kW | *2 Braking Torque (kg-m) | Resistor value spec. for each AC motor Drive | Braking Resistor for each Brake Unit | | | Braking Current (A) | Min. Resistor Value (Ω) | Max. Total Braking Current (A) | Peak Power (kW) |
| | | | | | *3 Part No. | Amount | Usage | | | | |
| VFD9A0MH43ANSLA<br>VFD9A0MH43AFSLA | 5 | 3.7 | 2.5 | 400W 150Ω | BR400W150 | 1 | | 5.1 | 84.4 | 9 | 6.8 |
| VFD13AMH43ANSLA<br>VFD13AMH43AFSLA | 7.5 | 5.5 | 3.7 | 1000W 75Ω | BR1K0W075 | 1 | | 10.2 | 50.7 | 15 | 11.4 |
| VFD17AMH43ANSLA<br>VFD17AMH43AFSLA | 10 | 7.5 | 5.1 | 1000W 75Ω | BR1K0W075 | 1 | | 10.2 | 40.0 | 19 | 14.4 |
| VFD25AMH43ANSLA<br>VFD25AMH43AFSLA | 15 | 11 | 7.4 | 1500W 43Ω | BR1K5W043 | 1 | | 17.6 | 33.0 | 23 | 17.5 |
| VFD32AMH43ANSLA<br>VFD32AMH43AFSLA | 20 | 15 | 10.2 | 2000W 32Ω | BR1K0W016 | 2 | 2 in series | 24 | 26.2 | 29 | 22.0 |

*1 Standard braking torque is 125 %. Because of the limited resistor power, the longest operation time for 10% ED is 10sec. (on: 10 sec. / off: 90 sec.).

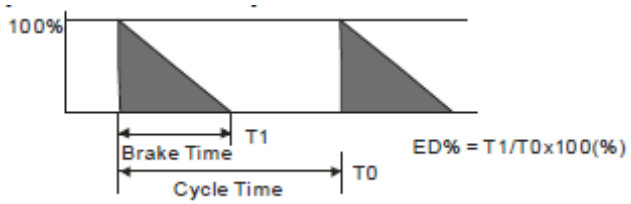
*2 Calculation for braking torque is for a four-pole motor (1800 rpm).

*3 Resistors of 400W or lower should be fixed to the frame and at a surface temperature below 250°C (400°C). Resistors of 1000W and above should be fixed on a surface with temperature below 600°C. If the temperature is higher than the resistor's temperature limit, it will be required to install heat dissipating system or use a resistor with higher power.

NOTE

1. Select the resistance value, power and brake usage (ED %) acc. to Delta rules.

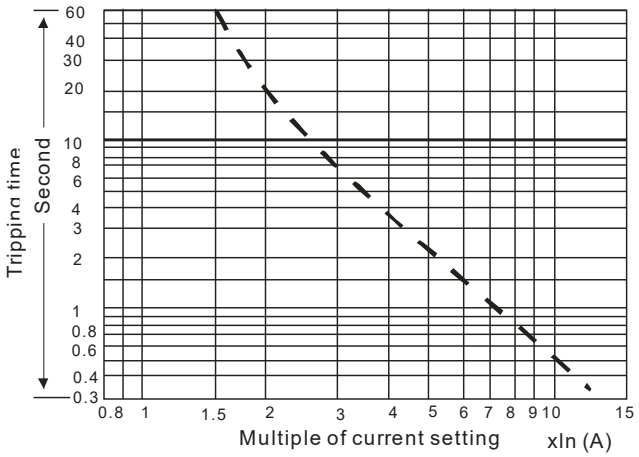
   Definition for Brake Usage ED%




   Explanation: ED (%) is defined to allow enough time for the brake unit and brake resistor to dissipate the heat generated by braking. Recommended cycle time T0 is one minute.

   For safety, install a thermal overload relay (O.L) between the brake unit and the brake resistor in conjunction with the magnetic contactor (MC) before the drive for additional protection. The thermal overload relay protects the brake resistor from damage due to frequent or continuous braking. Under such circumstances, turn off the power to prevent damage to the brake resistor, brake unit and drive.

2. Any damage to the drive or other equipment caused by using brake resistors and brake modules that are not provided by Delta voids the warranty.
3. Consider environmental safety factors when installing the brake resistors. If you use the minimum resistance value, consult local dealers for the power calculation.
4. When using more than two brake units, the equivalent resistor value of the parallel brake unit cannot be less than the value in the column “Minimum Resistor Value (Ω)”. Read the wiring information in the brake unit user manual thoroughly prior to operation. Visit the following links to get the instruction sheets for the wiring in the brake unit:
   - VFDB2015 / 2022 / 4030 / 4045 / 5055 Braking Modules Instruction Sheet
     http://www.deltaww.com/filecenter/Products/download/06/060101/Option/DELTA_IA-MDS_VFDB_I_EN_20070719.pdf
   - VFDB4110 / 4160 / 4185 Braking Modules Instruction Sheet
     http://www.deltaww.com/filecenter/Products/download/06/060101/Option/DELTA_IA-MDS_VFDB4110-4160-4185_I_EN_20101011.pdf
   - VFDB6055 / 6110 / 6160 / 6200 Braking Modules Instruction Sheet
     http://www.deltaww.com/filecenter/Products/download/06/060101/Option/DELTA_IA-MDS_VFDB6055-6110-6160-6200_I_TSE_20121030.pdf
5. Thermal Overload Relay (TOR): Choosing a thermal overload relay is based on whether its overload capacity is appropriate for the MH300. The standard braking capacity of the MH300 is 10% ED (Tripping time=10 s). As shown in the figure below, the thermal overload relay continuously operates for 10 seconds and it can withstand a 260% overload (Host starting). For example, a 460V, 15 kW MH300 has a braking current of 24 A (refer to the tables in this section), so it can use the thermal overload relay with a rated current of 10 A (10*260% = 26A > 24A).



## 7-2 Non-fuse Circuit Breaker

Comply with UL standard: Per UL 508, paragraph 45.8.4, part a.

| Model | Voltage / three-phase | Current Input / Output (Max.) | Breaker Rating Input (A) |
|---|---|---|---|
| VFD11AMH23ANSLA | 230V / three-phase | 13.2 A / 11.0 A | 40 |
| VFD17AMH23ANSLA | | 20.4 A / 17.0 A | 60 |
| VFD25AMH23ANSLA | | 30.0 A / 25.0 A | 63 |
| VFD33AMH23ANSLA | | 39.6 A / 33.0 A | 90 |
| VFD49AMH23ANSLA | | 58.8 A / 49.0 A | 125 |
| VFD65AMH23ANSLA | | 78.0 A / 65.0 A | 160 |

| Model | Voltage / three-phase | Current Input / Output (Max.) | Breaker Rating Input (A) |
|---|---|---|---|
| VFD9A0MH43ANSLA<br>VFD9A0MH43AFSLA | 460V / three-phase | 9.9 A / 9.0 A | 30 |
| VFD13AMH43ANSLA<br>VFD13AMH43AFSLA | | 14.3 A / 13.0 A | 32 |
| VFD17AMH43ANSLA<br>VFD17AMH43AFSLA | | 19.3 A / 17.5 A | 45 |
| VFD25AMH43ANSLA<br>VFD25AMH43AFSLA | | 27.5 A / 25.0 A | 60 |
| VFD32AMH43ANSLA<br>VFD32AMH43AFSLA | | 35.2 A / 32.0 A | 80 |

## 7-3 Fuse Specification Chart

- ☑ Fuse specifications lower than the table below are allowed.
- ☑ For installation in the United States, branch circuit protection must be provided in accordance with the National Electrical Code (NEC) and any applicable local codes. Use UL classified fuses to fulfill this requirement.
- ☑ For installation in Canada, branch circuit protection must be provided in accordance with Canadian Electrical Code and any applicable provincial codes. Use UL classified fuses to fulfill this requirement.

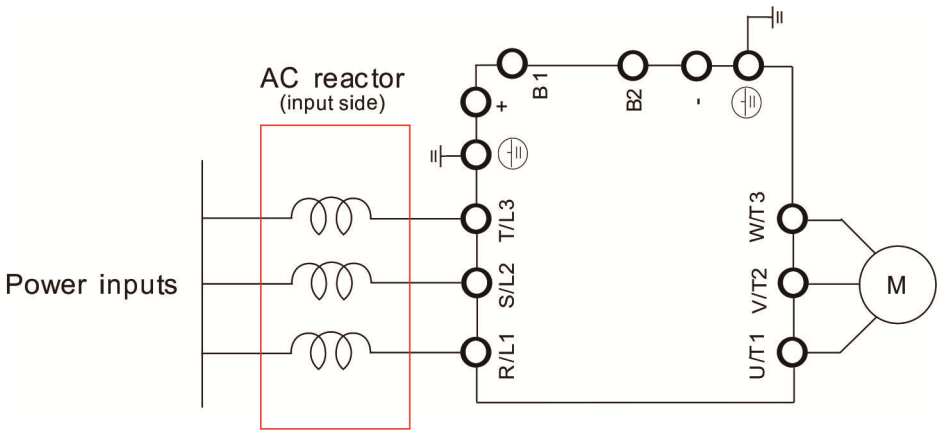
| Model | Voltage / three-phase | Current Input / Output (Max.) | Branch Circuit Fuses Output (A) |
|---|---|---|---|
| VFD11AMH23ANSLA | 230V / three-phase | 13.2 A / 11.0 A | 50<br>Class T JJS-50 |
| VFD17AMH23ANSLA | | 20.4 A / 17.0 A | 78<br>Class T JJS-80 |
| VFD25AMH23ANSLA | | 30.0 A / 25.0 A | 59.4<br>Class T JJS-60 |
| VFD33AMH23ANSLA | | 39.6 A / 33.0 A | 79.2<br>Class T JJS-80 |
| VFD49AMH23ANSLA | | 58.8 A / 49.0 A | 112.2<br>Class T JJS-110 |
| VFD65AMH23ANSLA | | 78.0 A / 65.0 A | 151.8<br>Class T JJS-150 |
| VFD9A0MH43ANSLA<br>VFD9A0MH43AFSLA | 460V / three-phase | 9.9 A / 9.0 A | 42<br>Class T JJS-45 |
| VFD13AMH43ANSLA<br>VFD13AMH43AFSLA | | 14.3 A / 13.0 A | 31.9<br>Class T JJS-30 |
| VFD17AMH43ANSLA<br>VFD17AMH43AFSLA | | 19.3 A / 17.5 A | 43.56<br>Class T JJS-45 |
| VFD25AMH43ANSLA<br>VFD25AMH43AFSLA | | 27.5 A / 25.0 A | 61.6<br>Class T JJS-60 |
| VFD32AMH43ANSLA<br>VFD32AMH43AFSLA | | 35.2 A / 32.0 A | 79.2<br>Class T JJS-80 |

# 7-4 AC/DC Reactor

Installing an AC reactor on the input side of an AC motor drive can increase line impedance, improve the power factor, reduce input current, and reduce interference generated from the motor drive. It also reduces momentary voltage surges or abnormal current spikes. For example, when the main power capacity is higher than 500 kVA, or when using a switching capacitor bank, momentary voltage and current spikes may damage the AC motor drive's internal circuit. An AC reactor on the input side of the AC motor drive protects it by suppressing surges.

## Installation

Install an AC input reactor in series with the main power to the three input phases R S T as shown below:




Connecting an AC input reactor Inductor

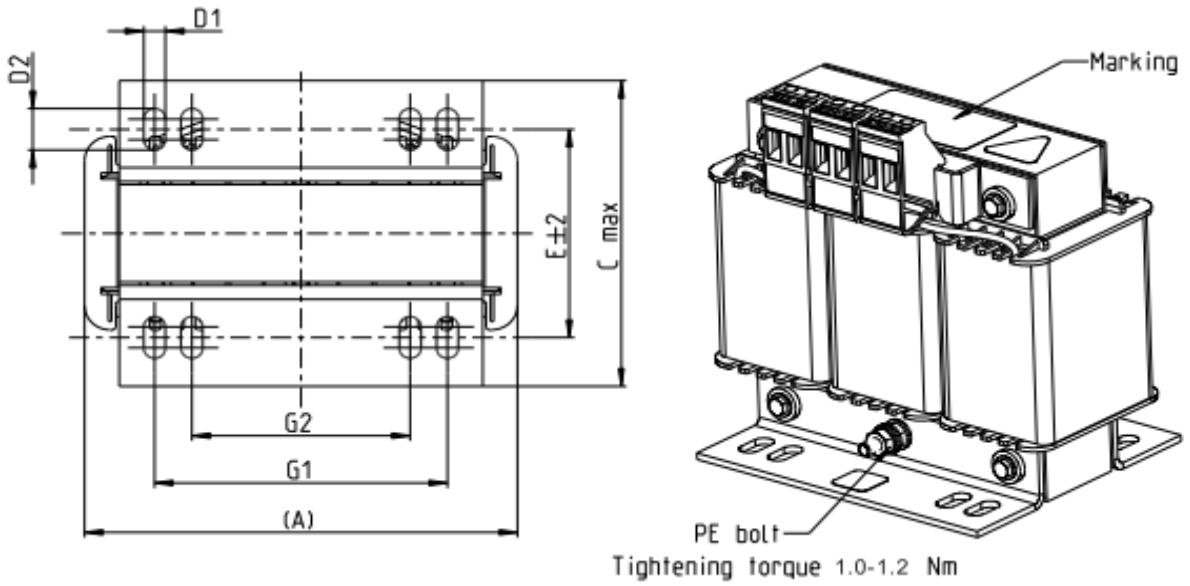
230V, 50–60Hz / Three-Phase

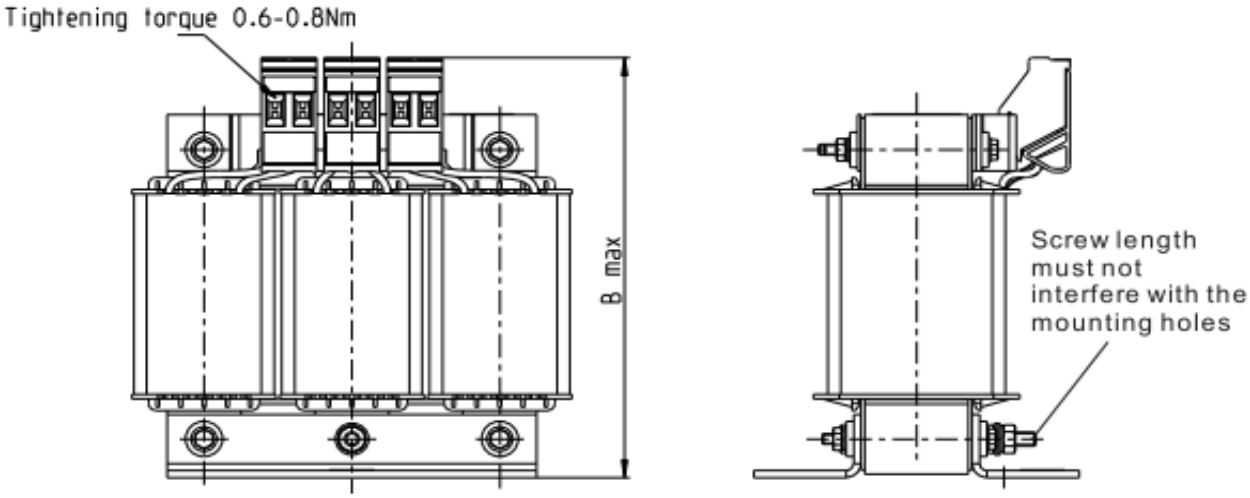
| Model | Rated Current ($A_{rms}$) | Saturation Current ($A_{rms}$) | AC Reactor | | DC Reactor | |
|---|---|---|---|---|---|---|
| | | | Input/ Output Inductor (mH) | Input Reactor Delta Part # | Inductor (mH) | Delta Part # |
| VFD11AMH23ANSLA | 11.0 | 22.0 | 1.152 | DR011A0115 | 2.662 | DR011D0266 |
| VFD17AMH23ANSLA | 17.0 | 34.0 | 0.746 | DR017AP746 | 1.722 | DR017D0172 |
| VFD25AMH23ANSLA | 25.0 | 50.0 | 0.507 | DR025AP507 | 1.172 | DR025D0117 |
| VFD33AMH23ANSLA | 33.0 | 66.0 | 0.32 | DR033AP320 | 0.851 | DR033DP851 |
| VFD49AMH23ANSLA | 49.0 | 98.0 | 0.216 | DR049AP215 | 0.574 | DR049DP574 |
| VFD65AMH23ANSLA | 65.0 | 130.0 | 0.163 | DR065AP162 | 0.432 | DR065DP432 |

460V, 50–60Hz / Three-Phase

| Model | Rated Current ($A_{rms}$) | Saturation Current ($A_{rms}$) | AC Reactor | | DC Reactor | |
|---|---|---|---|---|---|---|
| | | | Input/ Output Inductor (mH) | Input Reactor Delta Part # | Inductor (mH) | Delta Part # |
| VFD9A0MH43ANSLA<br>VFD9A0MH43AFSLA | 9.0 | 18.0 | 2.7 | DR009A0270 | 6.236 | DR009D0623 |
| VFD13AMH43ANSLA<br>VFD13AMH43AFSLA | 13.0 | 26.0 | 1.174 | DR018A0117 | 4.677 | DR012D0467 |
| VFD17AMH43ANSLA<br>VFD17AMH43AFSLA | 17.5 | 35.0 | 1.174 | DR018A0117 | 3.119 | DR018D0311 |
| VFD25AMH43ANSLA<br>VFD25AMH43AFSLA | 25.0 | 50.0 | 0.881 | DR024AP881 | 2.338 | DR024D0233 |
| VFD32AMH43ANSLA<br>VFD32AMH43AFSLA | 32.0 | 64.0 | 0.66 | DR032AP660 | 1.754 | DR032D0175 |

AC input reactor dimension and specification:

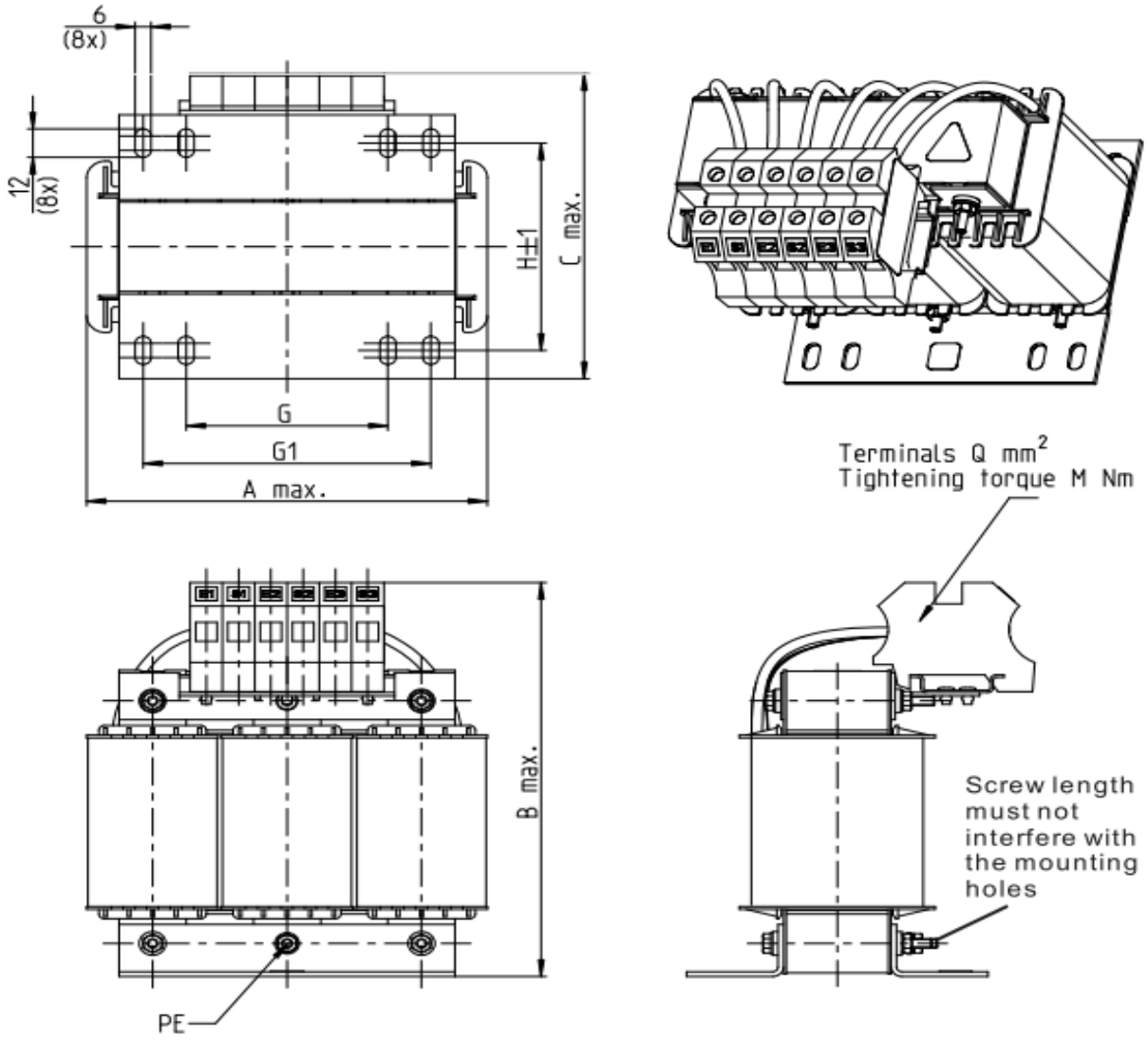



| Screw Location | Torque |
|---|---|
| Terminal | 5.32–7.09 kg-cm / [6.12–8.16 lb-in.] / [0.6–0.8 Nm] |
| PE bolt | 8.86–10.63 kg-cm / [10.2–12.24 lb-in.] / [1.0–1.2 Nm] |

| Input AC reactor Delta part # | A | B | C | D1*D2 | E | G1 | G2 | PE D |
|---|---|---|---|---|---|---|---|---|
| DR011A0115 | 120 | 120 | 88 | 6*12 | 60 | 80.5 | 60 | M4 |
| DR017AP746 | 120 | 120 | 93 | 6*12 | 65 | 80.5 | 60 | M4 |
| DR025AP507 | 150 | 150 | 112 | 6*12 | 88 | 107 | 75 | M4 |
| DR033AP320 | 150 | 150 | 112 | 6*12 | 88 | 107 | 75 | M4 |

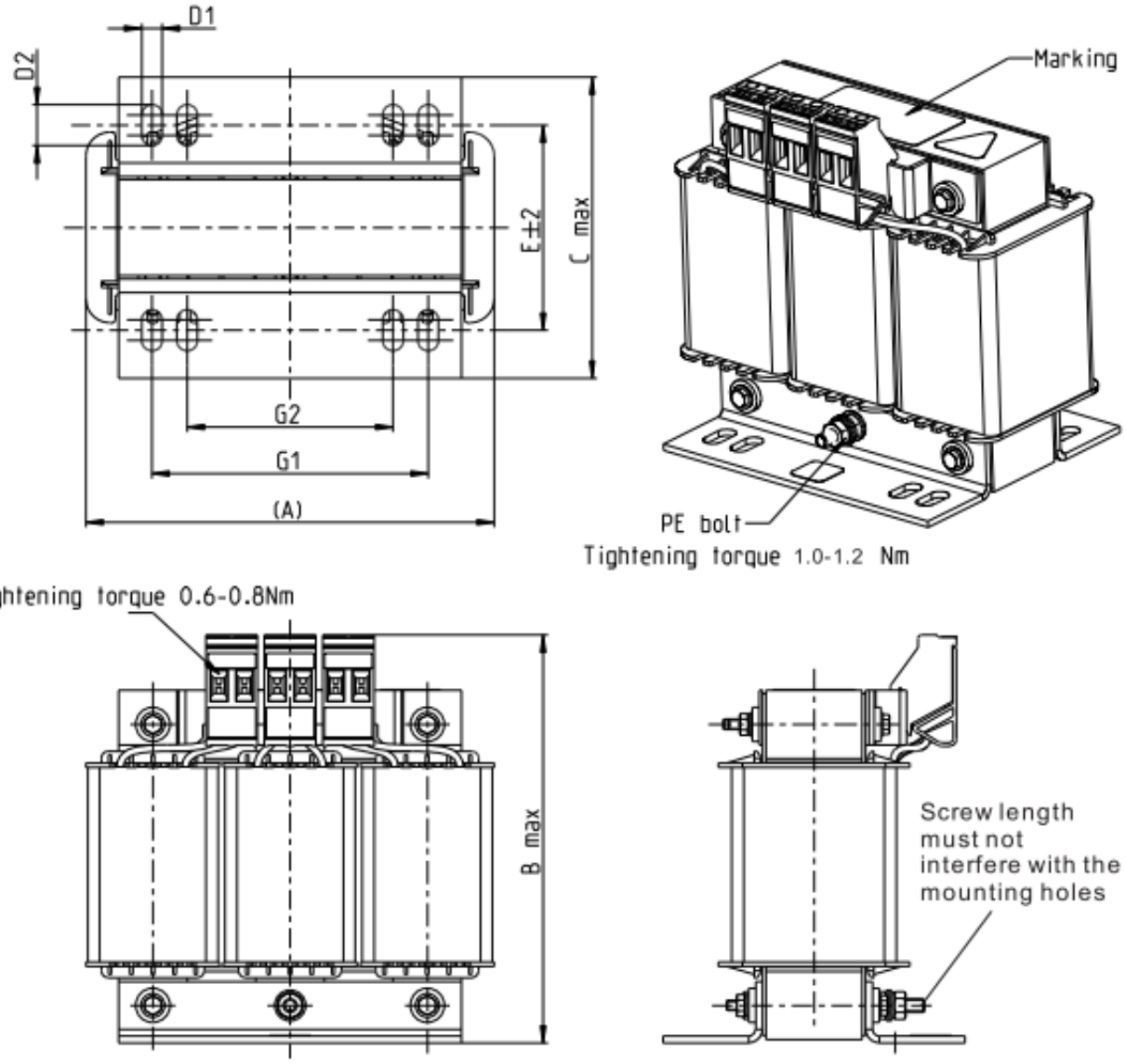
Unit：mm




| Screw Location | Torque |
|---|---|
| Terminal | 10.63–12.4 kg-cm / [12.24–14.28 lb-in.] / [1.2–1.4 Nm] |

| Input AC reactor Delta part # | A | B | C | D1*D2 | H | G | G1 | Q | M | PE D |
|---|---|---|---|---|---|---|---|---|---|---|
| DR049AP215 | 180 | 195 | 160 | 6*12 | 115 | 85 | 122 | 16 | 1.2–1.4 | M4 |
| DR065AP163 | 180 | 205 | 160 | 6*12 | 115 | 85 | 122 | 35 | 2.5–3.0 | M4 |

Unit：mm




| Screw Location | Torque |
|---|---|
| Terminal | 5.32–7.09 kg-cm / [6.12–8.16 lb-in.] / [0.6–0.8 Nm] |
| PE bolt | 8.86–10.63 kg-cm / [10.2–12.24 lb-in.] / [1.0–1.2 Nm] |

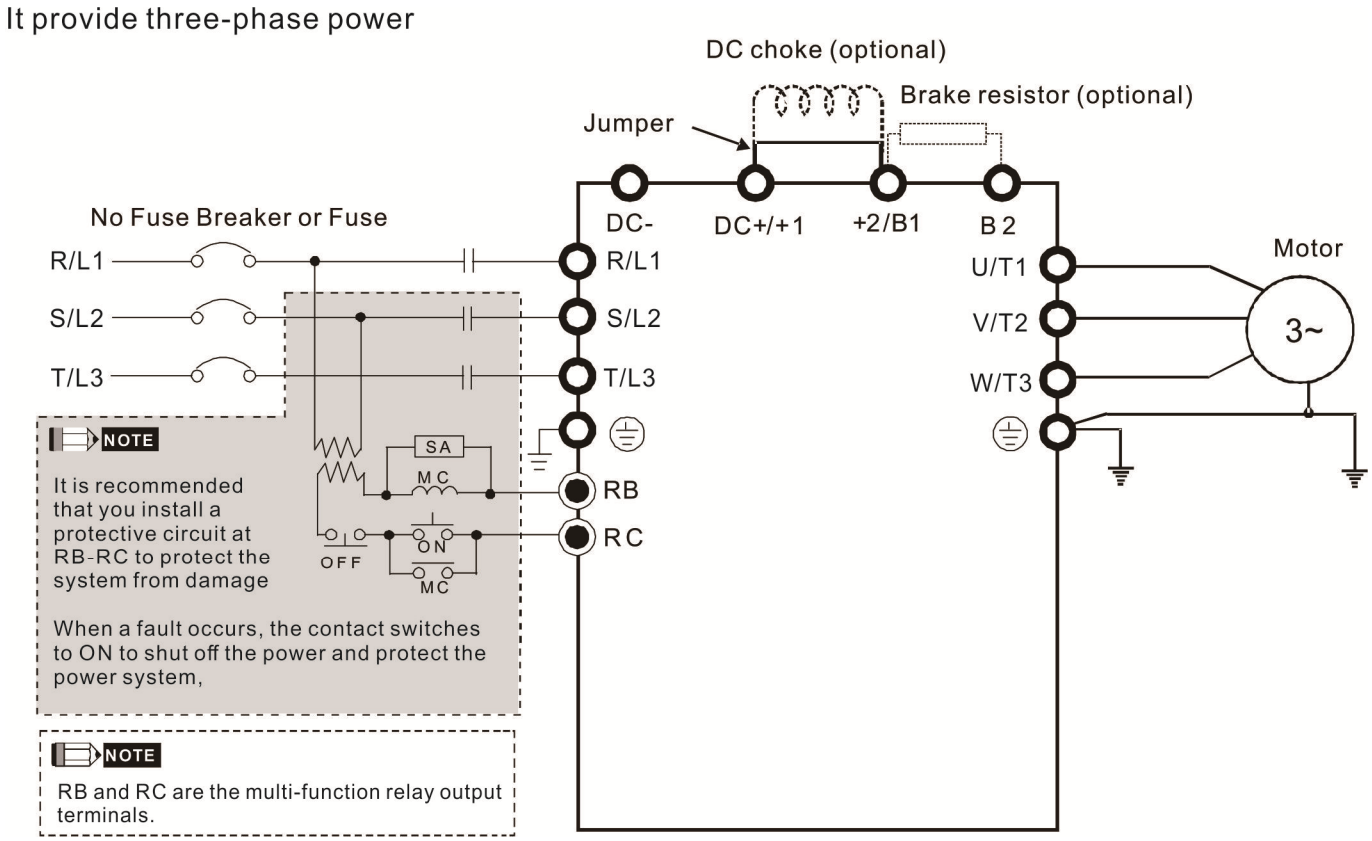
| Input AC reactor Delta part # | A | B | C | D1*D2 | E | G1 | G2 | PE D |
|---|---|---|---|---|---|---|---|---|
| DR009A0270 | 150 | 150 | 88 | 6*12 | 74 | 107 | 75 | M4 |
| DR018A0117 | 150 | 155 | 112 | 6*12 | 88 | 107 | 75 | M4 |
| DR024AP881 | 150 | 155 | 112 | 6*12 | 88 | 107 | 75 | M4 |
| DR032AP660 | 180 | 175 | 138 | 6*12 | 114 | 122 | 85 | M6 |

Unit：mm

A DC reactor can also improve the power factor, reduce input current, and reduce interference generated from the motor drive. A DC reactor stabilizes the DC BUS voltage. Compared to an AC input reactor, the advantages are smaller size, lower price, and lower voltage drop (lower power dissipation).

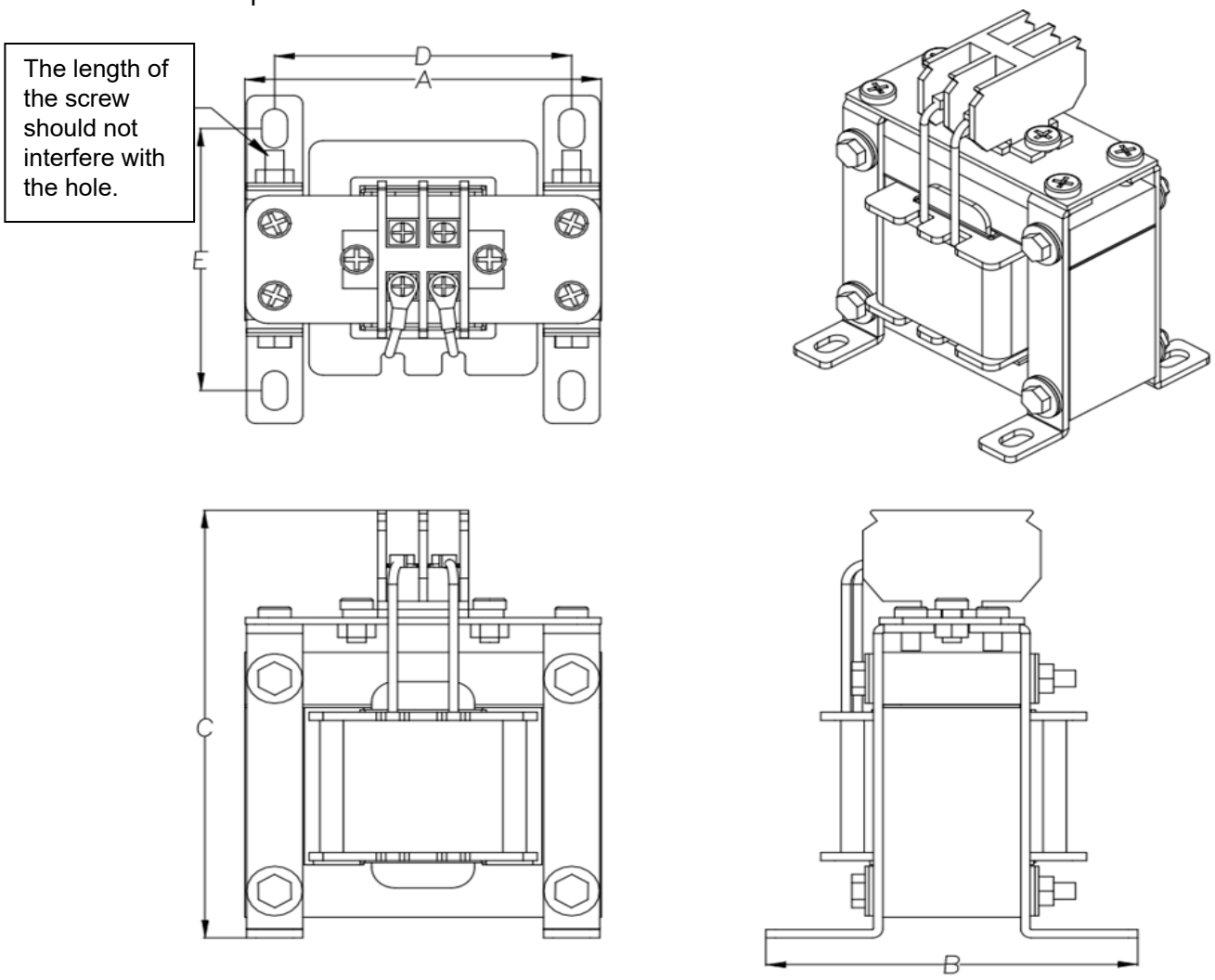
## Installation

Install the DC reactor between terminals +1 and +2. Remove the jumper, shown below, before installing the DC reactor.




Wiring of DC reactor

DC reactor dimension and specification:




| DC reactor Delta Part # | Rated Current (Arms) | Saturation current (Arms) | DC reactor (mH) | A (mm) | B (mm) | C (mm) | D (mm) | E (mm) | Dimension (mm) |
|---|---|---|---|---|---|---|---|---|---|
| DR011D0266 | 11 | 18 | 2.662 | 79 | 92 | 112 | 64±2 | 69.5±2 | 9.5*5.5 |
| DR017D0172 | 17 | 28.8 | 1.722 | 79 | 112 | 112 | 64±2 | 89.5±2 | 9.5*5.5 |
| DR025D0117 | 25 | 43.2 | 1.172 | 99 | 105 | 128 | 79±2 | 82.5±2 | 9.5*5.5 |
| DR033DP851 | 33 | 55.8 | 0.851 | 117 | 110 | 156 | 95±2 | 87±2 | 10*6.5 |
| DR049DP574 | 49 | 84.6 | 0.574 | 117 | 120 | 157 | 95±2 | 97±2 | 10*6.5 |
| DR065DP432 | 65 | 111.6 | 0.432 | 117 | 140 | 157 | 95±2 | 116.5±2 | 10*6.5 |
| DR009D0623 | 9 | 14.58 | 6.236 | 79 | 112 | 112 | 64±2 | 89.5±2 | 9.5*5.5 |
| DR012D0467 | 12 | 19.8 | 4.677 | 99 | 105 | 128 | 79±2 | 82.5±2 | 9.5*5.5 |
| DR018D0311 | 18 | 30.6 | 3.119 | 117 | 110 | 144 | 95±2 | 87±2 | 10*6.5 |
| DR024D0233 | 24 | 41.4 | 2.338 | 117 | 120 | 144 | 95±2 | 97±2 | 10*6.5 |
| DR032D0175 | 32 | 54 | 1.754 | 117 | 140 | 157 | 95±2 | 116.5±2 | 10*6.5 |

## Length of Motor Cable

1. Leakage current affects the motor and remedies

Due to larger parasitic capacitances in longer motor cables, longer cables increase the leakage current. This can activate the over-current protection and display the incorrect current. In the worst case, it can damage the drive.

If more than one motor is connected to the AC motor drive, the total motor cable length is the sum of the cable length from the AC motor drive to each motor.

For 460V series AC motor drives, when an overload relay is installed between the drive and the motor to protect the motor from overheating, the connecting cable must be shorter than 50 m.

However, the overload relay could still malfunction. To prevent this, install an AC output reactor (optional) to the drive and/or lower the carrier frequency setting (Pr.00-17).

2. Surge voltage affects the motor and remedies

When a PWM signal from an AC motor drive drives the motor, the motor terminals can easily experience surge voltages (dv/dt) due to IGBT switching and cable capacitance. When the motor cable is very long (especially for the 460V series), surge voltages (dv/dt) may reduce motor insulation quality. To prevent this, follow the rules listed below.

a. Use a motor with enhanced insulation.
b. Connect an output reactor (optional) to the output terminals of the AC motor drive.
c. Reduce the motor cable length to the values in the table below.

The suggested motor shielded cable length in the following table complies with IEC 60034-17, which is suitable for motors with a rated voltage ≤ 500 $V_{AC}$ and with an insulation level of ≥ 1.35 $kV_{p-p}$

| 230V three-phase Model | Rated current (Arms) | Without AC reactor | | With AC reactor | |
|---|---|---|---|---|---|
| | | Shielded Cable (meter) | Non-shielded cable (meter) | Shielded Cable (meter) | Non-shielded cable (meter) |
| VFD11AMH23ANSLA | 12.5 | 50 | 75 | 75 | 115 |
| VFD17AMH23ANSLA | 19.5 | 50 | 75 | 75 | 115 |
| VFD25AMH23ANSLA | 27.0 | 50 | 75 | 75 | 115 |
| VFD33AMH23ANSLA | 36.0 | 100 | 150 | 150 | 225 |
| VFD49AMH23ANSLA | 51.0 | 100 | 150 | 150 | 225 |
| VFD65AMH23ANSLA | 69.0 | 100 | 150 | 150 | 225 |

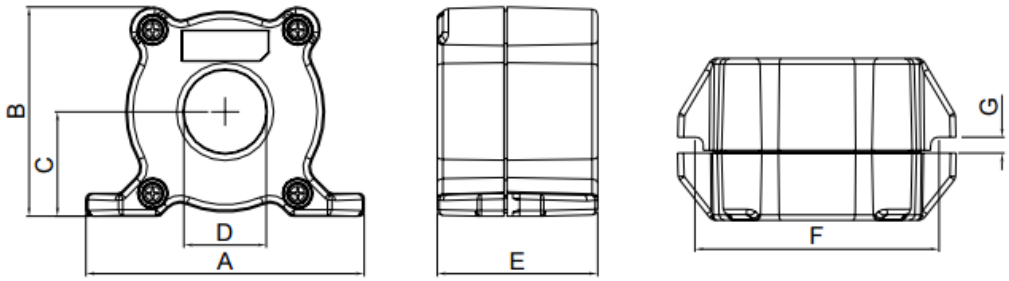
| 460V three-phase Model | Rated current (Arms) | Without AC reactor | | With AC reactor | |
|---|---|---|---|---|---|
| | | Shielded Cable (meter) | Non-shielded cable (meter) | Shielded Cable (meter) | Non-shielded cable (meter) |
| VFD9A0MH43ANSLA<br>VFD9A0MH43AFSLA | 10.5 | 50 | 75 | 75 | 115 |
| VFD13AMH43ANSLA<br>VFD13AMH43AFSLA | 14.5 | 50 | 75 | 75 | 115 |
| VFD17AMH43ANSLA<br>VFD17AMH43AFSLA | 19.8 | 100 | 150 | 150 | 225 |
| VFD25AMH43ANSLA<br>VFD25AMH43AFSLA | 28.0 | 100 | 150 | 150 | 225 |
| VFD32AMH43ANSLA<br>VFD32AMH43AFSLA | 36.0 | 100 | 150 | 150 | 225 |

## 7-5 Zero Phase Reactors

You can also suppress interference by installing a zero phase reactor at the main input or the motor output of the drive, depending on the location of the interference. Delta provides two types of zero phase reactors to solve interference problems.

A. Casing with mechanical fixed part

This solution is for the main input/motor output side and can withstand higher loading, and be used at higher frequencies. You can get higher impedance by increasing the number of turns.

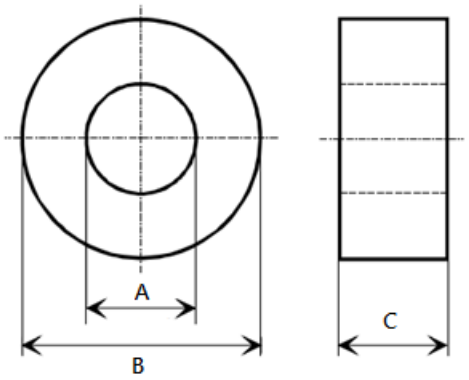



Unit: mm

| Model | A | B | C | D | E | F | G(Ø) | To use w/ |
|---|---|---|---|---|---|---|---|---|
| RF008X00A | 99 | 73 | 36.5 | 29 | 56.5 | 86 | 5.5 | Motor cable |

B. Casing without mechanical fixed part

This solution has higher performance: high initial magnetic permeability, high saturation induction density, low iron loss and perfect temperature characteristic. If the zero phase reactor does not need to be fixed mechanically, use this solution.




Unit: mm

| Model | A | B | C |
|---|---|---|---|
| T60006L2040W453 | 22.5 | 43.1 | 18.5 |
| T60006L2050W565 | 36.3 | 53.5 | 23.4 |

## Installation

During installation, pass the cable through at least one zero phase reactor.
Use a suitable cable type (insulation class and wire section) so that the cable passes easily through the zero phase reactor. Do not pass the grounding cable through the zero phase reactor; only pass the motor wire through the zero phase reactor.

With longer motor cables the zero phase reactor can effectively reduce interference at the motor output. Install the zero phase reactor as close to the output of the drive as possible. Figure A shows the installation diagram for a single turn zero phase reactor. If the wire diameter allows several turns, Figure B shows the installation of a multi-turn zero phase reactor. The more turns, the better the noise suppression effect.

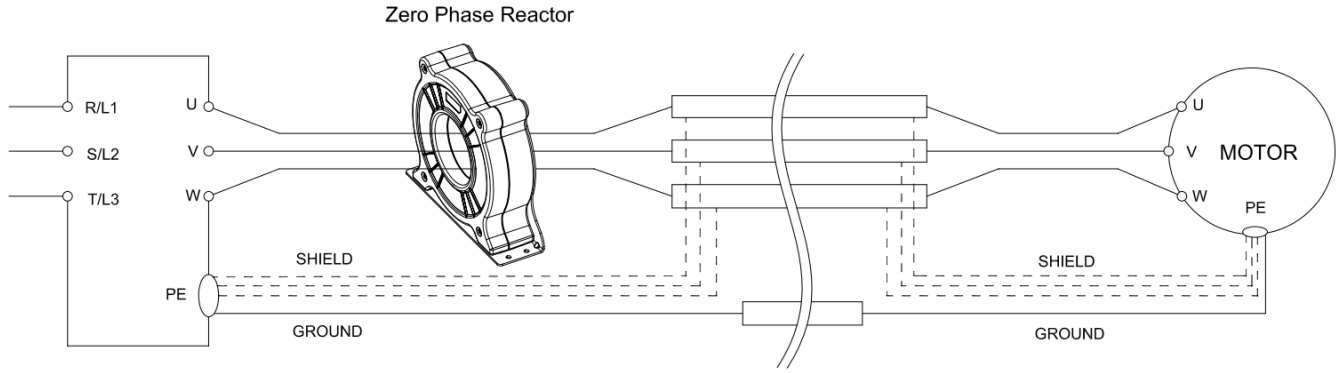



Figure A: Single turn wiring diagram of a shieling wire with a zero phase reactor

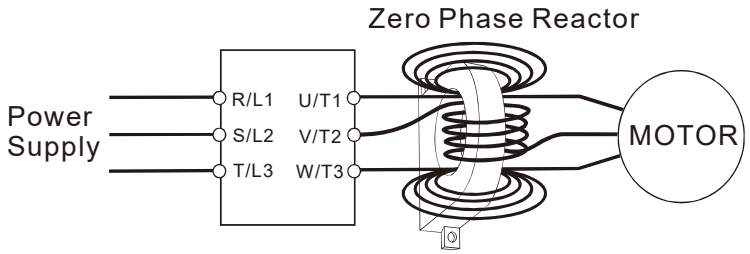



Figure B: Multi-Turn Zero Phase Reactor

## Installation notices

Install the zero phase reactor at the output terminal of the frequency converter (U.V.W.).
After the zero phase reactor is installed, it reduces the electromagnetic radiation and load stress emitted by the wiring of the frequency converter. The number of zero phase reactors required for the drive depends on the wiring length and the drive voltage.

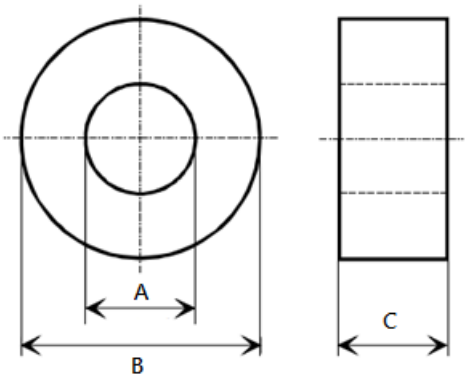
The normal operating temperature of the zero phase reactor should be lower than 85°C (176°F). However, when the zero phase reactor is saturated, its temperature may exceed 85°C (176°F). In this case, increase the number of zero phase reactors to avoid saturation. The following are reasons that might cause saturation of the zero phase reactors: the drive wiring is too long, the drive has several sets of loads, the wiring is in parallel, or the drive uses high capacitance wiring. If the temperature of the zero phase reactor exceeds 85°C (176°F) during the operation of the drive, increase the number of zero phase reactors.

### Recommended max. wiring gauge when installing zero phase reactor

| Model # of Zero Phase Reactor | Max, Wire Gauge or LUG width | Max. Wire Gauge AWG (1Cx3) | | Max. Wire Gauge AWG (1Cx4) | |
|---|---|---|---|---|---|
| | | 75 °C | 90 °C | 75 °C | 90 °C |
| RF008X00A | 13 mm | 3 AWG | 1 AWG | 3 AWG | 1 AWG |
| T600006L2040W453 | 11 mm | 9 AWG | 4 AWG | 6 AWG | 6 AWG |
| T600006L2050W565 | 16 mm | 1 AWG | 2/0 AWG | 1 AWG | 1/0 AWG |

### Zero Phase Reactor for Signal Cable

To solve interference problems between signal cables and electric devices, install a zero phase reactor on signal cable. Install it on the signal cable which is the source of the interference to suppress the noise for a better signal. The model names and dimensions are in the table below.

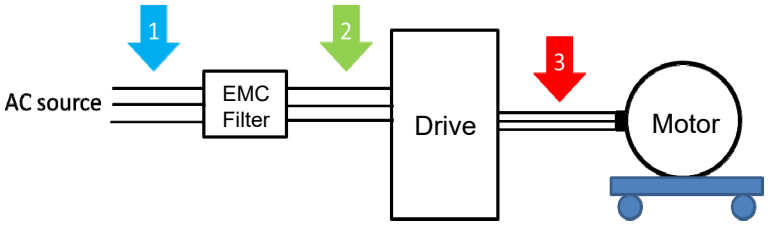



| Model | A | B | C |
|---|---|---|---|
| T60004L2016W620 | 10.7 | 17.8 | 8.0 |
| T60004L2025W622 | 17.5 | 27.3 | 12.3 |

Unit: mm

# 7-6 EMC Filter

| Frame | Model # | Input Current (A) | Filter model # | Recommended model of zero-phase reactor | | Conducted emission maximum motor cable length | | | | Radiated emission maximum motor cable length | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | C1 30m | | | C2 100m | C2 100m | | |
| | | | | | | Position to place zero phase reactor | | | | | | |
| | | | | DELTA | $V_{AC}$ | *1 | *2 | *3 | N/A | *1 | *2 | *3 |
| C | VFD11AMH23ANSLA | 15 | EMF24AM23B | RF008X00A | T60006L2040W453 | | ✓ | ✓ | NA | | ✓ | ✓ |
| C | VFD17AMH23ANSLA | 23.4 | EMF24AM23B | RF008X00A | T60006L2040W453 | | ✓ | ✓ | NA | | ✓ | ✓ |
| C | VFD9A0MH43ANSLA | 11.6 | EMF12AM43B | RF008X00A | T60006L2040W453 | | ✓ | ✓ | NA | | ✓ | ✓ |
| D | VFD25AMH23ANSLA | 32.4 | EMF33AM23B | RF008X00A | T60006L2050W565 | ✓ | ✓ | | NA | ✓ | ✓ | |
| D | VFD13AMH43ANSLA | 16.0 | EMF23AM43B | RF008X00A | T60006L2050W565 | ✓ | ✓ | ✓ | NA | ✓ | ✓ | ✓ |
| D | VFD17AMH43ANSLA | 21.8 | EMF23AM43B | RF008X00A | T60006L2050W565 | ✓ | ✓ | ✓ | NA | ✓ | ✓ | ✓ |
| E | VFD33AMH23ANSLA | 43.2 | B84143D0050R127 | RF008X00A | T60006L2050W565 | | ✓ | ✓ | NA | | ✓ | ✓ |
| E | VFD49AMH23ANSLA | 61.2 | B84143D0075R127 | RF008X00A | T60006L2050W565 | | ✓ | ✓ | NA | | ✓ | ✓ |
| E | VFD25AMH43ANSLA | 30.8 | B84143D0050R127 | RF008X00A | T60006L2050W565 | | ✓ | ✓ | NA | | ✓ | ✓ |
| E | VFD32AMH43ANSLA | 39.6 | B84143D0050R127 | RF008X00A | T60006L2050W565 | | ✓ | ✓ | NA | | ✓ | ✓ |
| F | VFD65AMH23ANSLA | 82.8 | B84143D0090R127 | RF008X00A | T60006L2050W565 | | ✓ | ✓ | NA | | ✓ | ✓ |

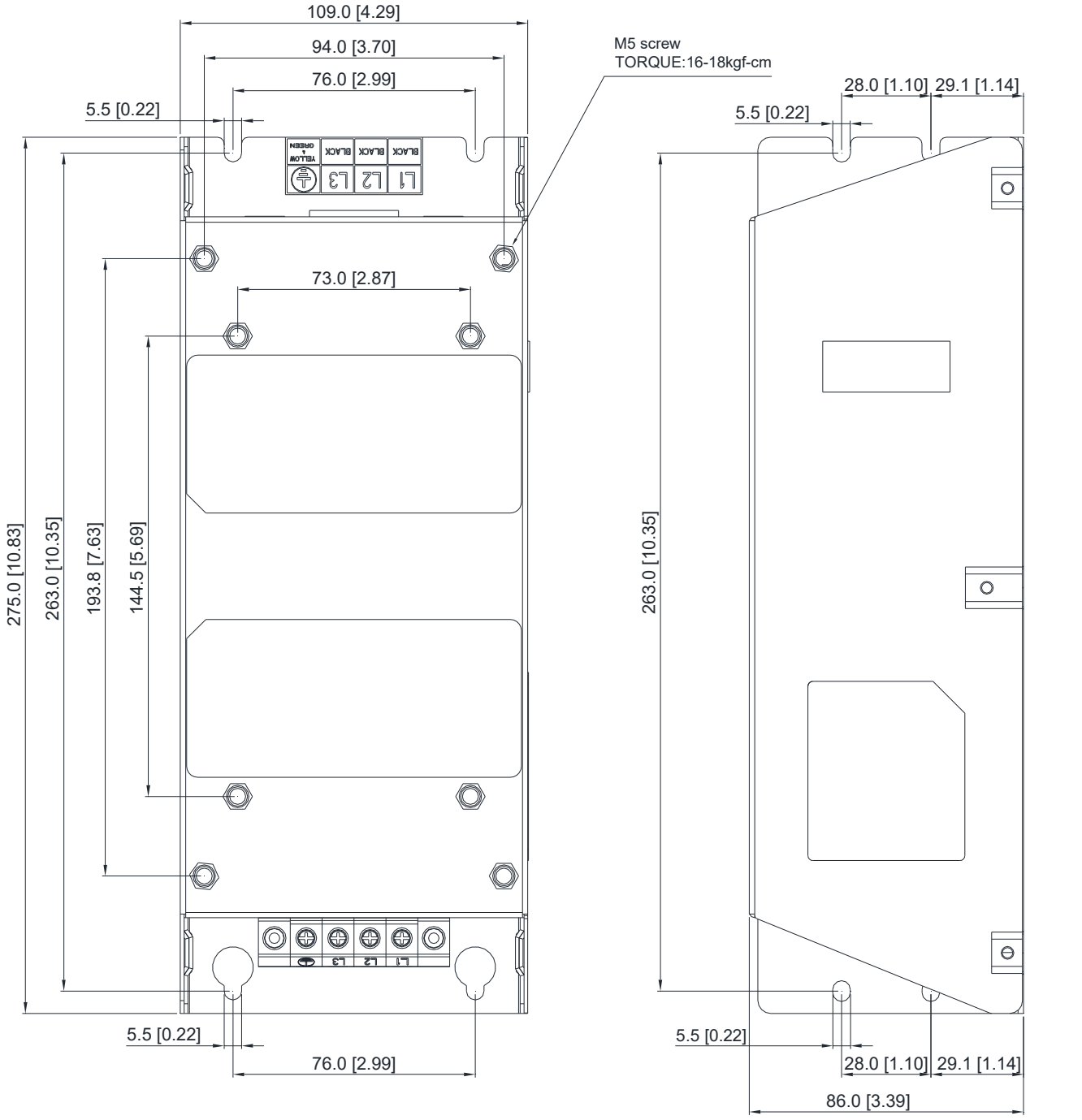


# Filter Dimension

EMF24AM23B; EMF33AM23B;

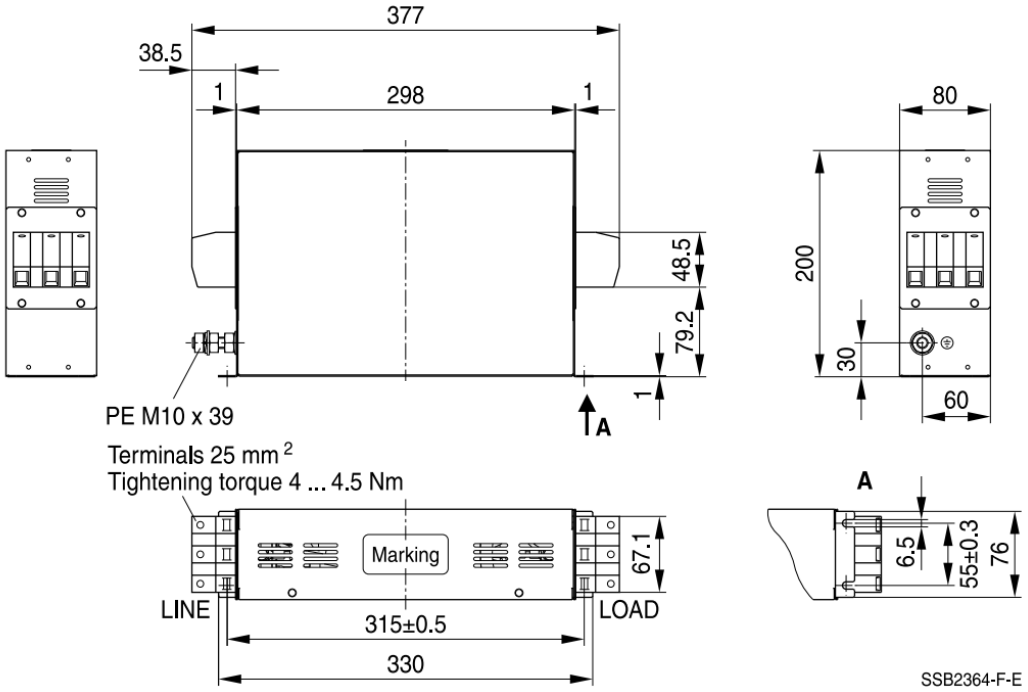
EMF12AM43B; EMF23AM43B;

| Screw | Torque |
|---|---|
| M5 * 4 | 16–20 kg-cm / [13.9–17.3 lb-in.] / [1.56–1.96 Nm] |

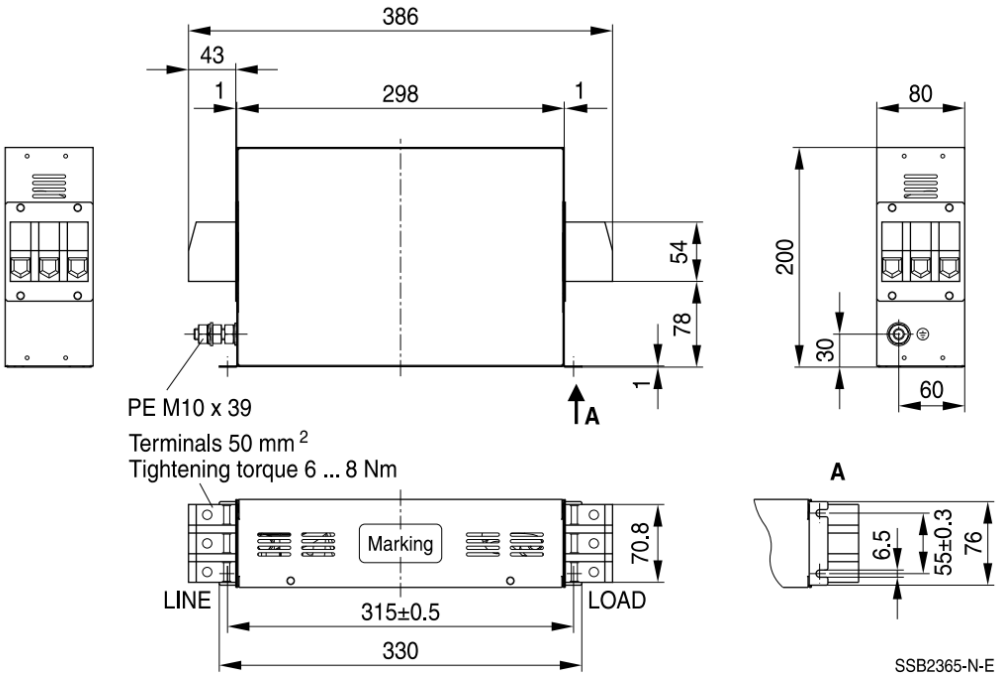



Unit: mm [inch]

TDK B84143D0050R127 (50A)




TDK B84143D0075R127 (75A), TDK B84143D0090R127 (90A)

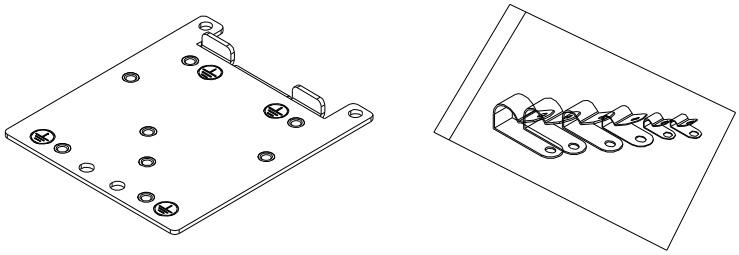
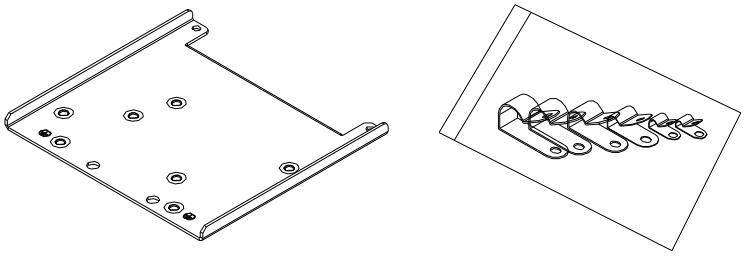
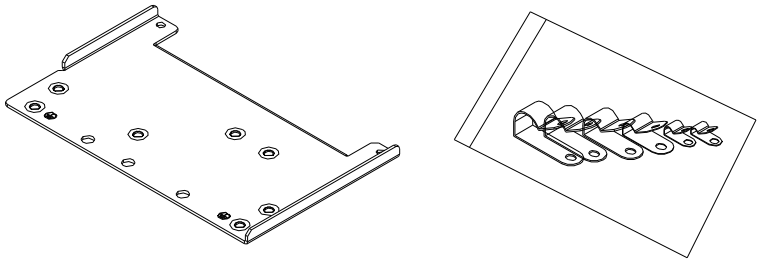
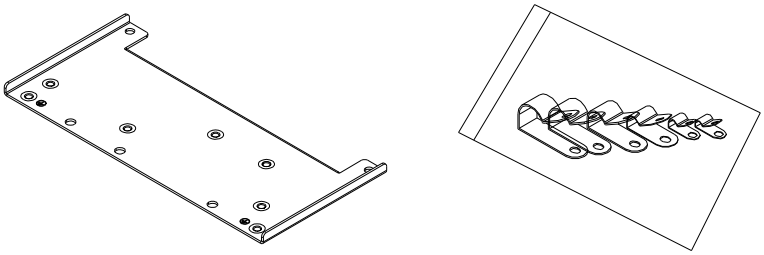


The table below is the maximum shielded cable length for drive models with built-in EMC filters. You can choose the corresponding shielded cable length according to the required noise emission and electromagnetic interference class.

| Drive Models with Built-in Filters | | Rated Current (HD) | Compliance with EMC (IEC 61800-3) Class C3 | | Compliance with EMC (IEC 61800-3) Class C2 | |
|---|---|---|---|---|---|---|
| Frame | Models | | Shielded Cable Length | Fc | Shielded Cable Length | Fc |
| C | VFD9A0MH43AFSLA | 9 | 30 m | 4 kHz | 20 m | 4 kHz |
| D | VFD13AMH43AFSLA | 13 | | | | |
| | VFD17AMH43AFSLA | 17.5 | | | | |
| E | VFD25AMH43AFSLA | 25 | | | | |
| | VFD32AMH43AFSLA | 32 | | | | |

# 7-7 EMC Shield Plate

EMC Shield Plate (for use with shielded cable)

| Frame | Model of EMC Shield Plate | Reference figure |
|---|---|---|
| C | MKM-EPC |  |
| D | MKM-EPD |  |
| E | MKM-EPE |  |
| F | MKM-EPF |  |

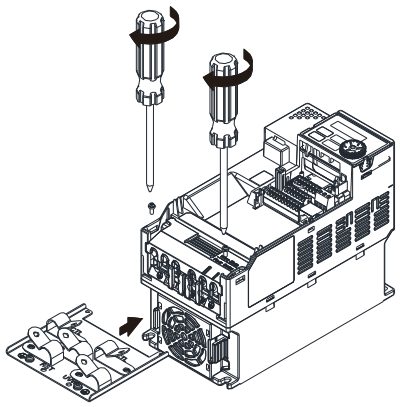
## Installation

(Frame D model as an example)

1. As shown on the right figures, fix the iron plate on the AC motor drive.

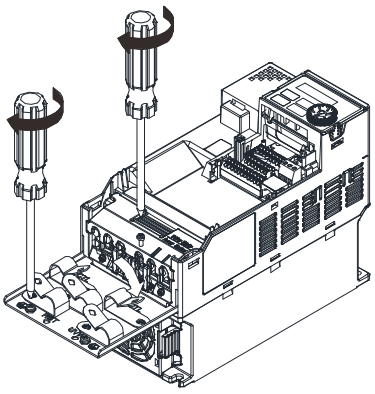
   Torque value:

| Frame | Screw | Torque |
|---|---|---|
| C | M4 | 6–8 kg-cm / [5.2–6.9 lb-in.] / [0.59–0.78 Nm] |
| D | M3 | 4–6 kg-cm / [3.5–5.2 lb-in.] / [0.39–0.59 Nm] |
| E | M3 | 4–6 kg-cm / [3.5–5.2 lb-in.] / [0.39–0.59 Nm] |
| F | M4 | 6–8 kg-cm / [5.2–6.9 lb-in.] / [0.59–0.78 Nm] |

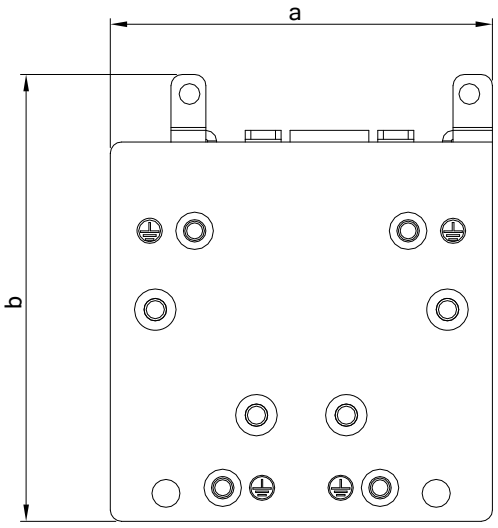


2. After selecting a suitable R-clip according to the wire gauge used, fix the R-clip on the shield plate.

| Screw | Torque |
|---|---|
| M4 | 6–8 kg-cm / [5.2–6.9 lb-in.] / [0.59–0.78 Nm] |

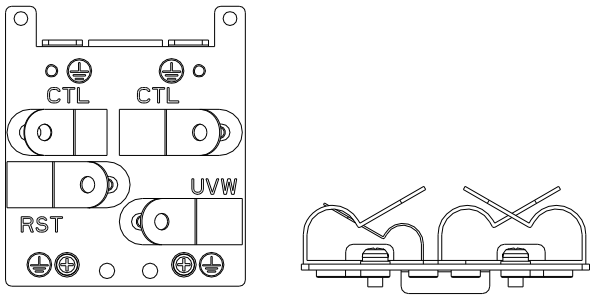
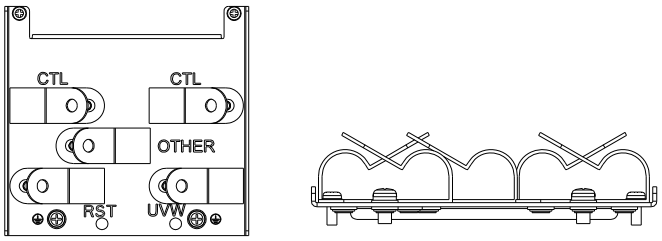
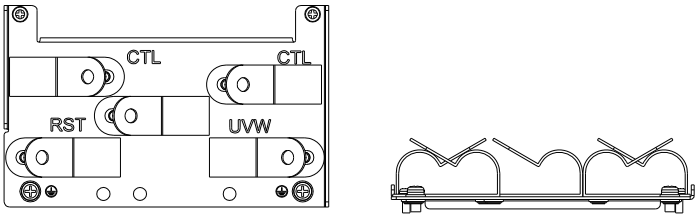
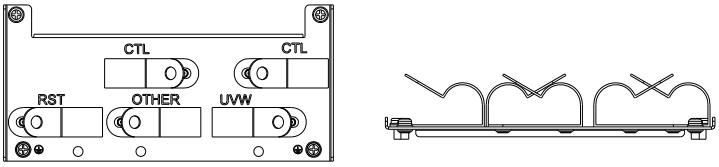


Dimensions of EMC Shield Plate




| Model | Dimensions of Shield Plate mm [inch] | |
|---|---|---|
| | a | b |
| MKM-EPC | 78.0 [3.07] | 91.0 [3.58] |
| MKM-EPD | 103.4 [4.07] | 97.0 [3.82] |
| MKM-EPE | 124.3 [4.89] | 77.4 [3.05] |
| MKM-EPF | 168.0 [6.61] | 80.0 [3.15] |

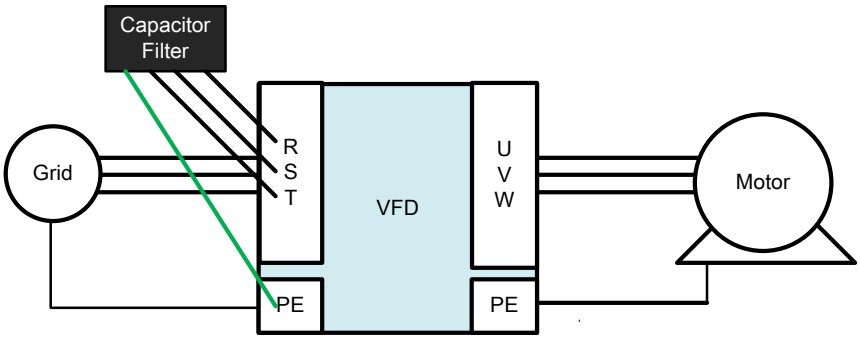
Recommended wire mounting method

| Frame | Model of EMC Shield Plate | Reference figure |
|---|---|---|
| C | MKM-EPC |  |
| D | MKM-EPD |  |
| E | MKM-EPE |  |
| F | MKM-EPF |  |

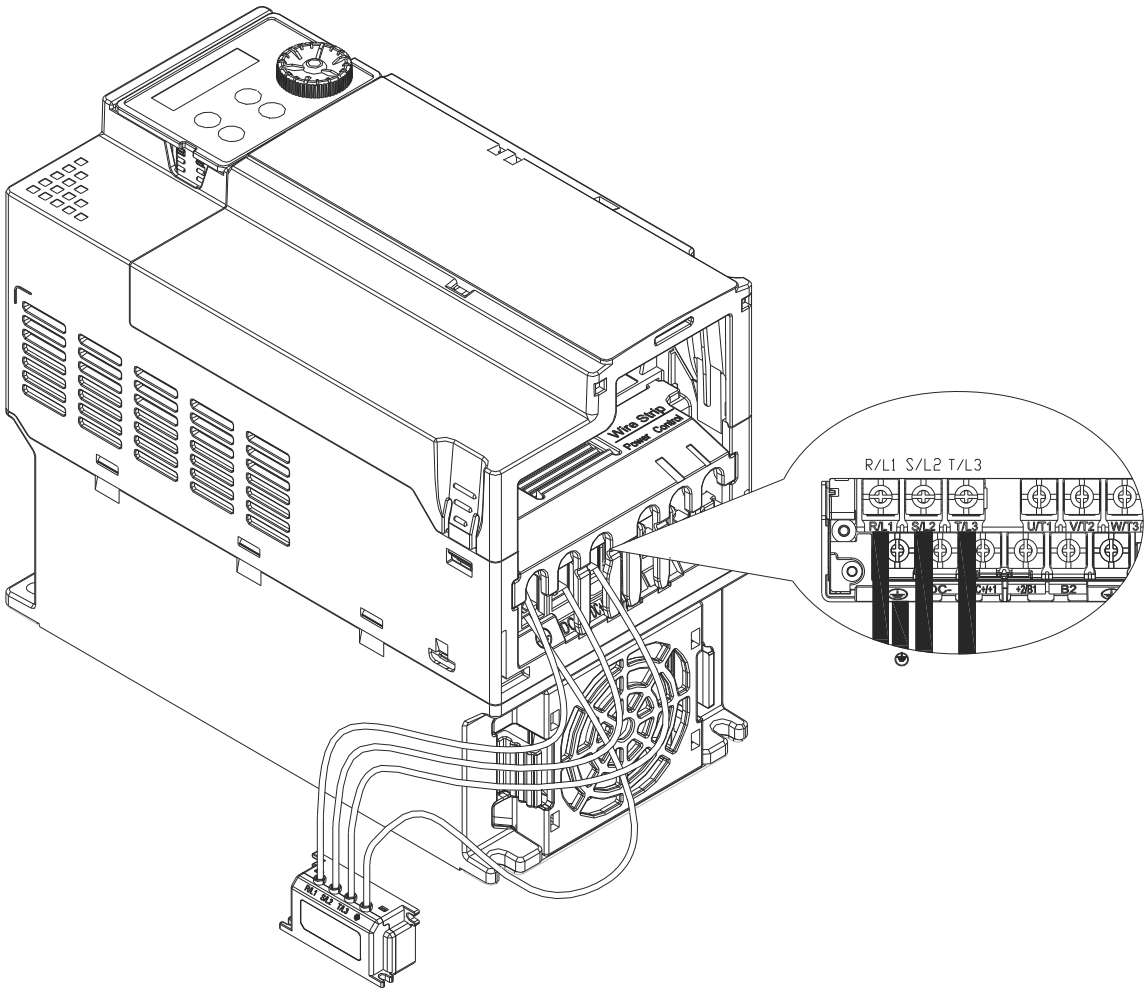
# 7-8 Capacitive Filter

### Installation diagram:

The capacitive filter (CXY101-43A) is a simple filter that supports basic filtering and noise interference reduction.




Capacitive filter and drive wiring figure:



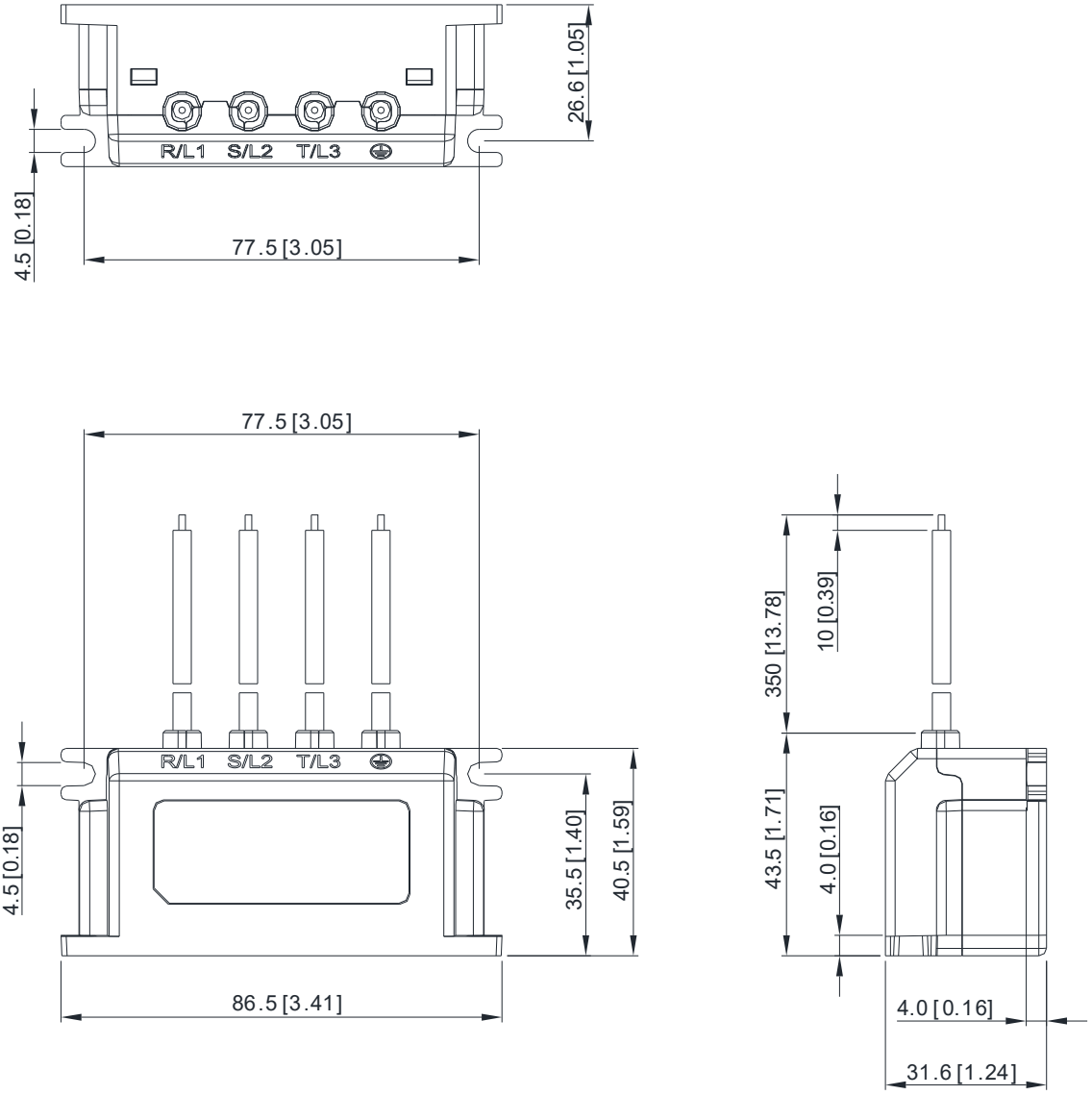
**Specification:**

| Model | Capacitance | Temperature range |
|---|---|---|
| CXY101-43A | Cx：1 μF ± 20 %<br>Cy：0.1 μF ± 20 % | -40—+85°C |

Dimensions:

CXY101-43A

Unit：mm [inch]

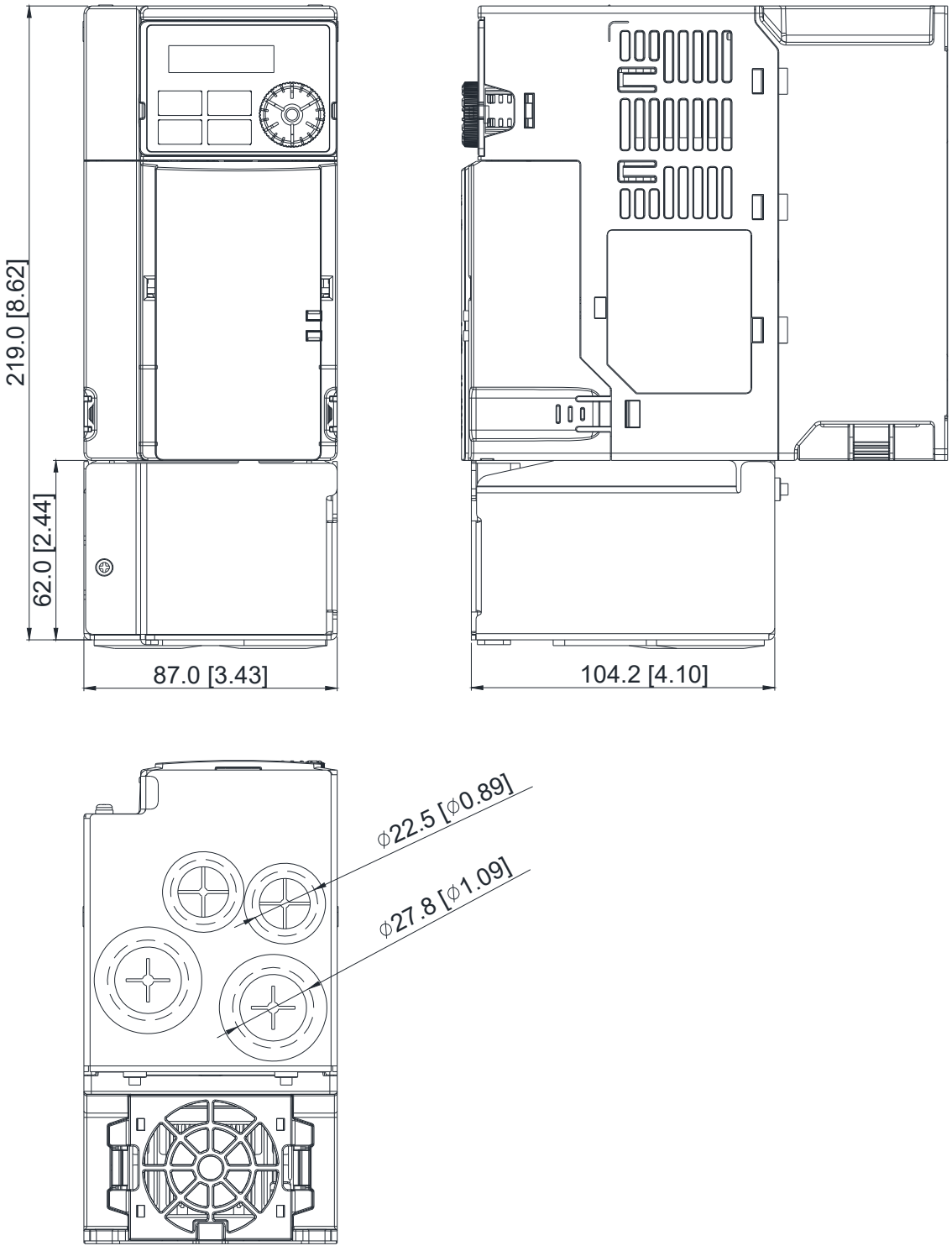


# 7-9 NEMA Kit

NEMA KIT complies with protection level NEMA 1 / UL Type 1.

**Frame C**

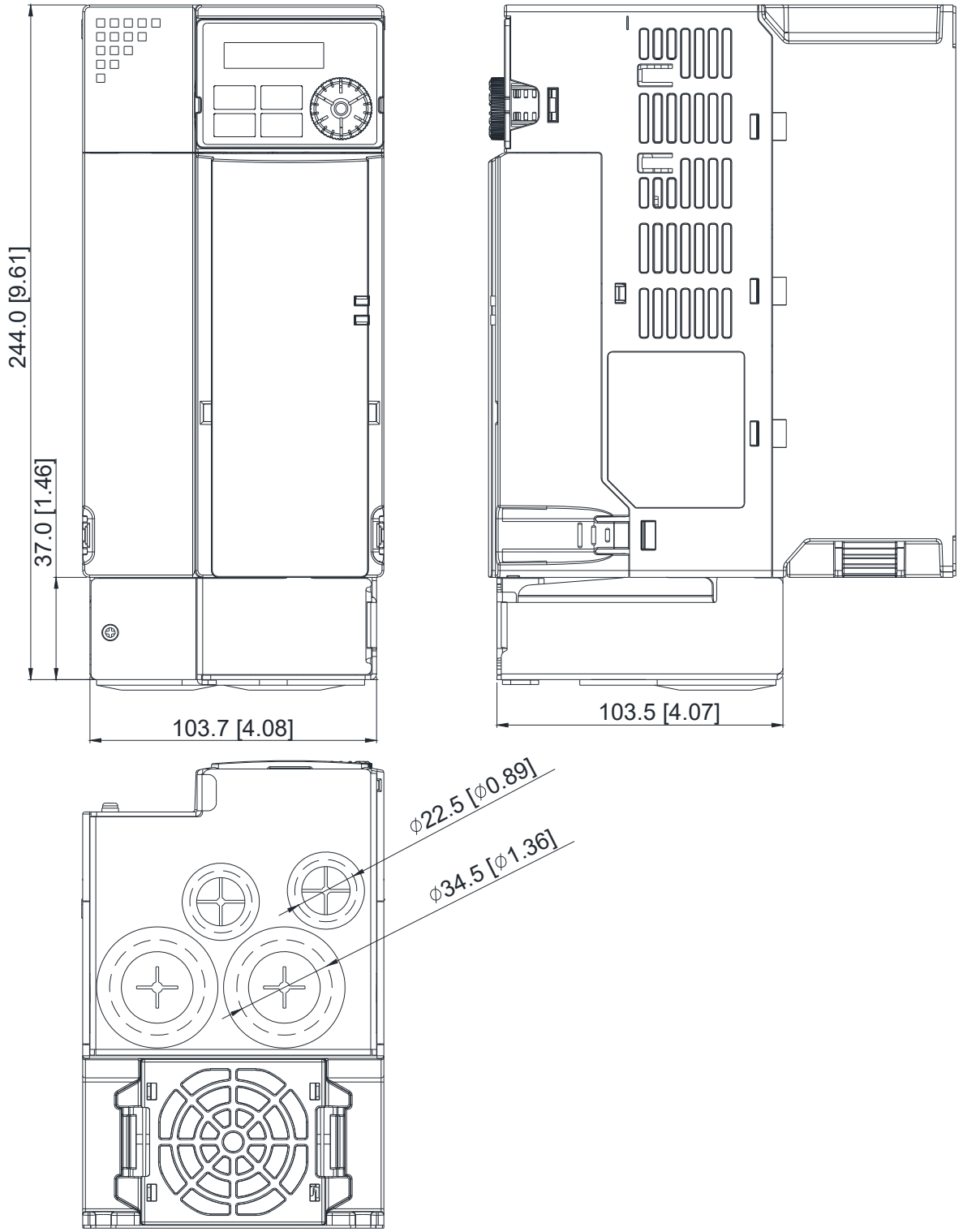
NEMA KIT model: MKMH-CBC




Unit: mm (inch)

**Frame D**

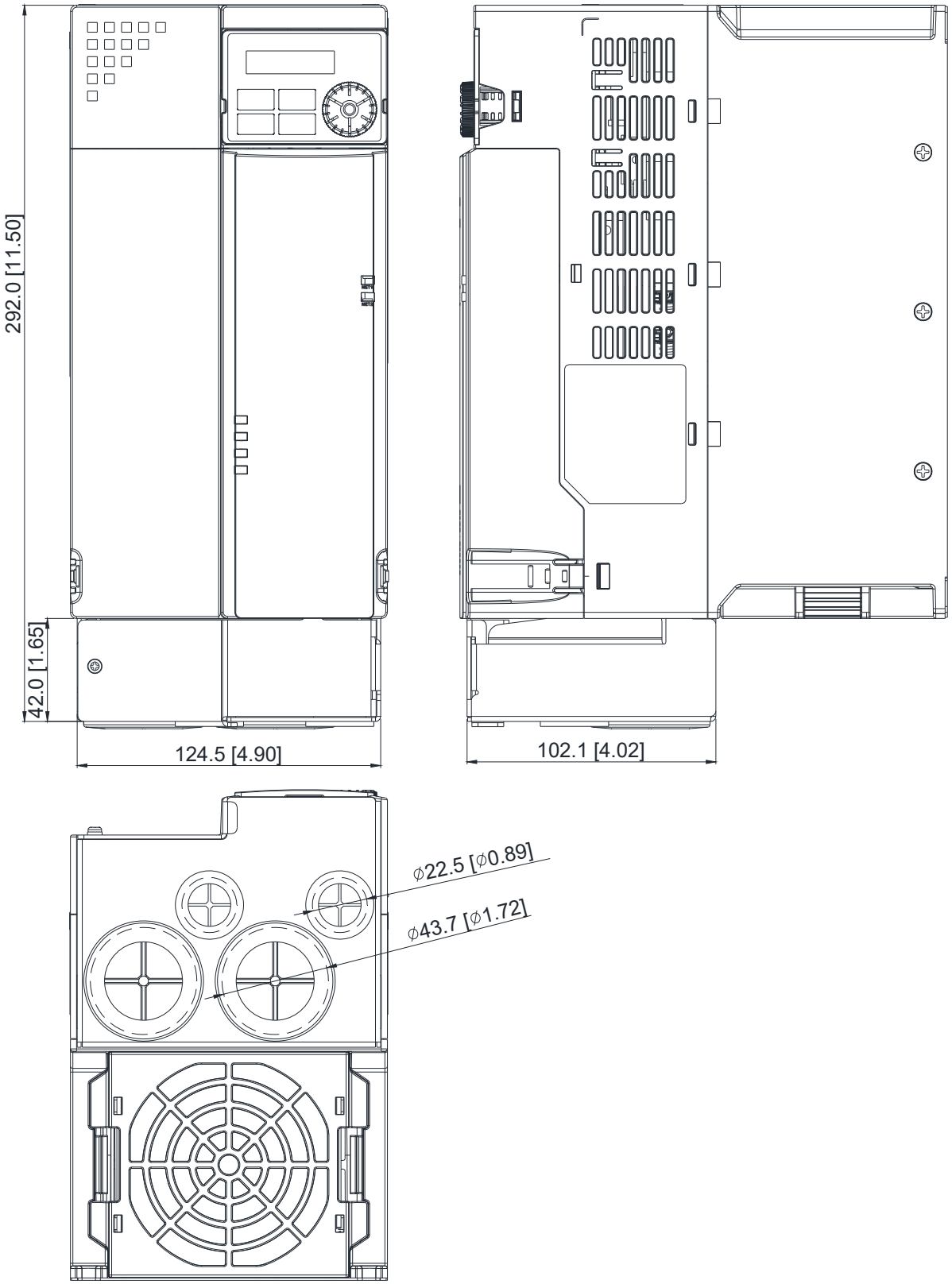
NEMA KIT model: MKMH-CBD




Unit: mm (inch)

## Frame E

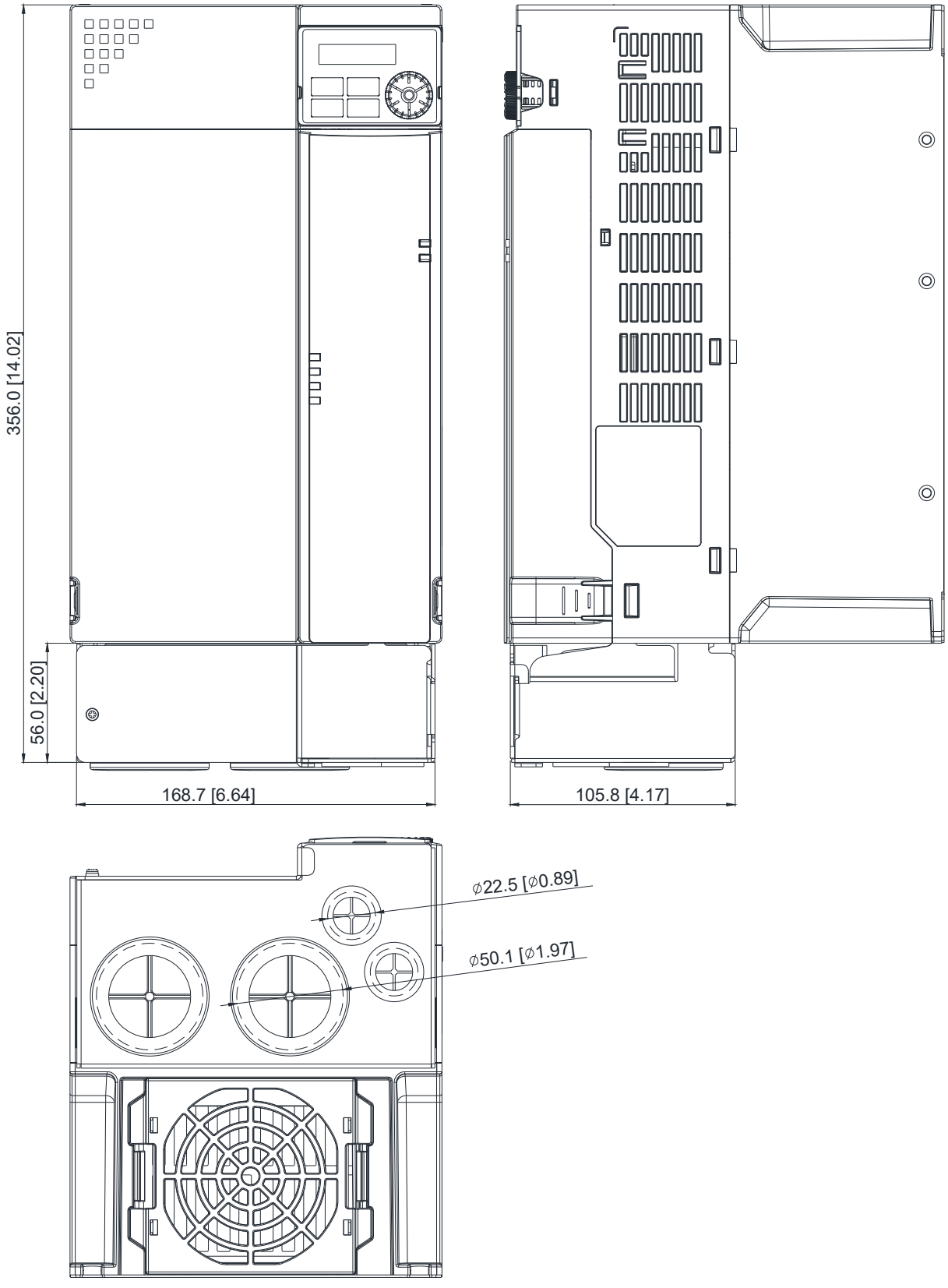
NEMA KIT model: MKMH-CBE




Unit: mm (inch)

**Frame F**

NEMA KIT model: MKMH-CBF



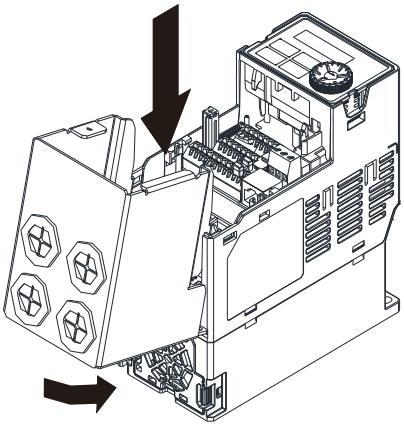

Unit: mm (inch)

## Installation

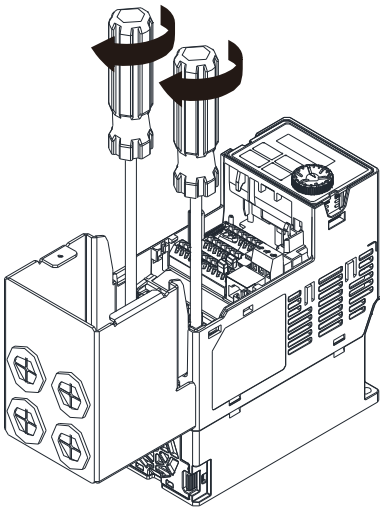
Recommended screw size and torque value: M3: 4–6 kg-cm / [3.5–5.2 lb-in.] / [0.39–0.59 Nm]
M3.5: 4–6 kg-cm / [3.5–5.2 lb-in.] / [0.39–0.59 Nm]
M4: 6–8 kg-cm / [5.2–6.9 lb-in.] / [0.59–0.78 Nm]

### Frame C–F

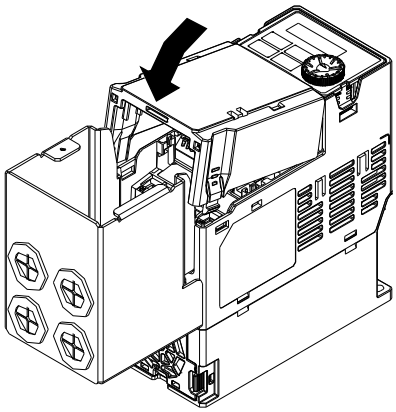
1) Aim the clips at the slots to assemble the conduit box.



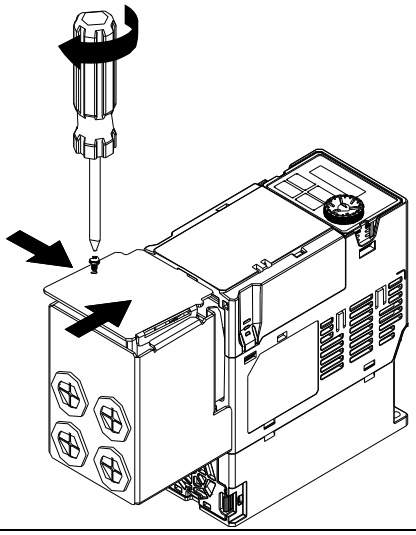
2) Tighten the screws to connect with the motor.



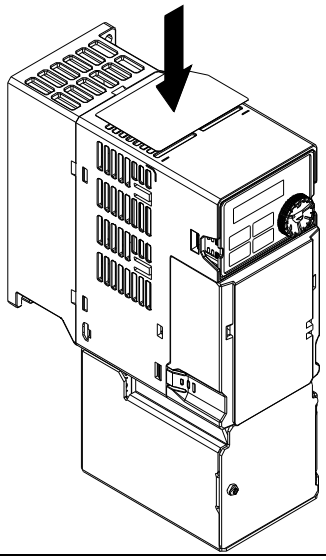
3) Install the front cover of the motor.



4) Install the front cover of the conduit box and tighten the screw.



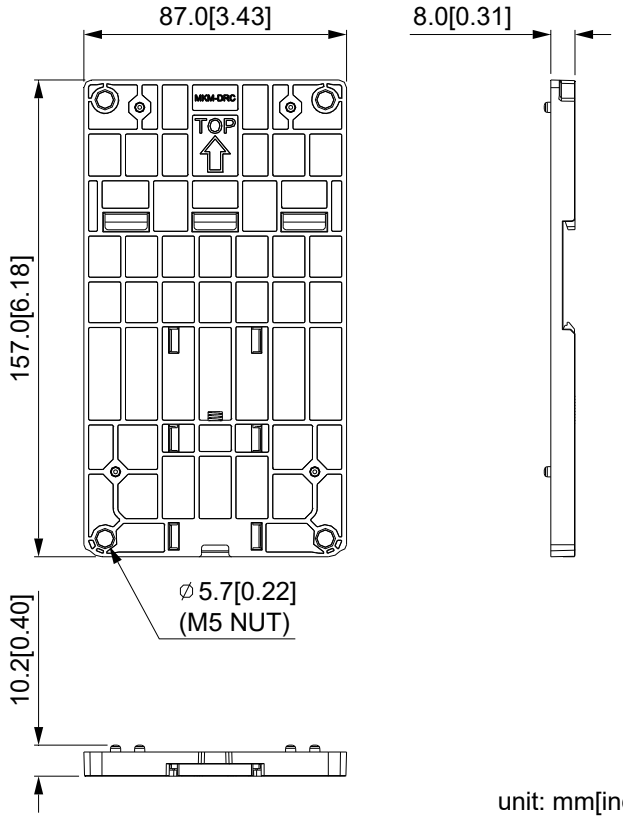
5) Attach the dust patch.



# 7-10 DIN-Rail Mounting

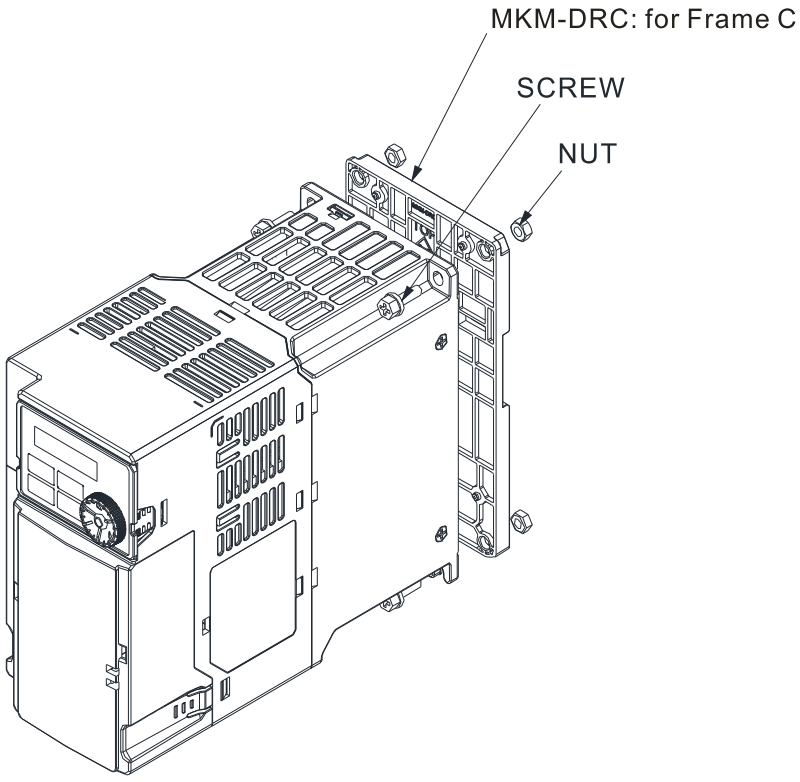
**MKM-DRC** (Applicable for Frame C)

| Screw | Torque |
|---|---|
| M5 * 4 pcs | 10–12 kg-cm<br>(8.7–10.4 lb-in.)<br>(0.98–1.18 Nm) |




## Installation

| Model | Screw | Torque |
|---|---|---|
| MKM-DRC | M5 * P0.8 * 4 pcs | 18–20 kg-cm / (15.7–17.3 lb-in.) / (1.77–1.96 Nm) |



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# Chapter 8 Option Cards

8-1 Option Card Installation

8-2 EMM-D3R2CA -- Three-point Digital Input / Relay Output Extension

(Two-point N.C. Output Terminal)

8-3 CANopen Communication Cable/

Digital Keypad RJ45 Extension Cable

The option cards in this chapter are optional items. Select the applicable option cards for your drive or contact your local distributor for suggestions. The option cards can significantly improve the efficiency of the motor drive. To prevent damage to the motor drive during installation, remove the digital keypad and the cover before wiring. Note that the option cards do not support hot swapping. Turn off the drive power before installing or removing the option cards.

## 8-1 Option Card Installation

The mounting position and connection method corresponding to each option card is listed as the table below. For detailed information, refer to following sections.

| Option card | Model | Function | Installation | Connection | Chapter |
|---|---|---|---|---|---|
| I/O + Relay card | EMM-D3R2CA | Digital Card – 3in + Relay (2 c point) | | | |

### 8-1-1 I/O Card Installation

Installation method: Use connector to fit the option card on the control board

1. As shown in the Figure 8-1, switch off the power of the motor drive, and then remove the front cover.
2. Mounting the connector: as shown in the Figure 8-2, aim the adapter/ option card at the connector on the control board and then insert it to the connector.
3. Assembling support frame: as shown in the Figure 8-3, aim the two clips at the two slots on the motor drive and then press downward to have the two clips engage the slots.
4. Assembling the adpapter/ option card: As shown in the figure 8-4, have the terminal block of the adaper/ option facing up, aim the two holes of the adapter/ option card to the position column and press downard so that the three clips are engage the adapter/ option card.
5. As shown in the Figure 8-5, make sure that three clips are properly engage the adapter/ option card and then fasten the screw. (Suggested torque value: 4–6 kg-cm [3.5–5.2 lb-in.] [0.39–0.59 Nm] )
6. As shown in the Figure 8-6, assembly is completed.

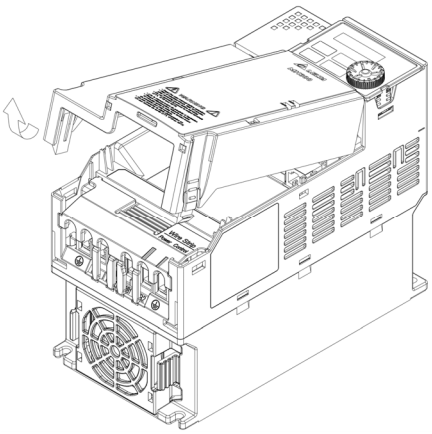


Figure 8-1

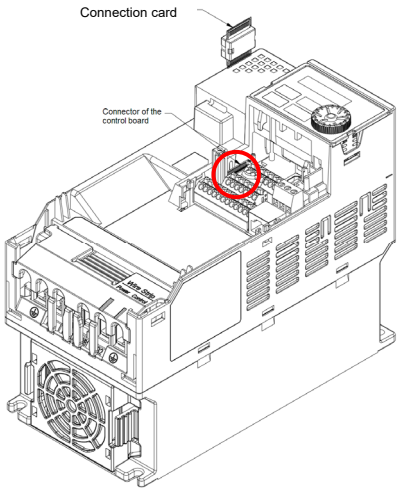



Figure 8-2

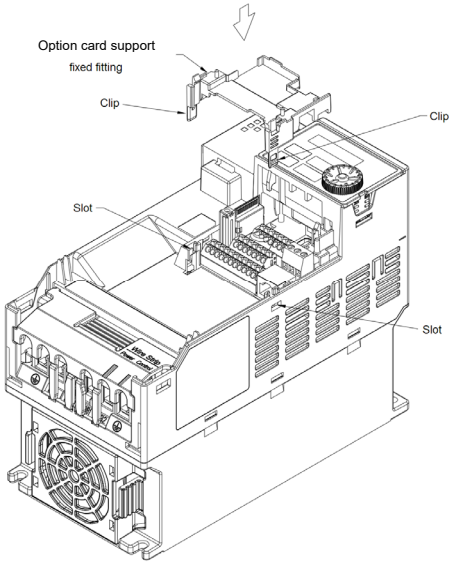



Figure 8-3

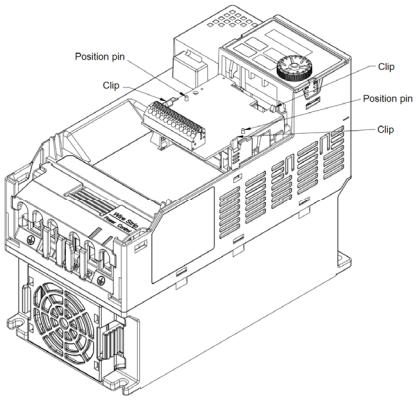



Figure 8-4

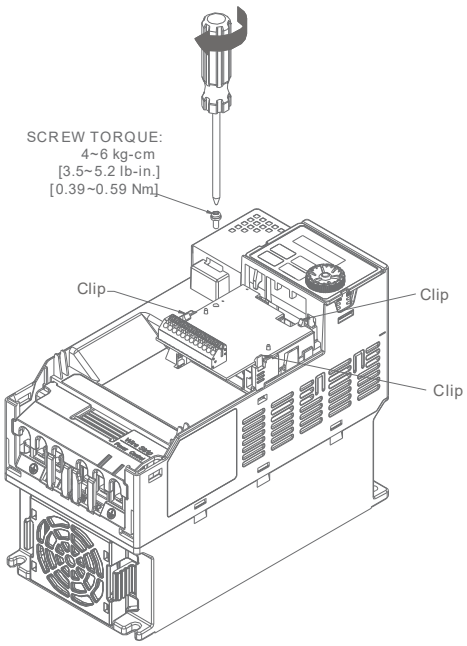



Figure 8-5

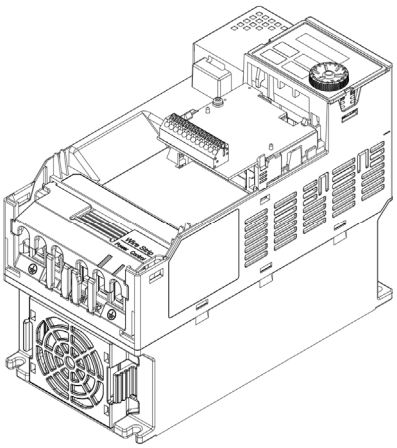


Figure 8-6

Note:

- The option cards listed below must connect to ground when wiring. The ground terminal is enclosed with option card as shown in Figure 8-7.

1. EMM-D3R2CA

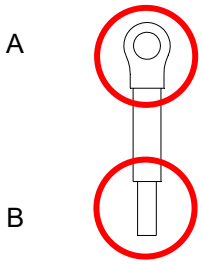



Figure 8-7

- Installation:

  The B side of the ground terminal connects to the ground terminal block on option card as No.4 of EMM-D3R2CA shown in Figure 8-8. See each section in Chapter 8 for ground terminal blocks of the other option cards. The A side of the ground terminal connects to the PE on the drive as the red circles shown in Figure 8-9.

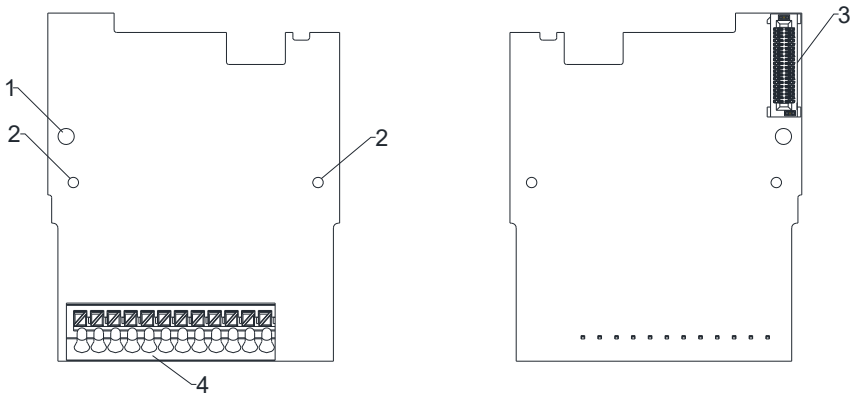



Figure 8-8

**Frame C–F**

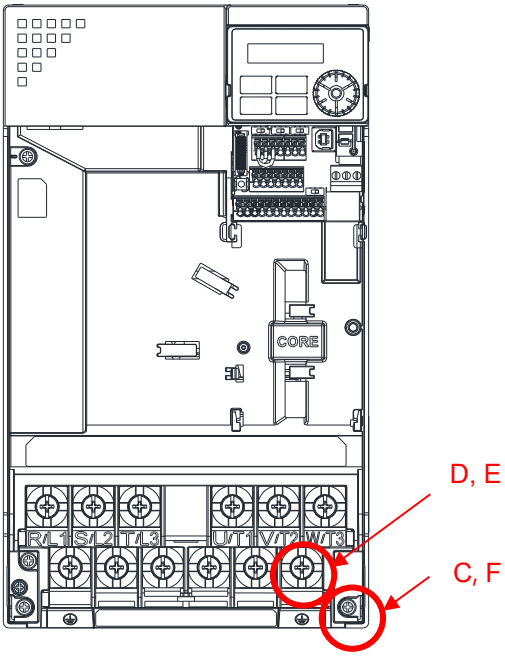
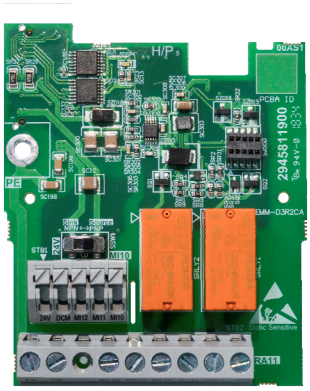


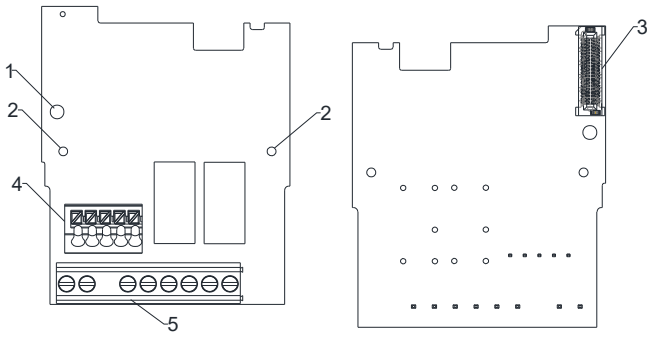

Figure 8-9

Torque (±10%)
Frame C: 20 kg-cm [17.4 lb-in.] [1.96 Nm]
Frame D: 20 kg-cm [17.4 lb-in.] [1.96 Nm]
Frame E: 25 kg-cm [21.7 lb-in.] [2.45 Nm]
Frame F: 20 kg-cm [17.4 lb-in.] [1.96 Nm]

# 8-2 EMM-D3R2CA

## ■ Product Profile



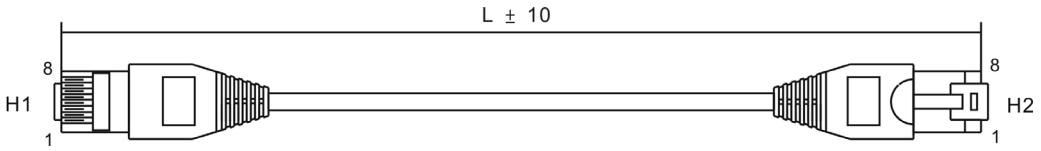



1. Screw fixing hole
2. Positioning hole
3. AC motor drive connection port
4. Spring Terminal block
5. Screw Terminal block

Wire: 0.25 $mm^2$ [24 AWG] –1.5 $mm^2$ [16 AWG]
Stripping length: 6 mm
Torque: 5 kg-cm / [4.3 lb-in.] / [0.49 Nm]

| | Terminals | Descriptions |
|---|---|---|
| Digital I/O & Relay Extension Card | 24V, DCM | Output power: +24 $V_{DC}$ ± 5 % < 30 mA |
| | MI10–MI12 | Refer to Pr.02-26–Pr.02-28 to program the multi-function inputs MI10–MI12.<br>Source Mode<br>ON: the activation current is 3.3 mA ≥ 11 $V_{DC}$<br>OFF: cut-off voltage ≤ 5 $V_{DC}$<br>Sink Mode<br>ON: the activation current is 3.3 mA ≤ 13 $V_{DC}$<br>OFF: cut-off voltage ≥ 19 $V_{DC}$ |
| | PE | Grounding terminal. To decrease noise, properly ground this terminal. |
| | RA10–RA11<br>RB10–RB11<br>RC10–RC11 | Refer to Pr.02-36–Pr.02-37 to program the multi-function<br>Resistive Load:<br>3 A (N.O.) / 3A (N.C.) 250 $V_{AC}$<br>5 A (N.O.) / 3A (N.C.) 30 $V_{AC}$<br>Function: outputs the monitor signals, such as drive in operation, frequency reached, or overload indication. |

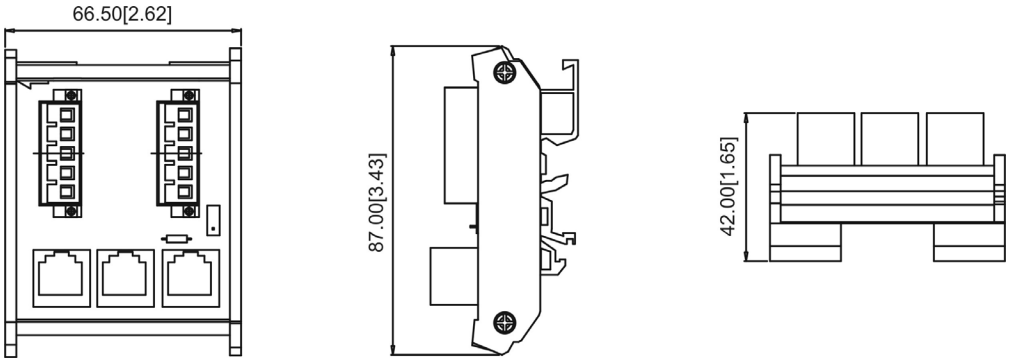
# 8-3 CANopen Communication Cable/Digital Keypad RJ45 Extension Cable




| No. | Part No. | Length (L) | |
|---|---|---|---|
| | | mm | inch |
| 1 | UC-CMC003-01A | 300 | 11.8 |
| 2 | UC-CMC005-01A | 500 | 19.6 |
| 3 | UC-CMC010-01A | 1000 | 39 |
| 4 | UC-CMC015-01A | 1500 | 59 |
| 5 | UC-CMC020-01A | 2000 | 78.7 |
| 6 | UC-CMC030-01A | 3000 | 118.1 |
| 7 | UC-CMC050-01A | 5000 | 196.8 |
| 8 | UC-CMC100-01A | 10000 | 393.7 |
| 9 | UC-CMC200-01A | 20000 | 787.4 |

## ■ CANopen Dimension

Model: TAP-CN03




Unit: mm [inch]

NOTE

For more information on CANopen, see the CANopen user manual or download related manuals from the Delta website: http://www.deltaww.com/iadownload_acmotordrive

# Chapter 9 Specification

9-1 230V Series

9-2 460V Series

9-3 Environment for Operation, Storage and Transportation

9-4 Derating of Ambient Temperature and Altitude

# 9-1 230V Series

## 230V, three-phase

| Frame | | C | | D | E | | F |
|---|---|---|---|---|---|---|---|
| Model VFD_ _ _ _ _ _ _ _ _SLA | | 11AMH23AN | 17AMH23AN | 25AMH23AN | 33AMH23AN | 49AMH23AN | 65AMH23AN |
| Applicable Motor Output (kW) | | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 |
| Applicable Motor Output (HP) | | 3 | 5 | 7.5 | 10 | 15 | 20 |
| Output Rating | Rated Output Capacity (kVA) | 4.2 | 6.5 | 9.5 | 12.6 | 18.7 | 24.8 |
| | Rated Output Current (A) | 11.0 | 17.0 | 25.0 | 33.0 | 49.0 | 65.0 |
| | Carrier Frequency (kHz) | 2–15 (Default: 8) | | | | | |
| Input Rating | Rated Input Current (A) | 13.2 | 20.4 | 30.0 | 39.6 | 58.8 | 78.0 |
| | Rated Voltage / Frequency | three-phase, AC 200V–240V (-15 % –+10 %), 50/60 Hz | | | | | |
| | Operating Voltage Range ($V_{AC}$) | 170–265 | | | | | |
| | Frequency Range (Hz) | 47–63 | | | | | |
| Weight (kg) | | 1.24 | 1.24 | 2.07 | 3.97 | 3.97 | 6.30 |
| Cooling Method | | Fan cooling | | | | | |
| EMC Filter | | Optional | | | | | |
| Ingress Protection Rating | | IP20 | | | | | |

**NOTE**

- The value of the carrier frequency is set in the factory. To increase the carrier frequency, decrease the current. See the derating curve diagram for Pr.06-55 for more information.
- When a load is a shock or impact load, use a higher level model.

# 9-2 460V Series

460V, three-phase

| Frame | | C | | D | | | | E | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Model VFD_ _ _ _ _ _ _ SLA | | 9A0MH43□_ | | 13AMH43□_ | | 17AMH43□_ | | 25AMH43□_ | | 32AMH43□_ | |
| | | AN | AF | AN | AF | AN | AF | AN | AF | AN | AF |
| Applicable Motor Output (kW) | | 3.7 | | 5.5 | | 7.5 | | 11 | | 15 | |
| Applicable Motor Output (HP) | | 5 | | 7.5 | | 10 | | 15 | | 20 | |
| Output Rating | Rated Output Capacity (KVA) | 6.9 | | 9.9 | | 13.3 | | 19.1 | | 24.4 | |
| | Rated Output Current (A) | 9.0 | | 13.0 | | 17.5 | | 25.0 | | 32.0 | |
| | Carrier Frequency (kHz) | 2–15 (Default: 8) | | | | | | | | | |
| Input Rating | Rated Input Current (A) | 9.9 | | 14.3 | | 19.3 | | 27.5 | | 35.2 | |
| | Rated Voltage / Frequency | three-phase AC 380V–480V ( -15 % – +10 %), 50/60 Hz | | | | | | | | | |
| | Operating Voltage Range ($V_{AC}$) | 323–528 | | | | | | | | | |
| | Frequency Range (Hz) | 47–63 | | | | | | | | | |
| Weight (kg) | | 1.24 | 1.84 | 2.07 | 2.93 | 2.07 | 2.93 | 3.97 | 5.19 | 3.97 | 5.19 |
| Cooling Method | | Fan cooling | | | | | | | | | |
| EMC Filter | | AN : Optional<br>AF : Built-in | | | | | | | | | |
| Ingress Protection Rating | | IP20 | | | | | | | | | |

**NOTE**

- The value of the carrier frequency is set in the factory. To increase the carrier frequency, decrease the current. See the derating curve diagram for Pr.06-55 for more information.
- When a load is a shock or impact load, use a higher level model.

## General Specifications

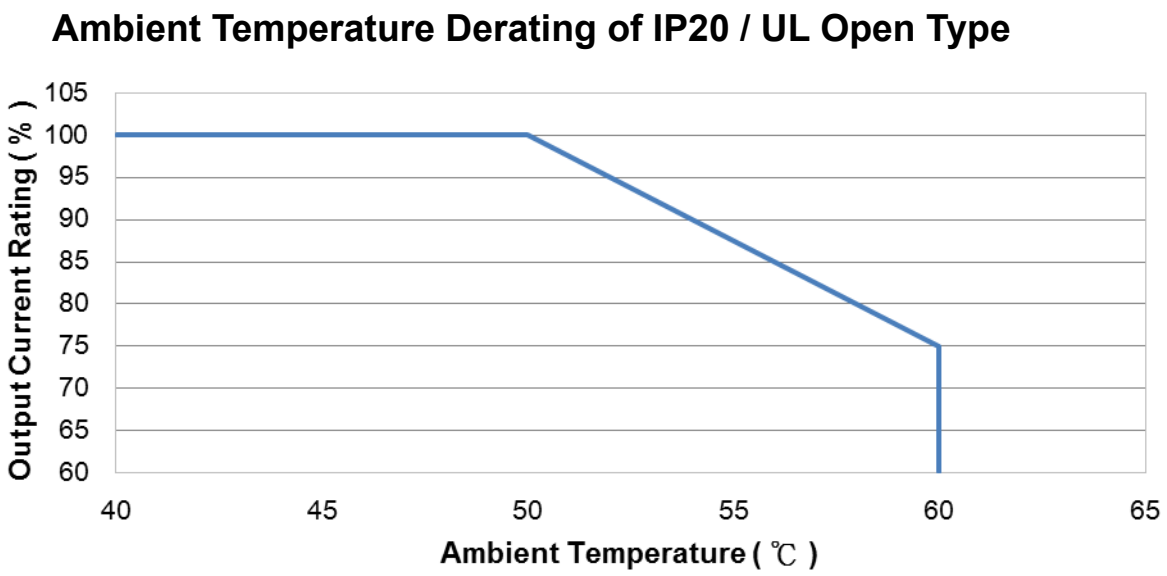
| | | |
|---|---|---|
| Control Characteristics | Control Method | V/F, SVC |
| | Applied Motor | IM (Induction Motor) |
| | Max. Output Frequency | 0.00–599.00Hz |
| | Starting Torque | 150 % / 3 Hz |
| | Speed Control Range | 1: 50 |
| | Overload Capability | 150 % 60s, 200 % 3s |
| | Frequency Setting Signal | 0–+10V / +10V – -10V<br>4–20 mA / 0–+10V<br>1 channel pulse input (33 kHz), 2 channel pulse output (33 kHz) |
| | Main Function | Fast start-up, Momentary power loss ride thru, Over-torque detection, 16-step speed (max.), Accel./decal. time switch, S-curve accel/decel, three-wire sequence, JOG frequency, Upper/lower limits for frequency reference, DC injection braking at start and stop, Built-in PLC (5 K steps), MODBUS and CAN are integrated as standard |
| Protection Characteristics | Motor Protection | Over-current, Over-voltage, Over-temperature, Phase loss, Over-load |
| | Stall Prevention | Stall prevention during acceleration, deceleration and running (independent settings) |
| Accessory | I/O extension cards | EMM-D3R2CA (Digital/Relay Card – 3 input and 2 relay C output) |
| Certifications | | UL, CE, C-Tick, RoHS, REACH, TUV(SIL2) |

# 9-3 Environment for Operation, Storage and Transportation

<table>
<tr><td colspan="6">DO NOT expose the AC motor drive in the bad environment, such as dust, direct sunlight, corrosive/ inflammable gasses, humidity, liquid and vibration environment. The salt in the air must be less than 0.01 mg/ cm$^2$ every year.</td></tr>
<tr><td rowspan="13">Environment</td><td>Installation location</td><td colspan="4">IEC60364-1/ IEC60664-1 Pollution degree 2, Indoor use only</td></tr>
<tr><td rowspan="4">Surrounding Temperature</td><td rowspan="2">Operation</td><td rowspan="2">IP20 / UL Open Type</td><td>-20–50 °C</td></tr>
<tr><td>-20–60 °C (Derating required)</td></tr>
<tr><td>Installed side by side</td><td>-20–55 °C (Derating required)</td></tr>
<tr><td>Storage</td><td colspan="2">-40–85 °C</td></tr>
<tr><td>Transportation</td><td colspan="2">-20–70 °C</td></tr>
<tr><td colspan="4">Non-condensation, non-frozen</td></tr>
<tr><td rowspan="3">Rated Humidity</td><td>Operation</td><td colspan="2">Max. 90 %</td></tr>
<tr><td>Storage / Transportation</td><td colspan="2">Max. 95 %</td></tr>
<tr><td colspan="3">No condense water</td></tr>
<tr><td rowspan="2">Air Pressure</td><td>Operation</td><td colspan="2">86 –106 kPa</td></tr>
<tr><td>Storage / Transportation</td><td colspan="2">70–106 kPa</td></tr>
<tr><td rowspan="5">Pollution Level</td><td colspan="3">IEC 60721-3-3</td></tr>
<tr><td>Operation</td><td colspan="2">Class 3C2; Class 3S2</td></tr>
<tr><td>Storage</td><td colspan="2">Class 2C2; Class 2S2</td></tr>
<tr><td>Transportation</td><td colspan="2">Class 1C2; Class 1S2</td></tr>
<tr><td colspan="3">Concentrate prohibited</td></tr>
<tr><td>Altitude</td><td colspan="4">Operable at altitude below 1000 m (derating if operated over 1,000 m)</td></tr>
<tr><td rowspan="2">Package Drop</td><td>Storage</td><td colspan="4" rowspan="2">ISTA procedure 1A (according to weight) IEC 60068-2-31</td></tr>
<tr><td>Transportation</td></tr>
<tr><td rowspan="2">Vibration</td><td>Operating</td><td colspan="4">1.0 mm, peak to peak value range from 2–13.2 Hz; 0.7 G–1.0 G range from 13.2–55 Hz; 1.0 G range from 55–512 Hz; Comply with IEC 60068-2-6</td></tr>
<tr><td>Non-operating</td><td colspan="4">2.5 G Peak<br>5 Hz–2 kHz<br>0.015" Displacement Max.</td></tr>
</table>

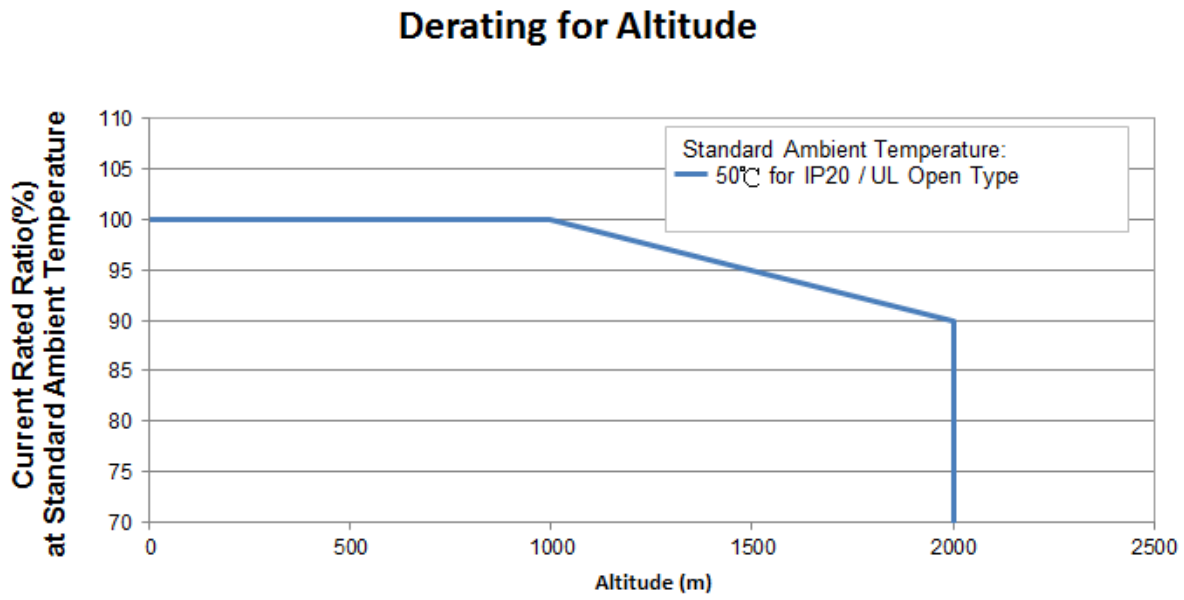
# 9-4 Derating of Ambient Temperature and Altitude

- **Derating of Ambient Temperature**




At the rated current the ambient temperature is -10˚C–+50°C.
Over 50°C, decrease the rated current 2.5%/°C up to 60°C.

- **Derating of Altitude**



For IP20 / UL Open Type

| Current derating at ambient temperature | | | | |
|---|---|---|---|---|
| Ambient temperature | | 40 °C | 45 °C | 50 °C |
| Operating altitude above sea level (m) | 0-1000 | 100% | | |
| | 1001–1500 | 100% | | 95% |
| | 1501–2000 | 100% | 95% | 90% |

| Operating Conditions | Ambient Temperature Limits |
|---|---|
| IP20 / UL Open Type | When the AC motor drive is operating at the rated current, the ambient temperature has to be between -20°C– +50 °C. When the temperature is over 50 °C, for every increase by 1 °C, decrease 2.5 % of the rated current. The maximum allowable temperature is 60 °C. |
| High Altitude | If the AC motor drive is installed at altitude 0–1000 m, follow normal operation restriction. If it is installed at altitude 1000–2000 m, decrease 1 % of rated current or lower 0.5 °C of temperature for every 100 m increase in altitude. Maximum altitude for Corner Grounded is 2000 m. Contact Delta for more information if you need to use this motor drive at an altitude of 2000 m or higher. |

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# Chapter 10 Digital Keypad

## KPMH-LC01 keyboard panel

**Main Display Area**
Displays Frequency, Current, Voltage, Steering, User-defined Units, Errors, and more.

**Status Display Area**

**Run Key**
Starts the drive.

**Stop / Reset Key**
Stops the drive and resets after error.

**Selection Key for Display Screen**
Changes the Display Screen mode.

**Digital dial**
1.Rotate to adjust the value of frequency or parameters, or select the parameters
2.Press to enter parameter setting page.

**Left Shift Key**
Changes the set value and parameters.

## Descriptions of Keypad Functions

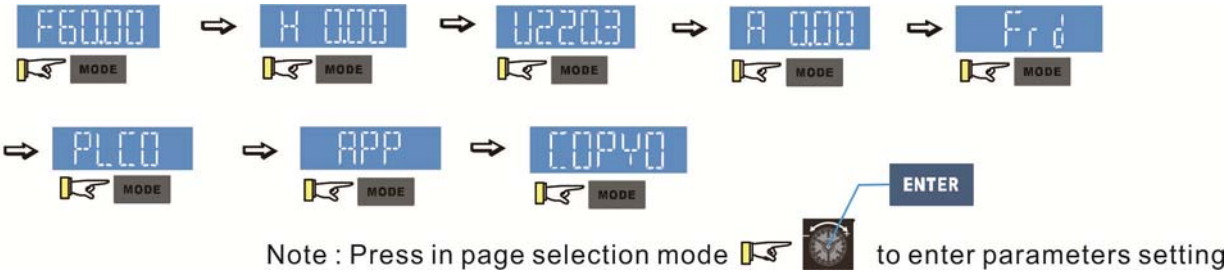
| Displayed items | Descriptions |
|---|---|
| | Displays the present frequency setting for the drive |
| | Displays the actual frequency output to the motor |
| | Displays the user-defined output of a physical quantity<br>This example is for parameter Pr.00-04 = 30 |
| | Displays the load current |
| | Forward command |
| | Reverse command |
| | Execute / stop the PLC function |
| | Parameter copy function |
| | Displays the count value |
| | Displays a parameter item |
| | Displays the content of a parameter value |
| | Displays an external fault |
| | Displays the data that has been accepted and automatically stored in the internal memory |

| Displayed items | Descriptions |
|---|---|
| | Displays the data set that is not accepted or has exceeded the value |



## Keypad operation process

A. Main Page Selection



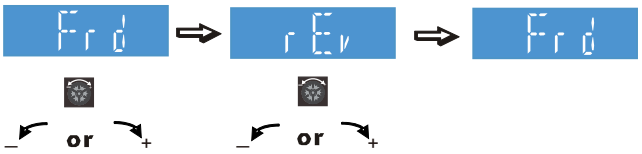

**Setting parameters**

NOTE：In the parameter setting mode, you can press to return the selecting mode.

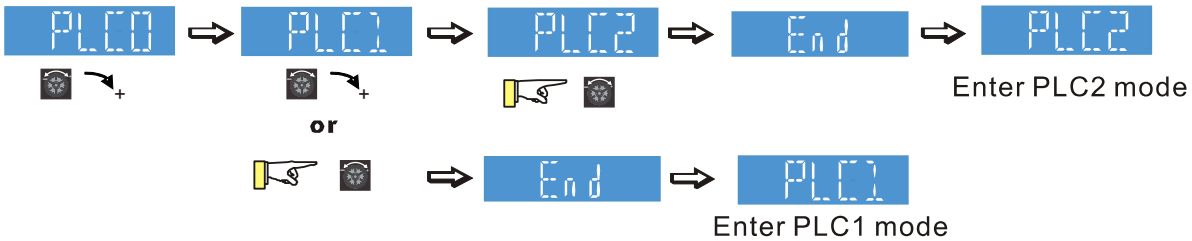
**To shift data**

START

**Setting direction** (When operation source is digital keypad)



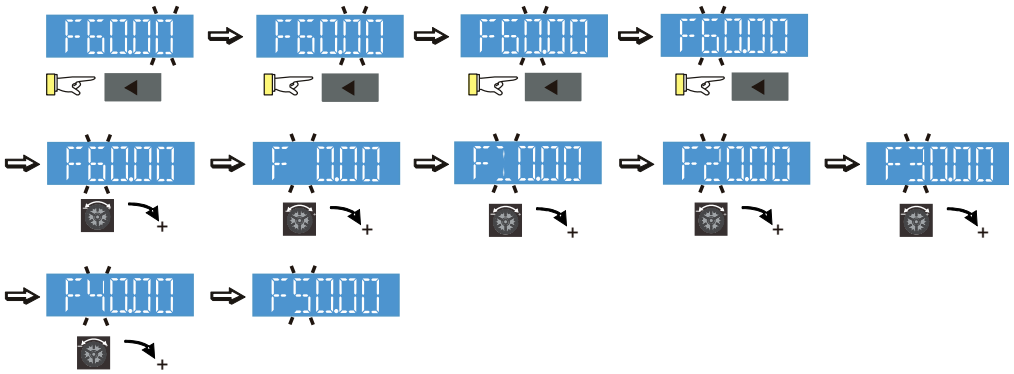

**Setting PLC Mode**



## B. F Page (Frequency command setting page)

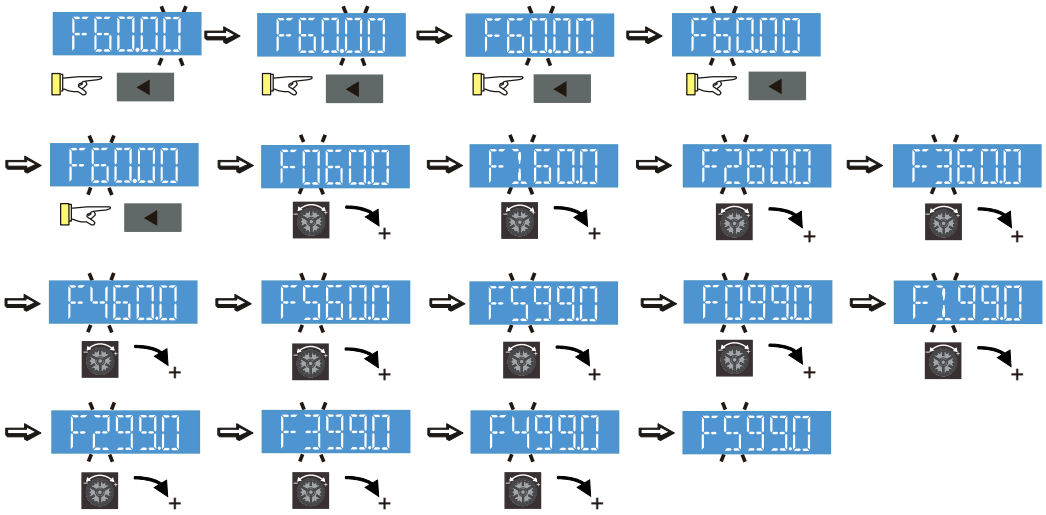
General Mode 1

(maximum operating frequency Pr.01-00 is 2 digits; for example Pr.01-00 = 60.00 Hz)



General Mode 2

(maximum operating frequency Pr.01-00 is 3 digits; for example Pr.01-00 = 599.0 Hz)



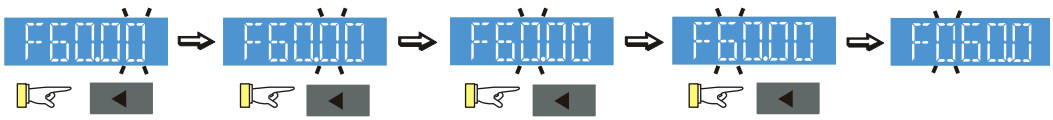
## C. Parameter setting

### C-1. Unsigned parameter

(parameter setting range≧0) (E.g.: Pr. 01-00)

1. Without using the left shift key: rotate the digital dial to select and adjust the parameters.
2. Using the left shift key: After you press the left shift key, and the last digit starts to blink. Press the left shift key to move the blinking cursor to the digit to adjust, and increase the value by rotating the digital dial clockwise. The value goes back to 0 after 9. Decrease the value by rotating the digital dial counter-clockwise. The value goes to 9 after 0.

   For example: the default setting for Pr.01-00 is 60.00. Pressing the left shift key causes the blinking cursor to move one digit to the left:



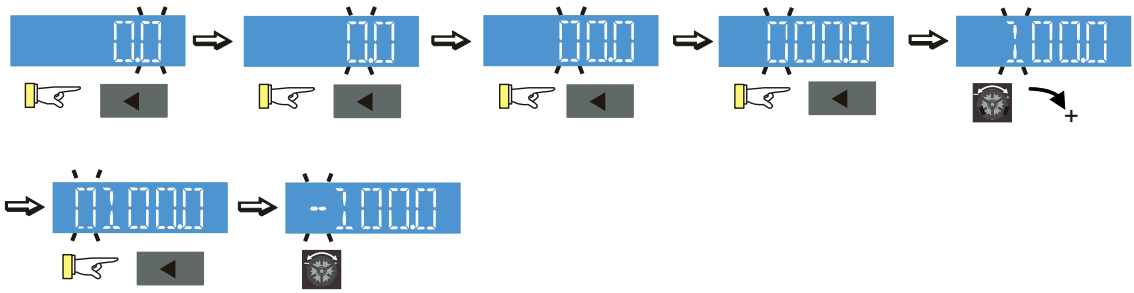
The upper setting limit for Pr.01-00 is 599.00. If you set a value greater than 599.00, “Err” appears after you press the digital dial, and then the keypad shows the upper limit (599.00) for a second to remind you of the incorrect setting. The setting remains as the original value and the cursor returns to the last digit.

## C-2. Signed parameter setting status 1

(Parameter setting range has no or one decimal place, e.g.: 03-03)

1. Without using the left shift key: rotate the digital dial to select and adjust the parameters.
2. Using left shift key: After pressing left shift key, the last digit starts to blink. Press the left shift key to move to the digit to adjust, and increase the value by rotating the digital dial clockwise.
   The value goes back to 0 after 9. Decrease the value by rotating the digital dial counter-clockwise, and the value goes to 9 after 0.
3. Press left shift button to shift the blinking cursor one digit to the left. When you shift to the first digit and press the digital dial, the digit “0” changes to “-” (minus).

For example: the default setting for Pr.03-03 is 0.0. If the value should be -100, then use the left shift key to shift the blinking cursor to the hundreds digit. Rotate the digital dial clockwise to 1, and then press left shift to move to the first digit. Rotate the digital dial from‘0’ to ‘-’.



The upper limit for Pr.03-03 is 100.0 and lower limit is -100.0. If the value is more than 100.0 or less than -100.0, “Err” appears after you press the digital dial, and then the keypad shows the upper limit (100.0) or lower limit (-100.0) for a second to remind you of the incorrect setting. The setting value remains as the original set value, and the cursor returns to the last digit.

## C-3. Signed parameter setting status 2

(The parameter setting range has 2 decimal places; for example: Pr.03-74)

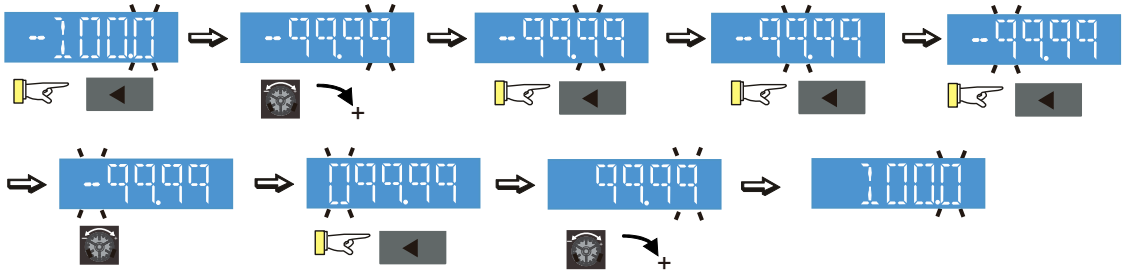
Do not use the left shift key: rotate the digital dial to select and adjust the parameters.

Use the left shift key: After pressing left shift key, and the last digit starts to blink. Press the left shift key to move to the digit to adjust, and then increase the value by rotating the digital dial clockwise. The value goes back to 0 after 9. Decrease the value by rotating the digital dial counter-clockwise, and the value goes to 9 after 0.

Press left shift button to shift the blinking cursor one digit to the left. When you shift to the first digit and press the digital dial, the digit “0” changes to “-” (minus).

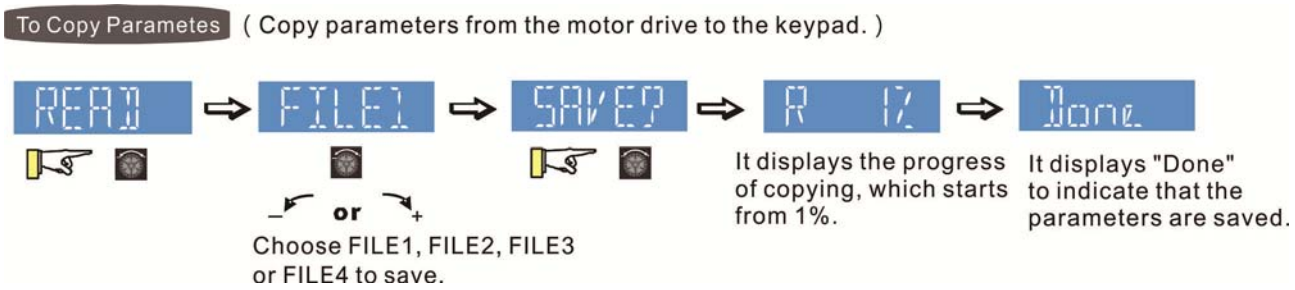
Note: When the parameter value can be set to 2 decimal places, and the set value has hundred digits, then you cannot shift the blinking cursor with the left shift key.

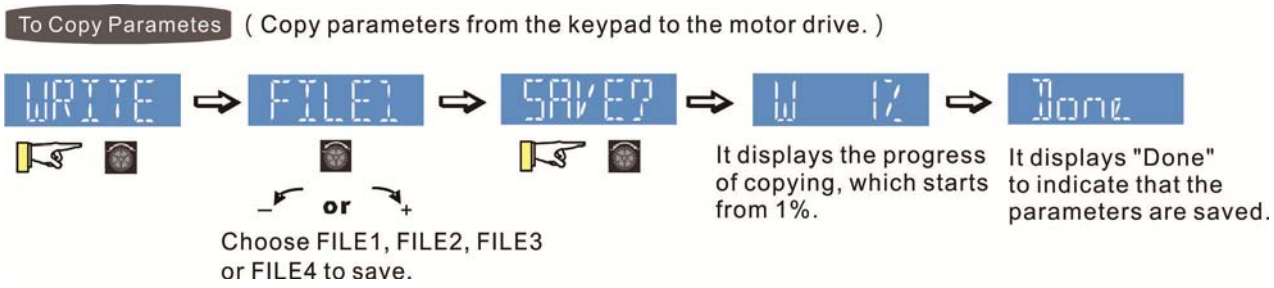
For example: change Pr.03-74 from -100 to 100



The upper limit for Pr.03-74 is 100.00 and lower limit is -100.00. If you set a value of more than 100.0 or less than -100.0, “Err” appears after you press the digital dial, and then the keypad shows the upper limit (100.0) or lower limit (-100.0) (only 1 decimal) for a second to remind you of the incorrect setting. The setting value remains as the original set value. The cursor returns to the last digit.

## D. To Copy Parameters



## Reference Table for the 16-segment LED Display of the Digital Keypad

| Number | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Eleven- Segment Display | | | | | | | | | | |
| Number | A | B | C | D | E | F | G | H | I | J |
| Eleven- Segment Display | | | | | | | | | | |
| Number | K | L | M | N | O | P | Q | R | S | T |
| Eleven- Segment Display | | | | | | | | | | |
| Number | U | V | W | X | Y | Z | | | | |
| Eleven- Segment Display | | | | | | | | | | |
| Number | b | c | d | e | f | h | i | j | n | o |
| Eleven- Segment Display | | | | | | | | | | |
| Number | q | r | t | u | v | w | | | | |
| Eleven- Segment Display | | | | | | | | | | |

# Chapter 11 Summary of Parameter Settings

This chapter provides a summary of parameter (Pr.) setting ranges and defaults. You can set, change, and reset parameters through the digital keypad.

NOTE

↗: You can set this parameter during operation

## 00 Drive Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | 00-00 | Identity code of the AC motor drive | 206: 230 V, Three-phase, 3 HP<br>207: 230 V, Three-phase, 5 HP<br>208: 230 V, Three-phase, 7.5 HP<br>209: 230 V, Three-phase, 10 HP<br>210: 230 V, Three-phase, 15 HP<br>211: 230 V, Three-phase, 20 HP<br>407: 460 V, Three-phase, 5 HP<br>408: 460 V, Three-phase, 7.5 HP<br>409: 460 V, Three-phase, 10 HP<br>410: 460 V, Three-phase, 15 HP<br>411: 460 V, Three-phase, 20 HP | Read only |
| | 00-01 | Display AC motor drive rated current | Display by models | Read only |
| | 00-02 | Parameter reset | 0: No function<br>1: Parameter write protection<br>5: Reset kWH display to 0<br>6: Reset PLC<br>7: Reset CANopen index (slave)<br>9: All parameters are reset to defaults (base frequency is 50 Hz)<br>10: All parameters are reset to defaults (base frequency is 60 Hz) | 0 |
| ↗ | 00-03 | Start-up display selection | 0: F (Frequency command)<br>1: H (output frequency)<br>2: U (user-defined, see Pr.00-04)<br>3: A (output current) | 0 |
| ↗ | 00-04 | Content of multi-function display (user-defined) | 0: Output current (A) (unit: Amps)<br>1: Counter value (c) (unit: CNT)<br>2: Actual output frequency (H.) (unit: Hz)<br>3: DC BUS voltage (V) (unit: $V_{DC}$)<br>4: Output voltage (E) (unit: $V_{AC}$) | 3 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | | | 5: Output power angle (n) (unit: deg)<br>6: Output power in kW (P) (unit: kW)<br>7: Motor speed (unit: rpm)<br>8: Estimated output torque percentage, motor's rated torque is 100% (t) (unit: %)<br>11: Signal value of AVI analog input terminal (1.) (unit: %)<br>12: Signal value of ACI analog input terminal (2.) (unit: %)<br>14: IGBT temperature (i.) (unit: °C)<br>15: CAP temperature (i.) (unit: °C)<br>16: Digital input status (ON / OFF) (i)<br>17: Digital output status ON / OFF (o)<br>18: Multi-step speed that is executing (S)<br>19: Digital input CPU pin status (d)<br>20: Digital output CPU pin status (0.)<br>25: Overload count (0.00–100.00%) (o.) (unit: %)<br>26: GFF ground fault (G.) (unit: %)<br>27: DC BUS voltage ripple (r.) (unit: $V_{DC}$)<br>30: Output user-defined parameter (U)<br>35: Control mode: 0 = Speed control mode (SPD)<br>36: Present operating carrier frequency (J.) (unit: Hz)<br>38: Drive status (6.)<br>41: kWH display (J) (unit: kWh)<br>47: Master frequency value (A ) (unit: Hz) | |
| | 00-06 | Firmware version | Read only | #.# |
| ✓ | 00-07 | Parameter protection password input | 0–65535<br>0–3 (number of wrong password attempts) | 0 |
| ✓ | 00-08 | Parameter protection password setting | 0–65535<br>0: No password protection / password is entered correctly (Pr.00-07)<br>1: Password has been set | 0 |
| | 00-11 | Speed control mode | 0: VF (IM V/F control)<br>2: SVC | 0 |
| | 00-17 | Carrier frequency | 2–15 kHz | 8 |
| | 00-19 | PLC command mask | bit 0: Control command forced by PLC control<br>bit 1: Frequency command forced by PLC control | Read only |
| ✓ | 00-20 | Master frequency command (AUTO) source | 0: Digital keypad<br>1: RS-485 serial communication<br>2: External analog input (Refer to Pr.03-00)<br>3: External terminals<br>6: CANopen input<br>Note: It is valid only when using with KPC-CC01. | 0 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ↗ | 00-21 | Operation command (AUTO) source | 0: Digital keypad<br>1: External terminals<br>2: Communication RS-485 input<br>3: CANopen input<br>Note: It is valid only when using with KPC-CC01. | 0 |
| ↗ | 00-48 | Display filter time (Current) | 0.001–65.535 sec. | 0.100 |
| ↗ | 00-49 | Display filter time (Keypad) | 0.001–65.535 sec. | 0.100 |
| | 00-50 | Software version (Date) | Read only | ##### |

# 01 Basic Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | 01-00 | Maximum operation frequency of motor 1 | 0.00–599.00 Hz | 60.00/ 50.00 |
| | 01-01 | Output frequency of motor 1 | 0.00–599.00 Hz | 60.00/ 50.00 |
| | 01-02 | Output voltage of motor 1 | 230V series : 0.0 V–255.0 V<br>460 V series : 0.0 V–510.0 V | 220.0<br>440.0 |
| | 01-03 | Mid-point frequency 1 of motor 1 | 0.00–599.00 Hz | 3.00 |
| ✓ | 01-04 | Mid-point voltage 1 of motor 1 | 230 V series : 0.0 V–240.0 V<br>460 V series : 0.0 V–480.0 V | 11.0<br>22.0 |
| | 01-05 | Mid-point frequency 2 of motor 1 | 0.00–599.00 Hz | 0.50 |
| ✓ | 01-06 | Mid-point voltage 2 of motor 1 | 230 V series : 0.0 V–240.0 V<br>460 V series : 0.0 V–480.0 V | 2.0<br>4.0 |
| | 01-07 | Minimum output frequency of motor 1 | 0.00–599.00 Hz | 0.00 |
| ✓ | 01-08 | Minimum output voltage of motor 1 | 230 V series : 0.0 V–240.0 V<br>460 V series : 0.0 V–480.0 V | 0.0<br>0.0 |
| | 01-09 | Start-up frequency | 0.00–599.00 Hz | 0.50 |
| ✓ | 01-10 | Output frequency upper limit | 0.00–599.00 Hz | 599.00 |
| ✓ | 01-11 | Output frequency lower limit | 0.00–599.00 Hz | 0.00 |
| ✓ | 01-12 | Acceleration time 1 | 0.00–600.00 sec. | 2.00 |
| ✓ | 01-13 | Deceleration time 1 | 0.00–600.00 sec. | 2.00 |
| ✓ | 01-14 | Acceleration time 2 | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-15 | Deceleration time 2 | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-16 | Acceleration time 3 | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-17 | Deceleration time 3 | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-18 | Acceleration time 4 | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-19 | Deceleration time 4 | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-20 | JOG acceleration time | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-21 | JOG deceleration time | 0.00–600.00 sec. | 10.00 |
| ✓ | 01-22 | JOG frequency | 0.00–599.00 Hz | 6.00 |
| ✓ | 01-23 | First/Fourth acceleration / deceleration frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 01-24 | S-curve acceleration begin time S1 | 0.00–25.00 sec. | 1.00 |
| ✓ | 01-25 | S-curve acceleration arrival time S2 | 0.00–25.00 sec. | 1.00 |
| ✓ | 01-26 | S-curve deceleration begin time S3 | 0.00–25.00 sec. | 1.00 |
| ✓ | 01-27 | S-curve deceleration arrival time S4 | 0.00–25.00 sec. | 1.00 |
| | 01-28 | Skip frequency 1 (upper limit) | 0.00–599.00 Hz | 0.00 |
| | 01-29 | Skip frequency 1 (lower limit) | 0.00–599.00 Hz | 0.00 |
| | 01-30 | Skip frequency 2 (upper limit) | 0.00–599.00 Hz | 0.00 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | 01-31 | Skip frequency 2 (lower limit) | 0.00–599.00 Hz | 0.00 |
| | 01-32 | Skip frequency 3 (upper limit) | 0.00–599.00 Hz | 0.00 |
| | 01-33 | Skip frequency 3 (lower limit) | 0.00–599.00 Hz | 0.00 |
| | 01-34 | Zero-speed mode | 0: Output waiting<br>1: Zero-speed operation<br>2: Fmin (Refer to Pr.01-07) | 2 |
| ↗ | 01-46 | CANopen quick stop time | 0.00–600.00 sec. | 1.00 |
| | 01-71 | Leveling Speed Switch | 0.00–599.00 Hz | 0.00 |
| ↗ | 01-72 | Lower than Leveling Speed S5 | 0.00–25.00 sec. | 1.00 |
| ↗ | 01-73 | Deceleration Time when Operating without RUN Command | 0.00–25.00 sec. | 2.00 |

# 02 Digital Input / Output Parameters

| Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|
| 02-00 | Two-wire / Three-wire operation control | 0: No function<br>1: Two-wire mode 1, power on for operation control (M1: FWD/STOP, M2: REV/STOP)<br>2: Two-wire mode 2, power on for operation control (M1: RUN/STOP, M2: FWD/REV)<br>3: Three-wire, power on for operation control (M1: RUN, M2: REV/FWD, M3: STOP)<br>4: Two-wire mode 1, Quick Start (M1: FWD/STOP, M2: REV/STOP)<br>5: Two-wire mode 2, Quick Start (M1: RUN/STOP, M2: FWD/REV)<br>6: Three-wire, Quick Start (M1: RUN, M2: REV/FWD, M3: STOP)<br>**IMPORTANT**<br>1. In the Quick Start mode, terminal output stays in a ready state, and the drive responds to the command immediately.<br>2. When using the Quick Start function, the output terminal has higher potential voltage. | 1 |
| 02-01 | Multi-function input command 1 (MI1) | 0: No function<br>1: Multi-step speed command 1 / multi-step position command 1<br>2: Multi-step speed command 2 / multi-step position command 2<br>3: Multi-step speed command 3 / multi-step position command 3<br>4: Multi-step speed command 4 / multi-step position command 4<br>5: Reset<br>6: JOG operation<br>7: Acceleration / deceleration speed inhibit<br>8: 1st, 2nd acceleration / deceleration time selection<br>9: 3rd, 4th acceleration / deceleration time selection<br>10: EF Input (Pr.07-20)<br>11: Base Block (B.B.) input from external<br>12: Output stop<br>15: Rotating speed command from AVI<br>16: Rotating speed command from ACI<br>18: Forced to stop (Pr.07-20) | 0 |
| 02-02 | Multi-function input command 2 (MI2) | | 0 |
| 02-03 | Multi-function input command 3 (MI3) | | 1 |
| 02-04 | Multi-function input command 4 (MI4) | | 2 |
| 02-05 | Multi-function input command 5 (MI5) | | 3 |
| 02-06 | Multi-function input command 6 (MI6) | | 4 |
| 02-07 | Multi-function input command 7 (MI7) | | 49 |
| 02-26 | Multi-function input command 10 (MI10) | | 0 |
| 02-27 | Multi-function input command 11 (MI11) | | 0 |
| 02-28 | Multi-function input command 12 (MI12) | | 0 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | | | 24: FWD JOG command<br>25: REV JOG command<br>28: Emergency stop (EF1)<br>29: Signal confirmation for Y-connection<br>30: Signal confirmation for Δ-connection<br>38: Disable EEPROM writing function<br>40: Force coasting to stop<br>49: Enable Drive<br>51: Selection for PLC mode bit 0<br>52: Selection for PLC mode bit 1<br>53: Trigger CANopen quick stop<br>58: Emergency power mode detection<br>59: Magnetic contactor error detection<br>60: Mechanical brake error detection<br>61: Power loss signal<br>62: Mechanical brake error detection 2 | |
| ✓ | 02-11 | Multi-function input response time | 0.000–30.000 sec. | 0.005 |
| ✓ | 02-12 | Multi-function input mode selection | 0000h–FFFFh (0: N.O.; 1: N.C.) | 0000 |
| ✓ | 02-13 | Multi-function output 1 (Relay 1) | 0: No function<br>1: Indication during RUN<br>2: Operation speed reached<br>3: Desired frequency reached 1 (Pr.02-22)<br>4: Desired frequency reached 2 (Pr.02-24)<br>5: Zero speed (Frequency command)<br>6: Zero speed, includes STOP (Frequency command)<br>7: Over-torque 1 (Pr.06-06–06-08)<br>9: Drive is ready<br>10: Low voltage warning (LV) (Pr.06-00)<br>11: Malfunction indication<br>12: Mechanical brake signal (Pr.02-39–Pr.02-42)<br>13: Over-heat warning (Pr.06-15)<br>16: Slip error (oSL)<br>19: External interrupt B.B. input (Base Block)<br>20: Warning output<br>21: Over-voltage<br>22: Over-current stall prevention<br>23: Over-voltage stall prevention<br>24: Operation source | 11 |
| ✓ | 02-16 | Multi-function output 2 (MO1) | | 0 |
| ✓ | 02-17 | Multi-function output 3 (MO2) | | 0 |
| ✓ | 02-36 | Output terminal of extension card (MO10) or (RY10) | | 0 |
| ✓ | 02-37 | Output terminal of extension card (MO11) or (RY11) | | 0 |
| ✓ | 02-38 | Output terminal of extension card (MO12) or (RY12) | | 0 |
| | | | | |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | | | 25: Forward command<br>26: Reverse command<br>27: Output when current ≥ Pr.02-41<br>28: Output when current < Pr.02-41<br>31: Y-connection for the motor coil<br>32: Δ-connection for the motor coil<br>33: Zero speed (actual output frequency)<br>34: Zero speed includes stop (actual output frequency)<br>35: Error output selection 1 (Pr.06-23)<br>36: Error output selection 2 (Pr.06-24)<br>37: Error output selection 3 (Pr.06-25)<br>38: Error output selection 4 (Pr.06-26)<br>40: Speed reached (including STOP)<br>44: Low current output (use with Pr.06-71–06-73)<br>45: UVW output magnetic contactor ON/OFF switch<br>50: Output control for CANopen<br>56: Power generation direction and status verification<br>57: Power generation direction<br>58: EPS MODE<br>67: Analog input level reached<br>75: Motor-controlled magnetic contactor output | |
| ✓ | 02-18 | Multi-function output direction | 0000h–FFFFh (0: N.O.; 1: N.C.) | 0000 |
| ✓ | 02-21 | Digital output gain (DFM) | 1–55 | 1 |
| ✓ | 02-22 | Desired frequency reached 1 | 0.00–599.00 Hz | 60.00/<br>50.00 |
| ✓ | 02-23 | Width of desired frequency reached 1 | 0.00–599.00 Hz | 2.00 |
| ✓ | 02-24 | Desired frequency reached 2 | 0.00–599.00 Hz | 60.00/<br>50.00 |
| ✓ | 02-25 | Width of desired frequency reached 2 | 0.00–599.00 Hz | 2.00 |
| ✓ | 02-30 | Turn On Delay of Magnetic Contactor between Drive and Motor | 0.010–65.000 sec. | 0.200 |
| ✓ | 02-31 | Turn Off Delay of Magnetic Contactor between Drive and Motor | 0.010–65.000 sec. | 0.200 |
| ✓ | 02-32 | Motor Magnetic Contactor Error Detection Time Setting | 0.00–10.00 sec. | 0.00 |
| ✓ | 02-33 | Mechanical Brake Error | 0.00–10.00 sec. | 0.00 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | | Detection Time Setting | | |
| ✓ | 02-35 | External operation control selection after reset and activation | 0: Disable<br>1: Drive runs if the RUN command remains after reset or reboot. | 0 |
| | 02-39 | Brake Release Delay Time When Elevator Starts | 0.010–65.000 sec. | 0.250 |
| | 02-40 | Brake Contracting Delay Time When Elevator Stops | 0.010–65.000 sec. | 0.250 |
| | 02-41 | Output Current Level Setting for External Terminals | 0–100% (Rated current of drive %) | 0 |
| ✓ | 02-42 | Brake Release Function Option | Bit 0 = 0: No function<br>Bit 0 = 1: Check torque output function switch<br>Bit 1 = 0: No function<br>Bit 1 = 1: Brake control by frequency threshold function switch | 0000h |
| | 02-43 | Brake Release Frequency | 0.00–10.00 Hz | 0.00 |
| | 02-44 | Brake Engage Frequency | 0.00–10.00 Hz | 0.00 |
| | 02-50 | Display the status of multi-function input terminals | Monitor the status of multi-function input terminals | Read only |
| | 02-51 | Display the status of multi-function output terminals | Monitor the status of multi-function output terminals | Read only |
| | 02-52 | Display external multi-function input terminals used by PLC | Monitor the status of PLC input terminals | Read only |
| | 02-53 | Display external multi-function output terminals used by PLC | Monitor the status of PLC output terminals | Read only |
| | 02-54 | Display the Frequency command executed by the external terminal | Read only | Read only |
| | 02-70 | IO card type | 9: EMM-D3R2CA | Read only |
| ✓ | 02-82 | Initial Frequency command (F) mode after stop | 0: Use current Frequency command<br>1: Use zero Frequency command<br>2: Refer to Pr.02-83 to set up | 0 |
| ✓ | 02-83 | Initial Frequency command (F) setting after stop | 0.00–599.0 Hz | 60.00 |

# 03 Analog Input / Output Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ✓ | 03-00 | Analog input selection (AVI) | 0: No function | 1 |
| ✓ | 03-01 | Analog input selection (ACI) | 1: Frequency command | 0 |
| ✓ | 03-03 | Analog input bias (AVI) | -100.0–100.0% | 0 |
| ✓ | 03-04 | Analog input bias (ACI) | -100.0–100.0% | 0 |
| ✓ | 03-07 | Positive / negative bias mode (AVI) | 0: No bias<br>1: Lower than or equal to bias<br>2: Greater than or equal to bias<br>3: The absolute value of the bias voltage while serving as the center<br>4: Bias serves as the center | 0 |
| ✓ | 03-08 | Positive / negative bias mode (ACI) | | |
| ✓ | 03-10 | Reverse setting when analog signal input is negative frequency | 0: Negative frequency input is not allowed. The digital keypad or external terminal controls the forward and reverse direction.<br>1: Negative frequency input is allowed. Positive frequency = run in forward direction; negative frequency = run in reverse direction. The digital keypad or external terminal control cannot switch the running direction. | 0 |
| ✓ | 03-11 | Analog input gain (AVI) | -500.0–500.0% | 100.0 |
| ✓ | 03-12 | Analog input gain (ACI) | -500.0–500.0% | 100.0 |
| ✓ | 03-15 | Analog input filter time (AVI) | 0.00–20.00 sec. | 0.01 |
| ✓ | 03-16 | Analog input filter time (ACI) | 0.00–20.00 sec. | 0.01 |
| ✓ | 03-18 | Analog input addition function | 0: Disable (AVI, ACI)<br>1: Enable | 0 |
| | 03-19 | Signal loss selection for analog input 4–20 mA | 0: Disable<br>1: Continue operation at the last frequency<br>2: Decelerate to 0 Hz<br>3: Stop immediately and display “ACE” | 0 |
| ✓ | 03-20 | Multi-function output (AFM) | 0: Output frequency (Hz)<br>1: Frequency command (Hz)<br>2: Motor speed (Hz)<br>3: Output current (rms)<br>4: Output voltage | 0 |
| ✓ | 03-21 | Analog output gain (AFM) | 0.0–500.0% | 100.0 |
| ✓ | 03-22 | Analog output in REV direction (AFM) | 0: Absolute value of output voltage<br>1: Reverse output 0 V; forward output 0–10 V<br>2: Reverse output 5–0 V; forward output 5–10 V | 0 |
| ✓ | 03-27 | AFM output bias | -100.00–100.00% | 0.00 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ✓ | 03-28 | AVI terminal input selection | 0: 0–10 V<br>3: -10–10 V (Pr.03-69–03-74 are valid) | 0 |
| ✓ | 03-29 | ACI terminal input selection | 0: 4–20 mA<br>1: 0–10 V<br>2: 0–20 mA | 0 |
| | 03-30 | Display the analog output terminals used by PLC | Monitor the status of PLC analog output terminals<br>bit 1: AFM<br>bit 2: AO10<br>bit 3: AO11 | Read only |
| ✓ | 03-31 | AFM output selection | 0: 0–10 V output<br>1: 0–20 mA output<br>2: 4–20 mA output | 0 |
| ✓ | 03-32 | AFM DC output setting level | 0.00–100.00% | 0.00 |
| ✓ | 03-35 | AFM filter output time | 0.00–20.00 sec. | 0.01 |
| ✓ | 03-39 | VR input selection | 0: Disable<br>1: Frequency command | 1 |
| ✓ | 03-44 | Multi-function MO output by AI level source | 0: AVI<br>1: ACI<br>3: Extension card input terminal AI10<br>4: Extension card input terminal AI11 | 0 |
| ✓ | 03-45 | AI upper level 1 | -100.00–100.00% | 50.00 |
| ✓ | 03-46 | AI lower level 2 | -100.00–100.00% | 10.00 |
| ✓ | 03-57 | ACI lowest point | Pr.03-29 = 1, 0.00–10.00 V<br>Pr.03-29 ≠ 1, 0.00–20.00 mA | 4.00 |
| ✓ | 03-58 | ACI proportional lowest point | 0.00–100.00% | 0.00 |
| ✓ | 03-59 | ACI mid-point | Pr.03-29 = 1, 0.00–10.00 V<br>Pr.03-29 ≠ 1, 0.00–20.00 mA | 12.00 |
| ✓ | 03-60 | ACI proportional mid-point | 0.00–100.00% | 50.00 |
| ✓ | 03-61 | ACI highest point | Pr.03-29 = 1, 0.00–10.00 V<br>Pr.03-29 ≠ 1, 0.00–20.00 mA | 20.00 |
| ✓ | 03-62 | ACI proportional highest point | 0.00–100.00% | 100.00 |
| ✓ | 03-63 | AVI voltage lowest point | 0.00–10.00 V | 0.00 |
| ✓ | 03-64 | AVI voltage proportional lowest point | -100.00–100.00% | 0.00 |
| ✓ | 03-65 | AVI voltage mid-point | 0.00–10.00 V | 5.00 |
| ✓ | 03-66 | AVI voltage proportional mid-point | -100.00–100.00% | 50.00 |
| ✓ | 03-67 | AVI voltage highest point | 0.00–10.00 V | 10.00 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ↗ | 03-68 | AVI voltage proportional highest point | -100.00–100.00% | 100.00 |
| ↗ | 03-69 | Negative AVI voltage lowest point | -10.00–0.00 V<br>(valid when Pr.03-28 sets as -10–10 V) | 0.00 |
| ↗ | 03-70 | Negative AVI voltage proportional lowest point | -100.00–100.00%<br>(valid when Pr.03-28 sets as -10–10 V) | 0.00 |
| ↗ | 03-71 | Negative AVI voltage mid-point | -10.00–0.00 V<br>(valid when Pr.03-28 sets as -10–10 V) | -5.00 |
| ↗ | 03-72 | Negative AVI voltage proportional mid-point | -100.00–100.00%<br>(valid when Pr.03-28 sets as -10–10 V) | -50.00 |
| ↗ | 03-73 | Negative AVI voltage highest point | -10.00–0.00 V<br>(valid when Pr.03-28 sets as -10–10 V) | -10.00 |
| ↗ | 03-74 | Negative AVI voltage proportional highest point | -100.00–100.00%<br>(valid when Pr.03-28 sets as -10–10 V) | -100.00 |

# 04 Multi-step Speed Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ✓ | 04-00 | 1st step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-01 | 2nd step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-02 | 3rd step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-03 | 4th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-04 | 5th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-05 | 6th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-06 | 7th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-07 | 8th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-08 | 9th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-09 | 10th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-10 | 11th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-11 | 12th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-12 | 13th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-13 | 14th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-14 | 15th step speed frequency | 0.00–599.00 Hz | 0.00 |
| ✓ | 04-50 | PLC buffer 0 | 0–65535 | 0 |
| ✓ | 04-51 | PLC buffer 1 | 0–65535 | 0 |
| ✓ | 04-52 | PLC buffer 2 | 0–65535 | 0 |
| ✓ | 04-53 | PLC buffer 3 | 0–65535 | 0 |
| ✓ | 04-54 | PLC buffer 4 | 0–65535 | 0 |
| ✓ | 04-55 | PLC buffer 5 | 0–65535 | 0 |
| ✓ | 04-56 | PLC buffer 6 | 0–65535 | 0 |
| ✓ | 04-57 | PLC buffer 7 | 0–65535 | 0 |
| ✓ | 04-58 | PLC buffer 8 | 0–65535 | 0 |
| ✓ | 04-59 | PLC buffer 9 | 0–65535 | 0 |
| ✓ | 04-60 | PLC buffer 10 | 0–65535 | 0 |
| ✓ | 04-61 | PLC buffer 11 | 0–65535 | 0 |
| ✓ | 04-62 | PLC buffer 12 | 0–65535 | 0 |
| ✓ | 04-63 | PLC buffer 13 | 0–65535 | 0 |
| ✓ | 04-64 | PLC buffer 14 | 0–65535 | 0 |
| ✓ | 04-65 | PLC buffer 15 | 0–65535 | 0 |
| ✓ | 04-66 | PLC buffer 16 | 0–65535 | 0 |
| ✓ | 04-67 | PLC buffer 17 | 0–65535 | 0 |
| ✓ | 04-68 | PLC buffer 18 | 0–65535 | 0 |
| ✓ | 04-69 | PLC buffer 19 | 0–65535 | 0 |

# 05 Motor Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | 05-00 | Motor parameter auto-tuning | 0: No function<br>1: Dynamic test for an induction motor (IM)<br>2: Static test for an induction motor (IM) | 0 |
| | 05-01 | Full-load current for an induction motor (A) | 10–120% of the drive's rated current | #.## |
| ✓ | 05-02 | Rated power for an induction motor (kW) | 0.00–655.35 kW | #.## |
| ✓ | 05-03 | Rated speed for an induction motor (rpm) | 0–65535 rpm<br>1710 (60 Hz, 4 poles); 1410 (50 Hz, 4 poles) | 1710 |
| | 05-04 | Number of poles for an induction motor | 2–20 | 4 |
| | 05-05 | No-load current for an induction motor (A) | 0.00–Pr.05-01 default | #.## |
| | 05-06 | Stator resistance (Rs) for an induction motor | 0.000–65.535 Ω | #.### |
| | 05-07 | Rotor resistance (Rr) for an induction motor | 0.000–65.535 Ω | #.### |
| | 05-08 | Magnetizing inductance (Lm) for an induction motor | 0.0–6553.5 mH | #.# |
| | 05-09 | Stator inductance (Lx) for an induction motor | 0.0–6553.5 mH | #.# |
| ✓ | 05-23 | Frequency for Y-connection /Δ-connection switch for an induction motor | 0.00–599.00 Hz | 60.00 |
| | 05-24 | Y-connection /Δ-connection switch for an induction motor | 0: Disable<br>1: Enable | 0 |
| ✓ | 05-25 | Delay time for Y-connection /Δ-connection switch for an induction motor | 0.000–60.000 sec. | 0.200 |
| | 05-26 | Accumulated Watt-second for a motor in low word (W-sec.) | Read only | #.# |
| | 05-27 | Accumulated Watt-second for a motor in high word (W-sec.) | Read only | #.# |
| | 05-28 | Accumulated Watt-hour for a motor (W-hour) | Read only | #.# |
| | 05-29 | Accumulated Watt-hour for a motor in low word (kW-hour) | Read only | #.# |

| Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|
| 05-30 | Accumulated Watt-hour for a motor in high word (kW-hour) | Read only | #.# |
| 05-31 | Accumulated motor operation time (minutes) | 0–1439 | 0 |
| 05-32 | Accumulated motor operation time (days) | 0–65535 | 0 |

# 06 Protection Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ✓ | 06-00 | Low voltage level | 230V: 150.0–220.0 $V_{DC}$<br>460V: 300.0–440.0 $V_{DC}$ | 180.0<br>360.0 |
| ✓ | 06-01 | Over-voltage stall prevention | 0: Disabled<br>230V: 0.0–450.0 $V_{DC}$<br>460V: 0.0–900.0 $V_{DC}$ | 380.0<br>760.0 |
| ✓ | 06-02 | Selection for over-voltage stall prevention | 0: Traditional over-voltage stall prevention<br>1: Smart over-voltage stall prevention | 0 |
| ✓ | 06-03 | Over-current stall prevention during acceleration | 0–200%<br>(100% corresponds to the rated current of the drive) | 180 |
| ✓ | 06-04 | Over-current stall prevention during operation | 0–200%<br>(100% corresponds to the rated current of the drive) | 180 |
| ✓ | 06-05 | Acceleration / deceleration time selection for stall prevention at constant speed | 0: By current acceleration / deceleration time<br>1: By the 1st acceleration / deceleration time<br>2: By the 2nd acceleration / deceleration time<br>3: By the 3rd acceleration / deceleration time<br>4: By the 4th acceleration / deceleration time<br>5: By auto-acceleration / auto-deceleration | 0 |
| ✓ | 06-06 | Over-torque detection selection (motor) | 0: No function<br>1: Continue operation after over-torque detection during constant speed operation<br>2: Stop after over-torque detection during constant speed operation<br>3: Continue operation after over-torque detection during RUN<br>4: Stop after over-torque detection during RUN | 0 |
| ✓ | 06-07 | Over-torque detection level (motor) | 10–250% (100% corresponds to the rated current of the drive) | 120 |
| ✓ | 06-08 | Over-torque detection time (motor) | 0.1–60.0 sec. | 0.1 |
| ✓ | 06-12 | Current limit | 0–250% (100% corresponds to the rated current of the drive) | 150 |
| ✓ | 06-13 | Electronic thermal relay selection 1 (motor) | 0: Inverter motor (with external forced cooling)<br>1: Standard motor (motor with fan on shaft)<br>2: Disable | 2 |
| ✓ | 06-14 | Electronic thermal relay action time 1 (motor) | 30.0–600.0 sec. | 60.0 |
| ✓ | 06-15 | Temperature level overheat (OH) warning | 0.0–110.0°C | 105.0 |

| Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|
| 06-16 | Stall prevention limit level | 0–100% (refer to Pr.06-03–06-04) | 100 |
| 06-17 | Fault record 1 | 0: No fault record<br>1: Over-current during acceleration (ocA)<br>2: Over-current during deceleration (ocd)<br>3: Over-current during constant speed (ocn)<br>4: Ground fault (GFF)<br>6: Over-current at stop (ocS)<br>7: Over-voltage during acceleration (ovA)<br>8: Over-voltage during deceleration (ovd)<br>9: Over-voltage during constant speed (ovn)<br>10: Over-voltage at stop (ovS)<br>11: Low-voltage during acceleration (LvA)<br>12: Low-voltage during deceleration (Lvd)<br>13: Low-voltage during constant speed (Lvn)<br>14: Low-voltage at stop (LvS)<br>15: Phase loss protection (orP)<br>16: IGBT overheat (oH1)<br>18: TH1 open: IGBT overheat protection error (tH1o)<br>21: Drive overload (oL)<br>22: Electronic thermal relay protection 1 (EoL1)<br>26: Over-torque 1 (ot1)<br>28: Low current (uC)<br>31: Memory read-out error (cF2)<br>33: U-phase current detection error (cd1)<br>34: V-phase current detection error (cd2)<br>35: W-phase current detection error (cd3)<br>36: Clamp current detection error (Hd0)<br>37: Over-current detection error (Hd1)<br>40: Auto-tuning error (AUE)<br>41: PID feedback loss (AFE)<br>48: Analog current input loss (ACE)<br>49: External fault input (EF)<br>50: Emergency stop (EF1)<br>51: External Base Block (B.B.)<br>52: Password error (Pcod)<br>54: Communication error (CE1)<br>55: Communication error (CE2)<br>56: Communication error (CE3)<br>57: Communication error (CE4)<br>58: Communication time-out (CE10)<br>61: Y-connection / Δ-connection switch error (ydc) | Read only |
| 06-18 | Fault record 2 | | Read only |
| 06-19 | Fault record 3 | | Read only |
| 06-20 | Fault record 4 | | Read only |
| 06-21 | Fault record 5 | | Read only |
| 06-22 | Fault record 6 | | Read only |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | | | 62: Deceleration energy backup error (dEb)<br>63: Slip error (oSL)<br>71: Mechanical brake error 2 (MBF2)<br>72: Channel 1 (S1–DCM) safety loop error (STL1)<br>74: Magnetic contactor error (MCF)<br>75: Mechanical brake error (MBF)<br>76: Safe Torque Off (STo)<br>77: Channel 2 (S2–DCM) safety loop error (STL2)<br>78: Internal loop error (STL3)<br>79: U-phase over-current before run (Uoc)<br>80: V-phase over-current before run (Voc)<br>81: W-phase over-current before run (Woc)<br>82: U-phase output phase loss (OPHL)<br>83: V-phase output phase loss (OPHL)<br>84: W-phase output phase loss (OPHL)<br>87: Drive overload in low frequency (oL3)<br>101: CANopen software disconnect 1 (CGdE)<br>102: CANopen software disconnect 2 (CHbE)<br>104: CANopen hardware disconnect (CbFE)<br>105: CANopen index setting error (CIdE)<br>106: CANopen station number setting error (CAdE)<br>107: CANopen memory error (CFrE)<br>127: Software version error (CP33)<br>140: GFF detected when power on (Hd6)<br>141: GFF before run (BGFF)<br>142: Auto-tuning error 1 (DC test stage) (AUE1)<br>143: Auto-tuning error 2 (High frequency test stage) (AUE2)<br>144: Auto-tuning error 3 (Rotary test stage) (AUE3) | |
| ✓ | 06-23 | Fault output option 1 | 0–65535 (refer to bit table for fault code) | 0 |
| ✓ | 06-24 | Fault output option 2 | 0–65535 (refer to bit table for fault code) | 0 |
| ✓ | 06-25 | Fault output option 3 | 0–65535 (refer to bit table for fault code) | 0 |
| ✓ | 06-26 | Fault output option 4 | 0–65535 (refer to bit table for fault code) | 0 |
| | 06-31 | Frequency command for malfunction | 0.00–599.00 Hz | Read only |
| | 06-32 | Output frequency at malfunction | 0.00–599.00 Hz | Read only |
| | 06-33 | Output voltage at malfunction | 0.0–6553.5 V | Read only |
| | 06-34 | DC voltage at malfunction | 0.0–6553.5 V | Read |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | | | | only |
| | 06-35 | Output current at malfunction | 0.00–655.35 Amp | Read only |
| | 06-36 | IGBT temperature at malfunction | -3276.7–3276.7°C | Read only |
| | 06-37 | Capacitance temperature at malfunction | -3276.7–3276.7°C | Read only |
| | 06-38 | Motor speed in rpm at malfunction | -32767–32767 rpm | Read only |
| | 06-40 | Status of the multi-function input terminal at malfunction | 0000h–FFFFh | Read only |
| | 06-41 | Status of the multi-function output terminal at malfunction | 0000h–FFFFh | Read only |
| | 06-42 | Drive status at malfunction | 0000h–FFFFh | Read only |
| ✓ | 06-44 | STO latch selection | 0: STO Latch<br>1: STO No Latch | 0 |
| ✓ | 06-45 | Output phase loss detection action (OPHL) | 0: Warn and continue operation<br>1: Warn and ramp to stop<br>2: Warn and coast to stop<br>3: No warning | 3 |
| ✓ | 06-46 | Detection time for output phase loss | 0.000–65.535 sec. | 0.500 |
| ✓ | 06-47 | Current detection level for output phase loss | 0.00–100.00% | 1.00 |
| ✓ | 06-48 | DC brake time for output phase loss | 0.000–65.535 sec. | 0.000 |
| ✓ | 06-49 | LvX auto-reset | 0: Disable<br>1: Enable | 0 |
| ✓ | 06-53 | Detected input phase loss action (OrP) | 0: Warn and ramp to stop<br>1: Warn and coast to stop | 0 |
| ✓ | 06-55 | Derating protection | 0: constant rated current and limit carrier wave by load current and temperature<br>1: constant carrier frequency and limit load current by setting carrier wave<br>2: constant rated current (same as setting 0), but close current limit | 0 |
| ✓ | 06-60 | Software detection GFF current level | 0.0–6553.5% | 60.0 |
| ✓ | 06-61 | Software detection GFF filter | 0.00–655.35 sec. | 0.10 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | | time | | |
| | 06-63 | Operation time of fault record 1 (Days) | 0–65535 days | Read only |
| | 06-64 | Operation time of fault record 1 (Minutes) | 0–65535 min. | Read only |
| | 06-65 | Operation time of fault record 2 (Days) | 0–65535 days | Read only |
| | 06-66 | Operation time of fault record 2 (Minutes) | 0–65535 min. | Read only |
| | 06-67 | Operation time of fault record 3 (Days) | 0–65535 days | Read only |
| | 06-68 | Operation time of fault record 3 (Minutes) | 0–65535 min. | Read only |
| | 06-69 | Operation time of fault record 4 (Days) | 0–65535 days | Read only |
| | 06-70 | Operation time of fault record 4 (Minutes) | 0–65535 min. | Read only |
| ✓ | 06-71 | Low current setting level | 0.0–100.0% | 0.0 |
| ✓ | 06-72 | Low current detection time | 0.00–360.00 sec. | 0.00 |
| ✓ | 06-73 | Low current action | 0: No function<br>1: Warn and coast to stop<br>2: Warn and ramp to stop by the 2nd deceleration time<br>3: Warn and continue operation | 0 |
| ✓ | 06-80 | Emergency power voltage in operation | 280.0–537.0 $V_{DC}$ | 300.0 |
| | 06-81 | Emergency power speed in operation | 0.00–599.00 Hz | Read only |
| | 06-82 | Emergency power capacity in operation | 0.0–100.0 KVA | 0.0 |
| ✓ | 06-83 | EPS mode selection | 0: Operate by current command direction.<br>1: Run in the running direction of power generation mode. Execute the power generation direction detection when running in power generation mode.<br>2: After determining the power generation direction, the host controller sends a running direction command. (When at STOP, the direction of power generation mode (MO = 57) confirmation and the direction of power generation does not maintain.) Execute the power generation direction detection each time whenever running. | 0 |

| Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|
| | | 3: After determining the power generation direction, the host controller sends a running direction command. (When at STOP, the direction of power generation mode (MO = 57) confirmation and the direction of the power generation does not maintain.) Execute the power generation direction detection only one time when running.<br>4: Run by the direction of power generation mode. Execute the power generation direction detection when running in normal mode. | |
| | 06-84 | Power generation direction search time | 0.0–5.0 sec. | 1.0 |
| ✓ | 06-85 | UPS output delay time | 0.0–10.0 sec. | 1.0 |
| ✓ | 06-86 | Power factor kevel for determining the power generation direction | 0.0–150.0 ° | 70.0 |
| | 06-87 | Reference level of the power factor when running | 0.0–200.0 ° | Read only |
| | 06-88 | Power generation direction | 0: Forward running<br>1: Reverse running | Read only |
| | 06-89 | Delay time on stopping UPS output | 0.0–60.0 sec. | 3.0 |
| | 06-90 | Operation time of fault record 5 (Day) | 0–65535 days | Read only |
| | 06-91 | Operation time of fault record 5 (Min.) | 0–65535 min. | Read only |
| | 06-92 | Operation time of fault record 6 (Day) | 0–65535 days | Read only |
| | 06-93 | Operation time of fault record 6 (Min.) | 0–65535 min. | Read only |

# 07 Special Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ✓ | 07-00 | Software brake level | 230V: 350.0–450.0 $V_{DC}$<br>460V: 700.0–900.0 $V_{DC}$ | 370.0<br>740.0 |
| ✓ | 07-01 | DC brake current level | 0–100 % | 30 |
| ✓ | 07-02 | DC brake time at Start-up | 0.0–60.0 sec. | 0.7 |
| ✓ | 07-03 | DC brake time at stop | 0.0–60.0 sec. | 0.7 |
| ✓ | 07-04 | DC brake frequency at stop | 0.00–599.00 Hz | 0.00 |
| ✓ | 07-05 | Voltage increasing gain | 1–200 % | 100 |
| ✓ | 07-06 | Restart after momentary power loss | 0: Stop operation<br>1: Speed tracking by the speed before the power loss<br>2: Speed tracking by the minimum output frequency | 0 |
| ✓ | 07-07 | Allowed power loss duration | 0.0–20.0 sec. | 2.0 |
| ✓ | 07-08 | Base block time | 0.1–5.0 sec. | 0.5 |
| ✓ | 07-09 | Current limit of speed tracking | 20–200 % | 100 |
| ✓ | 07-10 | Restart after fault action | 0: Stop operation<br>1: Speed tracking by current speed<br>2: Speed tracking by minimum output frequency | 0 |
| ✓ | 07-11 | Number of times of auto-restart after fault | 0–10 | 0 |
| ✓ | 07-12 | Speed tracking during start-up | 0: Disable<br>1: Speed tracking by maximum output frequency<br>2: Speed tracking by motor frequency at start<br>3: Speed tracking by minimum output frequency | 0 |
| ✓ | 07-13 | dEb function selection | 0: Disable<br>1: dEb with auto-acceleration / auto-deceleration, the drive does not output the frequency after the power is restored.<br>2: dEb with auto-acceleration / auto-deceleration, the drive outputs the frequency after the power is restored. | 0 |
| ✓ | 07-15 | Dwell time at acceleration | 0.00–600.00 sec. | 0.00 |
| ✓ | 07-16 | Dwell frequency at acceleration | 0.00–599.00 Hz | 0.00 |
| ✓ | 07-17 | Dwell time at deceleration | 0.00–600.00 sec. | 0.00 |
| ✓ | 07-18 | Dwell frequency at deceleration | 0.00–599.00 Hz | 0.00 |
| ✓ | 07-19 | Fan cooling control | 0: Fan always ON<br>1: Fan is OFF after the AC motor drive stops for one minute.<br>2: Fan is ON when the AC motor drive runs; fan is OFF when the AC motor drive stops.<br>3: Fan turns ON when the temperature reaches around 60°C. | 3 |

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ✓ | 07-20 | Deceleration of emergency or forced stop | 0: Coast to stop<br>1: Stop by the 1st deceleration time<br>2: Stop by the 2nd deceleration time<br>3: Stop by the 3rd deceleration time<br>4: Stop by the 4th deceleration time<br>5: System deceleration<br>6: Automatic deceleration | 0 |
| ✓ | 07-21 | Automatic energy-saving setting | 0: Disable<br>1: Enable | 0 |
| ✓ | 07-22 | Energy-saving gain | 10–1000% | 100 |
| ✓ | 07-23 | Automatic voltage regulation (AVR) function | 0: Enable AVR<br>1: Disable AVR<br>2: Disable AVR during deceleration | 0 |
| ✓ | 07-24 | Torque command filter time (V/F and SVC control mode) | 0.001–10.000 sec. | 0.050 |
| ✓ | 07-25 | Slip compensation filter time (V/F and SVC control mode) | 0.001–10.000 sec. | 0.100 |
| ✓ | 07-26 | Torque compensation gain | 0–10 | 1 |
| ✓ | 07-27 | Slip compensation gain (V/F and SVC control mode) | 0.00–10.00<br>(default value is 1 in SVC mode) | 0.00 |
| ✓ | 07-29 | Slip deviation level | 0.0–100.0%<br>0: No detection | 0 |
| ✓ | 07-30 | Slip deviation detection time | 0.0–10.0 sec. | 1.0 |
| ✓ | 07-31 | Slip deviation action | 0: Warn and continue operation<br>1: Warn and ramp to stop<br>2: Warn and coast to stop<br>3: No warning | 0 |
| ✓ | 07-32 | Motor shock compensation factor | 0–10000 | 1000 |
| ✓ | 07-33 | Auto-restart interval of fault | 0.0–6000.0 sec. | 60.0 |
| ✓ | 07-34 | Slip compensation gain % (power generation mode) | 0.0–100.0 % | 0.0 |
| ✓ | 07-35 | Slip compensation gain % (electricity mode) | 0.0–100.0 % | 0.0 |
| ✓ | 07-36 | Maximum slip frequency | 0.00–200.00 Hz | 0.00 |

# 09 Communication Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| ✓ | 09-00 | Communication address | 1–254 | 1 |
| ✓ | 09-01 | COM1 transmission speed | 4.8–115.2 kbps | 9.6 |
| ✓ | 09-02 | COM1 transmission fault treatment | 0: Warn and continue operation<br>1: Display error and ramp to stop<br>2: Display error and coast to stop<br>3: No warning, no error displayed and continue operation | 3 |
| ✓ | 09-03 | COM1 time-out detection | 0.0–100.0 sec. | 0.0 |
| ✓ | 09-04 | COM1 communication protocol | 1: 7N2 (ASCII)<br>2: 7E1 (ASCII)<br>3: 7O1 (ASCII)<br>4: 7E2 (ASCII)<br>5: 7O2 (ASCII)<br>6: 8N1 (ASCII)<br>7: 8N2 (ASCII)<br>8: 8E1 (ASCII)<br>9: 8O1 (ASCII)<br>10: 8E2 (ASCII)<br>11: 8O2 (ASCII)<br>12: 8N1 (RTU)<br>13: 8N2 (RTU)<br>14: 8E1 (RTU)<br>15: 8O1 (RTU)<br>16: 8E2 (RTU)<br>17: 8O2 (RTU) | 1 |
| ✓ | 09-09 | Communication response delay time | 0.0–200.0 ms | 2.0 |
| ✓ | 09-33 | PLC command force to 0 | 0–65535 | 0 |
| | 09-35 | PLC address | 1–254 | 2 |
| | 09-36 | CANopen slave address | 0: Disable<br>1–127 | 0 |
| | 09-37 | CANopen speed | 0: 1 Mbps<br>1: 500 Kbps<br>2: 250 Kbps<br>3: 125 Kbps<br>4: 100 Kbps (Delta only)<br>5: 50 Kbps | 0 |

| Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|
| 09-39 | CANopen warning record | bit 0: CANopen software disconnection 1 (CANopen guarding time-out)<br>bit 1: CANopen software disconnection 2 (CANopen heartbeat time-out)<br>bit 3: CANopen SDO time-out<br>bit 4: CANopen SDO buffer overflow<br>bit 5: CANopen hardware disconnection warning (Can Bus OFF)<br>bit 6: Error protocol for CANopen | 0 |
| 09-40 | CANopen decoding method | 0: Delta-defined decoding method<br>1: CANopen standard DS402 protocol | 1 |
| 09-41 | CANopen communication status | 0: Node reset<br>1: Com reset<br>2: Boot up<br>3: Pre-operational<br>4: Operation<br>5: Stopped | Read only |
| 09-42 | CANopen control status | 0: Not ready for use<br>1: Inhibit start<br>2: Ready to switch on<br>3: Switched on<br>4: Enable operation<br>7: Quick stop active<br>13: Error reaction activation<br>14: Error state | Read only |
| 09-43 | CANopen reset index | bit 0: CANopen reset, internal address 20XX is 0<br>bit 1: CANopen reset, internal address 264X is 0<br>bit 2: CANopen reset, internal address 26AX is 0<br>bit 3: CANopen reset, internal address 60XX is 0 | 65535 |

# 11 Advanced Parameters

| | Pr. | Parameter Name | Setting Range | Default |
|---|---|---|---|---|
| | 11-41 | PWM mode selection | 0: Two-phase<br>2: Space vector | 0 |
| ↙ | 11-42 | System control flag | 0000–FFFFh | 0000 |

# Chapter 12 Description of Parameter Settings

## 00 Drive Parameters

You can set this parameter during operation.

### 00-00 Identity Code of the AC Motor Drive

Default: #.#

Settings Read Only

### 00-01 Display AC Motor Drive Rated Current

Default: #.#

Settings Read Only

Pr.00-00 displays the identity code of the AC motor drive. Use the following specification table to check if the Pr.00-01 setting is the rated current of the AC motor drive. Pr.00-01 corresponds to the identity code of the motor.

| | 230V Series: Three-Phase | | | | | | 460V Series: Three-Phase | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frame | C | | D | E | | F | C | D | | E | |
| kW | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 3.7 | 5.5 | 7.5 | 11 | 15 |
| HP | 3 | 5 | 7.5 | 10 | 15 | 20 | 5 | 7.5 | 10 | 15 | 20 |
| Identity Code | 206 | 207 | 208 | 209 | 210 | 211 | 407 | 408 | 409 | 410 | 411 |
| Rated Current | 11 | 17 | 25 | 33 | 49 | 65 | 9 | 13 | 17 | 25 | 32 |

### 00-02 Parameter Reset

Default: 0

Settings 0: No Function
1: Parameter write protection
5: Reset kWH display to 0
6: Reset PLC
7: Reset CANopen index (Slave)
9: All parameters are reset to defaults (base frequency is 50 Hz)
10: All parameters are reset to defaults (base frequency is 60 Hz)

1: All parameters are read-only except Pr.00-02, 00-07, and 00-08. You must set Pr.00-02 to 0 before changing other parameter settings.

5: You can set the kWh displayed value to 0 even when the drive is operating. Reset Pr.05-26, 05-27, 05-28, 05-29, 05-30 to 0.

6: Clear internal PLC program (including the related settings for PLC internal CANopen master)

7: Reset the related settings for CANopen slave.

9 or 10: All parameters are reset to defaults. If password is set in Pr.00-08, enter the password set in Pr.00-07 to reset to defaults.

6, 9, 10: Reboot the motor drive after you finish setting.

## 00-03 Start-up Display Selection

Default: 0

Settings
0: F (Frequency command)
1: H (output frequency)
2: U (user-defined) (refer to Pr.00-04)
3: A (output current)

Determines the start-up display page. User-defined display selection is according to the setting in Pr.00-04.

## 00-04 Content of Multi-function Display (User-Defined)

Default: 3

Settings
0: Display output current (A) (Unit: Amps)
1: Display counter value (c) (Unit: CNT)
2: Display actual output frequency (H.) (Unit: Hz)
3: Display DC BUS voltage (v) (Unit: $V_{DC}$)
4: Display output voltage of U, V, W (E) (Unit: $V_{AC}$)
5: Display output power angle of U, V, W (n) (Unit: deg)
6: Display output power of U, V, W (P) (Unit: kW)
7: Display motor speed rpm (r) (Unit: rpm)
8: Display estimated output torque %, motor's rated torque is 100% (Unit: %)
11: Display signal value of AVI analog input terminal (1.) (Unit: %)
12: Display signal value of ACI analog input terminal (2.) (Unit: %)
14: Display IGBT temperature (i.) (Unit: °C)
15: Display CAP temperature (i.) (Unit: °C)
16: Display digital input status (ON / OFF) (i)
17: Display digital output status (ON / OFF) (o)
18: Display multi-step speed that is executing (S)
19: Display corresponding CPU pin status of digital input (d)
20: Display corresponding CPU pin status of digital output (0.)
25: Display overload count (0.00–100.00%) (o.) (Unit: %)
26: Display GFF Ground Fault (G.) (Unit: %)
27: Display DC BUS voltage ripple (r.) (Unit: $V_{DC}$)
30: Display user-defined output (U)
35: Display control mode:
0 = speed control mode (SPD)
36: Display present operating carrier frequency (Hz) (J.)
38: Display drive status (6.)
41: Display kWH (J) (Unit: kWh)
47: Display master frequency value (A ) (Unit: Hz)

Explanation 1

- It can also display negative values when setting analog input bias (Pr.03-03–03-10).
- Example: Assume that AVI input voltage is 0 V, Pr.03-03 is 10.0%, Pr.03-07 is 4 (Bias serves as the center), and Pr.03-10 is 1 allowing negative frequency input.

Explanation 2

- Example: If MI1 and MI6 are ON, the following table shows the status of the terminals.
  Normally opened contact (N.O.): (0: OFF, 1: ON)

| Terminal | MI7 | MI6 | MI5 | MI4 | MI3 | MI2 | MI1 |
|---|---|---|---|---|---|---|---|
| Status | 0 | 1 | 0 | 0 | 0 | 0 | 1 |

- The value is 0000 0000 0010 0001 in binary and 0021H in HEX. When Pr.00-04 is set to “16” or “19”, the u page on the keypad displays 0021h.
- The setting 16 is the ON / OFF status of digital input according to Pr.02-12 setting and the setting 19 is the corresponding CPU pin ON / OFF status of the digital input.
- When MI1 / MI2 default setting is two-wire/ three-wire operation control (Pr.02-00 ≠ 0), and MI3 is set as three-wire, it is not affected by Pr.02-12.
- You can set 16 to monitor the digital input status, and then set 19 to check if the circuit is normal.

Explanation 3

- Example: Assume that RY: Pr.02-13 is set to 9 (Drive is ready). After the drive applies power, if there is no other abnormal status, the contact is ON. The display status is shown below.
  Normally opened contact (N.O.):

| Terminal | MO2 | MO1 | RY1 |
|---|---|---|---|
| Status | 0 | 0 | 1 |

- If Pr.00-04 is set to 17 or 20, it displays in hexadecimal “0001h” with LED u page is ON on the keypad.
- The setting 17 is the ON / OFF status of digital output according to Pr.02-18 setting and the setting 20 is the corresponding CPU pin ON / OFF status of the digital output.
- You can set 17 to monitor the digital output status, and then set 20 to check if the circuit is normal.

Explanation 4

- Setting value 8: 100% means the motor rated torque.
  Motor rated torque = (motor rated power x 60 / 2$\pi$) / motor rated rotating speed.

Explanation 5

- Setting value 25: when display value reaches 100.00 %, the drive shows “oL” as an overload warning.

Explanation 6

- Setting value 38:
  bit 0: The drive is running forward.
  bit 1: The drive is running backward.
  bit 2: The drive is ready.
  bit 3: Errors occurred on the drive.
  bit 4: The drive is running.
  bit 5: Warnings occurred on the drive.

## 00-06 Firmware Version

Default: #.#

Settings Read only

## 00-07 Parameter Protection Password Input

Default: 0

Settings 0–65535

0–3 (number of wrong password attempts)

- Allows you to enter your password (which is set in Pr.00-08) to unlock the parameter protection and to change parameters.
- Be sure to record the password for later use after you set this parameter.
- Pr.00-07 and Pr.00-08 are used to prevent personnel from setting other parameters by accident. If you forget the password, clear the password setting by entering 9999 and pressing the ENTER key, then enter 9999 again and press ENTER within 10 seconds. After decoding, all the settings return to default.
- When setting is under password protection, all the parameters read 0, except Pr.00-08.

## 00-08 Parameter Protection Password Setting

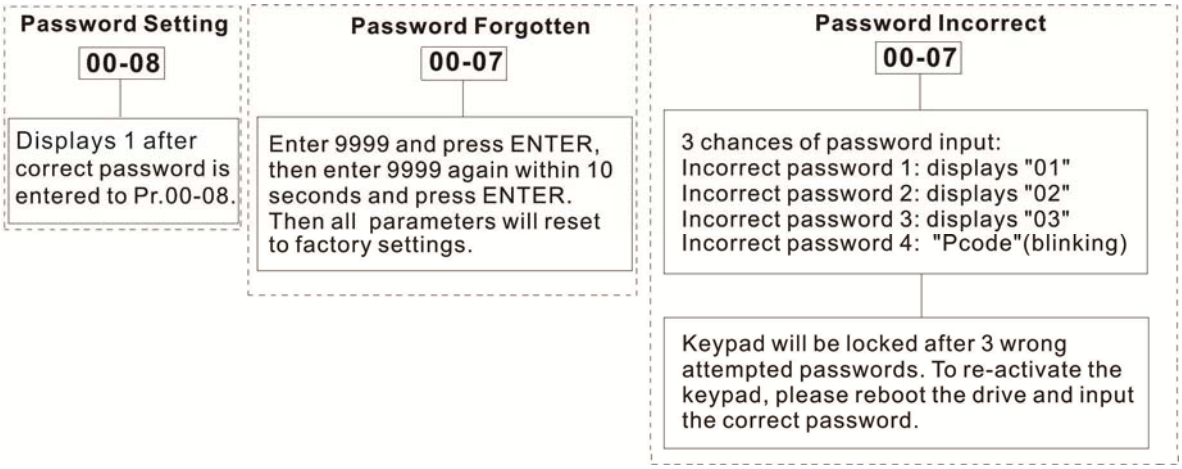
Default: 0

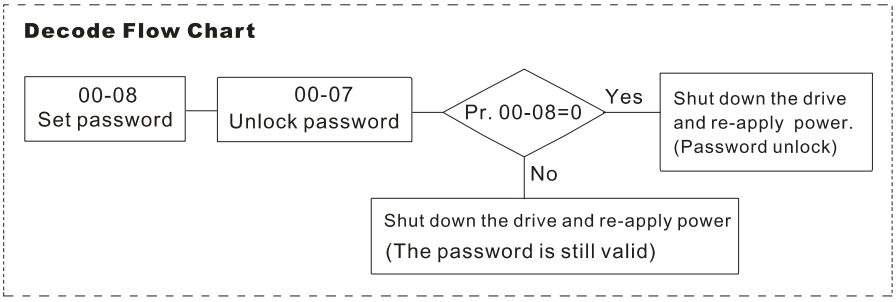
Settings 0–65535

0: No password protection or password is entered correctly (Pr.00-07)

1: Password has been set

- This parameter is for setting the password protection. Password can be set directly the first time. After you set the password, the value of Pr.00-08 is 1, which means password protection is activated. At this time, if you want to change any of the parameter settings, you must enter the correct password in Pr.00-07 to deactivate the password temporarily, and this would make Pr.00-08 become 0. After you finish setting the parameters, reboot the motor drive and the password is activated again.
- Entering the correct password in Pr.00-07 only temporarily deactivates the password. To permanently deactivate password protection, set Pr.00-08 to 0 manually. Otherwise, password protection is always reactivated after you reboot the motor drive.
- The keypad copy function works only when the password protection is deactivated (temporarily or permanently), and the password set in Pr.00-08 cannot be copied to the keypad. So when copying parameters from the keypad to the motor drive, set the password manually again in the motor drive to activate password protection.




## 00-11 Speed Control Mode

Default: 0

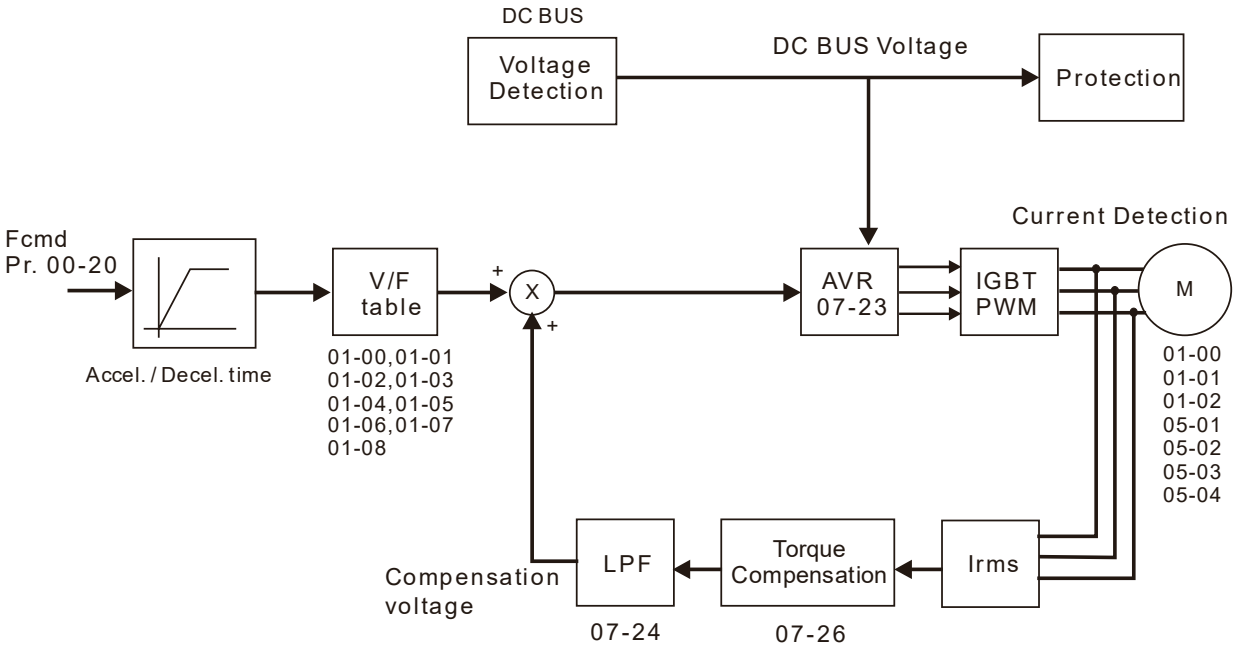
Settings 0: V/F (IM V/F control)
2: SVC

🕮 Determines the control mode of the AC motor drive:

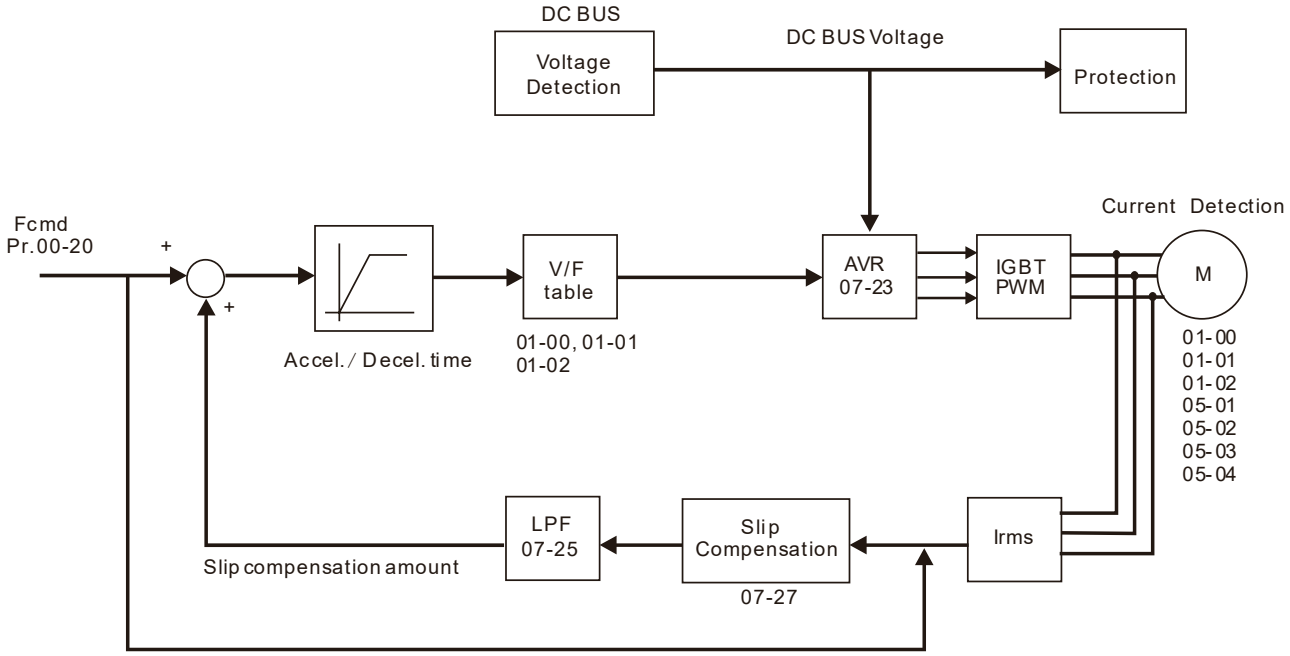
0: IM V/F control: user can design proportion of V/F as required and control multiple motors simultaneously.

2: IM sensorless vector control: get the optimal control by the auto-tuning of motor parameters.

🕮 When Pr.00-10 = 0 and set Pr.00-11 to 0, the V/F control diagram is shown as follows:



When Pr.00-10 = 0 and set Pr.00-11 to 2, the sensorless vector control diagram is shown as follows:




## 00-17 Carrier Frequency

Default: 8

Settings 2–15 kHz

Determinates the PWM carrier frequency for the AC motor drive.

| Carrier Frequency | Acoustic Noise | Electromagnetic Noise or Leakage Current | Heat Dissipation | Current Wave |
|---|---|---|---|---|
| 2 kHz | Significant | Minimal | Minimal | |
| 8 kHz | ↕ | ↕ | ↕ | |
| 15 kHz | Minimal | Significant | Significant | |

From the table, you see that the PWM carrier frequency has significant influences on the electromagnetic noise, the AC motor drive heat dissipation, and the motor acoustic noise. Therefore, if the surrounding noise is greater than the motor noise, lower the carrier frequency to reduce the temperature rise. Although the motor has quiet operation in the higher carrier frequency, consider the entire wiring and interference.

When the carrier frequency is higher than the default, decrease the carrier frequency to protect the drive. Refer to Pr.06-55 for related setting and details.

## 00-19 PLC Command Mask

Default: Read Only

Settings bit 0: Control command forced by PLC control
bit 1: Frequency command forced by PLC control

Determines if frequency command or control command is locked by the PLC.

## 00-20 Master Frequency Command (AUTO) Source

Default: 0

Settings 0: Digital keypad
1: RS-485 serial communication
2: External analog input (Refer to Pr.03-00)
3: External terminals
6: CANopen input
Note: It is valid only when using with KPC-CC01.

- You can switch the AUTO / HAND mode with the keypad KPC-CC01 (optional).
- Pr.00-20 and Pr.00-21 are for setting the frequency source and operation source in AUTO mode. Pr.00-30 and Pr.00-31 are for setting the frequency source and operation source in HAND mode.
- The default for the frequency source or operation source is for AUTO mode. It returns to AUTO mode whenever you cycle the power. If you use a multi-function input terminal to switch between AUTO and HAND mode, the highest priority is the multi-function input terminal. When the external terminal is OFF, the drive does not accept any operation signal and cannot execute JOG.

### 00-21 Operation Command (AUTO) Source

Default: 0

Settings 0: Digital keypad
1: External terminals.
2: Communication RS-485 input
3: CANopen input
Note: It is valid only when using with KPC-CC01.

- Determines the operation frequency source in AUTO mode.
- When you control the operation command by the keypad KPC-CC01 (optional), keys RUN, STOP and JOG (F1) are valid.

### 00-48 Display Filter Time (Current)

Default: 0.100

Settings 0.001–65.535 sec.

- Minimizes the current fluctuation displayed by digital keypad.

### 00-49 Display Filter Time (Keypad)

Default: 0.100

Settings 0.001–65.535 sec.

- Minimizes the value fluctuation displayed by digital keypad.

### 00-50 Software Version (Date)

Default: #####

Settings Read only

- Displays the current drive software version by date.

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# 01 Basic Parameters

✓ You can set this parameter during operation.

## 01-00 Maximum Operation Frequency of Motor 1

Default: 60.00 / 50.00

Settings 00.00–599.00 Hz

📖 Determines the drive's maximum operation frequency range. This setting corresponds to the maximum value for the analog input frequency setting signal (0–10 V, 4–20 mA, 0–20 mA, ±10 V).

## 01-01 Output Frequency of Motor 1

Default: 60.00 / 50.00

Settings 00.00–599.00 Hz

📖 Set this value according to the motor's rated frequency from the motor's nameplate. If the motor's rated frequency is 60 Hz, set the value to 60 Hz. If the motor's rated frequency is 50 Hz, set the value to 50 Hz.

## 01-02 Output Voltage of Motor 1

Default: 220.0 / 440.0

Settings 230 V series: 0.0–255.0 V
460 V series: 0.0–510.0 V

📖 Set this value according to the rated voltage of the motor from the motor's nameplate. If the motor's rated voltage is 220 V, set the value to 220.0 V. If the motor's rated voltage is 200 V, set the value to 200.0 V.

📖 There are a wide variety of motors, but the power system for each country is different. The convenient and economical way to solve this problem is to use an AC motor drive, which can deal with different voltages and frequencies, while supporting the original characteristics and life of the motor.

## 01-03 Mid-point Frequency 1 of Motor 1

Default: 3.00

Settings 0.00–599.00 Hz

## ✓ 01-04 Mid-point Voltage 1 of Motor 1

Default: 11.0 / 22.0

Settings 230 V series: 0.0 V–240.0 V
460 V series: 0.0 V–480.0 V

## 01-05 Mid-point Frequency 2 of Motor 1

Default: 0.50

Settings 0.00–599.00 Hz

## ✓ 01-06 Mid-point Voltage 2 of Motor 1

Default: 2.0 / 4.0

Settings 230 V series: 0.0 V–240.0 V
460 V series: 0.0 V–480.0 V

### 01-07 Minimum Output Frequency of Motor 1

Default: 0.00

Settings 0.00–599.00 Hz

### 01-08 Minimum Output Voltage of Motor 1

Default: 0.0 / 0.0

Settings 230 V series: 0.0 V–240.0 V
460 V series: 0.0 V–480.0 V

### 01-09 Start-up Frequency

Default: 0.50

Settings 0.00–599.00 Hz

When start frequency is higher than the minimum output frequency, drive's output is from the starting frequency to the setting frequency. Refer to the following diagram for details.

Fcmd = frequency command;

Fstart = start frequency (Pr.01-09);

fstart = actual start frequency of drive;

Fmin = 4th output frequency setting (Pr.01-07);

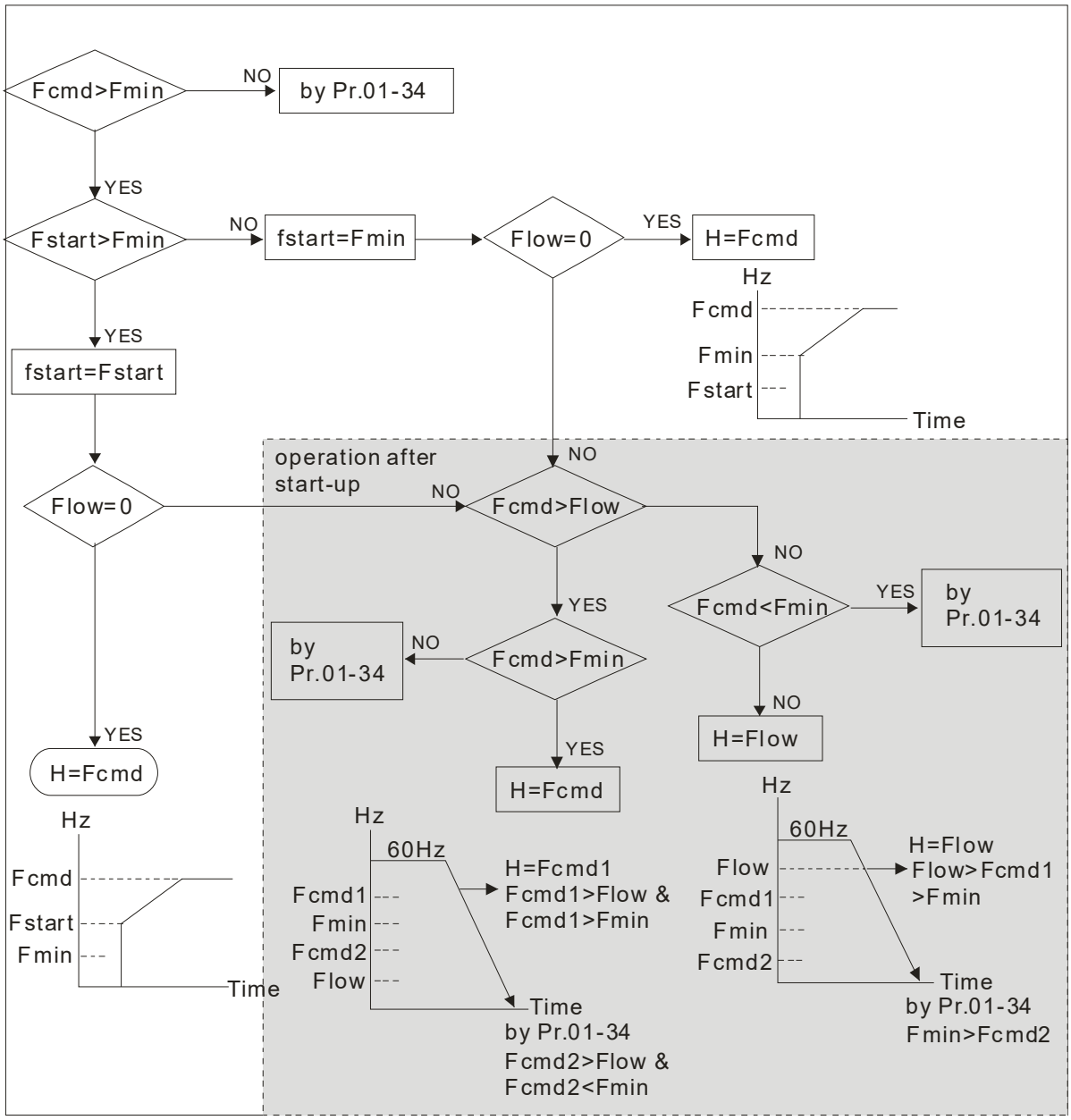
Flow = output frequency lower limit (Pr.01-11)

When Fcmd > Fmin and Fcmd < Fstart:

If Flow < Fcmd, drive runs directly by Fcmd.

If Flow ≥ Fcmd, drive runs by Fcmd, then rise to Flow according to acceleration time.

The output frequency goes directly to 0 when decelerating to Fmin.




## 01-10 Output Frequency Upper Limit

Default: 599.00

Settings 0.00–599.00 Hz

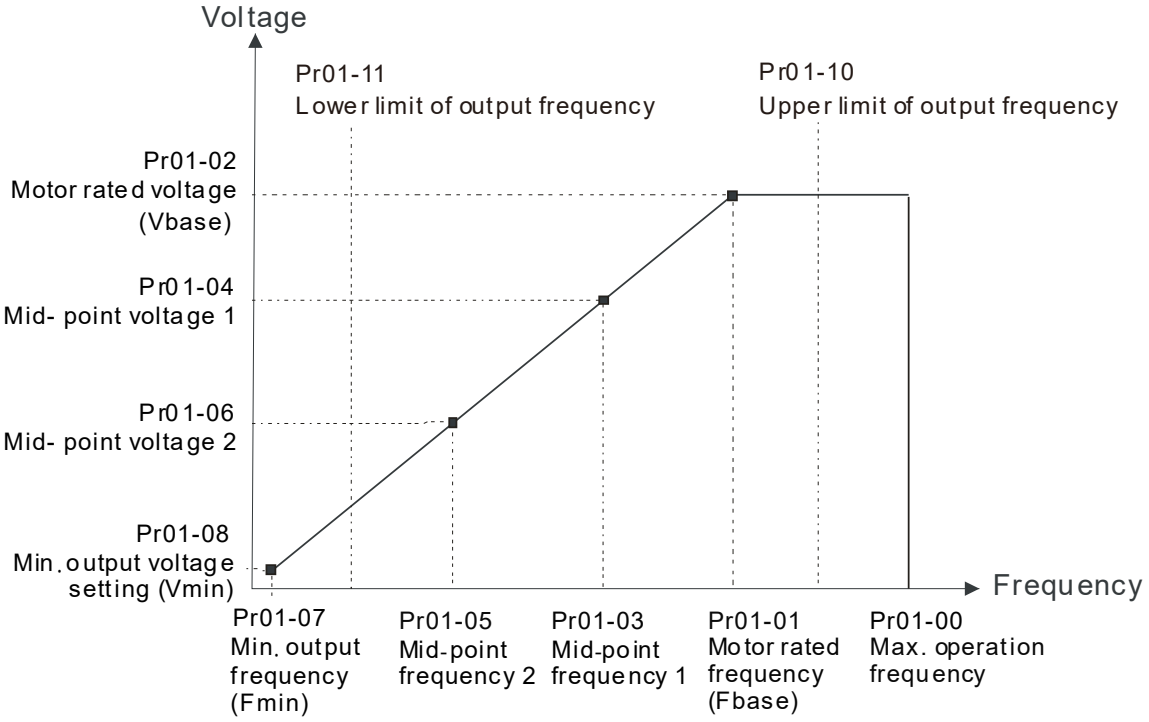
## 01-11 Output Frequency Lower Limit

Default: 0.00

Settings 0.00–599.00 Hz

- Use the upper and lower limit output frequency settings to limit the actual output frequency. If the frequency setting is higher than the upper limit (Pr.01-10), the drive uses the upper limit frequency. If the output frequency is lower than lower limit (Pr.01-11) and frequency setting is higher than minimum frequency (Pr.01-07), the drive uses the lower limit frequency. Set the upper limit frequency > lower limit frequency (Pr.01-10 setting value must be > Pr.01-11 setting value).
- The upper output frequency limits the maximum output frequency of the drive. If the frequency setting is higher than Pr.01-10, the Pr.01-10 setting limits the output frequency.
- When the drive starts the slip compensation function (Pr.07-27) or PID feedback control, the drive output frequency may exceed frequency command but is still limited by this setting.

🕮 Related parameters: Pr.01-00 Maximum Operation Frequency.




🕮 The lower output frequency limits the minimum output frequency of the drive. When the drive frequency command is lower than this setting, the lower limit of the frequency limits the drive output frequency.

🕮 When the drive starts, it operates from the minimum output frequency (Pr.01-07) and accelerates to the setting frequency. It is not limited by the lower output frequency settings.

🕮 Use the output frequency upper and lower limit settings to prevent operator misuse, overheating caused by operating at a too low frequency, or damage caused by excessive speed.

🕮 If the output frequency upper limit setting is 50 Hz and the frequency setting is 60 Hz, the maximum output frequency is 50 Hz.

🕮 If the output frequency lower limit setting is 10 Hz and the minimum operation frequency setting (Pr.01-07) is 1.5 Hz, the drive operates at 10 Hz when the frequency command is greater than Pr.01-07 and less than 10 Hz. If the frequency command is less than Pr.01-07, the drive stays in ready status with no output.

🕮 If the frequency output upper limit is 60 Hz and the frequency setting is also 60 Hz, only the Frequency command is limited in 60 Hz. The actual frequency output may exceed 60 Hz if the drive starts the slip compensation function.

| | |
|---|---|
| 01-12 | Acceleration Time 1 |
| | Default: 2.00 |
| 01-13 | Deceleration Time 1 |
| | Default: 2.00 |
| 01-14 | Acceleration Time 2 |
| 01-15 | Deceleration Time 2 |
| 01-16 | Acceleration Time 3 |
| 01-17 | Deceleration Time 3 |
| 01-18 | Acceleration Time 4 |
| 01-19 | Deceleration Time 4 |

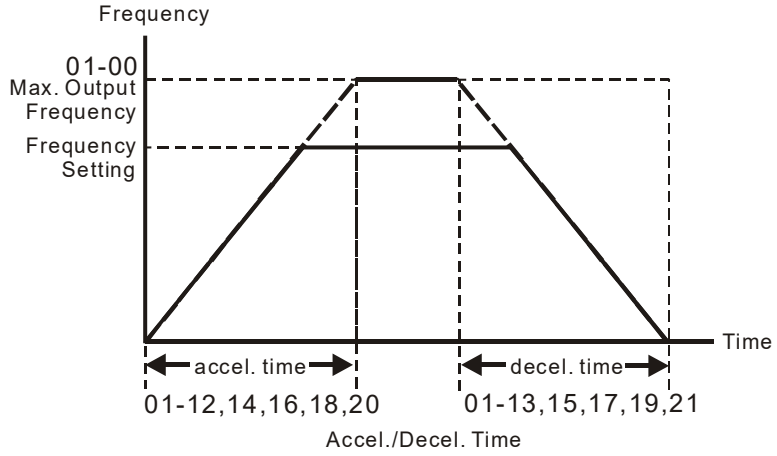
## 01-20 JOG Acceleration Time

## 01-21 JOG Deceleration Time

Default: 10.00

Settings 0.00–600.00 sec.

- Use the acceleration time to determine the time required for the AC motor drive to accelerate from 0 Hz to maximum output frequency (Pr.01-00).
- Select the acceleration and deceleration time 1, 2, 3, and 4 with the multi-function input terminals settings. The defaults are acceleration and deceleration time 1. With the enabled torque limits and stall prevention functions, the actual acceleration and deceleration time are longer than the above action time.
- Note that setting the acceleration and deceleration time too short may trigger the protection function (Pr.06-03 Over-current Stall Prevention during Acceleration or Pr.06-01 Over-voltage Stall Prevention).
- Note that setting the acceleration time too short may cause motor damage or trigger drive protection due to over-current during acceleration.
- Note that setting the deceleration time too short may cause motor damage or trigger drive protection due to over-current during deceleration or over-voltage.
- Use suitable brake resistors (refer to Chapter 07 Optional Accessories) to decelerate in a short time and prevent over-voltage.
- When you enable Pr.01-24–Pr.01-27 (S-curve acceleration and deceleration begin and arrival time), the actual acceleration and deceleration time are longer than the setting.




## 01-22 JOG Frequency

Default: 6.00

Settings 0.00–599.00 Hz

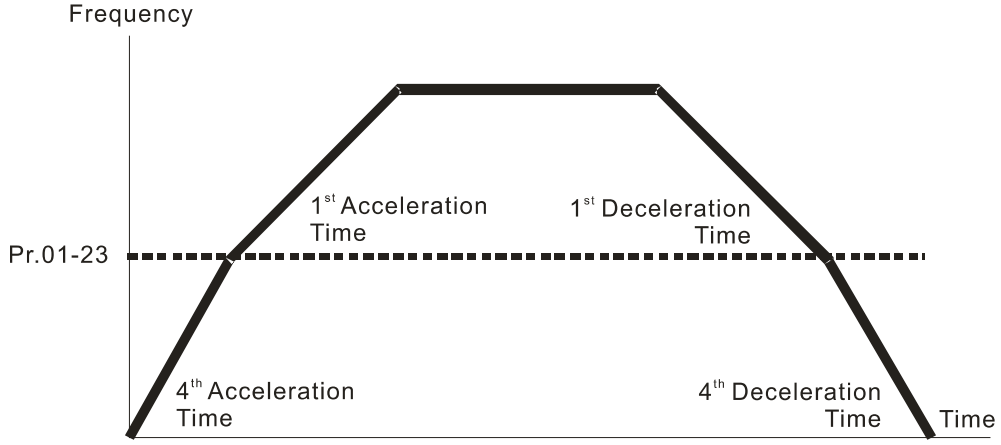
- You can use both the external terminal JOG and F1 key on the optional keypad KPC-CC01 to set the JOG function. When the JOG command is ON, the AC motor drive accelerates from 0 Hz to the JOG frequency (Pr.01-22). When the JOG command is OFF, the AC motor drive decelerates from the JOG frequency to stop. The JOG acceleration and deceleration time (Pr.01-20, Pr.01-21) are the time to accelerate from 0.0 Hz to the JOG frequency (Pr.01-22). You cannot execute the JOG command when the AC motor drive is running. When the JOG command is executing, other operation commands are invalid.

## 01-23 First / Fourth Acceleration / Deceleration Frequency

Default: 0.00

Settings 0.00–599.00 Hz

- This function does not require the external terminal switching function; it switches the acceleration and deceleration time automatically by the Pr.01-23 setting. If you set the external terminal, it is based on the external terminal first, and not on Pr.01-23.
- When using this function, set the S-curve acceleration time to 0.



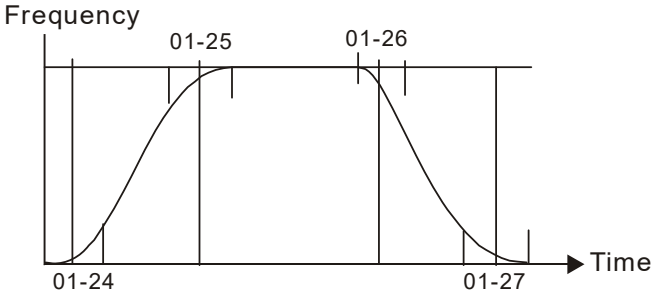

1st/4th Acceleration/Deceleration Frequency Switching

## 01-24 S-curve Acceleration Begin Time S1
## 01-25 S-curve Acceleration Arrival Time S2
## 01-26 S-curve Deceleration Begin Time S3
## 01-27 S-curve Deceleration Arrival Time S4

Default: 1.00

Settings 0.00–25.00 sec.

- Sets a slow start when the drive begins to accelerate at the start. The acceleration and deceleration curve adjust the S-curve acceleration and deceleration according to the parameter value. When you enable this function, the drive has a different acceleration and deceleration curve based on the acceleration and deceleration time.
- The S-curve function is disabled when you set the acceleration and deceleration time to 0.
- When Pr.01-12, 01-14, 01-16, 01-18 ≥ Pr.01-24 and Pr.01-25,
  the actual acceleration time = Pr.01-12, 01-14, 01-16, 01-18 + (Pr.01-24 + Pr.01-25) / 2.
- When Pr.01-13, 01-15, 01-17, 01-19 ≥ Pr.01-26 and Pr.01-27,
  the actual deceleration time = Pr.01-13, 01-15, 01-17, 01-19 + (Pr.01-26 + Pr.01-27) / 2.



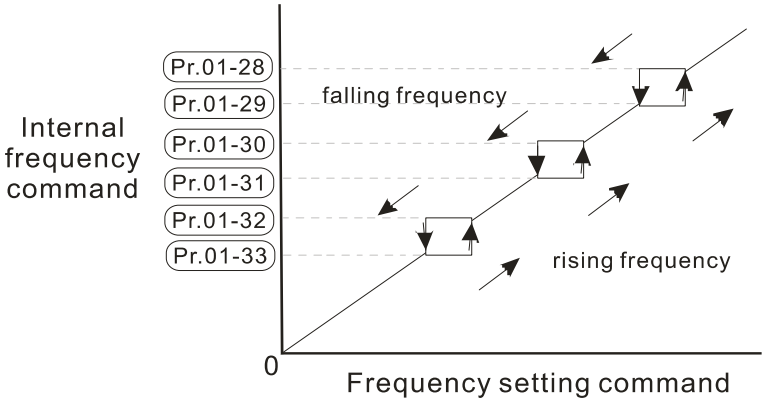

## 01-28 Skip Frequency 1 (Upper Limit)

| | |
|---|---|
| 01-29 | Skip Frequency 1 (Lower Limit) |
| 01-30 | Skip Frequency 2 (Upper Limit) |
| 01-31 | Skip Frequency 2 (Lower Limit) |
| 01-32 | Skip Frequency 3 (Upper Limit) |
| 01-33 | Skip Frequency 3 (Lower Limit) |

Default: 0.00

Settings 0.00–599.00 Hz

- Sets the AC drive's skip frequency. The drive's frequency setting skips these frequency ranges. However, the frequency output is continuous. There are no limits for these six parameters and you can combine them. Pr.01-28 does not need to be greater than Pr.01-29; Pr.01-30 does not need to be greater than Pr.01-31; Pr.01-32 does not need to be greater than Pr.01-33. Pr.01-28–01-33 can be set as required. There is no size distinction among these six parameters.
- These parameters set the skip frequency ranges for the AC motor drive. You can use this function to avoid frequencies that cause mechanical resonance. The skip frequencies are useful when a motor has resonance vibration at a specific frequency bandwidth. Skipping this frequency avoids the vibration. There are three frequency skip zones available. You can set the Frequency command (F) within the range of skip frequencies. Then the output frequency (H) is limited to the lower limit of skip frequency ranges.
- When accelerating and decelerating, the output frequency still passes through the skip frequency ranges.



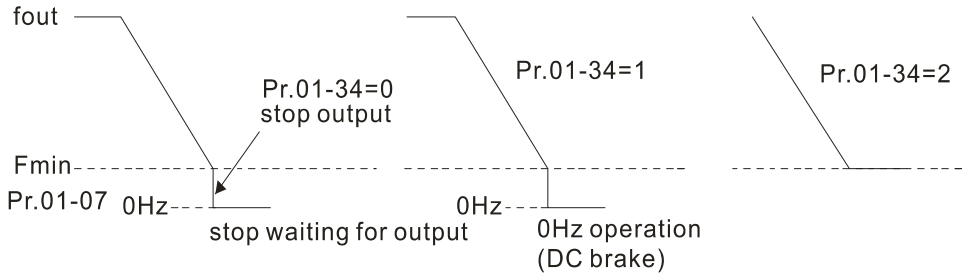

| | |
|---|---|
| 01-34 | Zero-speed Mode |

Default: 2

Settings 0: Output waiting
1: Zero-speed operation
2: Fmin (Refer to Pr.01-07)

- When the frequency command of drive is less than Fmin (Pr.01-07), the drive operates using this parameter.
- 0: the AC motor drive is in waiting mode without voltage output from terminals U, V, W.
- 1: the drive executes the DC brake by Vmin (Pr.01-08 and Pr.01-42) in V/F and SVC modes.
- 2: the AC motor drive runs using Fmin (Pr.01-07) and Vmin (Pr.01-08, Pr.01-42) in V/F and SVC modes.

In V/F and SVC modes:




## 01-46 Time for CANopen Quick Stop

Default: 1.00

Settings 0.00–600.00 sec.

🕮 Use this to set the time to decelerate from the maximum operation frequency (Pr.01-00) to 0.00 Hz by CANopen control.

## 01-71 Leveling Speed Switch

Default: 0.00

Settings 0.00–599.00 Hz

🕮 When the drive decelerates from S4 to S5, it switches the frequency to reach a smooth stop.

🕮 Set the speed for Pr.01-07 to the same as that for elevator.

## 01-72 Lower than Leveling Speed S5

Default: 1.00

Settings 0.00–25.00 sec.

🕮 It activates S-curve deceleration. The drive's deceleration curves act at different speed according to the original deceleration time.

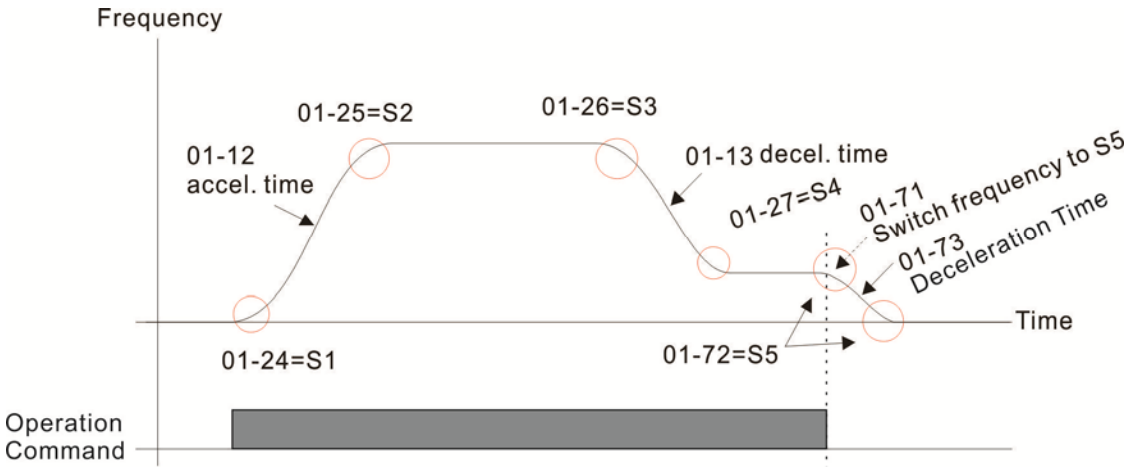
🕮 The Actual Deceleration Time = Pr.01-73 deceleration time + Pr.01-72.

## 01-73 Deceleration Time when Operating without RUN Command

Default: 2.00

Settings 0.00–25.00 sec.

🕮 When you cancel RUN command, the drive decelerates according to the dEB deceleration time in this parameter setting.




Actual Elevator Curve and Parameter Configuration Diagram

## 02 Digital Input / Output Parameter

You can set this parameter during operation.

### 02-00 Two-wire / Three-wire Operation Control

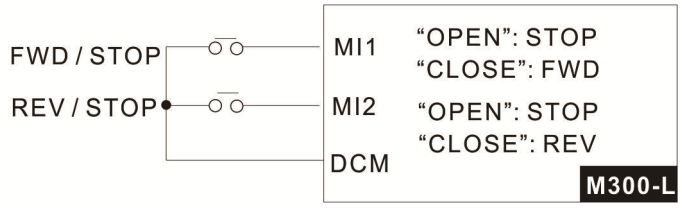
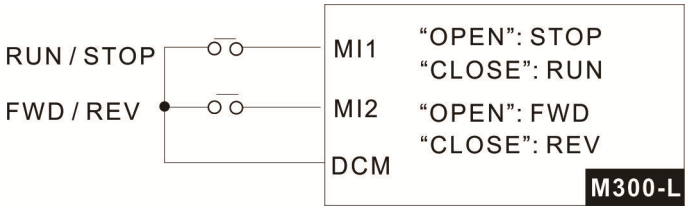
Default: 1

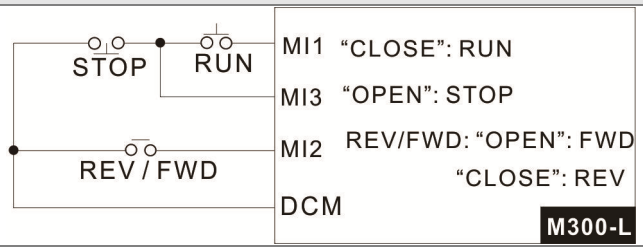
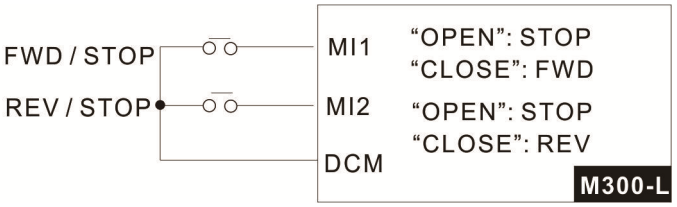
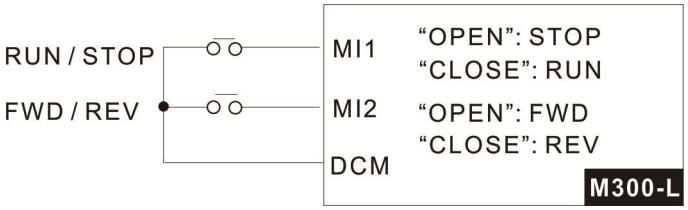
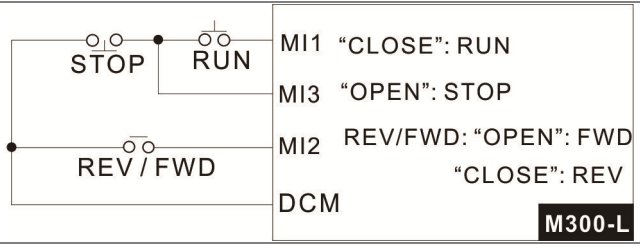
Settings
0: No function
1: Two-wire mode 1, power on for operation control
(M1: FWD / STOP, M2: REV / STOP)
2: Two-wire mode 2, power on for operation control
(M1: RUN / STOP, M2: FWD / REV)
3: Three-wire, power on for operation control
(M1: RUN, M2: REV / FWD, M3: STOP)
4: Two-wire mode 1, Quick Start
(M1: FWD / STOP, M2: REV / STOP)
5: Two-wire mode 2, Quick Start
(M1: RUN / STOP, M2: FWD / REV)
6: Three-wire, Quick Start
(M1: RUN, M2: REV / FWD, M3: STOP)

**IMPORTANT**

1. In the Quick Start function, terminal output stays in ready status, and the drive responds to the command immediately.
2. When using the Quick Start function, the output terminal has higher potential voltage.

- In the Quick Start function, the output remains ready for operation. The drive responds to the Start command immediately.
- When using the Quick Start function, there is greater potential voltage on the output terminals.
- This parameter sets the configuration of the external drive operation control and the Quick Start function. There are six different control modes listed in the following table.

| Pr.02-00 | External Terminal Control Circuits |
|---|---|
| Setting value: 1<br>Two-wire<br>FWD / STOP<br>REV / STOP |  |
| Setting value: 2<br>Two-wire<br>RUN / STOP<br>FWD / REV |  |

| Pr.02-00 | External Terminal Control Circuits |
|---|---|
| Setting value: 3<br>Three-wire |  |
| Setting value: 4<br>Two-wire<br>Quick Start |  |
| Setting value: 5<br>Two-wire<br>Quick Start |  |
| Setting value: 6<br>Three-wire<br>Quick Start |  |

| | |
|---|---|
| 02-01 | Multi-function Input Command 1 (MI1) |
| 02-02 | Multi-function Input Command 2 (MI2) |
| | Default: 0 |
| 02-03 | Multi-function Input Command 3 (MI3) |
| | Default: 1 |
| 02-04 | Multi-function Input Command 4 (MI4) |
| | Default: 2 |
| 02-05 | Multi-function Input Command 5 (MI5) |
| | Default: 3 |
| 02-06 | Multi-function Input Command 6 (MI6) |
| | Default: 4 |
| 02-07 | Multi-function Input Command 7 (MI7) |
| | Default: 49 |
| 02-26 | Multi-function Input Command 10 (MI10) |
| 02-27 | Multi-function Input Command 11 (MI11) |
| 02-28 | Multi-function Input Command 12 (MI12) |
| | Default: 0 |

Settings 0: No function

1: Multi-step speed command 1 / multi-step position command 1

2: Multi-step speed command 2 / multi-step position command 2
3: Multi-step speed command 3 / multi-step position command 3
4: Multi-step speed command 4 / multi-step position command 4
5: Reset
6: JOG operation (by KPC-CC01 or external control)
7: Acceleration / deceleration speed inhibit
8: The first and second acceleration / deceleration time selection
9: The third and fourth acceleration / deceleration time selection
10: EF input (Pr.07-20)
11: B.B. input from external (Base Block)
12: Output stop
15: Rotating speed command from AVI
16: Rotating speed command from ACI
18: Forced to stop (Pr.07-20)
24: FWD JOG command
25: REV JOG command
28: Emergency stop (EF1)
29: Signal confirmation for Y-connection
30: Signal confirmation for Δ-connection
38: Disable write EEPROM function
39: Torque command direction
40: Force coasting to stop
49: Enable Drive
51: Selection for PLC mode bit 0
52: Selection for PLC mode bit 1
53: Trigger CANopen quick stop
58: Emergency power mode detection
59: Detection of Magnetic
60: Mechanical brake error detection
61: Power down signal
62: Mechanical brake error detection 2

---

- This parameter selects the functions for each multi-function terminal.
- When Pr.02-00 = 0, you can set multi-function options with the multi-function input terminals MI1, MI2.
- When Pr.02-00 ≠ 0, the multi-function input terminals MI1, MI2 work in accordance with the setting values for Pr.02-00.

  Example:

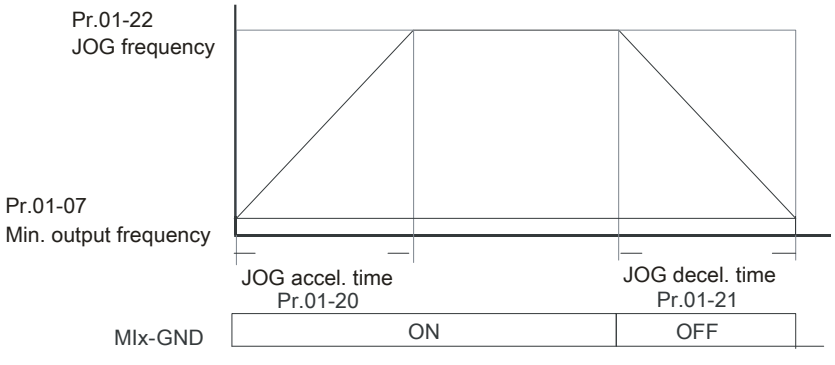
  If Pr. 02-00 = 1: multi-function input terminal MI1 = FWD / STOP,
  multi-function input terminal MI2 = REV / STOP.

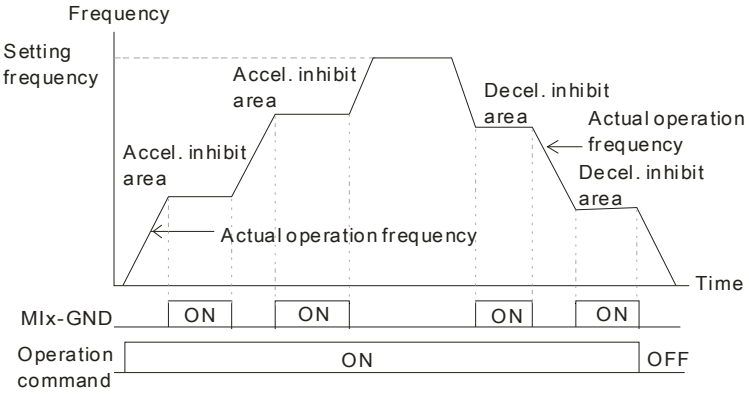
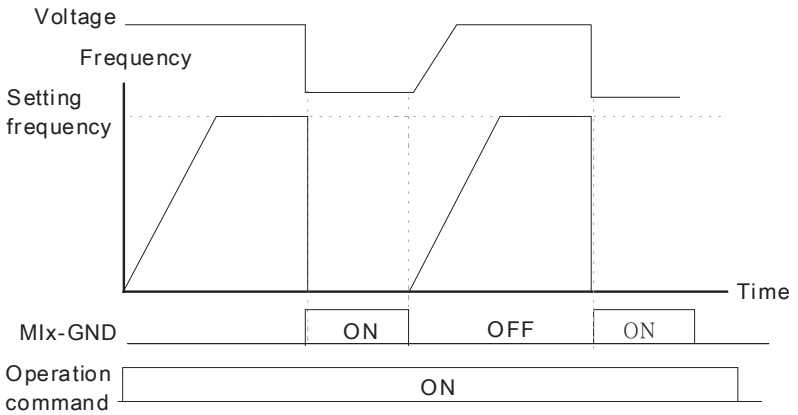
  If Pr. 02-00 = 2: multi-function input terminal MI1 = RUN / STOP,
  multi-function input terminal MI2 = FWD / REV.

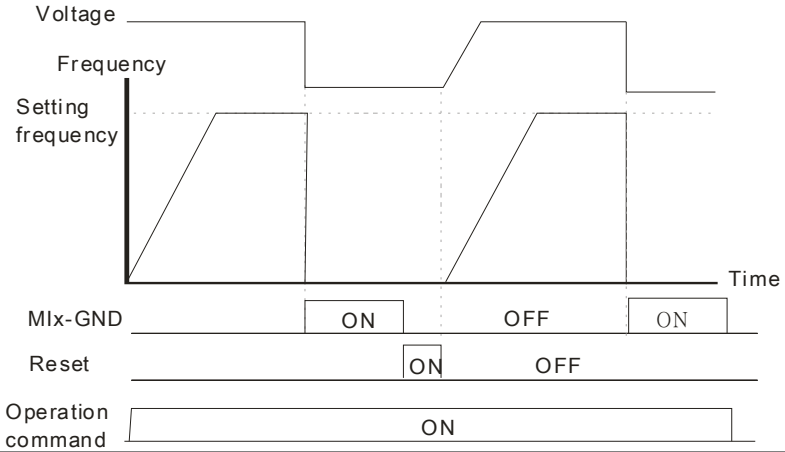
- When multi-function input terminal MI7 = 0, MI7 is designated as a pulse input terminal.
- If Pr.02-00 is set to three-wire operation control, terminal MI3 is for the STOP contact. The function set previously for this terminal is automatically invalid.

Summary of function settings

Take the normally opened contact (N.O.) for example, ON: contact is closed, OFF: contact is open.

| Settings | Functions | Descriptions |
|---|---|---|
| 0 | No Function | |
| 1 | Multi-step speed command 1 / multi-step position command 1 | You can set 15 steps of speed or 15 positions with the digital status of these 4 terminals. You can use 16-steps of speed if you include the master speed when setting as 15 steps of speed (refer to Parameter Group 04 Multi-step Speed Parameters). |
| 2 | Multi-step speed command 2 / multi-step position command 2 | |
| 3 | Multi-step speed command 3 / multi-step position command 3 | |
| 4 | Multi-step speed command 4 / multi-step position command 4 | |
| 5 | Reset | Use this terminal to reset the drive after clearing a drive fault. |
| 6 | JOG operation | This function is valid when the source of the operation command is the external terminals.<br>The JOG operation executes when the drive stops completely.<br>While running, you can still change the operation direction, and the STOP key on the keypad is valid. Once the external terminal receives the OFF command, the motor stops in the JOG deceleration time. Refer to Pr.01-20–01-22 for details.<br>  <br>Mix: external terminal |

| Settings | Functions | Descriptions |
|---|---|---|
| 7 | Acceleration / deceleration speed inhibit | When you enable this function, the drive stops acceleration or deceleration immediately. After you disable this function, the AC motor drive starts to accelerate or decelerate from the inhibit point.<br>  |
| 8 | The first, second acceleration / deceleration time selection | You can select the acceleration and deceleration time of the drive with this function, or from the digital status of the terminals; there are four acceleration and deceleration selections. |
| 9 | The third, fourth acceleration / deceleration time selection | |
| 10 | EF input<br>(EF: External Fault) | For external fault input. The drive decelerates according to the Pr.07-20 setting, and the keypad shows “EF” (it shows the fault record when an external fault occurs). The drive keeps running until the fault is cleared (terminal status restored) after RESET. |
| 11 | B.B. input from external<br>(B.B.: Base Block) | ON: the output of the drive stops immediately. The motor is in free run and the keypad displays the B.B. signal. Refer to Pr.07-08 for details. |
| 12 | Output stop<br>(output pause) | When the switch is ON, output of the drive stops immediately and the motor is in free run status. The drive is in output waiting status until the switch is turned to OFF, and then the drive restarts and runs to the current setting frequency.<br>  |

| Settings | Functions | Descriptions |
|---|---|---|
| 15 | Rotating speed command from AVI | ON: force the source of the frequency to be AVI. If the rotating speed commands are set to AVI and ACI at the same time, the priority is AVI > ACI. |
| 16 | Rotating speed command from ACI | ON: force the source of the frequency to be ACI. If the rotating speed commands are set to AVI and ACI at the same time, the priority is AVI > ACI. |
| 18 | Forced to stop | ON: the drive ramps to stop according to the Pr.07-20 setting. |
| 24 | FWD JOG command | This function is valid when the source of the operation command is external terminal. ON: the drive executes forward JOG. When executing the JOG command in torque mode, the drive automatically switches to speed mode. The drive returns to torque mode after the JOG command is complete. |
| 25 | REV JOG command | This function is valid when the source of the operation command is external terminal. ON: the drive executes reverse JOG. When executing the JOG command in torque mode, the drive automatically switches to speed mode. The drive returns to torque mode after the JOG command is complete. |
| 28 | Emergency stop (EF1) | ON: the output of the drive stops immediately, displays “EF1” on the keypad, and the motor is in free run status. The drive keeps running until the fault is cleared after you press RESET on the keypad (EF: External Fault).   |
| 29 | Signal confirmation for Y-connection | When the control mode is V/F, ON: the drive operates by the first V/F. |
| 30 | Signal confirmation for Δ-connection | When the control mode is V/F, ON: the drive operates by the second V/F. |
| 38 | Disable EEPROM write function (parameters memory disable) | ON: writing to EEPROM is disabled. Changed parameters are not saved after power off. |
| 40 | Force coasting to stop | ON: during operation, the drive free runs to stop. |

<table>
<tr><th>Settings</th><th>Functions</th><th>Descriptions</th></tr>
<tr><td>49</td><td>Enable drive</td><td>When the drive is enabled, the RUN command is valid.<br>When the drive is disabled, the RUN command is invalid.<br>When the drive is operating, the motor coasts to stop.<br>This function varies with MO=45.</td></tr>
<tr><td>51</td><td>Selection for PLC mode (bit 0)</td><td rowspan="2"><table><tr><th>PLC status</th><th>bit 1</th><th>bit 0</th></tr><tr><td>Disable PLC function (PLC 0)</td><td>0</td><td>0</td></tr><tr><td>Trigger PLC to operate (PLC 1)</td><td>0</td><td>1</td></tr><tr><td>Trigger PLC to stop (PLC 2)</td><td>1</td><td>0</td></tr><tr><td>No function</td><td>1</td><td>1</td></tr></table></td></tr>
<tr><td>52</td><td>Selection for PLC mode (bit 1)</td></tr>
<tr><td>53</td><td>Trigger CANopen Quick Stop</td><td>When this function is enabled under CANopen control, it changes to Quick Stop. Refer to Chapter 15 CANopen Overview for more details.</td></tr>
<tr><td>58</td><td>Emergency power mode detection</td><td>If the drive runs during power lose and detects DC voltage is lower than Lv limit, the drive stops running. At this time, shut down the normal power supply magnetic contactor, generate the emergency power, then set the terminal of this parameter setting to closed and enter RUN command again. The drive runs according to the internal secured frequency set.</td></tr>
<tr><td>59</td><td>Detection of Magnetic contactor</td><td>Uses for magnetic contactor ON/OFF feedback signal.<br>When the drive receives RUN command after Pr.02-30 release time, it switches its corresponding multi-function output terminal (setting value = 75) to ON. Then the drive begins to confirm whether the contact for this parameter setting receives magnetic contactor’s normal signal (closed) according to Pr.02-32 magnetic contactor detection time. If the drive does not close within Pr.02-32 release time, it means that magnetic contactor is abnormal, and the drive displays error code 74 (MCF).</td></tr>
<tr><td>60</td><td>Mechanical brake error detection</td><td>When the drive receives RUN command after Pr.02-39 release time, it switches its corresponding multi-function output terminal (setting value = 12) to ON. Then the drive begins to confirm whether the contact for this parameter setting receives brake’s normal signal (closed) according to Pr.02-33 mechanical brake detection time. If the drive does not close within Pr.02-33 release time, it means that mechanical brake is abnormal, and the drive displays error code 75 (MBF).</td></tr>
<tr><td>61</td><td>Power down signal</td><td>When system power loses, host controller must enter this signal to inform the drive. When the drive receives this signal after Pr.06-85 sec., MO = 58 signal closes.</td></tr>
<tr><td>62</td><td>Mechanical brake error detection 2</td><td>When the drive receives RUN command after Pr.02-39 release</td></tr>
</table>

| Settings | Functions | Descriptions |
|---|---|---|
| | | time, it switches its corresponding multi-function output terminal (setting value = 12) to ON. Then the drive begins to confirm whether the contact for this parameter setting receives brake's normal signal (closed) according to Pr.02-33 mechanical brake detection time. If the drive does not close within Pr.02-33 release time, it means that mechanical brake is abnormal, and the drive displays error code 71 (MBF2). |

## 02-11 Multi-function Input Response Time

Default: 0.005

Settings 0.000–30.000 sec.

- Use this parameter to set the response time of the digital input terminals MI1–MI7.
- This function is to delay and confirm the digital input terminal signal. The time for delay is also the time for confirmation. The confirmation prevents interference that could cause error in the input to the digital terminals. But in the meanwhile, it delays the response time though confirmation improves accuracy.

## 02-12 Multi-function Input Mode Selection

Default: 0000

Settings 0000h–FFFFh (0: N.O.; 1: N.C.)

- This parameter setting is in hexadecimal.
- This parameter sets the status of the multi-function input signal (0: normally open; 1: normally closed) and it is not affected by the status of SINK / SOURCE.
- bit 0–bit 6 correspond to MI1–MI7.
- The default for bit 0 (MI1) is FWD terminal, and the default for bit 1 (MI2) is REV terminal. You cannot use this parameter to change the input mode when Pr.02-00 ≠ 0.
- You can change the terminal ON / OFF status through communications.
  For example: MI3 is set to 1 (multi-step speed command 1) and MI4 is set to 2 (multi-step speed command 2). Then the forward + second step speed command = $1001_2 = 9_{10}$.
- As long as Pr.02-12 = 9 is set through communications, there is no need to wire any multi-function terminal to run forward with the second step speed.

| bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
|---|---|---|---|---|---|---|
| MI7 | MI6 | MI5 | MI4 | MI3 | MI2 | MI1 |

## 02-13 Multi-function Output 1 (Relay1)

Default: 11

## 02-16 Multi-function Output 2 (MO1)

## 02-17 Multi-function Output 3 (MO2)

## 02-36 Output Terminal of Extension Card (MO10) or (RY10)

## 02-37 Output Terminal of Extension Card (MO11) or (RY11)

## 02-38 Output Terminal of Extension Card (MO12) or (RY12)

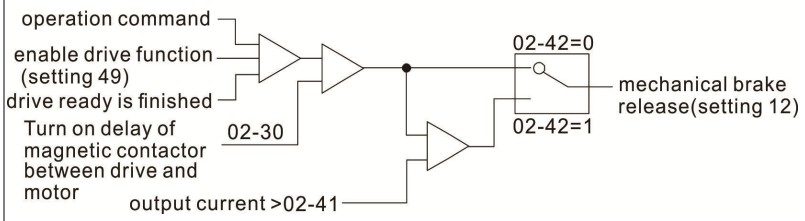
Default: 0

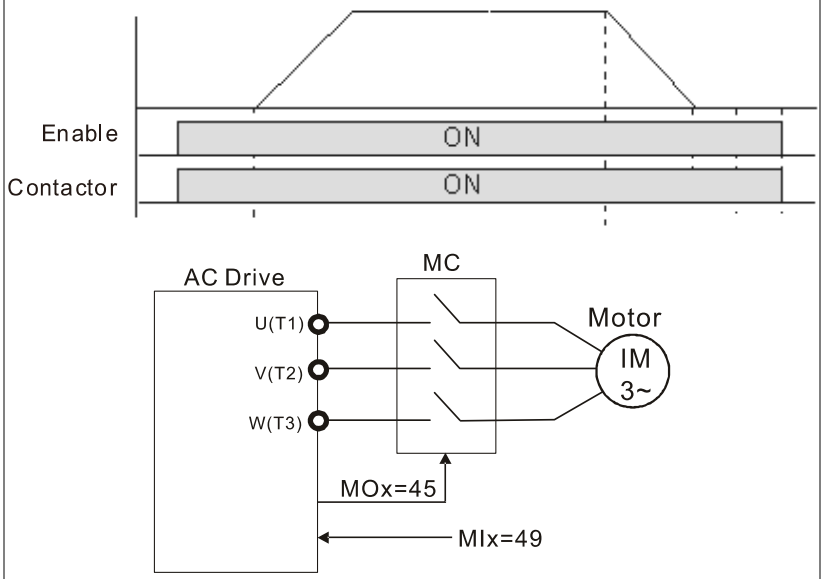
Settings
0: No function
1: Indication during RUN
2: Operation speed reached
3: Desired frequency reached 1 (Pr.02-22)
4: Desired frequency reached 2 (Pr.02-24)
5: Zero speed (Frequency command)
6: Zero speed, includes STOP (Frequency command)
7: Over-torque 1 (Pr.06-06–06-08)
9: Drive is ready
10: Low voltage warning (LV) (Pr. 06-00)
11: Malfunction indication
12: Mechanical brake signal (Pr. 02-39–Pr. 02-42)
13: Over-heat warning (Pr. 06-15)
16: Slip error (oSL)
19: External interrupt B.B. input (Base Block)
20: Warning output
21: Over-voltage
22: Over-current stall prevention
23: Over-voltage stall prevention
24: Operation source
25: Forward command
26: Reverse command
27: Output when current >= Pr.02-41
28: Output when current < Pr.02-41
31: Y-connection for the motor coil
32: △ -connection for the motor coil
33: Zero speed (actual output frequency)
34: Zero speed include stop (actual output frequency)
35: Error output selection 1 (Pr. 06-23)
36: Error output selection 2 (Pr. 06-24)
37: Error output selection 3 (Pr. 06-25)
38: Error output selection 4 (Pr. 06-26)
40: Speed reached (including STOP)
44: Low current output (use with Pr.06-71–Pr.06-73)
45: UVW output magnetic contactor ON / OFF switch
50: Output control for CANopen
56: Power generation direction and status verify
57: Power generation direction
58: EPS MODE
67: Analog input level reached
75: Motor-controlled magnetic contactor output

📖 Use this parameter to set the function of the multi-function terminals.

Summary of function settings

Take the normally open contact (N.O.) for example, ON: contact is closed, OFF: contact is open.

| Settings | Functions | Descriptions |
|---|---|---|
| 0 | No Function | Output terminal with no function |
| 1 | Indication during RUN | Active when the drive is not at STOP. |
| 2 | Operation speed reached | Active when output frequency of the drive reaches the setting frequency. |
| 3 | Desired frequency attained 1 (Pr. 02-22) | Active when the desired frequency (Pr.02-22) reached. |
| 4 | Desired frequency attained 2 (Pr. 02-24) | Active when the desired frequency (Pr.02-24) reached. |
| 5 | Zero speed (Frequency command) | Active when frequency command = 0 (the drive must be in RUN status). |
| 6 | Zero speed, includes STOP (Frequency command) | Active when frequency command = 0 or stopped. |
| 7 | Over-torque 1 | Active when the drive detects over-torque. Pr.06-07 sets the over-torque detection level (motor 1), and Pr.06-08 sets the over-torque detection time (motor 1).<br>Refer to Pr.06-06–06-08. |
| 9 | Drive is ready | Active when the drive is ON with no error detected. |
| 10 | Low voltage warn (LV) | Active when the DC BUS voltage is too low<br>(refer to Pr.06-00 Low Voltage Level). |
| 11 | Malfunction indication | Active when fault occurs (except Lv stop). |
| 12 | Mechanical brake signal | When the drive runs after Pr.02-39 delay time, this contact is closed. Use this function with DC brake and use ”b”(N.C) contact. (Refer to Pr.02-39–Pr.02-42)<br>  |
| 13 | Over-heat warning | Active when IGBT or heat sink overheats; to prevent the drive from shutting down due to over-heating (refer to Pr.06-15). |
| 16 | Slip error (oSL) | Active when the slip error is detected. |
| 19 | External interrupt B.B. input (Base Block) | Active when external interrupt (B.B.) stop output occurs in the drive. |
| 20 | Warning output | Active when a warning is detected. |
| 21 | Over-voltage | Active when over-voltage is detected. |
| 22 | Over-current stall prevention | Active when over-current stall prevention is detected. |
| 23 | Over-voltage stall prevention | Active when over-voltage stall prevention is detected. |

| Settings | Functions | Descriptions |
|---|---|---|
| 24 | Operation source | Active when the source of operation command is controlled by the digital keypad (Pr.00-21 = 0). |
| 25 | Forward command | Active when the operation direction is forward. |
| 26 | Reverse command | Active when the operation direction is reverse. |
| 27 | Output when current >= Pr.02-41 | Active when current is >= Pr.02-41 |
| 28 | Output when current < Pr.02-41 | Active when current is < Pr.02-41 |
| 31 | Y-connection for the motor coil | Active when Pr.05-24 = 1, the frequency output is lower than Pr.05-23 minus 2 Hz, and the time is longer than Pr.05-25. |
| 32 | Δ-connection for the motor coil | Active when Pr.05-24 = 1, the frequency output is higher than Pr.05-23 plus 2 Hz, and the time is longer than Pr.05-25. |
| 33 | Zero speed<br>(actual output frequency) | Active when the actual output frequency is 0<br>(the drive is in RUN mode). |
| 34 | Zero speed includes stop (actual output frequency) | Active when the actual output frequency is 0 or stopped. |
| 35 | Error output selection 1 | Active when Pr. 06-23 is ON. |
| 36 | Error output selection 2 | Active when Pr. 06-24 is ON. |
| 37 | Error Output Selection 3 | Active when Pr. 06-25 is ON. |
| 38 | Error Output Selection 4 | Active when Pr. 06-26 is ON. |
| 40 | Speed reached (including Stop) | Active when the output frequency reaches the setting frequency or stopped. |
| 44 | Low current output | Use this function with Pr.06-71–Pr.06-73. |
| 45 | UVW output magnetic contactor ON / OFF switch | Use this function with external terminal input = 49 (drive enabled) and external terminal output = 45 (magnetic contactor enabled), and then the magnetic contactor is ON or OFF according to the status of the drive.<br>  |
| 50 | Output control for CANopen | Control the multi-function output terminals through CANopen. The mapping table of the CANopen DO is shown in the following table: |

<table>
<tr><th>Settings</th><th>Functions</th><th>Descriptions</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Physical terminal</th><th>Setting for related parameters</th><th>Attribute</th><th>Corresponding index</th></tr>
<tr><td>RY1</td><td>Pr.02-13 = 50</td><td>RW</td><td>2026-41<br>bit 0 of initial value 0x01</td></tr>
<tr><td>MO1</td><td>Pr.02-16 = 50</td><td>RW</td><td>2026-41<br>bit 3 of initial value 0x01</td></tr>
<tr><td>MO2</td><td>Pr.02-17 = 50</td><td>RW</td><td>2026-41<br>bit 4 of initial value 0x01</td></tr>
</table>
Refer to Section 15-3-5 for more information.
</td></tr>
<tr><td>56</td><td>Power generation direction and status verify</td><td>When finish searching the power generating mode, this switch will be closed.</td></tr>
<tr><td>57</td><td>Power generation direction</td><td>When the running direction of the power generating mode is forward, this switch will be closed.</td></tr>
<tr><td>58</td><td>EPS MODE</td><td>When receiving signals from the upper drive, (Pr.02-01 =61), there will be a few seconds of delay (Pr.06-85), then this switch will be closed.</td></tr>
<tr><td>67</td><td>Analog input level reached output</td><td>The multi-function output terminals operate when the analog input level is between the high level and the low level.<br>Pr.03-44: Select one of the analog input channels (AVI, ACI) to be compared.<br>Pr.03-45: The high level for the analog input, default is 50%.<br>Pr.03-46: The low level for the analog input, default is 10%.<br>If analog input > Pr.03-45, the multi-function output terminal operates. If analog input < Pr.03-46, the multi-function output terminal stops output.</td></tr>
<tr><td>75</td><td>Motor-controlled magnetic contactor output</td><td>When the drive receives that multi-function input terminal is set to 49 (drive enable), this contact is closed.<br>(Refer to Pr.02-30 and Pr.02-31)</td></tr>
</table>

## 02-18 Multi-function Output Direction

Default: 0000

Settings 0000h–FFFFh (0:N.O.; 1:N.C.)

- This parameter is in hexadecimal.
- This parameter is set by a bit. If the bit is 1, the corresponding multi-function output acts in an opposite way.

Example:

- Assume Pr.02-13 = 1 (indication when the drive is operating). If the output is positive, the bit is set to 0, and then Relay is ON when the drive runs and is OFF when the drive stops. On the contrary, if the output is negative, and the bit is set to 1, then the Relay is OFF when the drive runs and is ON when the drive stops.

| bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
|---|---|---|---|---|
| MO2 | MO1 | reserved | reserved | RY |

## 02-21 Digital Output Gain（DFM）

Default: 1

Settings 1–55

Sets the signal for the digital output terminals (DFM-DCM) and the digital frequency output (pulse, work period = 50 %). The output pulse per second = output frequency X Pr.02-21.

## 02-22 Desired Frequency Attained 1

Default: 60.00 / 50.00

Settings 0.00–599.00 Hz

## 02-23 Width of the Desired Frequency Attained 1

Default: 2.00

Settings 0.00–599.00 Hz

## 02-24 Desired Frequency Attained 2

Default: 60.00 / 50.00

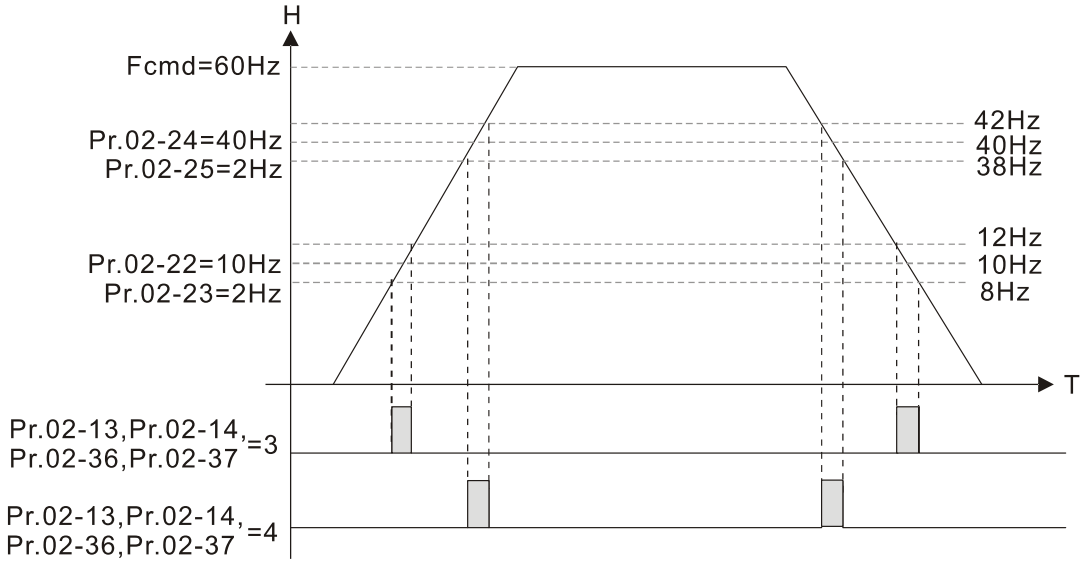
Settings 0.00–599.00 Hz

## 02-25 Width of the Desired Frequency Attained 2

Default: 2.00

Settings 0.00–599.00 Hz

Once the output speed (frequency) reaches the desired speed (frequency), if the corresponding multi-function output terminal is set to 3–4 (Pr.02-13, Pr.02-36, and Pr.02-37), this multi-function output terminal is “closed”.




## 02-30 Turn On Delay of Magnetic Contactor between Drive and Motor

## 02-31 Turn Off Delay of Magnetic Contactor between Drive and Motor

Default: 0.200

Settings 0.010–65.000 sec.

## 02-32 Magnetic Contactor Error Detection Time Setting

## 02-33 Mechanical Brake Error Detection Time Setting

Default: 0.00

Settings 0.00–10.00 sec.

**Magnetic Contactor Feedback Error**

1. MI terminal setting 59 (magnetic contactor feedback signal)
2. MO terminal setting 75 (magnetic contactor output signal)
3. Pr.02-32 (Magnetic Contactor Error Detection Time Setting)
4. When magnetic contactor output signal and feedback signal are not in the same level and exceeds the setting time for Pr.02-32, “Magnetic contactor error (MCF)” displays with an error code 74.
5. Homing condition: magnetic contactor output signal and feedback signal are in the same level.

**Mechanical Brake Feedback Error**

1. MI terminal setting 60 and 62 (mechanical brake feedback signals)
2. MO terminal setting 12 (mechanical brake output signal)
3. Pr.02-33 (Mechanical Brake Error Detection Time Setting)
4. When mechanical brake output signal and feedback signal are not in the same level and exceeds the setting time for Pr.02-33, “Mechanical brake error (MBF)” displays with an error code 75 and “Mechanical brake error 2 (MBF2)” displays with an error code 71 .
5. Homing condition: mechanical brake output signal and feedback signal are in the same level.

## 02-35 External Operation Control Selection after Reset and Activate

Default: 0

Settings 0: Disable
1: Drive runs if the RUN command remains after reset or reboot.

Set value as 1:

- Status 1: After the drive is powered on and the external terminal for RUN stays ON, the drive runs.
- Status 2: After clearing a fault once a fault is detected and the external terminal for RUN stays ON, you can run the drive by pressing the RESET key.

## 02-39 Brake Release Delay Time When Elevator Starts
## 02-40 Brake Contracting Delay Time When Elevator Stops

Default: 0.250

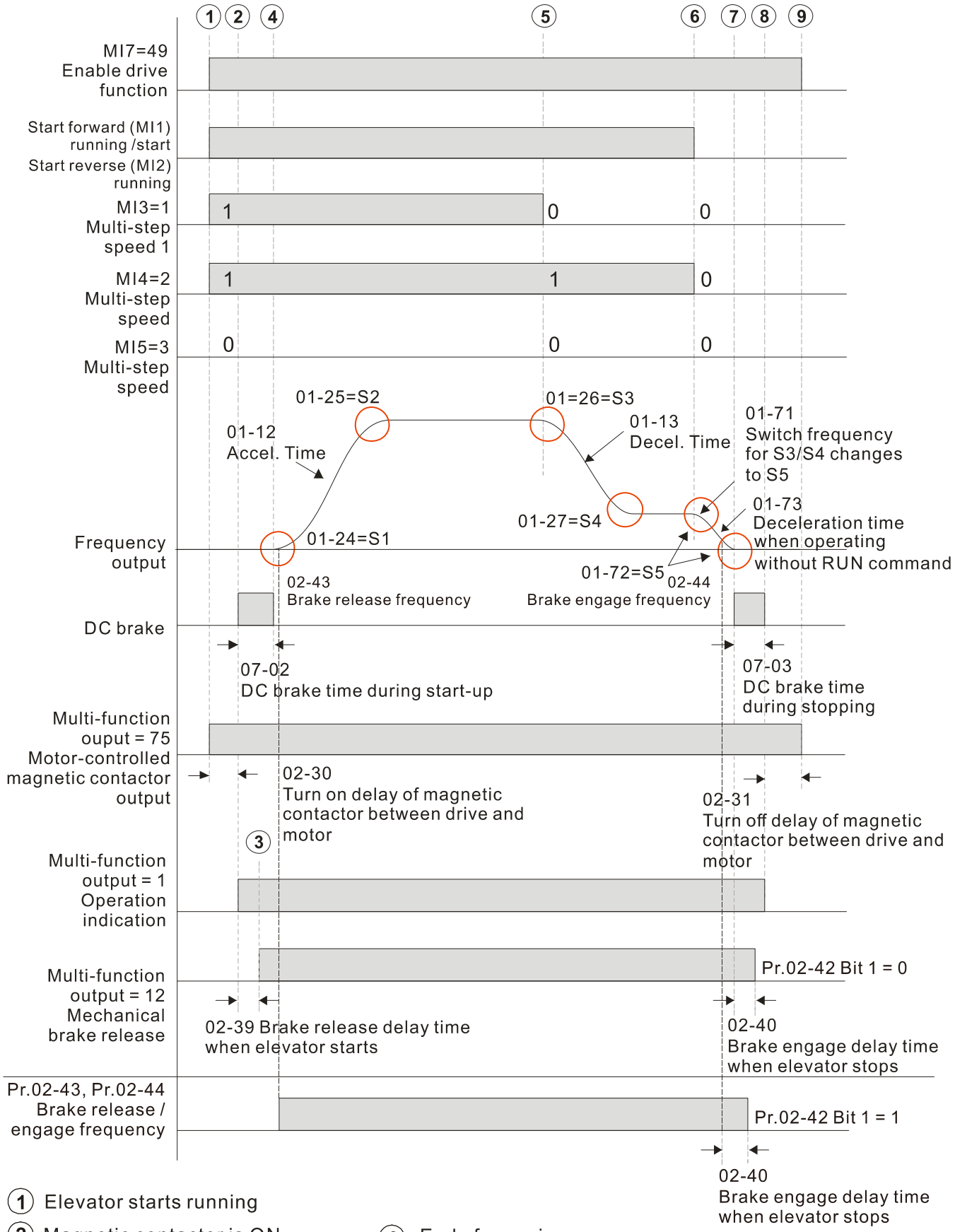
Settings 0.010–65.000 sec.

**Start-up Time Sequence**

As below diagram shows, magnetic contactor attracts when the drive is enabled. After Pr.02-30 delay time, DC brake starts to make the drive output and maintain motor’s speed at 0. The mechanical brake releases after Pr.02-39 delay time. Elevator starts to lift (rotation speed starts increasing) when DC brake stops (Pr.07-02).

**Stop Time Sequence**

As below diagram shows, DC brake starts when elevator stops to lift (rotation speed decreases to 0) to make the drive output and maintain the motor’s speed at 0. The mechanical brake contracts after Pr.02-40 delay time. When DC brake stops (Pr.07-03) and after Pr.02-31 delay time, motor magnetic contactor releases and time sequence stops.




① Elevator starts running
② Magnetic contactor is ON
③ Brake release
④ End of <DC brake time at start-up>
⑤ Start of deceleration
⑥ End of creeping
⑦ Start of <DC brake time at stop>
⑧ End of <DC brake time at stop>
⑨ Motor release

Elevator Timing Diagram

## 02-41 Output Current Level Setting for External Terminals

Default: 0

Settings 0–100% (Rated current of drive %)

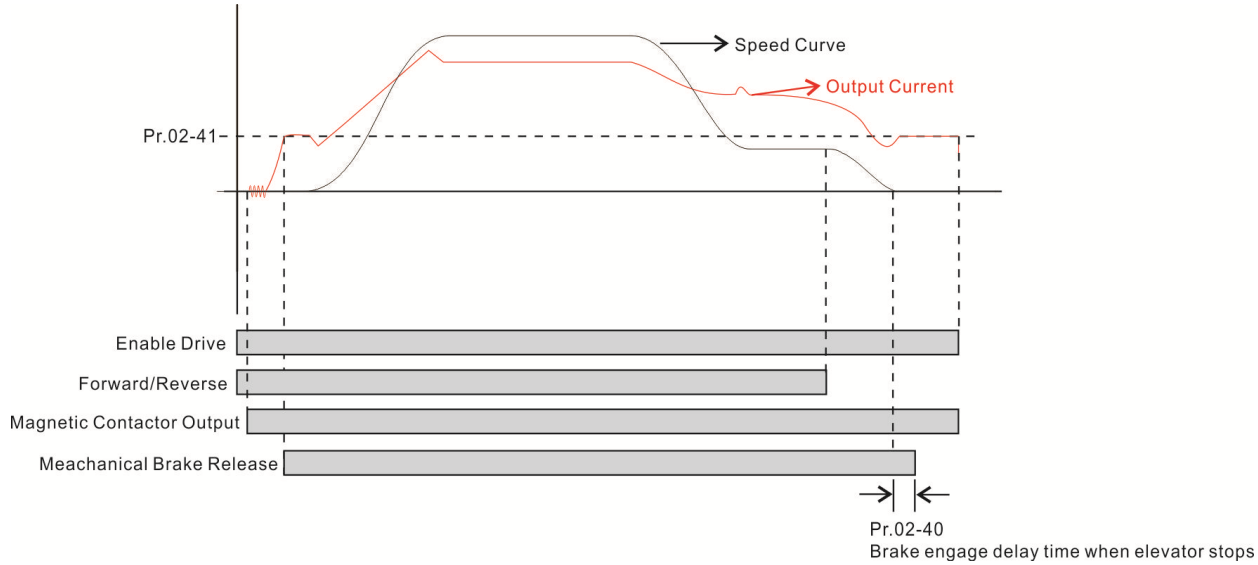
- When output current is >= Pr.02-41, it will activate multi-function output terminal (Pr.02-13, 16, 17, 36, 37, 38 is set to 27).
- When output current is < Pr.02-41, it will activate multi-function output terminal (Pr.02-13, 16, 17, 36, 37, 38 is set to 28).

## 02-42 Brake Release Function Option

Default: 0000h

Settings Bit 0 = 0: No function
Bit 0 = 1: Check torque output function switch
Bit 1 = 0: No function
Bit 1 = 1: Brake control by frequency threshold function switch

- Bit 0: When the drive receives the operation signal, the drive checks if there is a torque output. When enabled, the drive releases mechanical brake after confirming that there is torque output.




Sequence Diagram

- Bit 1: See the elevator timing diagram on page 12-02-15.
- Roll-back solution:
  1. Set contactor delay and DC brake (Pr.07-01 and Pr.07-03) constant time during stop.
  2. Set Pr.02-42 Bit 1=1.
  3. Set frequencies for brake release and brake engage (Pr.02-43 and Pr.02-44) to solve roll-back issue.

## 02-43 Brake Release Frequency

Default: 0.00

Settings 0.00–10.00 Hz

- Use this function with Pr.02-42 Bit 1 =1.

## 02-44 Brake Engage Frequency

Default: 0.00

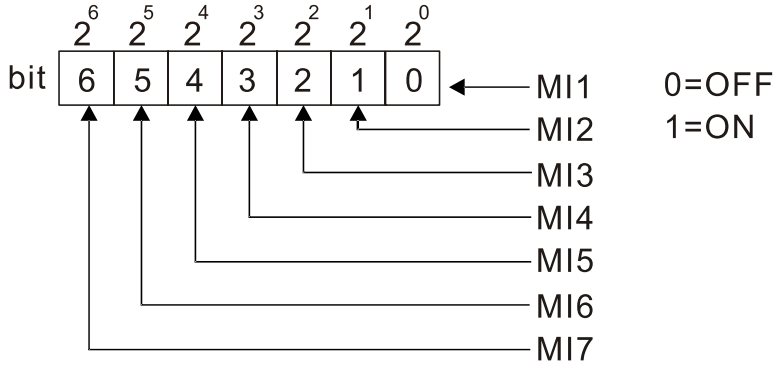
Settings 0.00–10.00 Hz

Use this function with Pr.02-42 Bit 1 =1.

## 02-50 Display the Status of Multi-function Input Terminal

Default: Read only

Settings Monitor the status of the Multi-function Input Terminal



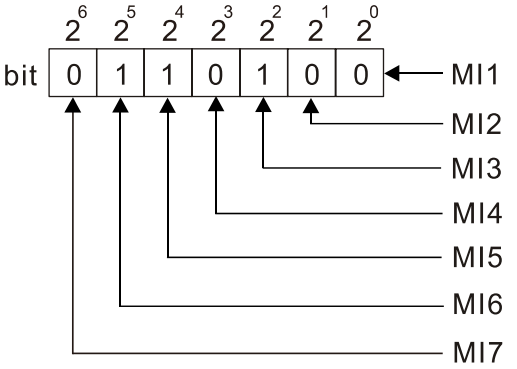

NOTE

$2^6 = 64$ $2^5 = 32$ $2^4 = 16$

$2^3 = 8$ $2^2 = 4$ $2^1 = 2$ $2^0 = 1$

Example:

When Pr.02-50 displays 0034h (hex) (that is, the value is 52 (decimal) and 0110100 (binary)), it means that MI3, MI5 and MI6 are ON.




0=OFF
1=ON

Setting

$= \text{bit } 5 \times 2^5 + \text{bit } 4 \times 2^4 + \text{bit } 2 \times 2^2$

$= 1 \times 2^5 + 1 \times 2^4 + 1 \times 2^2$

$= 32 + 16 + 4$

$= 52$

NOTE

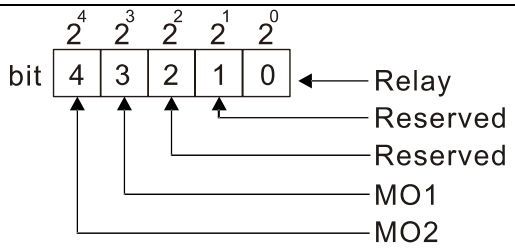
$2^6 = 64$ $2^5 = 32$ $2^4 = 16$

$2^3 = 8$ $2^2 = 4$ $2^1 = 2$ $2^0 = 1$

## 02-51 Status of Multi-function Output Terminal

Default: Read only

Settings Monitor the status of the Multi-function Output Terminal



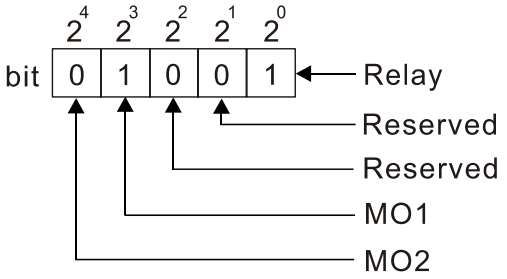

NOTE

$2^4 = 16$ $2^3 = 8$ $2^2 = 4$

$2^1 = 2$ $2^0 = 1$

Example:

When Pr.02-51 displays 0009h (hex) (that is, the value is 9 (decimal) and 01001 (binary)), it means that Relay and MO1 are ON.




0=OFF
1=ON

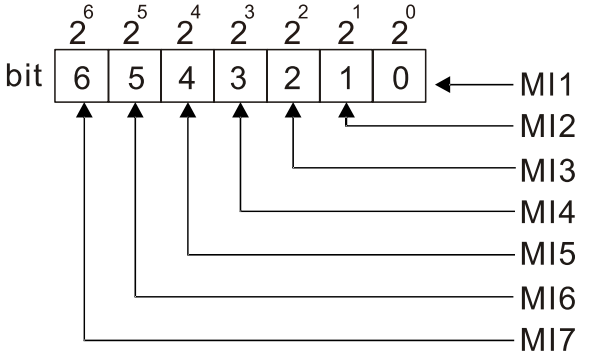
Setting
= bit 3 x $2^3$ + bit 0 x $2^0$
= 1 x $2^3$ + 1 x $2^0$
= 8 + 1
= 9

NOTE
$2^4$= 16 $2^3$= 8 $2^2$= 4
$2^1$= 2 $2^0$= 1

## 02-52 Display External Multi-function Input Terminals Used by PLC

Default: Read only

Settings Monitor the status of the PLC input terminals

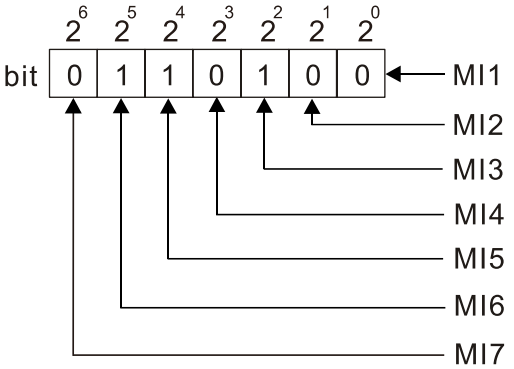



0=OFF
1=ON

NOTE
$2^6$= 64 $2^5$= 32 $2^4$= 16
$2^3$= 8 $2^2$= 4 $2^1$= 2 $2^0$= 1

Example:

When Pr.02-52 displays 0034h (hex) (that is, the value is 52 (decimal) and 0110100 (binary)), it means that MI3, MI5 and MI6 are used by PLC.




0=OFF
1=ON

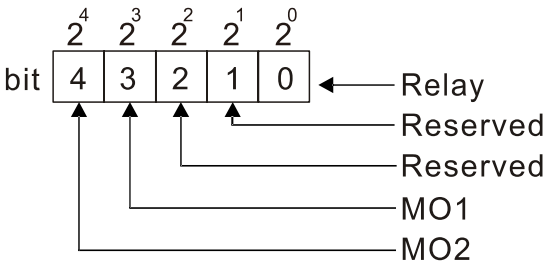
Setting
= bit 5 x $2^5$ + bit 4 x $2^4$ + bit 2 x $2^2$
= 1 x $2^5$ + 1 x $2^4$ + 1 x $2^2$
= 32 + 16 + 4
= 52

NOTE
$2^6$= 64 $2^5$= 32 $2^4$= 16
$2^3$= 8 $2^2$= 4 $2^1$= 2 $2^0$= 1

## 02-53 Display External Multi-function Output Terminals Used by PLC

Default: Read only

Settings Monitor the status of the PLC output terminals

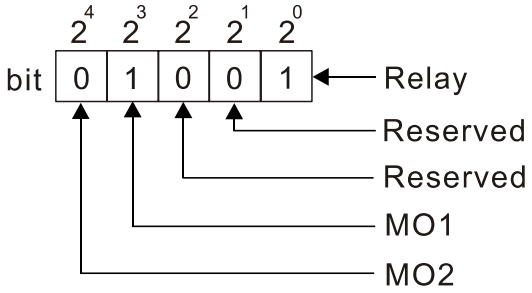



0=OFF
1=ON

NOTE
$2^4$= 16 $2^3$= 8 $2^2$= 4
$2^1$= 2 $2^0$= 1

Example:

When Pr.02-53 displays 0009h (hex) (that is, the value is 9 (decimal) and 01001 (binary)), it means that Relay and MO1 are used by PLC.




0=OFF
1=ON

Setting
= bit 3 x $2^3$ + bit 0 x $2^0$
= 1 x $2^3$ + 1 x $2^0$
= 8 + 1
= 9

NOTE
$2^4$ = 16 $2^3$ = 8 $2^2$ = 4
$2^1$ = 2 $2^0$ = 1

## 02-54 Display the Frequency Command Executed by External Terminal

Default: Read only

Settings Read only

When you set the source of the Frequency command as the external terminal, if Lv or Fault occurs, the external terminal Frequency command is saved in this parameter.

## 02-70 IO Card Types

Default: Read only

Settings 09: EMM-D3R2CA

## 02-82 Initial Frequency Command (F) Mode after Stop

Default: 0

Settings 0: Use current Frequency command
1: Use zero Frequency command
2: Refer to Pr.02-83 to set up

## 02-83 Initial Frequency Command (F) Setting after Stop

Default: 60.00

Settings 0.00–599.0 Hz

Sets the elevator's running speed when using Emergency Power Supply (EPS).

When elevator uses EPS, it runs at Pr.02-83, and the maximum running speed should not be larger than Pr.06-81 (Emergency Power Speed in Operation). If you set Pr.02-83 to be larger than Pr.06-81, the elevator runs at Pr.06-81 setting value.

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## 03 Analog Input / Output Parameters

✎ You can set this parameter during operation.

### ✎ 03-00 Analog Input Selection (AVI)

Default: 1

### ✎ 03-01 Analog Input Selection (ACI)

Default: 0

Settings 0: No function
1: Frequency command

🕮 When you use analog input as the PID reference target input, you must set Pr.00-20 to 2 (external analog input).
Setting method 1: Pr.03-00–03-01 set 1 as PID reference target input.

🕮 When you use the Frequency command, the corresponding value for 0– ±10 V / 4–20 mA is 0–maximum operation frequency (Pr.01-00).

🕮 When the settings for Pr.03-00–Pr.03-01 are the same, the highest priority is AVI.

### ✎ 03-03 Analog Input Bias (AVI)

Default: 0

Settings -100.0–100.0 %

🕮 Sets the corresponding AVI voltage for the external analog input 0.

### ✎ 03-04 Analog Input Bias (ACI)

Default: 0

Settings -100.0–100.0 %

🕮 Sets the corresponding ACI voltage for the external analog input 0.

### ✎ 03-07 Positive / Negative Bias Mode (AVI)

### ✎ 03-08 Positive / Negative Bias Mode (ACI)

Default: 0

Settings 0:No bias
1: Lower than or equal to bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

🕮 In a noisy environment, use negative bias to provide a noise margin. Do NOT use less than 1 V to set the operation frequency.

### ✎ 03-10 Reverse Setting when Analog Signal Input is Negative Frequency

Default: 0

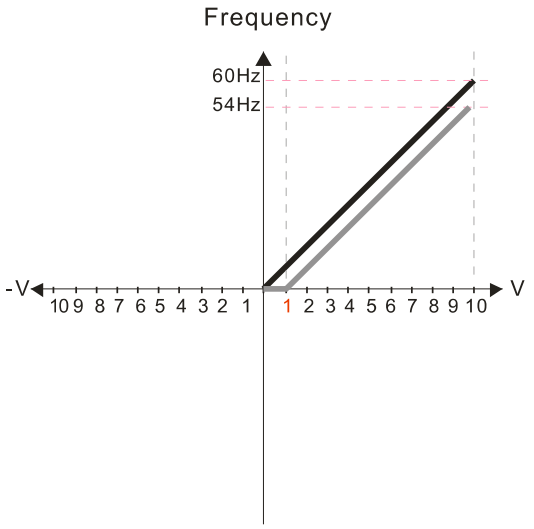
Settings 0: Negative frequency input is not allowed. The digital keypad or external terminal controls the forward and reverse direction.
1: Negative frequency input is allowed. Positive frequency = run in forward direction; negative frequency = run in reverse direction. The digital keypad or external terminal control cannot switch the running direction.

- Use Pr.03-10 to enable running in the reverse direction command when a negative frequency (negative bias and gain) is input to the AVI or ACI analog signal input.
- Condition for negative frequency (reverse)
  1. Pr.03-10 = 1
  2. Bias mode = Bias serves as the center
  3. Corresponded analog input gain < 0 (negative); this makes the input frequency negative.

  In using the additional analog input function (Pr.03-18 = 1), when the analog signal is negative after the addition, you can set this parameter to allow or not allow the reverse direction. The result after adding is restricted by the “Condition for negative frequency (reverse)”.

**In the diagram below: Black line: Curve with no bias. Gray line: curve with bias**

**Diagram 01**



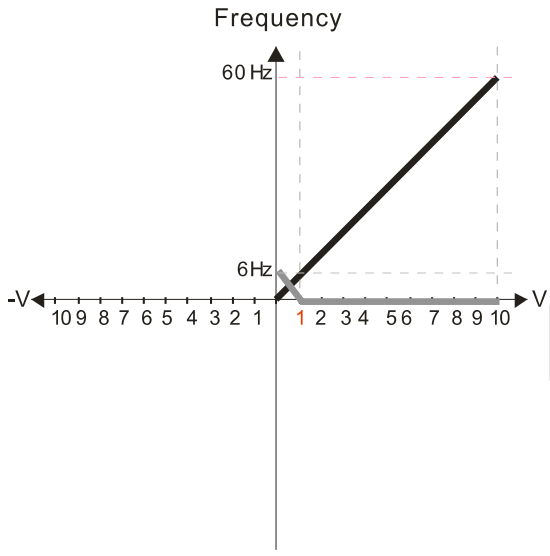

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

**Diagram 02**



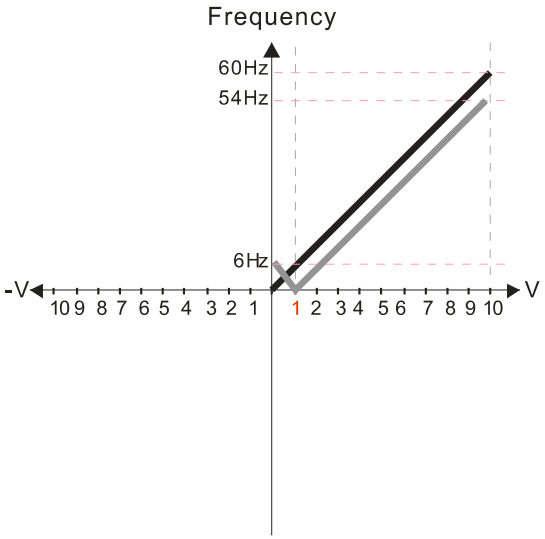

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

**Diagram 03**



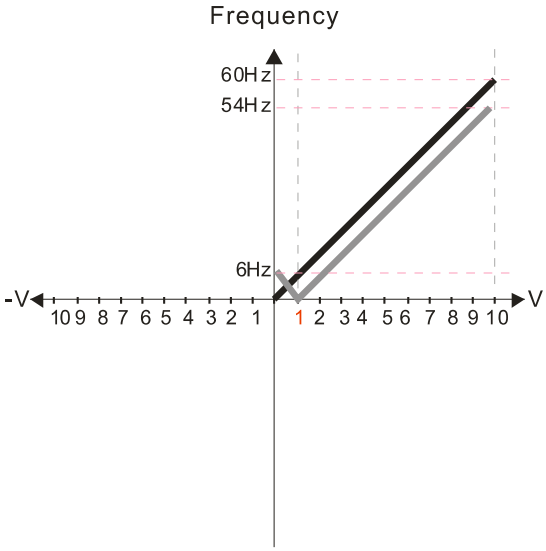

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 04



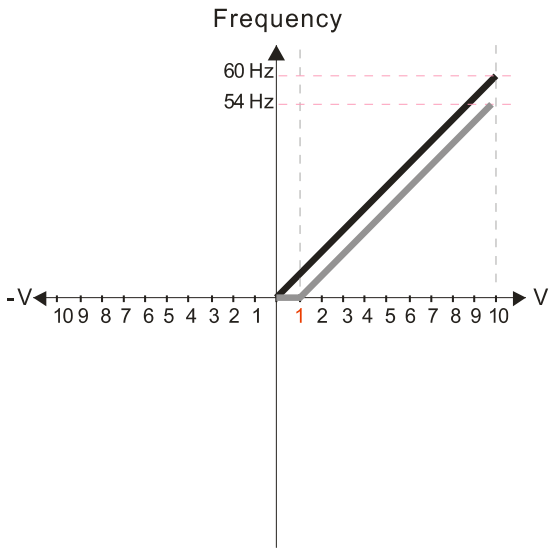

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 05



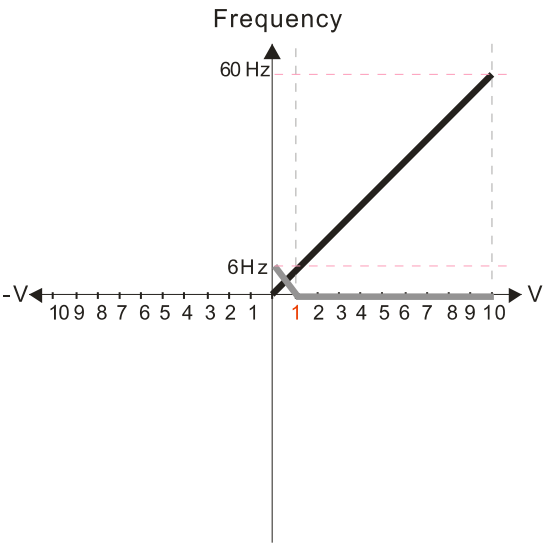

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 06



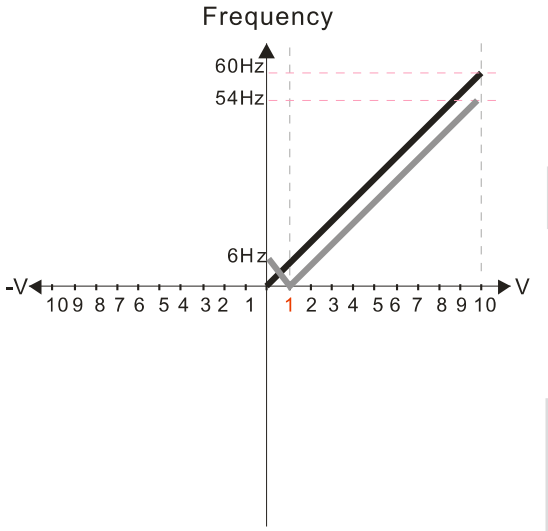

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 07



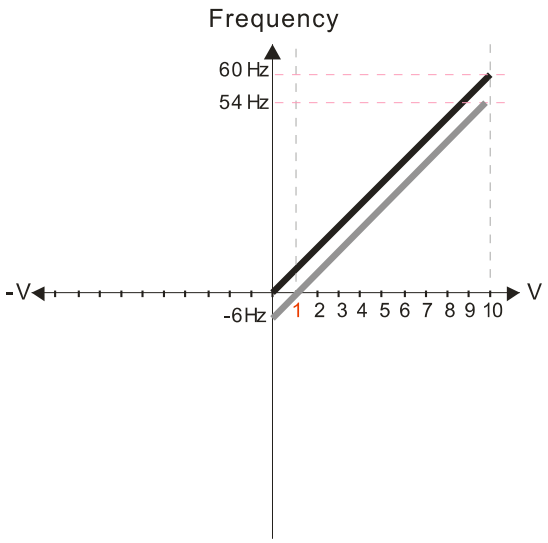

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 08



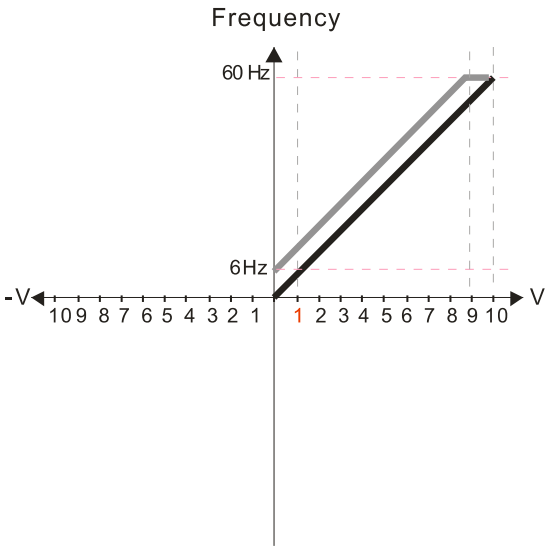

Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 09



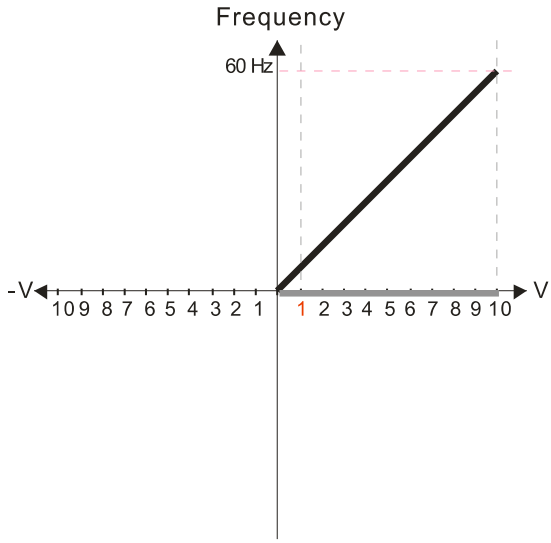

Pr.03-03=-10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

**Diagram 10**

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Positive frequency = forward run;
negative frequency = reverse run.
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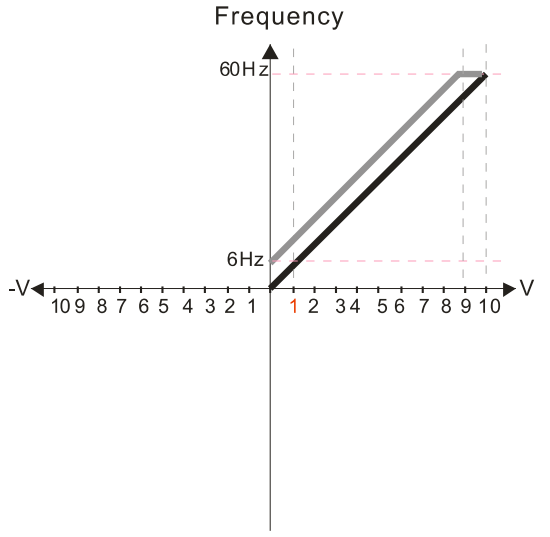
Pr.03-11 Analog input Gain (AVI) = 100%

**Diagram 11**

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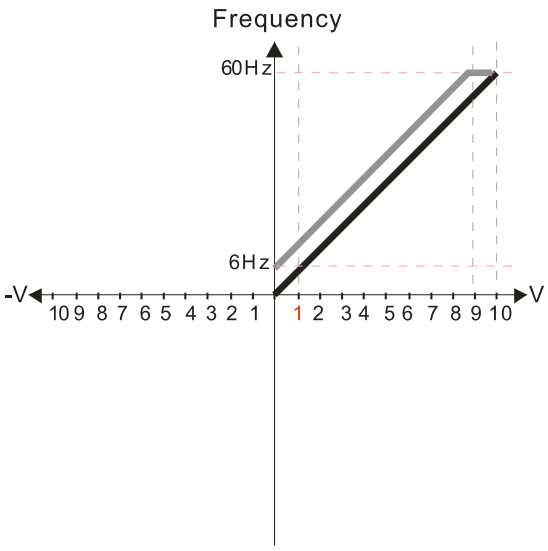
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

**Diagram 12**

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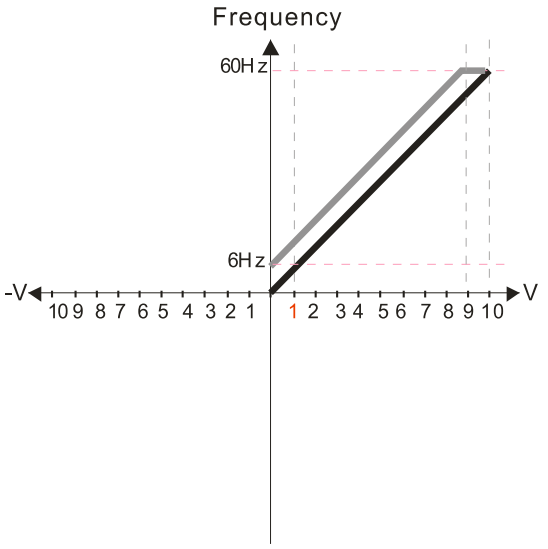
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 13

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Pr.03-07–03-08 (Positive/Negative Bias Mode)

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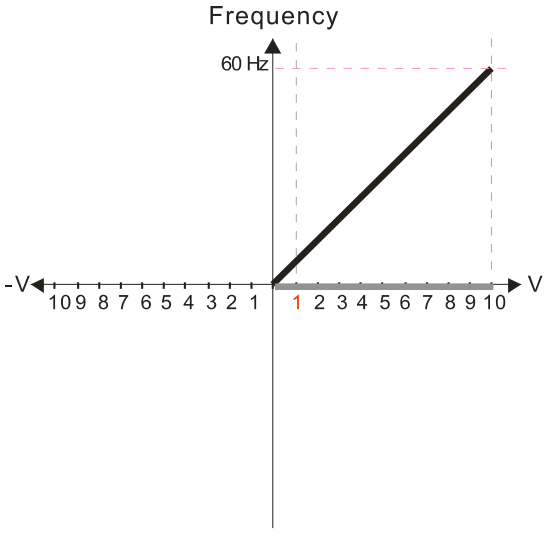
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 14




Pr.03-03=-10%
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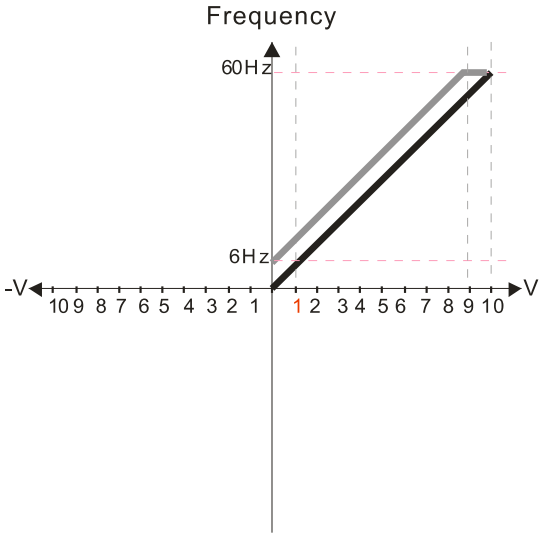
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

## Diagram 15




Pr.03-03=-10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
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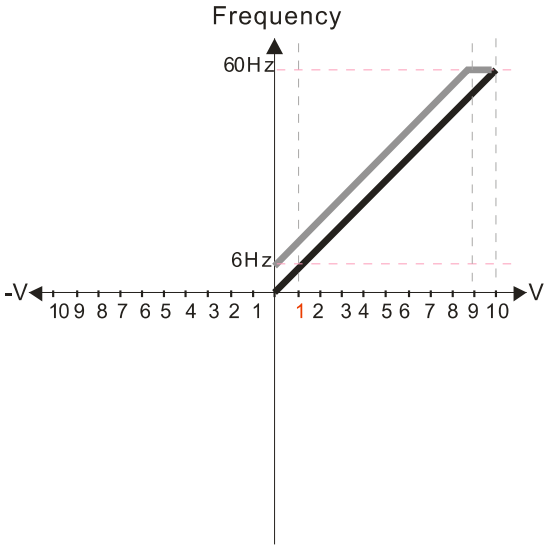
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

**Diagram 16**

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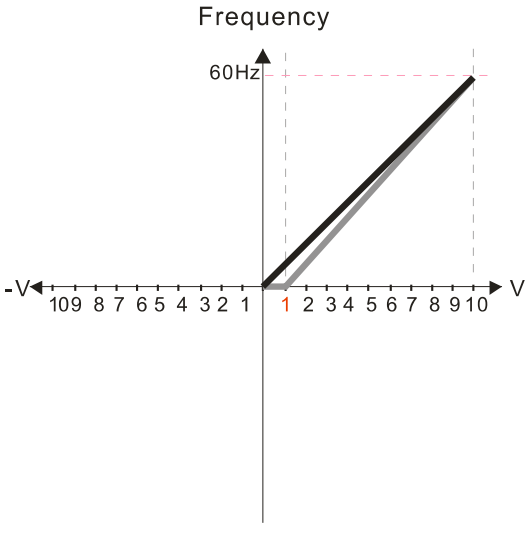
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 100%

**Diagram 17**




Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

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1: Negative frequency is valid.
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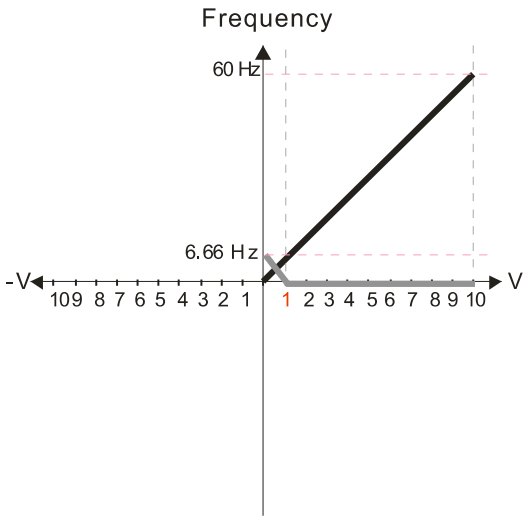
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 111.1%
10/9 = 111.1%

**Diagram 18**




Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
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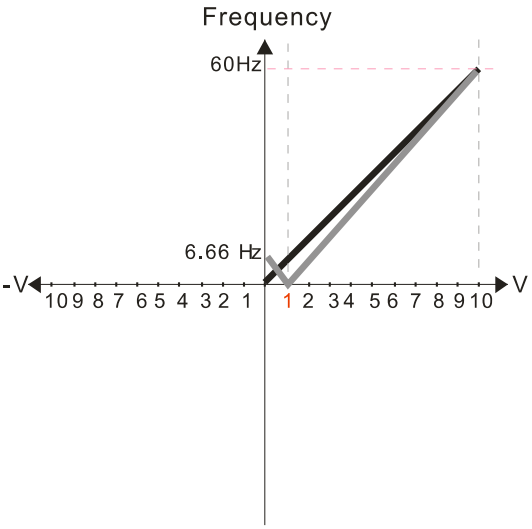
Direction can not be switched by digital keypad or external terminal control.

Pr.03-11 Analog input Gain (AVI) = 111.1%
10/9 = 111.1%

**Diagram 19**




Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

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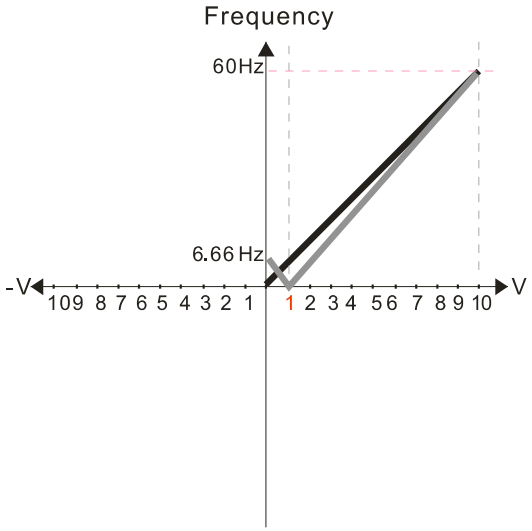
Pr.03-11 Analog input Gain (AVI) = 111.1%
10/9 = 111.1%

**Diagram 20**




Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

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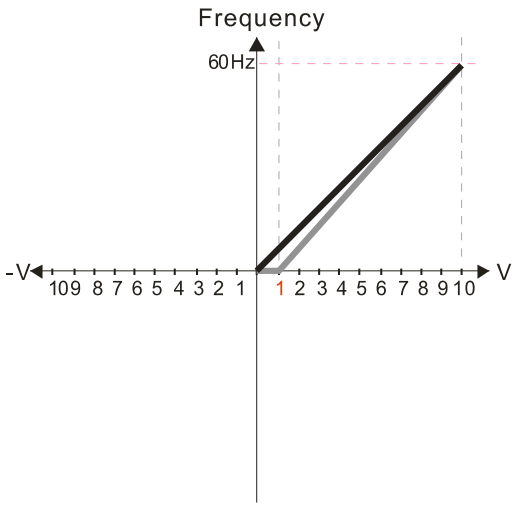
Pr.03-11 Analog input Gain (AVI) = 111.1%
10/9 = 111.1%

**Diagram 21**




Pr.03-03=10%
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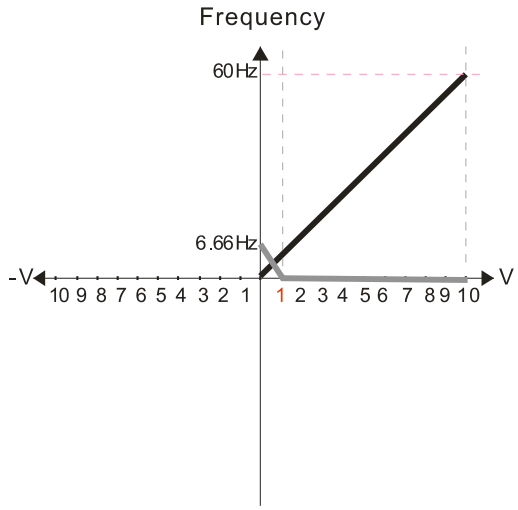
10/9 = 111.1%

## Diagram 22




Pr.03-03=10%
Pr.03-07–03-08 (Positive/Negative Bias Mode)

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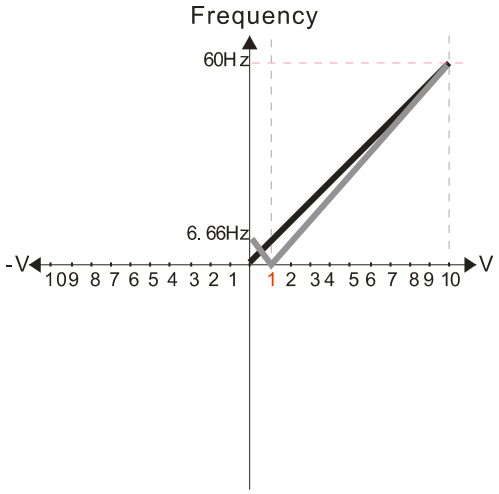
## Diagram 23

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Pr.03-07–03-08 (Positive/Negative Bias Mode)

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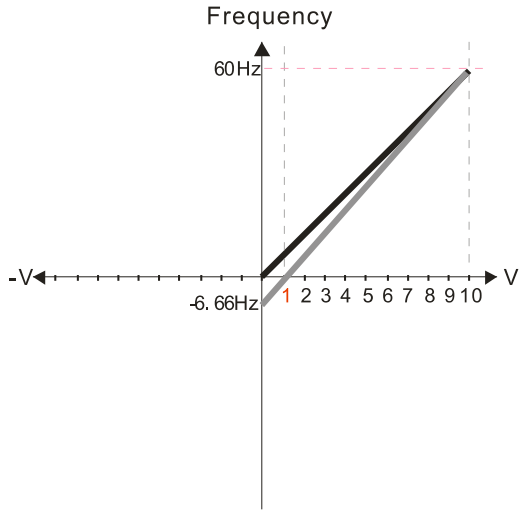
10/9 = 111.1%

## Diagram 24

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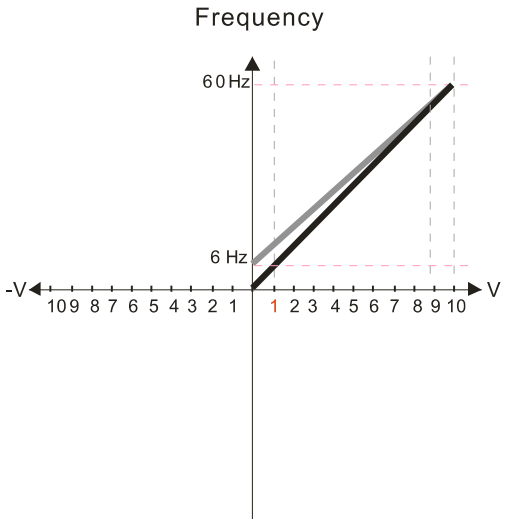
Pr.03-11 Analog input Gain (AVI) = 111.1%
10/9 = 111.1%

## Diagram 25

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Calculate the bias:

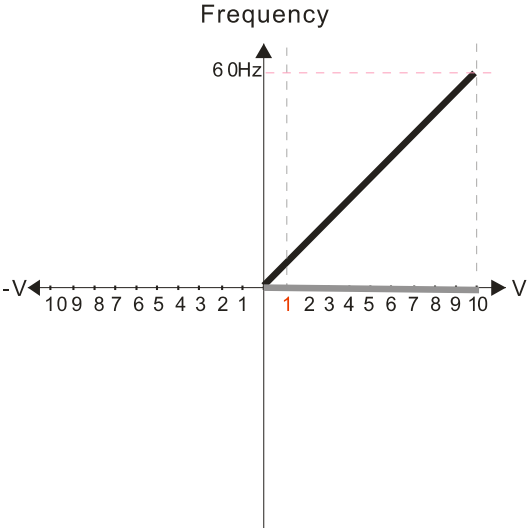
$$\frac{60-6\text{Hz}}{10\text{V}} = \frac{6-0\text{Hz}}{(0-X\ \text{V})} \quad XV = \frac{100}{-9} = -1.11\text{V} \quad \therefore 03\text{-}03 = \frac{-1.11}{10} \times 100\%$$

$$= -11.1\ \%$$

Calculate the gain:

$$\text{Pr.03-11} = \frac{10\text{V}}{11.1\text{V}} \times 100\% = 90.0\ \%$$

## Diagram 26

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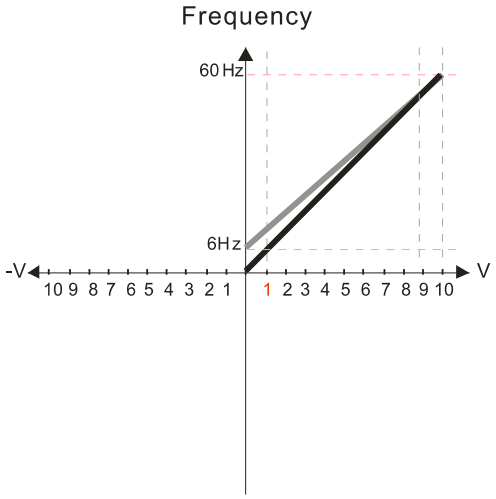
## Diagram 27

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Calculate the bias:

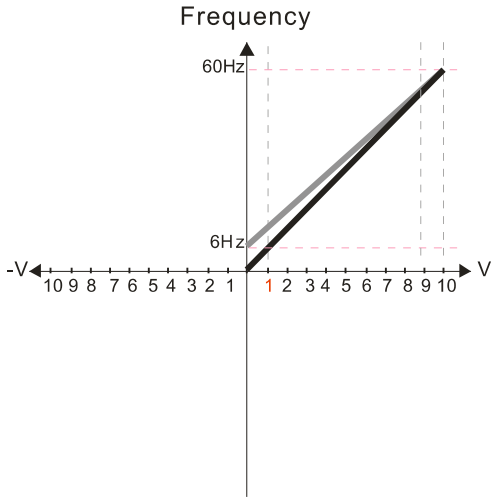
$$\frac{60-6Hz}{10V}=\frac{6-0Hz}{(0-XV)} \quad XV=\frac{100}{-9}=-1.11V \quad \therefore 03\text{-}03=\frac{-1.11}{10}\times 100\%$$

$$=-11.1\%$$

Calculate the gain:

$$Pr.03\text{-}11=\frac{10V}{11.1V}\times 100\%=90.0\%$$

**Diagram 28**

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Calculate the bias:

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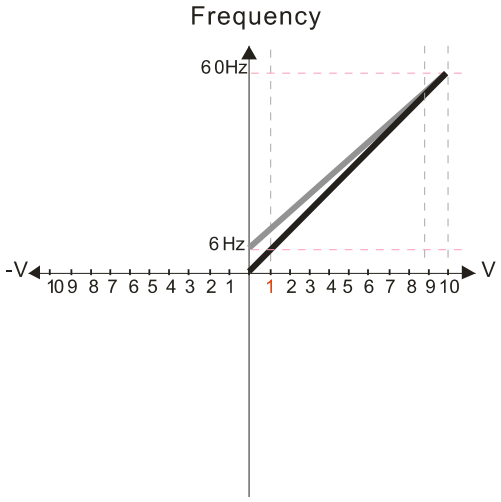
$$=-11.1\%$$

Calculate the gain:

$$Pr.03\text{-}11=\frac{10V}{11.1V}\times 100\%=90.0\%$$

**Diagram 29**




Pr.03-07–03-08 (Positive/Negative Bias Mode)

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Direction can not be switched by digital keypad or external terminal control.

Calculate the bias:

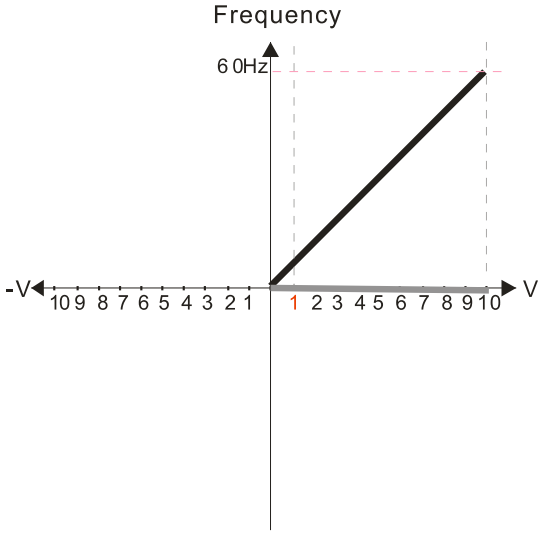
$\frac{60-6Hz}{10V} = \frac{6-0Hz}{(0-XV)}$ $XV = \frac{100}{-9} = -1.11V$ ∴03-03 $= \frac{-1.11}{10} \times 100\%$

$= -11.1\%$

Calculate the gain:

Pr.03-11 $= \frac{10V}{11.1V} \times 100\% = 90.0\%$

## Diagram 30

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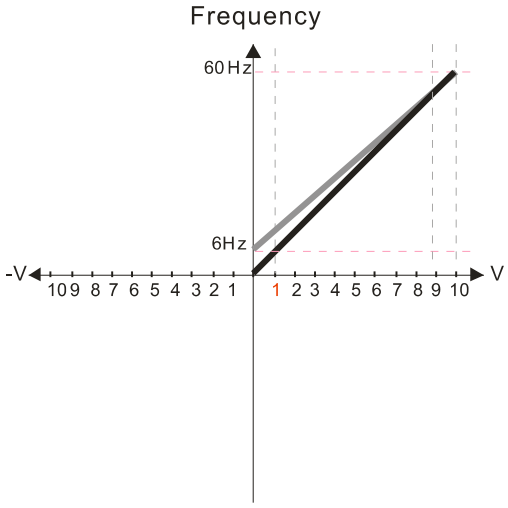
## Diagram 31

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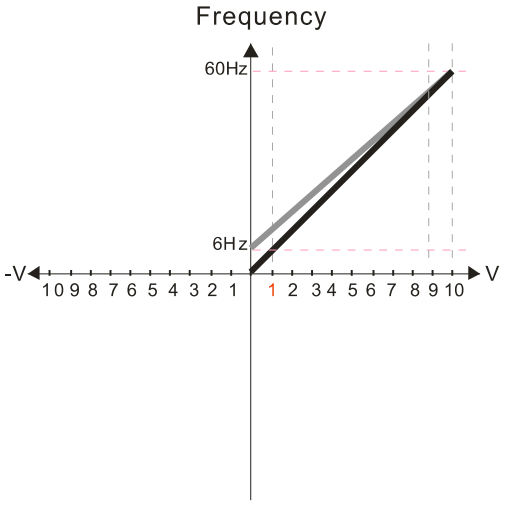
Calculate the bias:

$$\frac{60-6\text{Hz}}{10\text{V}} = \frac{6-0\text{Hz}}{(0-\text{XV})} \quad \text{XV} = \frac{100}{-9} = -1.11\text{V} \quad \therefore 03\text{-}03 = \frac{-1.11}{10} \times 100\% = -11.1\,\%$$

Calculate the gain:

$$\text{Pr.03-11} = \frac{10\text{V}}{11.1\text{V}} \times 100\% = 90.0\,\%$$

**Diagram 32**




Pr.03-07–03-08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

Pr.03-10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Calculate the bias:

$$\frac{60-6\text{Hz}}{10\text{V}} = \frac{6-0\text{Hz}}{(0-\text{XV})} \quad \text{XV} = \frac{100}{-9} = -1.11\text{V} \quad \therefore 03\text{-}03 = \frac{-1.11}{10} \times 100\% = -11.1\,\%$$

Calculate the gain:

$$\text{Pr.03-11} = \frac{10\text{V}}{11.1\text{V}} \times 100\% = 90.0\,\%$$

## 03-11 Analog Input Gain (AVI)

## 03-12 Analog Input Gain (ACI)

Default: 100.0

Settings -500.0–500.0 %

Use Pr.03-03–03-12 when the Frequency command source is the analog voltage or current signal.

## 03-15 Analog Input Filter Time (AVI)

## 03-16 Analog Input Filter Time (ACI)

Default: 0.01

Settings 0.00–20.00 sec.

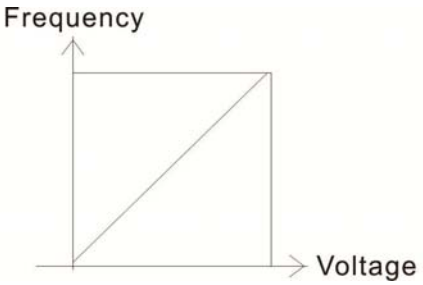
- Use these input delays to filter a noisy analog signal.
- When the time constant setting is too large, the control is stable but the control response is slow. When the time constant setting is too small, the control response is faster but the control may be unstable. For optimal setting, adjust the setting based on the control stability or the control response.

## 03-18 Analog Input Addition Function

Default: 0

Settings 0: Disable (AVI, ACI)
1: Enable

- 1: Example: Pr.03-00 = Pr.03-01 = 1 Frequency command = AVI + ACI
- 0 and the analog input setting are the same: the priority for AVI and ACI is AVI > ACI.




$$\text{F command}=[(\text{ay}\pm\text{bias})*\text{gain}]*\frac{\text{Fmax (01-00)}}{\text{10V or 16mA or 20mA}}$$

F command: the corresponding frequency for 10V or 20mA
ay: 0~10V, 4~20mA, 0~20mA
bias: Pr. 03-03, Pr. 03-04
gain: Pr. 03-11, Pr. 03-12

## 03-19 Signal Loss Selection for Analog Input 4–20 mA

Default: 0

Settings 0: Disable
1: Continue operation at the last frequency
2: Decelerate to 0 Hz
3: Stop immediately and display “ACE”

- Determines the treatment when the 4–20 mA signal is lost, when ACIc (Pr.03-29 = 0).
- When Pr.03-29 ≠ 0, the voltage input to ACI terminal is 0–10 V or 0–20 mA, and Pr.03-19 is invalid.
- When the setting is 1 or 2, the keypad displays the warning code “ANL”. It keeps blinking until the ACI signal is restored.
- When the motor drive stops, the warning condition does not continue to exist, so the warning disappears.

## 03-20 Multi-function Output (AFM)

Default: 0

Settings 0–4

Function Chart

| Settings | Functions | Descriptions |
|---|---|---|
| 0 | Output frequency (Hz) | Maximum frequency Pr.01-00 is processed as 100%. |
| 1 | Frequency command (Hz) | Maximum frequency Pr.01-00 is processed as 100%. |
| 2 | Motor speed (Hz) | Maximum frequency Pr.01-00 is processed as 100%. |

| Settings | Functions | Descriptions |
|---|---|---|
| 3 | Output current (rms) | (2.5 X rated current) is processed as 100%. |
| 4 | Output voltage | (2 X rated voltage) is processed as 100%. |

## 03-21 Analog Output Gain (AFM)

Default: 100.0

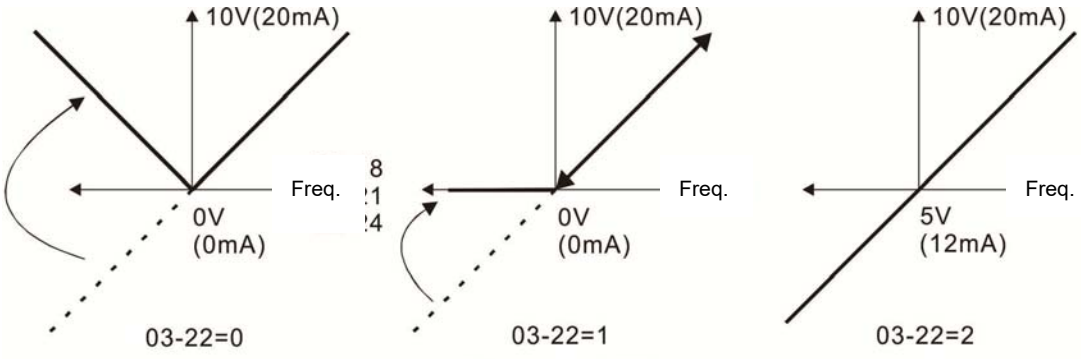
Settings 0–500.0 %

Adjusts the voltage level outputted to the analog meter from the analog signal (Pr.03-20) output terminal AFM of the drive.

## 03-22 Analog Output in REV Direction (AFM)

Default: 0

Settings 0: Absolute value of output voltage
1: Reverse output 0 V; forward output 0–10 V
2: Reverse output 5–0 V; forward output 5–10 V




Analog output direction selection

## 03-27 AFM Output Bias

Default: 0.00

Settings -100.00–100.00 %

Example 1: AFM 0–10 V is set to the output frequency, the output equation is

$$10\text{V} \times (\frac{\text{Output Frequency}}{01\text{-}00}) \times 03\text{-}24 + 10\text{V} \times 03\text{-}27$$

Example 2: AFM 0–20 mA is set to the output frequency, the output equation is

$$20\text{mA} \times (\frac{\text{Output Frequency}}{01\text{-}00}) \times 03\text{-}24 + 20\text{mA} \times 03\text{-}27$$

Example 3: AFM 4–20 mA is set to the output frequency, the output equation is

$$4\text{mA} + 16\text{mA} \times (\frac{\text{Output Frequency}}{01\text{-}00}) \times 03\text{-}24 + 16\text{mA} \times 03\text{-}27$$

This parameter sets the corresponding voltage for the analog output 0.

## 03-28 AVI Terminal Input Selection

Default: 0

Settings 0: 0–10 V
3: -10–10 V (Pr.03-69–03-74 are valid)

## 03-29 ACI Terminal Input Selection

Default: 0

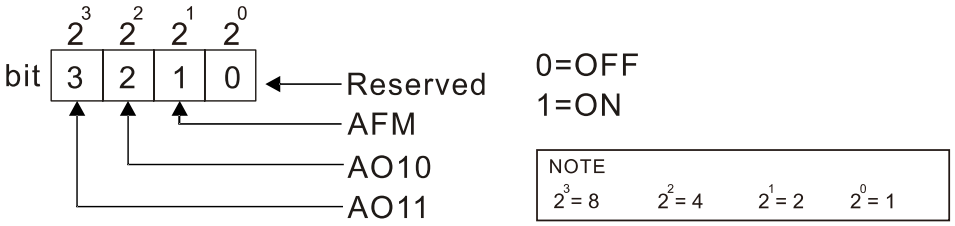
Settings 0: 4–20 mA
1: 0–10 V
2: 0–20 mA

When you change the input mode, verify that the external terminal switch position (ACI) is correct.

## 03-30 Display the Analog Output Terminals Used by PLC

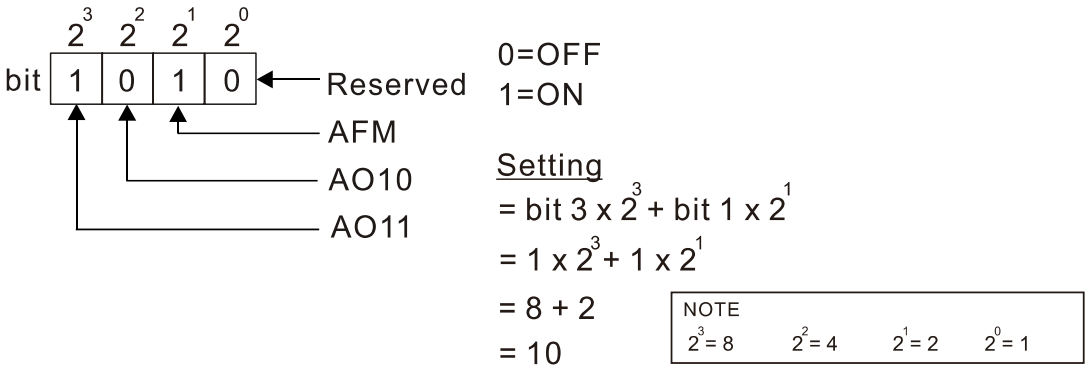
Default: Read only

Settings Monitor the status of the PLC analog output terminals
bit 1: AFM
bit 2: AO10
bit 3: AO11




Example:

When Pr.03-30 displays 000Ah (hex) (that is, the value is 10 (decimal) and 1010 (binary)), it means that AFM and AO11 are used by PLC.




## 03-31 AFM Output Selection

Default: 0

Settings 0: 0–10 V output
1: 0–20 mA output
2: 4–20 mA output

## 03-32 AFM DC Output Setting Level

Default: 0.00

Settings 0.00–100.00 %

### 03-35 AFM Filter Output Time

Default: 0.01

Settings 0.00–20.00 sec.

### 03-39 VR Input Selection

Default: 1

Settings 0: Disable
1: Frequency command

### 03-44 Multi-function MO Output by AI Level Source

Default: 0

Settings 0: AVI
1: ACI
3: Extension card input terminal AI10
4: Extension card input terminal AI11

### 03-45 AI Upper Level 1

Default: 50.00

Settings -100.00–100.00%

### 03-46 AI Lower Level 2

Default: 10.00

Settings -100.00–100.00%

📖 Multi-function output terminal 67 must work with Pr.03-44 to select input channels. When analog input level is higher than Pr.03-45, multi-function output acts; when analog input level is lower than Pr.03-46, multi-function output terminals stop outputting.

📖 When setting levels, AI upper level must be higher than AI lower level.

### 03-57 ACI Lowest Point

Default: 4.00

Settings Pr.03-29 = 1, 0.00–10.00 V
Pr.03-29 ≠ 1, 0.00–20.00 mA

### 03-58 ACI Proportional Lowest Point

Default: 0.00

Settings 0.00–100.00%

### 03-59 ACI Mid-point

Default: 12.00

Settings Pr.03-29 = 1, 0.00–10.00 V
Pr.03-29 ≠ 1, 0.00–20.00 mA

### 03-60 ACI Proportional Mid-point

Default: 50.00

Settings 0.00–100.00%

### 03-61 ACI Highest Point

Default: 20.00

Settings Pr.03-29 = 1, 0.00–10.00 V
Pr.03-29 ≠ 1, 0.00–20.00 mA

### 03-62 ACI Proportional Highest Point

Default: 100.00

Settings 0.00–100.00%

- When Pr.03-29 = 1, the ACI setting is 0–10 V and the unit is voltage (V).
  When Pr.03-29 ≠ 1, the ACI setting is 0–20 mA or 4–20 mA and the unit is current (mA).
- When you set the analog input ACI to the Frequency command, 100% corresponds to Fmax (Pr.01-00 Maximum Operation Frequency).
- The requirement for these three parameters (Pr.03-57, Pr.03-59 and Pr.03-61) is Pr.03-57 < Pr.03-59 < Pr.03-61. The values for three proportional points (Pr.03-58, Pr.03-60 and Pr.03-62) have no limits. There is a linear calculation between two points.
- The output % becomes 0% when the ACI input value is lower than lowest point setting.
  For example:
  If Pr.03-57 = 2 mA; Pr.03-58 = 10%, then the output becomes 0% when the AVI input is ≤ 2 mA.
  If the ACI input swings between 2 mA and 2.1 mA, the drive's output frequency oscillates between 0% and 10%.

### 03-63 AVI Voltage Lowest Point

Default: 0.00

Settings 0.00–10.00 V

### 03-64 AVI Voltage Proportional Lowest Point

Default: 0.00

Settings -100.00–100.00%

### 03-65 AVI Voltage Mid-point

Default: 5.00

Settings 0.00–10.00 V

### 03-66 AVI Voltage Proportional Mid-point

Default: 50.00

Settings -100.00–100.00%

### 03-67 AVI Voltage Highest Point

Default: 10.00

Settings 0.00–10.00 V

### 03-68 AVI Voltage Proportional Highest Point

Default: 100.00

Settings -100.00–100.00%

- When you set the positive voltage AVI to the Frequency command, 100% corresponds to Fmax (Pr.01-00 Maximum Operation Frequency) and the motor runs in the forward direction.
- The requirement for these three parameters (Pr.03-63, Pr.03-65 and Pr.03-67) is Pr.03-63 < Pr.03-65 < Pr.03-67. The values for three proportional points (Pr.03-64, Pr.03-66 and Pr.03-68) have no limits. There is a linear calculation between two points.
- The output % becomes 0% when the positive voltage AVI input value is lower than lowest point setting. For example:
  If Pr.03-63 = 1 V; Pr.03-64 = 10%, then the output becomes 0% when the AVI input is ≤ 1 V.
  If the AVI input swings between 1 V and 1.1 V, the drive's output frequency oscillates between 0% and 10%.

### 03-69 Negative AVI Voltage Lowest Point

Default: 0.00

Settings 0.00– -10.00 V
(valid when Pr.03-28 sets as -10–10 V)

### 03-70 Negative AVI Voltage Proportional Lowest Point

Default: 0.00

Settings -100.00–100.00%
(valid when Pr.03-28 sets as -10–10 V)

### 03-71 Negative AVI Voltage Mid-point

Default: -5.00

Settings 0.00– -10.00 V
(valid when Pr.03-28 sets as -10–10 V)

### 03-72 Negative AVI Voltage Proportional Mid-point

Default: -50.00

Settings -100.00–100.00%
(valid when Pr.03-28 sets as -10–10 V)

### 03-73 Negative AVI Voltage Highest Point

Default: -10.00

Settings 0.00– -10.00 V
(valid when Pr.03-28 sets as -10–10 V)

### 03-74 Negative AVI Voltage Proportional Highest Point

Default: -100.00

Settings -100.00–100.00%
(valid when Pr.03-28 sets as -10–10 V)

- When you set the negative voltage AVI to the Frequency command, -100% corresponds to Fmax (Pr.01-00 Maximum Operation Frequency) and the motor runs in the reverse direction.
- The requirement for these three parameters (Pr.03-69, Pr.03-71 and Pr.03-73) is Pr.03-69 < Pr.03-71 < Pr.03-73. The values for three proportional points (Pr.03-70, Pr.03-72 and Pr.03-74) have no limits. There is a linear calculation between two points.
- The output % becomes 0% when the negative AVI input value is lower than the lowest point setting.
  For example:
  If Pr.03-69 = -1 V; Pr.03-70 = 10%, then the output becomes 0% when the AVI input is ≥ -1 V.
  If the AVI input swings between -1 V and -1.1 V, drive's output frequency oscillates between 0% and 10%.

## 04 Multi-Step Speed Parameters

✎ You can set this parameter during operation.

| | |
|---|---|
| ✎ 04-00 | 1st Step Speed Frequency |
| ✎ 04-01 | 2nd Step Speed Frequency |
| ✎ 04-02 | 3rd Step Speed Frequency |
| ✎ 04-03 | 4th Step Speed Frequency |
| ✎ 04-04 | 5th Step Speed Frequency |
| ✎ 04-05 | 6th Step Speed Frequency |
| ✎ 04-06 | 7th Step Speed Frequency |
| ✎ 04-07 | 8th Step Speed Frequency |
| ✎ 04-08 | 9th Step Speed Frequency |
| ✎ 04-09 | 10th Step Speed Frequency |
| ✎ 04-10 | 11th Step Speed Frequency |
| ✎ 04-11 | 12th Step Speed Frequency |
| ✎ 04-12 | 13th Step Speed Frequency |
| ✎ 04-13 | 14th Step Speed Frequency |
| ✎ 04-14 | 15th Step Speed Frequency |

Default: 0.00

Settings 0.00–599.00 Hz

🕮 Use the multi-function input terminals (refer to settings 1–4 of Pr.02-01–02-07 and Pr.02-26–02-28 Multi-function Input Command) to select multi-step speed command (the maximum is 15th step speed). Pr.04-00 to Pr.04-14 sets the multi-step speed frequency as shown in the following diagram.

🕮 The external terminal/digital keypad/communication controls the RUN and STOP commands with Pr.00-21.

🕮 You can set each multi-step speed between 0.00–599.00 Hz during operation.

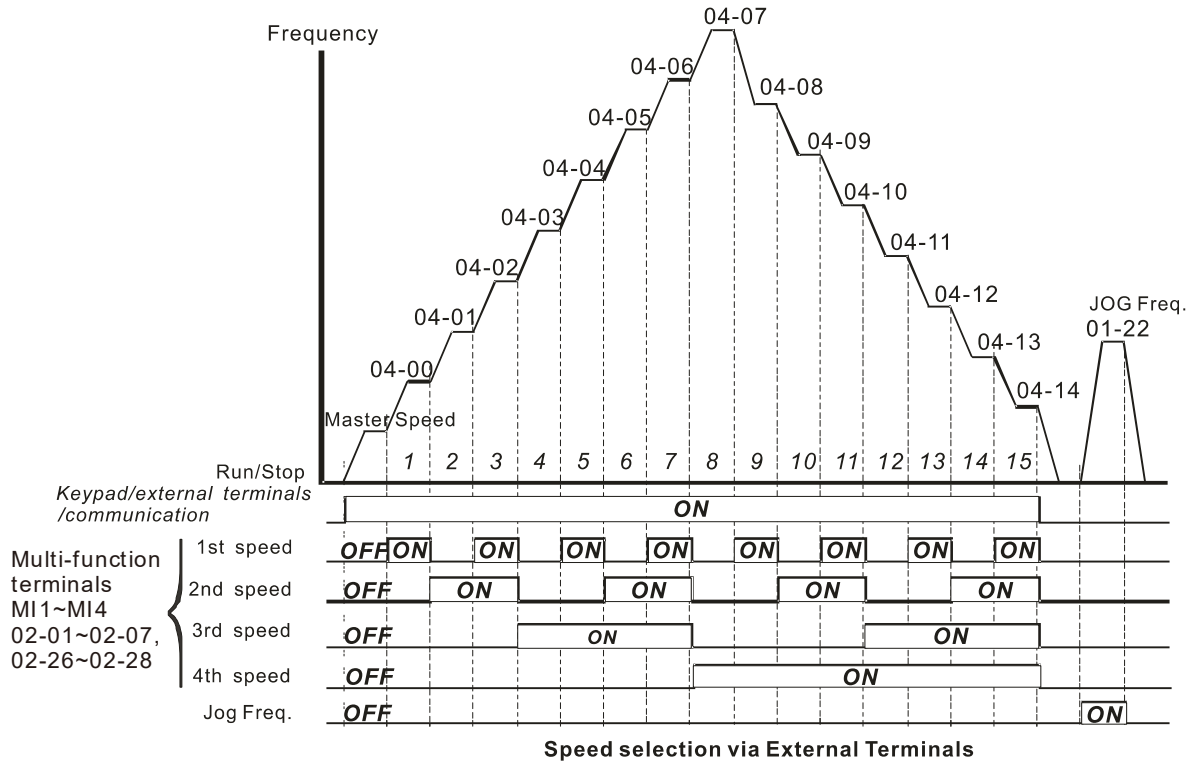
🕮 Explanation for the timing diagram of the multi-step speed and external terminals

The related parameter settings are:

1. Pr.04-00–04-14: sets the 1st–15th multi-step speed (to set the frequency of each step speed).
2. Pr.02-01–02-07 and Pr.02-26–02-28: sets the multi-function input terminals (multi-step speed command 1–4).

🕮 Related parameters:

- Pr.01-22 JOG frequency setting
- Pr.02-01 multi-function input command 1 (MI1)
- Pr.02-02 multi-function input command 2 (MI2)
- Pr.02-03 multi-function input command 3 (MI3)
- Pr.02-04 multi-function input command 4 (MI4)




**Speed selection via External Terminals**

| | |
|---|---|
| 04-50 | PLC Buffer 0 |
| 04-51 | PLC Buffer 1 |
| 04-52 | PLC Buffer 2 |
| 04-53 | PLC Buffer 3 |
| 04-54 | PLC Buffer 4 |
| 04-55 | PLC Buffer 5 |
| 04-56 | PLC Buffer 6 |
| 04-57 | PLC Buffer 7 |
| 04-58 | PLC Buffer 8 |
| 04-59 | PLC Buffer 9 |
| 04-60 | PLC Buffer 10 |
| 04-61 | PLC Buffer 11 |
| 04-62 | PLC Buffer 12 |
| 04-63 | PLC Buffer 13 |
| 04-64 | PLC Buffer 14 |
| 04-65 | PLC Buffer 15 |
| 04-66 | PLC Buffer 16 |
| 04-67 | PLC Buffer 17 |
| 04-68 | PLC Buffer 18 |
| 04-69 | PLC Buffer 19 |

Default: 0

Settings 0–65535

You can combine the PLC buffer with the built-in PLC function for a variety of applications.

## 05 Motor Parameters

✓ You can set this parameter during operation.

### 05-00 Motor Parameter Auto-Tuning

Default: 0

Settings 0: No function
1: Dynamic test for an induction motor (IM)
2: Static test for an induction motor (IM)

### 05-01 Full-load Current for an Induction Motor (A)

Unit: Ampere
Default: #.##

Settings 10–120 % of drive's rated current

🕮 Sets this value according to the rated current of the motor as indicated on the motor nameplate. The default is 90% of the drive's rated current.

Example: The rated current for a 7.5 HP (5.5 kW) motor is 25 A. The default is 22.5 A.
The setting range is 2.5–30 A. (25 × 10 % = 2.5 A and 25 × 120 % = 30 A).

### ✓ 05-02 Rated Power for an Induction Motor (kW)

Default: #.##

Settings 0.00–655.35 kW

🕮 Sets the rated power for motor 1. The default is the drive's power value.

### ✓ 05-03 Rated Speed for an Induction Motor (rpm)

Default: 1710

Settings 0–65535 rpm
1710 (60 Hz 4 poles); 1410 (50 Hz 4 poles)

🕮 Sets the rated speed for the motor as indicated on the motor nameplate.

### 05-04 Number of Poles for an Induction Motor

Default: 4

Settings 2–20

🕮 Sets the number of poles for the motor (must be an even number).

🕮 Set up Pr.01-01 and Pr.05-03 before setting up Pr.05-04 to make sure the motor operates normally.

### 05-05 No-load Current for an Induction Motor (A)

Unit: Ampere
Default: #.##

Settings 0.00–Pr.05-01 Default

🕮 The default is 40% of the motor's rated current.

### 05-06 Stator Resistance (Rs) for an Induction Motor
### 05-07 Rotor Resistance (Rr) for an Induction Motor

Default: #.###

Settings 0.000–65.535 Ω

### 05-08 Magnetizing Inductance (Lm) for an Induction Motor
### 05-09 Stator Inductance (Lx) for an Induction Motor

Default: #.#

Settings 0.0–6553.5 mH

### 05-23 Frequency for Y-connection /△-connection Switch for an Induction Motor

Default: 60.00

Settings 0.00–599.00 Hz

### 05-24 Y-connection /△-connection Switch for an Induction Motor

Default: 0

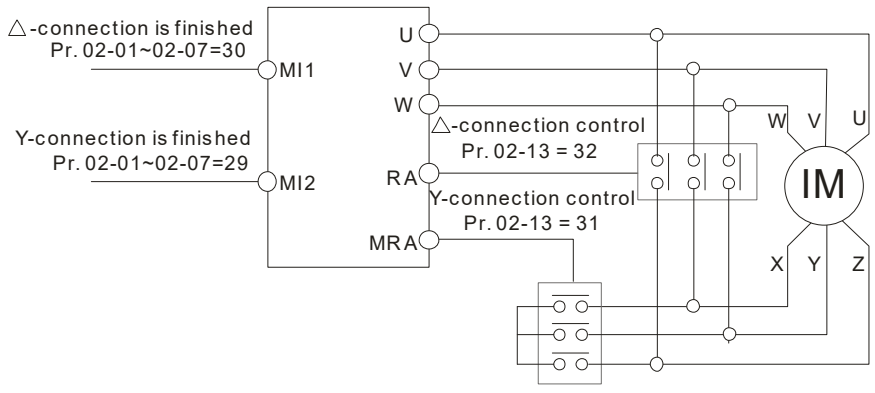
Settings 0: Disable
1: Enable

### 05-25 Delay Time for Y-connection/△-connection Switch for an Induction Motor

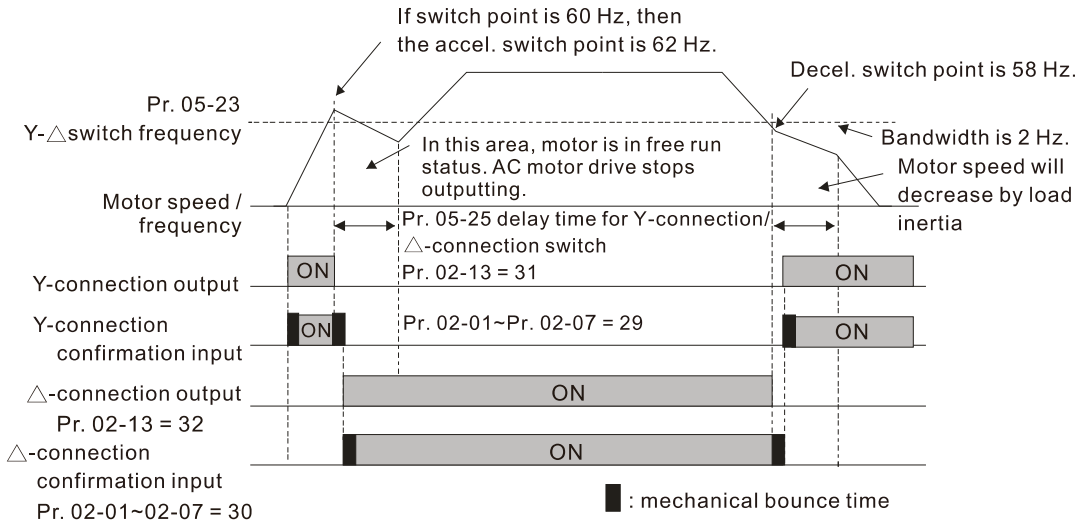
Default: 0.200

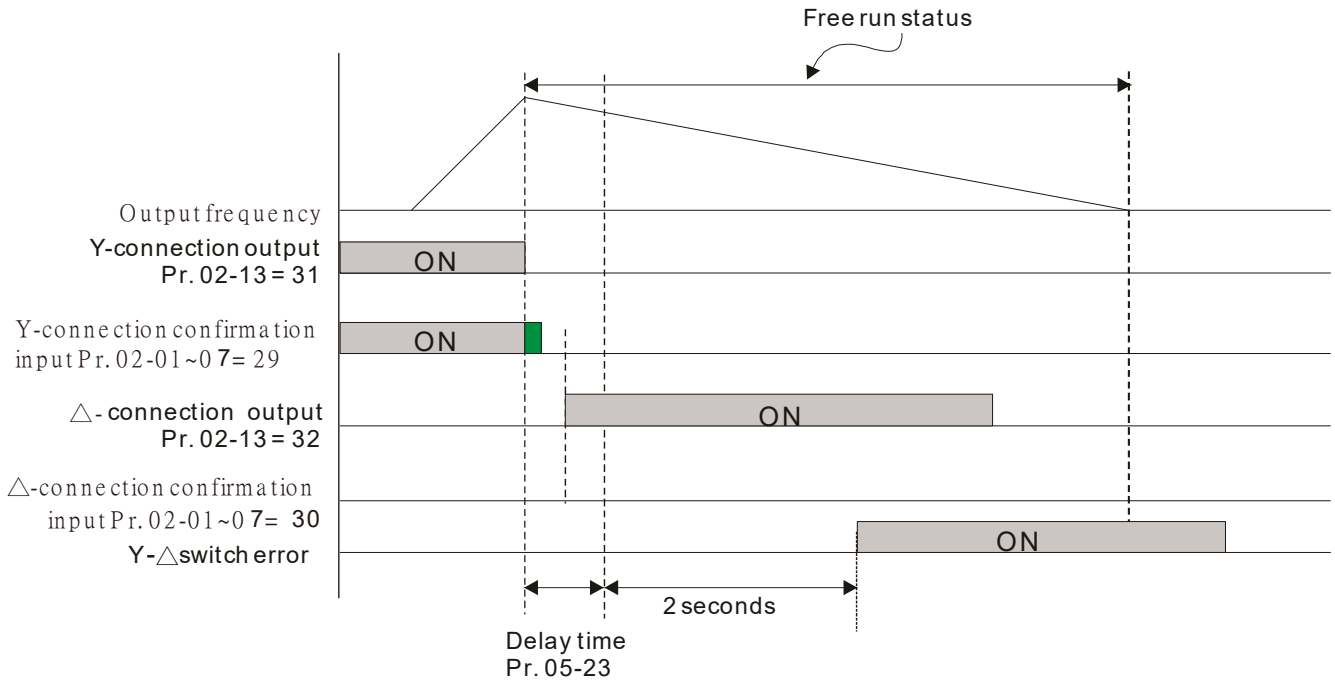
Settings 0.000–60.000 sec.

- You can apply Pr.05-23–Pr.05-25 in a wide range of motors, and the motor coil executes the Y-connection / Δ-connection switch as required. The wide range motors are related to the motor design. In general, the motor has higher torque with low speed Y-connection and has higher speed with high speed Δ-connection
- Pr.05-24 enables and disables the switch of Y-connection / Δ-connection.
- When you set Pr.05-24 as 1, the drive uses the Pr.05-23 setting and current motor frequency, and switches the current motor to Y-connection or Δ-connection. You can switch the relevant motor parameter settings simultaneously.
- Pr.05-25 sets the switch delay time of Y-connection / Δ-connection.
- When the output frequency reaches the Y-connection / Δ-connection switch frequency, the drive delays according to Pr.05-25 before activating the multi-function output terminals.




Y- △connection switch: can be used for wide range motor
Y-connection for low speed: higher torque can be used for rigid tapping
△-connection for high speed: higher torque can be used for high-speed drilling




| | |
|---|---|
| 05-26 | Accumulative Watt-second for a Motor in Low Word (W-sec.) |
| 05-27 | Accumulative Watt-second for a Motor in High Word (W-sec.) |
| 05-28 | Accumulative Watt-hour for a Motor (W-Hour) |
| 05-29 | Accumulative Watt-hour for a Motor in Low Word (kW-Hour) |
| 05-30 | Accumulative Watt-hour for a Motor in High Word (kW-Hour) |

Default: #.#

Settings Read only

🕮 Pr.05-26–05-30 records the amount of power the motors consume. The accumulation begins when the drive is activated and the record is saved when the drive stops or turns OFF. The amount of consumed watts continues to accumulate when the drive is activated again. To clear the accumulation, set Pr.00-02 as 5 to return the accumulation record to 0.

🕮 The accumulated total watts of the motor per second = Pr.05-27 x 65536 + Pr.05-26

Example: when Pr.05-26 = 2548.1 and Pr.05-27 = 15.2, the accumulated total watts of the motor per second = 15.2 x 65536 + 2548.1 = 996147.2 + 2548.1 = 998695.3

🕮 The accumulated total kilowatts of the motor per hour = Pr.05-30 x 65536 + Pr.05-29

Example: when Pr.05-29 = 3361.4 and Pr.05-30 = 11.2, the accumulated total kilowatts of the motor per hour = 11.2 x 65536 + 3361.4 = 734003.2 + 3361.4 = 737364.6

### 05-31 Accumulative Motor Operation Time (Min.)

Default: 0

Settings 0–1439

### 05-32 Accumulative Motor Operation Time (Day)

Default: 0

Settings 0–65535

🕮 Use Pr.05-31 and Pr.05-32 to record the motor operation time. To clear the operation time, set Pr.05-31 and Pr.05-32 as 00. An operation time shorter than 60 seconds is not recorded.

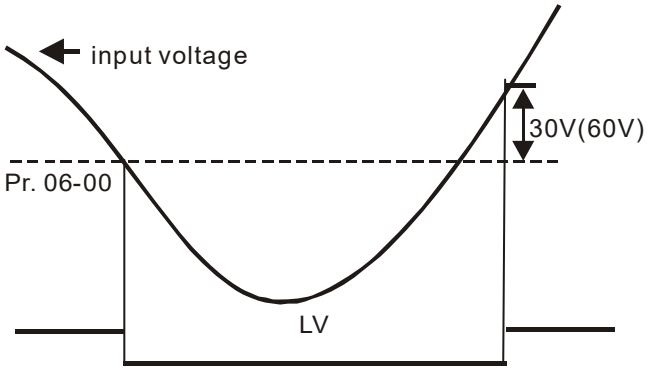
# 06 Protection Parameters

✓ You can set this parameter during operation.

## ✓ 06-00 Low Voltage Level

| | | Default: |
|---|---|---|
| Settings | 230V: 150.0–220.0 $V_{DC}$ | 180.0 |
| | 460V: 300.0–440.0 $V_{DC}$ | 360.0 |

- Sets the Low Voltage (LV) level. When the DC BUS voltage is lower than Pr.06-00, the drive stops output and the motor free runs to a stop.
- If the LV fault is triggered during operation, the drive stops output and the motor free runs to a stop. There are three LV faults, LvA (LV during acceleration), Lvd (LV during deceleration), and Lvn (LV in constant speed) that are triggered according to the status of acceleration or deceleration. You must press RESET to clear the LV fault. The drive automatically restarts if you set to restart after momentary power loss (refer to Pr.07-06 Restart after Momentary Power Loss and Pr.07-07 Allowed Power Loss Duration for details).
- If the LV fault is triggered when the drive is in STOP status, the drive displays LvS (LV during stop), which is not recorded, and the drive restarts automatically when the input voltage is higher than the LV level of 30 V (230V series) or 60 V (460V series).




## ✓ 06-01 Over-voltage Stall Prevention

| | | Default: |
|---|---|---|
| Settings | 0: Disabled | |
| | 230V: 0.0–450.0 $V_{DC}$ | 380.0 |
| | 460V: 0.0–900.0 $V_{DC}$ | 760.0 |

- Setting Pr.06-01 to 0.0 disables the over-voltage stall prevention function (connected with braking unit or braking resistor). Use this setting when braking units or resistors are connected to the drive.
- Setting Pr.06-01 to a value > 0 enables the over-voltage stall prevention. This setting refers to the power supply system and loading. If the setting is too low, then over-voltage stall prevention is easily activated, which may increase deceleration time.
- Related parameters:
  Pr.01-13, Pr.01-15, Pr.01-17, Pr.01-19 Deceleration Time 1–4, Pr.02-13 Multi-function Output 1 (Relay 1), Pr.02-16–Pr.02-17 Multi-function Output 2–3 (MO1, 2), and Pr.06-02 Selection for Over-voltage Stall Prevention.

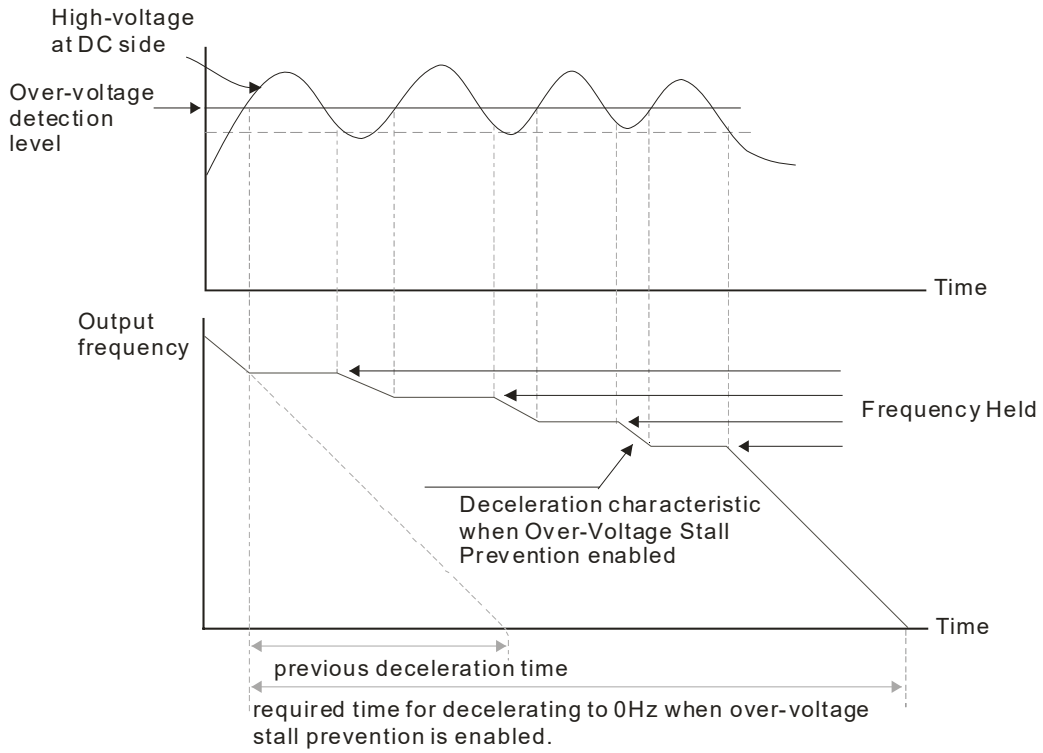
## 06-02 Selection for Over-voltage Stall Prevention

Default: 0

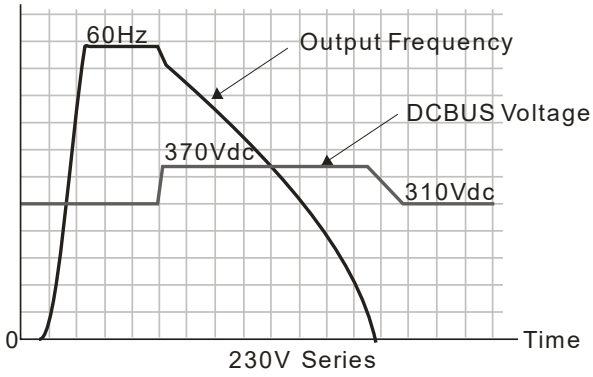
Settings 0: Traditional over-voltage stall prevention
1: Smart over-voltage stall prevention

Use this function when you are unsure about the load inertia. When stopping under normal load, the over-voltage does not occur during deceleration and meet the deceleration time setting. Sometimes it may not stop due to over-voltage during decelerating to STOP when the load regenerative inertia increases. In this case, the AC motor drive extends the deceleration time automatically until the drive stops.

When you set Pr.06-02 to 0, during deceleration the motor exceeds the synchronous speed due to load inertia. In this case, the motor becomes an electrical generator. The DC BUS voltage may exceed its maximum allowable value due to motor regeneration in some situations, such as loading inertia being too high or deceleration time being set too short. When you enable traditional over-voltage stall prevention and the DC BUS voltage detected is too high, the drive stops decelerating (output frequency remains unchanged) until the DC BUS voltage drops below the setting value.




When you set Pr.06-02 to 1, to use smart over-voltage stall prevention during deceleration, the drive maintains the DC BUS voltage when decelerating and prevents the drive from OV.



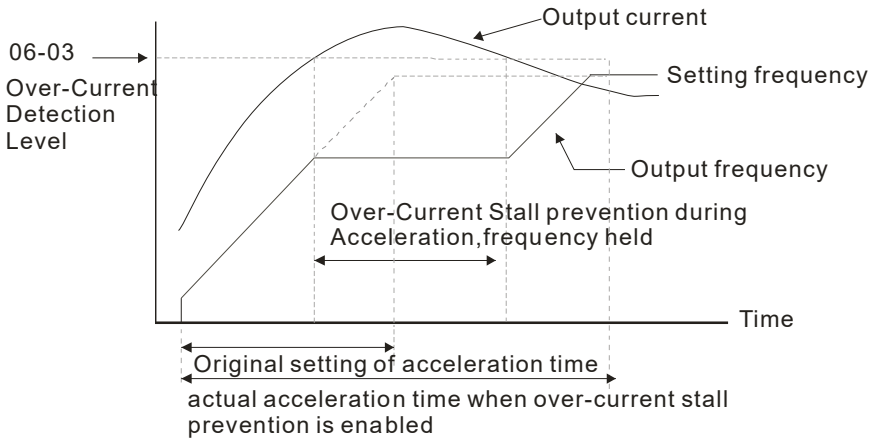
- When you enable the over-voltage stall prevention, the drive's deceleration time is longer than the setting. If you encounter any problem with deceleration time, refer to the following guides for troubleshooting.
  1. Increase the deceleration time to a suitable value.
  2. Install a brake resistor (refer to Section 7-1 All Brake Resistors and Brake Units Used in AC Motor Drives for details) to dissipate the electrical energy that is generated from the motor.
- Related parameters:
  Pr.01-13, Pr.01-15, Pr.01-17, Pr.01-19 Deceleration Time 1–4, Pr.02-13 Multi-function Output 1 (Relay 1), Pr.02-16–Pr.02-17 Multi-function Output 2–3 (MO1, 2), and Pr.06-01 Over-voltage Stall Prevention.

## 06-03 Over-current Stall Prevention during Acceleration

Default: 180

Settings 0–200% (100% corresponds to the rated current of the drive)

- This parameter only works in VF and SVC modes.
- If the motor load is too large or the drive's acceleration time is too short, the output current of the drive may be too high during acceleration, and it may cause motor damage or trigger protection functions (OL or OC). Use this parameter to prevent these situations.
- During acceleration, the output current of the drive may increase abruptly and exceed the setting value of Pr.06-03. In this case, the drive stops accelerating and keeps the output frequency constant, and then continues to accelerate until the output current decreases.
- When you enable the over-current stall prevention, the drive's acceleration time is longer than the setting.
- When the over-current stall prevention occurs because the motor capacity is too small or operates in the default, decrease the Pr.06-03 setting value.
- When you encounter any problem with the acceleration time, refer to the following guides for troubleshooting.
  1. Increase the deceleration time to a suitable value.
  2. Related parameters: Pr.01-12, 01-14, 01-16, 01-18 Acceleration Time 1–4), Pr.02-13 Multi-function Output 1 (Relay 1), Pr.02-16–02-17 Multi-function Output 2–3 (MO1, 2).

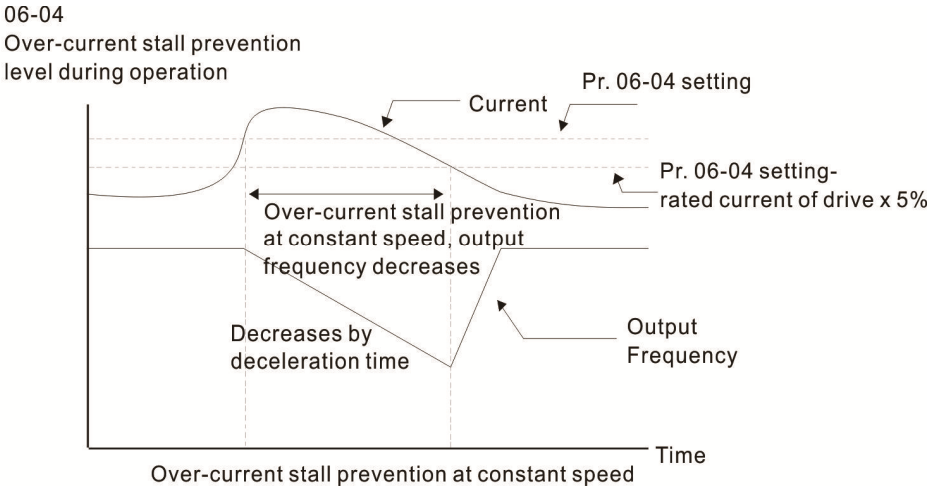


## 06-04 Over-current Stall Prevention during Operation

Default: 180

Settings 0–200% (100% corresponds to the rated current of the drive)

- This parameter only works in VF and SVC modes.
- This is a protection for the drive to decrease output frequency automatically when the motor overloads abruptly during constant motor operation.
- If the output current exceeds the setting value of Pr.06-04 when the drive is operating, the drive decreases output frequency (according to Pr.06-05) to prevent the motor from stalling. If the output current is lower than the setting value of Pr.06-04, the drive accelerates (according to Pr.06-05) again to the setting frequency.




## 06-05 Accel. / Decel. Time Selection for Stall Prevention at Constant Speed

Default: 0

Settings 0: By current acceleration / deceleration time
1: By the 1st acceleration / deceleration time
2: By the 2nd acceleration / deceleration time
3: By the 3rd acceleration / deceleration time
4: By the 4th acceleration/ deceleration time
5: By auto-acceleration / auto-deceleration

- Sets the acceleration/deceleration time selection when stall prevention occurs at constant speed.

## 06-06 Over-torque Detection Selection (Motor)

Default: 0

Settings 0: No function
1: Continue operation after over-torque detection during constant speed operation
2: Stop after over-torque detection during constant speed operation
3: Continue operation after over-torque detection during RUN
4: Stop after over-torque detection during RUN

## 06-07 Over-torque Detection Level (Motor)

Default: 120

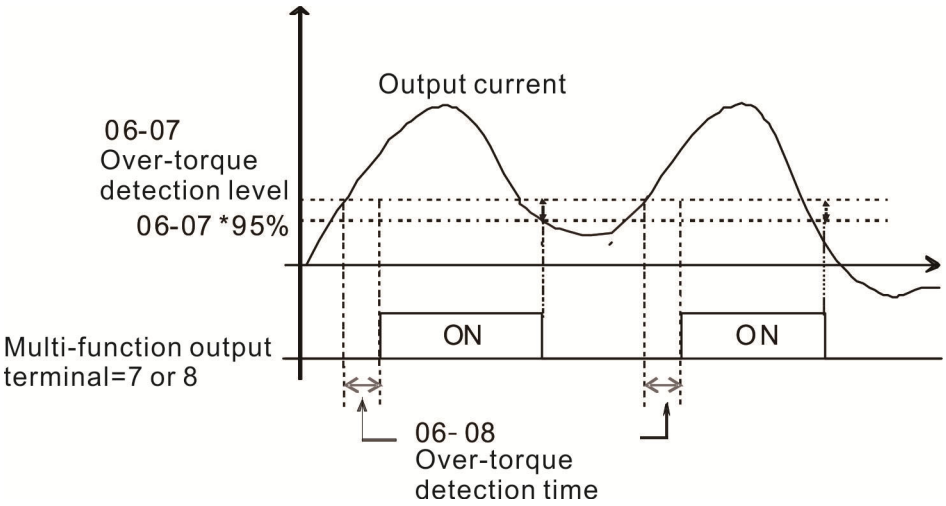
Settings 10–250% (100% corresponds to the rated current of the drive)

## 06-08 Over-torque Detection Time (Motor)

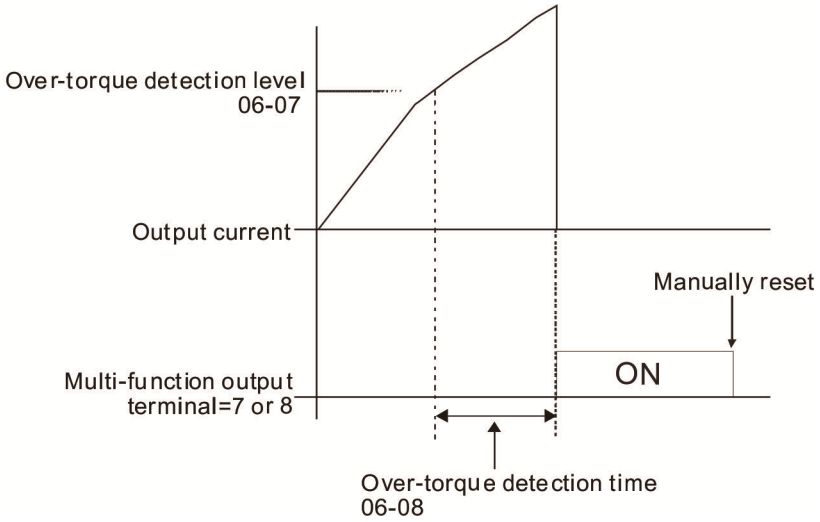
Default: 0.1

Settings 0.1–60.0 sec.

- When the output current exceeds over-torque detection level (Pr.06-07) and also exceeds over-torque detection time (Pr.06-08), the over-torque detection follows the settings for Pr.06-06.
- When you set Pr.06-06 to 1 or 3, an ot1 warning displays while the drive keeps running. The warning remains on until the output current is smaller than 5% of the over-torque detection level.




- When you set Pr.06-06 to 2 or 4, an ot1 warning displays and the drive stops running after over-torque detection. The drive keeps running after you manually reset it.




## 06-12 Current Limit

Default: 150

Settings 0–250% (100% corresponds to the rated current of the drive)

- Sets the maximum output current of the drive.

## 06-13 Electronic Thermal Relay Selection 1 (Motor)

Default: 2

Settings 0: Inverter motor (with external forced cooling)
1: Standard motor (motor with fan on the shaft)
2: Disable

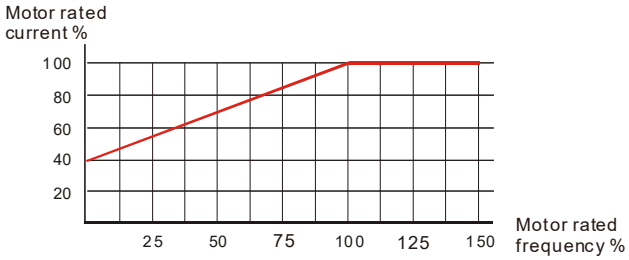
- Prevents self-cooled motor from overheating under low speed. Use an electronic thermal relay to limit the drive's output power.
- Setting the parameter to 0 is suitable for an inverter motor (motor fan using an independent power supply). For this kind of motor, there is no significant correlation between cooling capacity and motor speed. Therefore, the action of electronic thermal relays remain stable in low speed to ensure the load capability of the motor in low speed.
- Setting the parameter to 1 is suitable for standard motor (motor fan is fixed on the rotor shaft). For this kind of motor, the cooling capacity is lower in low speed; therefore, the action of an electronic thermal relay reduces the action time to ensure the life of motor.
- When the power is cycled frequently, if the power is switched OFF, the electronic thermal relay protection is reset; therefore even setting the parameter to 0 or 1 may not protect the motor well. If there are several motors connected to one drive, install an electronic thermal relay in each motor.

## 06-14 Electronic Thermal Relay Action Time 1 (Motor)

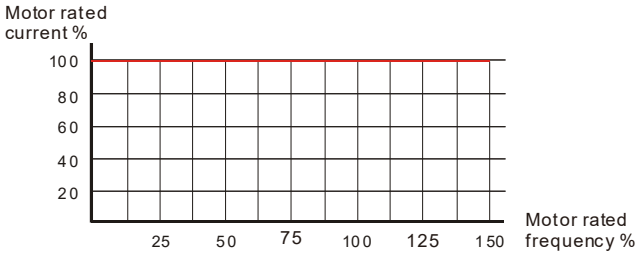
Default: 60.0

Settings 30.0–600.0 sec.

- Set the parameter to 150% of motor rated current and use with the setting of Pr.06-14 to prevent motor damage due to overheating. When it reaches the setting, the drive displays "EoL1", and the motor free runs to stop.
- Use this parameter to set the action time of the electronic thermal relay. It works based on the I2t characteristic curve of electronic thermal relay, the output frequency and current of the drive, and the operation time to prevent the motor from overheating.



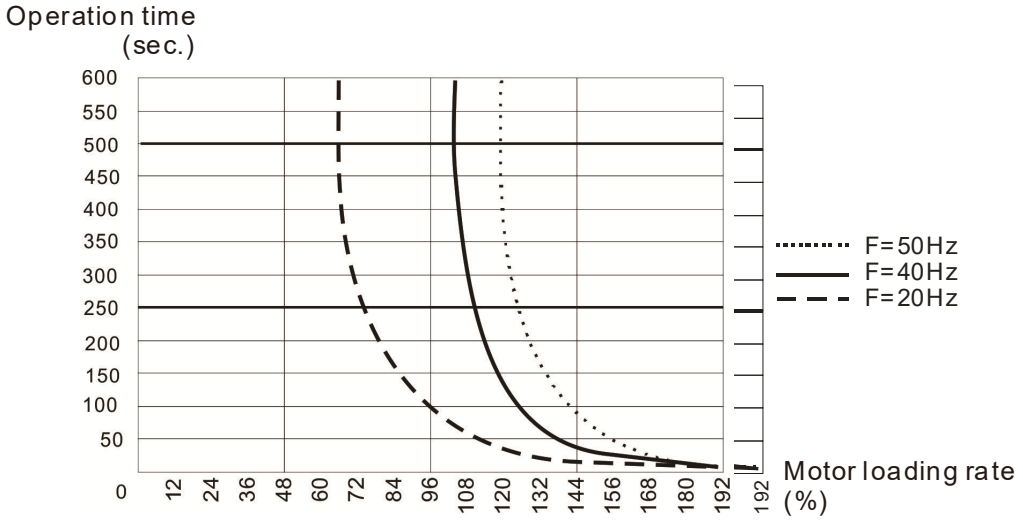

Motor cooling curve with shaft-fixed fan




Motor cooling curve with independent fan

- The action of electronic thermal relay depends on the settings of Pr.06-13.

1. Pr.06-13 is set to 0 (using inverter motor):
   When output current of drive is higher than 150% of motor rated current (refer to motor cooling curve with independent fan), the drive will starts to count the time. The electronic thermal relay will acts when the accumulated time exceeds Pr.06-14.
2. Pr.06-13 is set to 1 (using standard motor):
   When the output current of the drive is higher than 150% of the motor rated current (refer to the motor cooling curve with shaft-fixed fan), the drive starts to count the time. The electronic thermal relay acts when the accumulated time exceeds Pr.06-14.
   The actual electronic thermal relay action time adjusts according to the drive output current (shown as the motor loading rate %). The action time is short when the current is high, and the action time is long when the current is low. Refer to the following chart:




## 06-15 Temperature Level Overheat (OH) Warning

Default: 105.0

Settings 0.0–110.0 ºC

The default of this parameter is 105ºC. When using Sensorless control mode, the OH warning is disabled if Pr.06-15 is not reduced. When the temperature reaches 100ºC, the drive stops with an IGBT overheat fault.

## 06-16 Stall Prevention Limit Level

Default: 100

Settings 0–100% (Refer to Pr.06-03, Pr.06-04)

Sets the over-current stall prevention level when operation frequency is larger than Pr.01-01.

Example: When Pr.06-03 = 150%, Pr.06-04 = 100% and Pr.06-16 = 80%.

The over-current stall prevention level during acceleration:

Pr.06-03 * Pr.06-16 = 150 x 80% = 120%.

The over-current stall prevention level during operation:

Pr.06-04 * Pr.06-16 = 100 x 80% = 80%.

## 06-17 Fault Record 1
## 06-18 Fault Record 2
## 06-19 Fault Record 3
## 06-20 Fault Record 4
## 06-21 Fault Record 5
## 06-22 Fault Record 6

Default: 0

Settings 0: No fault record

1: Over-current during acceleration (ocA)

2: Over-current during deceleration (ocd)

3: Over-current during constant speed (ocn)

4: Ground fault (GFF)

6: Over-current at stop (ocS)

7: Over-voltage during acceleration (ovA)
8: Over-voltage during deceleration (ovd)
9: Over-voltage during constant speed (ovn)
10: Over-voltage at stop (ovS)
11: Low-voltage during acceleration (LvA)
12: Low-voltage during deceleration (Lvd)
13: Low-voltage during constant speed (Lvn)
14: Low-voltage at stop (LvS)
15: Phase loss protection (orP)
16: IGBT overheat (oH1)
18: TH1 open: IGBT overheat protection error( tH1o)
21: Drive overload (oL)
22: Electronic thermal relay protection 1 (EoL1)
26: Over-torque 1 (ot1)
28: Low current (uC)
31: Memory read-out error (cF2)
33: U-phase current detection error (cd1)
34: V-phase current detection error (cd2)
35: W-phase current detection error (cd3)
36: Clamp current detection error (Hd0)
37: Over-current detection error (Hd1)
40: Auto-tuning error (AUE)
41: PID feedback loss (AFE)
. 48: Analog current input loss (ACE)
49: External fault input (EF)
50: Emergency stop (EF1)
51: External Base Block (B.B.)
52: Password error (Pcod)
54: Communication error (CE1)
55: Communication error (CE2)
56: Communication error (CE3)
57: Communication error (CE4)
58: Communication time-out (CE10)
61: Y-connection / Δ-connection switch error (ydc)
62: Deceleration Energy Backup Error (dEb)
63: Slip error (oSL)
71: Mechanical brake error 2 (MBF2)
72: Channel 1 (S1–DCM) safety loop error (STL1)
74: Magnetic contactor error (MCF)
75: Mechanical brake error (MBF)
76: Safe Torque Off (STo)
77: Channel 2 (S2–DCM) safety loop error (STL2)

78: Internal loop error (STL3)
79: U-phase over-current before run (Uoc)
80: V-phase over-current before run (Voc)
81: W-phase over-current before run (Woc)
82: U-phase output phase loss (OPHL)
83: V-phase output phase loss (OPHL)
84: W-phase output phase loss (OPHL)
87: Drive overload in low frequency (oL3)
101: CANopen software disconnect 1 (CGdE)
102: CANopen software disconnect 2 (CHbE)
104: CANopen hardware disconnect (CbFE)
105: CANopen index setting error (CIdE)
106: CANopen station number setting error (CAdE)
107: CANopen memory error (CFrE)
127: Software version error (CP33)
140: GFF detected when power on (Hd6)
141: GFF before run (BGFF)
142: Auto-tuning error 1 (DC test stage) (AUE1)
143: Auto-tuning error 2 (High frequency test stage) (AUE2)
144: Auto-tuning error 3 (Rotary test stage) (AUE3)

- When the fault occurs and forces stopping, the fault is recorded in this parameter.
- During stop with low voltage Lv (LvS warning), there is no error record. During operation with mid-low voltage Lv (LvA, Lvd, Lvn error), there is a record.
- When dEb function is valid and enabled, the drive executes dEb and record fault code 62 to Pr.06-17–Pr.06-22 simultaneously.

## 06-23 Fault Output Option 1
## 06-24 Fault Output Option 2
## 06-25 Fault Output Option 3
## 06-26 Fault Output Option 4

Default: 0

Settings 0–65535 (refer to bit table for fault code)

- Use these parameters with multi-function output terminal (set to 35–38) for the specific requirement. When the fault occurs, the corresponding terminals activate. Convert the binary value to decimal value before you enter the value for Pr.06-23–Pr.06-26.

| Fault Code | bit 0 | bit 1 | bit 2 | bit 3 | bit 4 | bit 5 | bit 6 |
|---|---|---|---|---|---|---|---|
| | current | Volt. | OL | SYS | FBK | EXI | CE |
| 0: No fault record | | | | | | | |
| 1: Over-current during acceleration (ocA) | ● | | | | | | |
| 2: Over-current during deceleration (ocd) | ● | | | | | | |
| 3: Over-current during constant speed (ocn) | ● | | | | | | |

| Fault Code | bit 0 | bit 1 | bit 2 | bit 3 | bit 4 | bit 5 | bit 6 |
|---|---|---|---|---|---|---|---|
| | current | Volt. | OL | SYS | FBK | EXI | CE |
| 4: Ground fault (GFF) | ● | | | | | | |
| 6: Over-current at stop (ocS) | ● | | | | | | |
| 7: Over-voltage during acceleration (ovA) | | ● | | | | | |
| 8: Over-voltage during deceleration (ovd) | | ● | | | | | |
| 9: Over-voltage during constant speed (ovn) | | ● | | | | | |
| 10: Over-voltage at stop (ovS) | | ● | | | | | |
| 11: Low-voltage during acceleration (LvA) | | ● | | | | | |
| 12: Low-voltage during deceleration (Lvd) | | ● | | | | | |
| 13: Low-voltage during constant speed (Lvn) | | ● | | | | | |
| 14: Low-voltage at stop (LvS) | | ● | | | | | |
| 15: Phase loss protection (orP) | | ● | | | | | |
| 16: IGBT overheat (oH1) | | | ● | | | | |
| 18: TH1 open: IGBT overheat protection error (tH1o) | | | ● | | | | |
| 21: Drive overload (oL) | | | ● | | | | |
| 22: Electronic thermal relay protection 1 (EoL1) | | | ● | | | | |
| 26: Over-torque 1 (ot1) | | | ● | | | | |
| 28: Low current (uC) | ● | | | | | | |
| 31: Memory read-out error (cF2) | | | | ● | | | |
| 33: U-phase current detection error (cd1) | | | | ● | | | |
| 34: V-phase current detection error (cd2) | | | | ● | | | |
| 35: W-phase current detection error (cd3) | | | | ● | | | |
| 36: Clamp current detection error (Hd0) | | | | ● | | | |
| 37: Over-current detection error (Hd1) | | | | ● | | | |
| 40: Auto-tuning error (AUE) | | | | ● | | | |
| 41: PID feedback loss (AFE) | | | | | ● | | |
| 48: Analog current input loss (ACE) | | | | | ● | | |
| 49: External fault input (EF) | | | | | | ● | |
| 50: Emergency stop (EF1) | | | | | | ● | |
| 51: External Base Block (B.B.) | | | | | | ● | |
| 52: Password error (Pcod) | | | | ● | | | |
| 54: Communication error (CE1) | | | | | | | ● |
| 55: Communication error (CE2) | | | | | | | ● |
| 56: Communication error (CE3) | | | | | | | ● |
| 57: Communication error (CE4) | | | | | | | ● |
| 58: Communication time-out (CE10) | | | | | | | ● |
| 61: Y-connection / Δ-connection switch error (ydc) | | | | | | ● | |
| 62: Deceleration Energy Backup Error (dEb) | | ● | | | | | |

| Fault Code | bit 0 | bit 1 | bit 2 | bit 3 | bit 4 | bit 5 | bit 6 |
|---|---|---|---|---|---|---|---|
| | current | Volt. | OL | SYS | FBK | EXI | CE |
| 63: Slip error (oSL) | | | | | | ● | |
| 71: Mechanical brake error 2 (MBF2) | | | | ● | | | |
| 72: Channel 1 (S1–DCM) safety loop error (STL1) | | | | ● | | | |
| 74: Magnetic contactor error (MCF) | | | | ● | | | |
| 75: Mechanical brake error (MBF) | | | | ● | | | |
| 76: Safe Torque Off (STo) | | | | ● | | | |
| 77: Channel 2 (S2–DCM) safety loop error (STL2) | | | | ● | | | |
| 78: Internal loop error (STL3) | | | | ● | | | |
| 79: U-phase over-current before run (Uoc) | ● | | | | | | |
| 80: V-phase over-current before run (Voc) | ● | | | | | | |
| 81: W-phase over-current before run (Woc) | ● | | | | | | |
| 82: U-phase output phase loss (OPHL) | ● | | | | | | |
| 83: V-phase output phase loss (OPHL) | ● | | | | | | |
| 84: W-phase output phase loss (OPHL) | ● | | | | | | |
| 87: Drive overload in low frequency (oL3) | | | ● | | | | |
| 101: CANopen software disconnect 1 (CGdE) | | | | | | | ● |
| 102: CANopen software disconnect 2 (CHbE) | | | | | | | ● |
| 104: CANopen hardware disconnect (CbFE) | | | | | | | ● |
| 105: CANopen index setting error (CIdE) | | | | | | | ● |
| 106: CANopen station number setting error (CAdE) | | | | | | | ● |
| 107: CANopen memory error (CFrE) | | | | | | | ● |
| 127: Software version error (CP33) | | | | ● | | | |
| 140: GFF detected when power on (Hd6) | | | | ● | | | |
| 141: GFF before run (BGFF) | | | | ● | | | |
| 142: Auto-tuning error 1 (DC test stage) (AUE1) | | | | ● | | | |
| 143: Auto-tuning error 2 (High frequency test stage) (AUE2) | | | | ● | | | |
| 144: Auto-tuning error 3 (Rotary test stage) (AUE3) | | | | ● | | | |

## 06-31 Frequency Command for Malfunction

Default: Read only

Settings 0.00–599.00 Hz

📖 When a malfunction occurs, check the current Frequency command. If it happens again, it overwrites the previous record.

## 06-32 Output Frequency at Malfunction

Default: Read only

Settings 0.00–599.00 Hz

When a malfunction occurs, check the current output frequency. If it happens again, it overwrites the previous record.

### 06-33 Output Voltage at Malfunction

Default: Read only

Settings 0.0–6553.5 V

When a malfunction occurs, check the current output voltage. If it happens again, it overwrites the previous record.

### 06-34 DC Voltage at Malfunction

Default: Read only

Settings 0.0–6553.5 V

When a malfunction occurs, check the current DC voltage. If it happens again, it overwrites the previous record.

### 06-35 Output Current at Malfunction

Default: Read only

Settings 0.00–655.35 Amp

When a malfunction occurs, check the current output current. If it happens again, it overwrites the previous record.

### 06-36 IGBT Temperature at Malfunction

Default: Read only

Settings -3276.7–3276.7 ºC

When a malfunction occurs, check the current IGBT temperature. If it happens again, it overwrites the previous record.

### 06-37 Capacitance Temperature at Malfunction

Default: Read only

Settings -3276.7–3276.7 ºC

When a malfunction occurs, check the current capacitance temperature. If it happens again, it overwrites the previous record.

### 06-38 Motor Speed in rpm at Malfunction

Default: Read only

Settings -3276.7–3276.7 rpm

When a malfunction occurs, check the current motor speed in rpm. If it happens again, it overwrites the previous record.

### 06-40 Status of the Multi-function Input Terminal at Malfunction

Default: Read only

Settings 0000h–FFFFh

### 06-41 Status of the Multi-function Output Terminal at Malfunction

Default: Read only

Settings 0000h–FFFFh

When a malfunction occurs, check the current status of the multi-function input/output terminals. If it happens again, it overwrites the previous record.

### 06-42 Drive Status at Malfunction

Default: Read only

Settings 0000h–FFFFh

When a malfunction occurs, check the current drive status (communication address 2101H). If it happens again, it overwrites the previous record.

### 06-44 STO Latch Selection

Default: 0

Settings 0: STO Latch
1: STO no Latch

Pr.06-44 = 0: STO Alarm Latch. After you clear the cause of the STO Alarm, use a Reset command to clear the STO Alarm.

Pr.06-44 = 1: STO Alarm no Latch. After you clear the cause of the STO Alarm, the STO Alarm clears automatically.

All of the STL1–STL3 errors are “Alarm Latch” mode (in STL1–STL3 mode, the Pr.06-44 function is not effective).

### 06-45 Output Phase Loss Detection Action (OPHL)

Default: 3

Settings 0: Warn and continue operation
1: Warn and ramp to stop
2: Warn and coast to stop
3: No warning

The OPHL protect function is active when the setting is not 3.

### 06-46 Detection Time for Output Phase Loss

Default: 0.500

Settings 0.000–65.535 sec.

### 06-47 Current Detection Level for Output Phase Loss

Default: 1.00

Settings 0.00–100.00 %

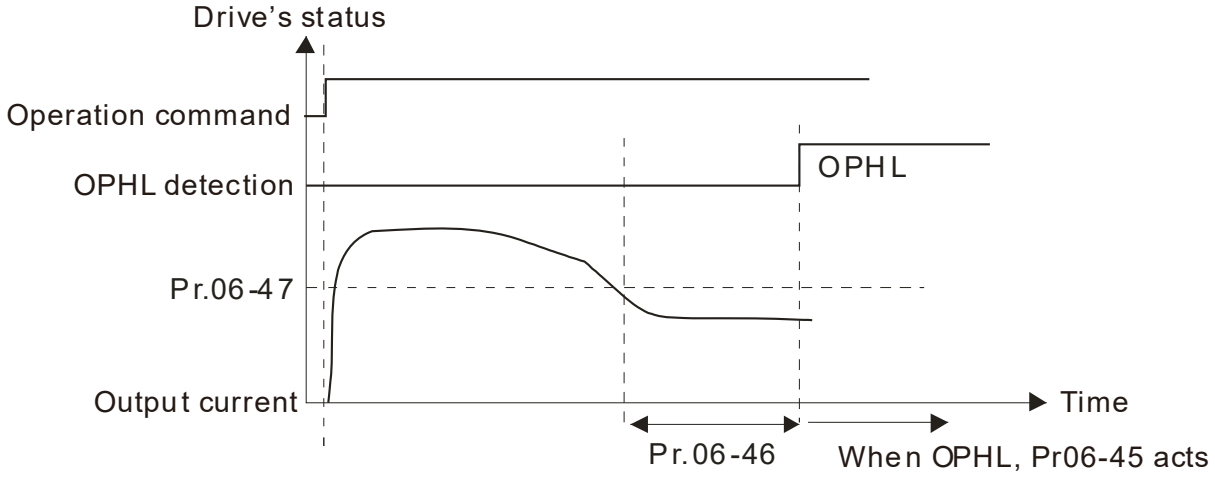
### 06-48 DC Brake Time for Output Phase Loss

Default: 0.000

Settings 0.000–65.535 sec.

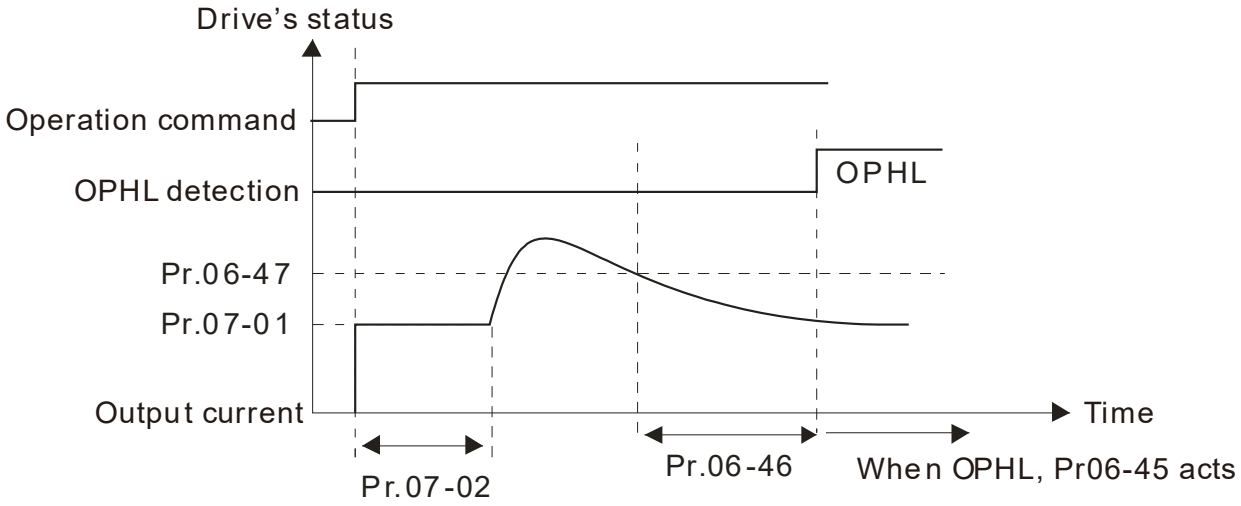
Setting Pr.06-48 to 0 disables the OPHL detection function.

Status 1: The drive is in operation
When any phase is less than the Pr.06-47 setting, and exceeds the Pr.06-46 setting time, the drive executes according to the Pr.06-45 setting.




Status 2: The drive is in STOP; Pr.06-48 = 0; Pr.07-02 ≠ 0

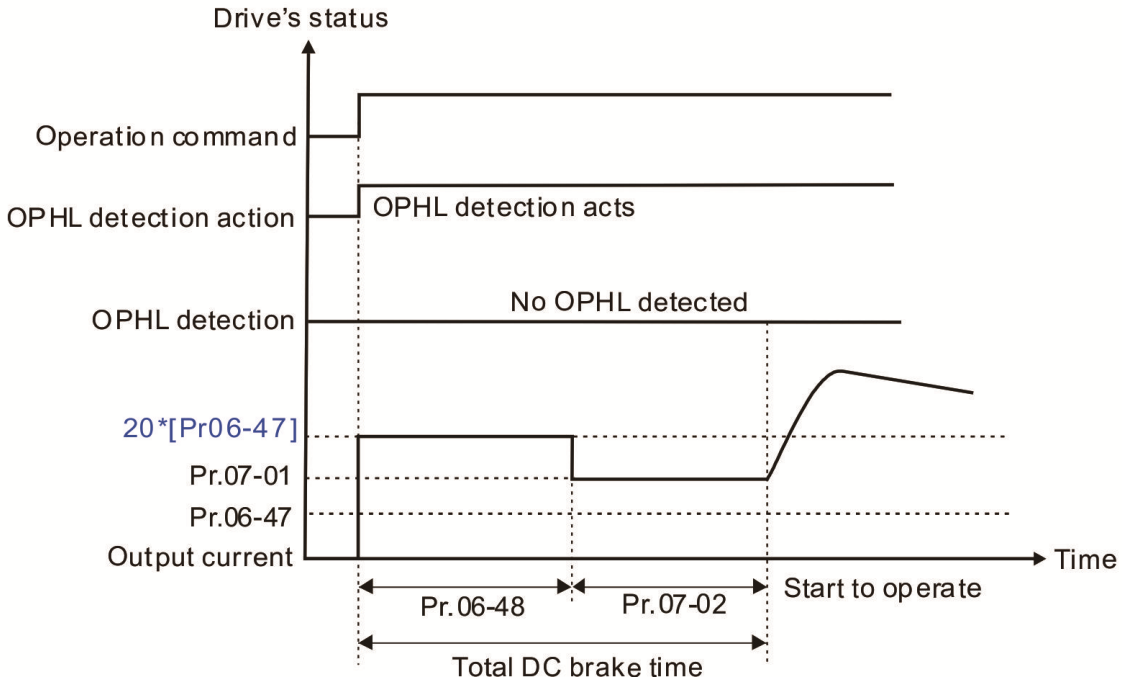
After the drive starts, the DC brake operates according to Pr.07-01 and Pr.07-02. During this period, OPHL detection is not active. After the DC brake action is completed, the drive starts to run, and enables the OPHL protection as mentioned above for status 1.



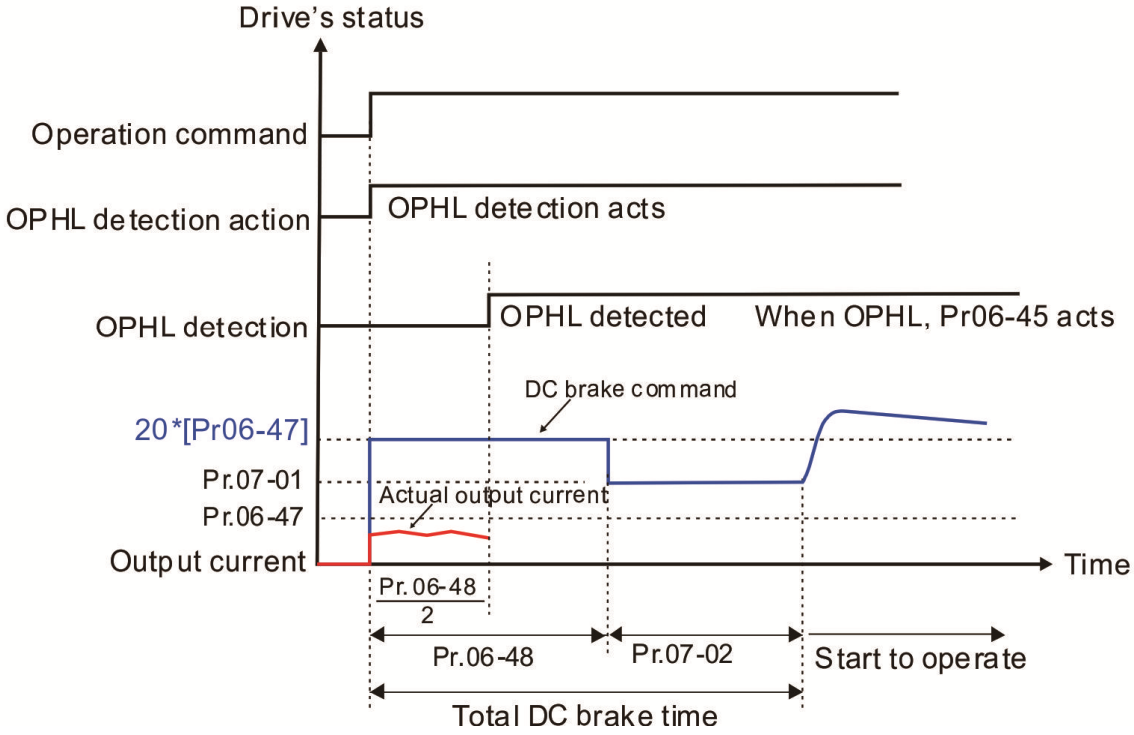

Status 3: The drive is in STOP; Pr.06-48 ≠ 0; Pr.07-02 ≠ 0

When the drive starts, it executes Pr.06-48 first, and then executes Pr.07-02 (DC brake). The DC brake current level in this state includes two parts: one is 20 times the Pr.06-47 setting value in Pr.06-48 setting time; the other is the Pr.07-01 setting value in Pr.07-02 setting time. In this period, if an OPHL happens within the time for Pr.06-48, the drive executes the Pr.06-45 setting after the drive starts counting for half the time of Pr.06-48.

Status 3-1: Pr.06-48 ≠0, Pr.07-02 ≠ 0 (No OPHL detected before operation)



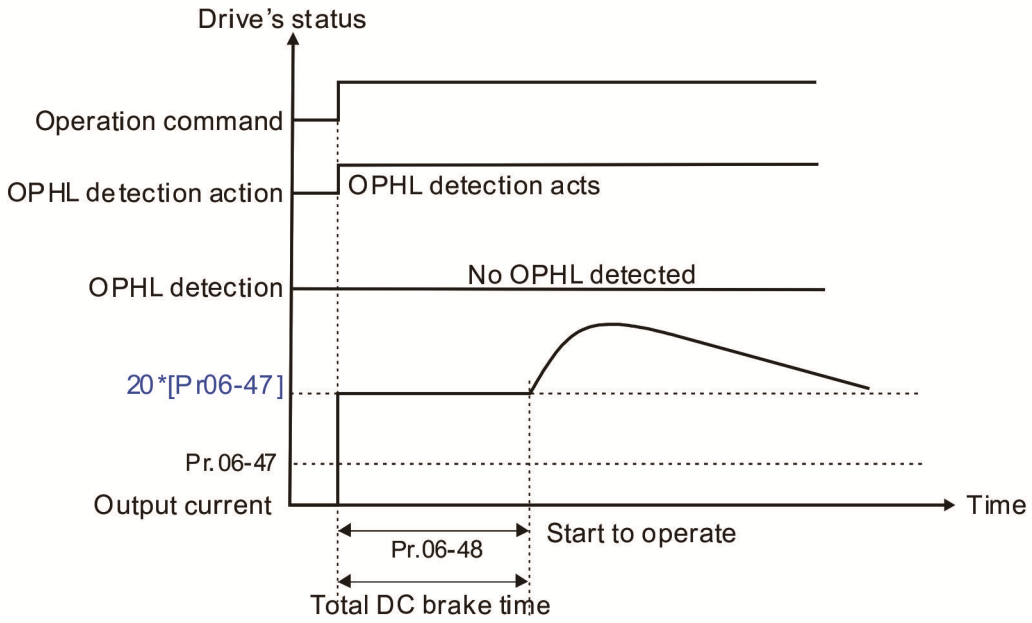

Status 3-2: Pr.06-48 ≠0, Pr.07-02 ≠ 0 (OPHL detected before operation)



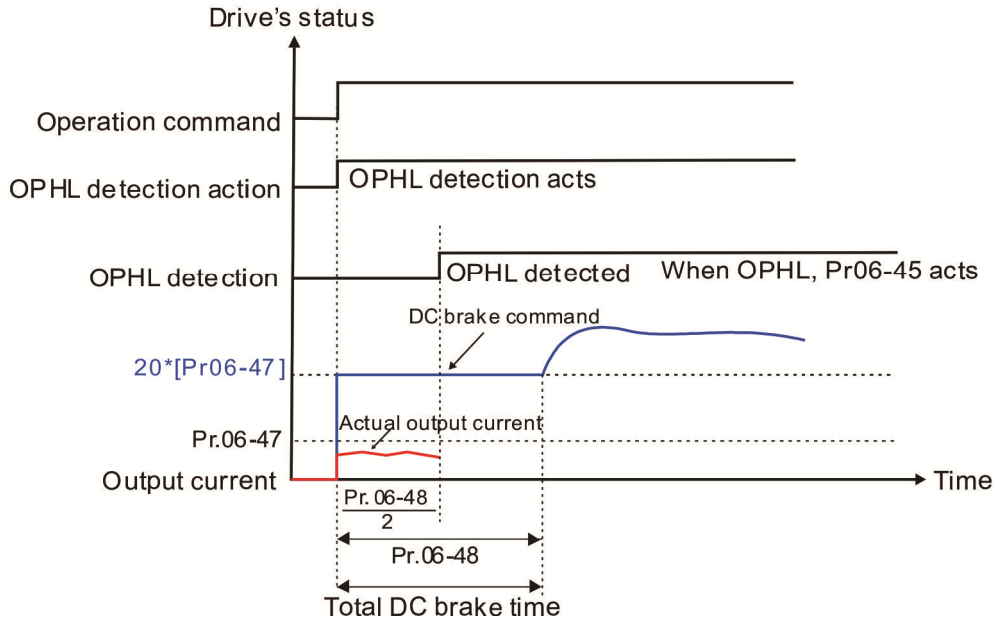

Status 4: The drive is in STOP; Pr.06-48 ≠ 0; Pr.07-02 = 0

When the drive starts, it executes Pr.06-48 as the DC brake. The DC brake current level is 20 times the Pr.06-47 setting value. In this period, if an OPHL happens within the time for Pr.06-48, the drive executes the Pr.06-45 setting after the drive starts counting for half the time of Pr.06-48.

Status 4-1: Pr.06-48 ≠0, Pr.07-02 = 0 (No OPHL detected before operation)




Status 4-2: Pr.06-48 ≠0, Pr.07-02 = 0 (OPHL detected before operation)




## 06-49 LvX Auto-reset

Default: 0

Settings 0: Disable
1: Enable

## 06-53 Detected Input Phase Loss Action (OrP)

Default: 0

Settings 0: Warn and ramp to stop
1: Warn and coast to stop

The drive executes the input phase loss protection according to Pr.06-53.

## 06-55 Derating Protection

Default: 0

Settings 0: Constant rated current and limit carrier wave by load current and temperature
1: Constant carrier frequency and limit load current by setting carrier wave
2: Constant rated current (same as setting 0), but close current limit

Allowable maximum output frequency and the minimum carrier wave limit in control mode:
For VF and SVC modes:
When the maximum output frequency is 599 Hz, the minimum carrier wave is 6 k.

Setting 0:
When the operating point is greater than the derating curve (when the operating carrier wave is greater than the rated carrier wave), the rated current is constant, and carrier frequency (Fc) output by the drive decreases automatically according to the ambient temperature, overload output current and overload time. If overloads are not frequent, and the concern is only about the carrier frequency operating with the rated current for a long time, and changes to the carrier wave due to short overload are acceptable, set to 0. Refer to the following diagram for the level of carrier frequency.

Setting 1:
When the operating point exceeds derating curve 1, the carrier frequency is fixed to the set value. Select this mode if the change of carrier wave and motor noise caused by ambient temperature and frequent overload are not acceptable. Refer to Pr.00-17.

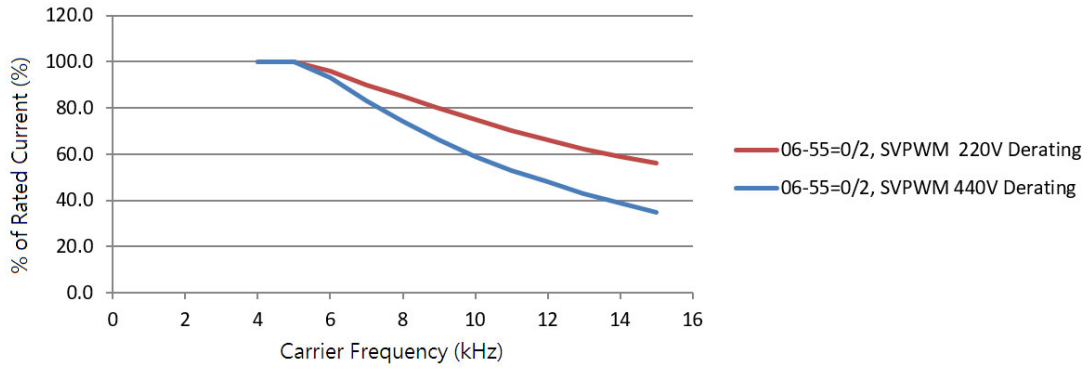
Setting 2:
The protection method and action are the same as setting it to 0, but this disables the current limit when output current is the derating ratio ×180 % (default value).
The advantage is that this can provide a higher starting output current when the carrier frequency setting is higher than the default. The disadvantage is that the carrier wave derates easily when it overloads.

Example: when Pr.06-55 = 0 or 1, over-current stall prevention level = ratio*Pr.06-03. When Pr.06-55 = 2, over-current stall prevention level = Pr.06-03. Use with the setting for Pr.00-17.

The derating is also affected by the ambient temperature. Refer to the ambient temperature derating curve.

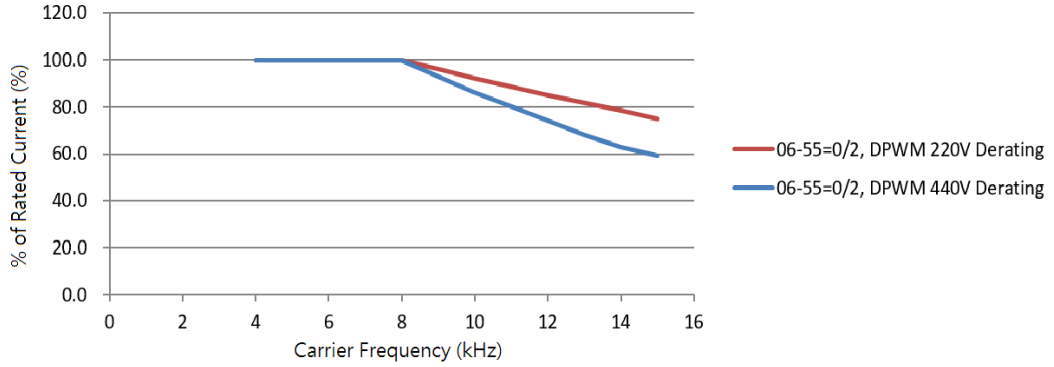
Ambient temperature derating curve for general control

Pr.06-55=0/2



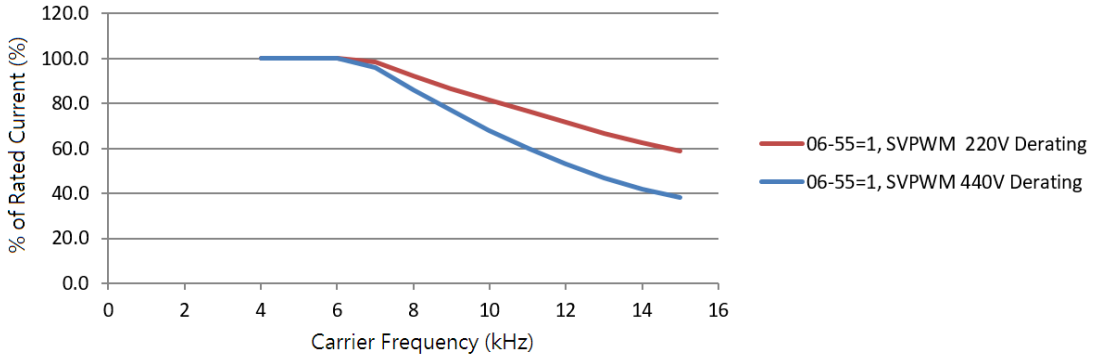

space vector modulation mode

Pr.06-55=0/2



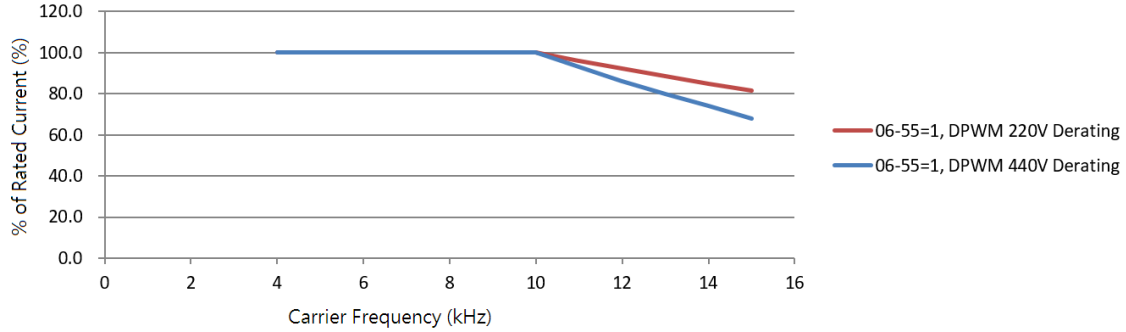

two-phase modulation mode

Pr.06-55=1




space vector modulation mode

Pr.06-55=1




two-phase modulation mode

### 06-60 Software Detection GFF Current Level

Default: 60.0

Settings 0.0–6553.5 %

### 06-61 Software Detection GFF Filter Time

Default: 0.10

Settings 0.00–655.35 sec.

When the drive detects the unbalanced three-phase output current is higher than the setting for Pr.06-60, GFF protection activates. The drive then stops output.

### 06-63 Operation Time of Fault Record 1 (Day)
### 06-65 Operation Time of Fault Record 2 (Day)
### 06-67 Operation Time of Fault Record 3 (Day)
### 06-69 Operation Time of Fault Record 4 (Day)
### 06-90 Operation Time of Fault Record 5 (Day)
### 06-92 Operation Time of Fault Record 6 (Day)

Default: Read only

Settings 0–65535 days

### 06-64 Operation Time of Fault Record 1 (Min.)
### 06-66 Operation Time of Fault Record 2 (Min.)
### 06-68 Operation Time of Fault Record 3 (Min.)
### 06-70 Operation Time of Fault Record 4 (Min.)
### 06-91 Operation Time of Fault Record 5 (Min.)
### 06-93 Operation Time of Fault Record 6 (Min.)

Default: Read only

Settings 0–65535 min.

If there is any malfunction when the drive operates, Pr.06-17–06-22 records the malfunctions, and Pr.06-63–06-70 records the operation time for four sequential malfunctions. Check if there is any problem with the drive according to the interval of the recorded fault.

Example:

The first error: ocA occurs after motor drive operates for 1000 minutes.
The second error: ocd occurs after another 1000 minutes.
The third error: ocn occurs after another 1000 minutes.
The fourth error: ocA occurs after another 1000 minutes.
The fifth error: ocd occurs after another 1000 minutes.
The sixth error: ocn occurs after another 1000 minutes.
Then Pr.06-17–06-22 and Pr.06-63–06-70 are recorded as follows:

| | 1st fault | 2nd fault | 3rd fault | 4th fault | 5th fault | 6th fault |
|---|---|---|---|---|---|---|
| Pr.06-17 | ocA | ocd | ocn | ocA | ocd | ocn |
| Pr.06-18 | 0 | ocA | ocd | ocn | ocA | ocd |
| Pr.06-19 | 0 | 0 | ocA | ocd | ocn | ocA |

| | 1st fault | 2nd fault | 3rd fault | 4th fault | 5th fault | 6th fault |
|---|---|---|---|---|---|---|
| Pr.06-20 | 0 | 0 | 0 | ocA | ocd | ocn |
| Pr.06-21 | 0 | 0 | 0 | 0 | ocA | ocd |
| Pr.06-22 | 0 | 0 | 0 | 0 | 0 | ocA |
| Pr.06-63 | 1000 | 560 | 120 | 1120 | 680 | 240 |
| Pr.06-64 | 0 | 1 | 2 | 2 | 3 | 4 |
| Pr.06-65 | 0 | 1000 | 560 | 120 | 1120 | 680 |
| Pr.06-66 | 0 | 0 | 1 | 2 | 2 | 3 |
| Pr.06-67 | 0 | 0 | 1000 | 560 | 120 | 1120 |
| Pr.06-68 | 0 | 0 | 0 | 1 | 2 | 2 |
| Pr.06-69 | 0 | 0 | 0 | 1000 | 560 | 120 |
| Pr.06-70 | 0 | 0 | 0 | 0 | 1 | 2 |

※ By examining the time record, you can see that that the last fault (Pr.06-17) happened after the drive ran for 4 days and 240 minutes.

### 06-71 Low Current Setting Level

Default: 0.0

Settings 0.0–100.0 %

### 06-72 Low Current Detection Time

Default: 0.00

Settings 0.00–360.00 sec.

### 06-73 Low Current Action

Default: 0

Settings 0 : No function
1 : Warn and coast to stop
2 : Warn and ramp to stop by the second deceleration time
3 : Warn and continue operation

🕮 The drive operates according to the setting for Pr.06-73 when the output current is lower than the setting for Pr.06-71 and when the time of the low current exceeds the detection time for Pr.06-72. Use this parameter with the external multi-function output terminal 44 (for low current output).

🕮 The low current detection function does not execute when drive is in sleep or standby status.

### 06-80 Emergency Power Voltage in Operation

Default: 300.0

Settings 280.0–537.0 $V_{DC}$

🕮 The output voltage for the external emergency power.

### 06-81 Emergency Power Speed in Operation

Default: Read only

Settings 0.00–599.00 Hz

🕮 Sets the elevator's maximum running speed when using Emergency Power Supply (EPS).

🕮 You can set the elevator's running speed during EPS by using Pr.02-83, but the running speed should not be larger than Pr.06-81 setting value.

## 06-82 Emergency Power Capacity in Operation

Default: 0.0

Settings 0.0–100.0 kVA

🕮 The power capacity for the external emergency power.

🕮 When using EPS as an emergency power system, you must enter the power capacity of emergency power. When using emergency power, the drive calculates elevators' running speed according to the calculation formula below.

$$V_{eps_\max} = \frac{06-82 \times 0.5}{\sqrt{3} \times I_{motor_rated}}$$

$$f_{eps_limit} = \frac{V_{eps_\max}}{01-02} \times 01-01 \times 0.5$$

$$I_{motor_rated} = 05-01 \text{ (Induction Motor)}$$

When Frequency command > fEPS, the running speed of EPS emergency power: fEPS.

When Frequency command ≤ fEPS, the running speed of EPS emergency power: runs according to the current Frequency command.

## 06-83 EPS Mode Selection

Default: 0

Settings 0: Operate by current command direction.

1: Run in the running direction of power generation mode. Execute the power generation direction detection when running in power generation mode.

2: After determining the power generation direction, the host controller sends a running direction command. (When at STOP, the direction of power generation mode (MO = 57) confirmation and the direction of power generation does not maintain.) Execute the power generation direction detection each time whenever running.

3: After determining the power generation direction, the host controller sends a running direction command. (When at STOP, the direction of power generation mode (MO = 57) confirmation and the direction of the power generation maintain.) Execute the power generation direction detection only one time when running.

4: Run by the direction of power generation mode. Execute the power generation direction detection when running in normal mode.

🕮 This parameter is enabled when the EPS function at the external terminal is activated.

🕮 4: (the motor has a gear box.)

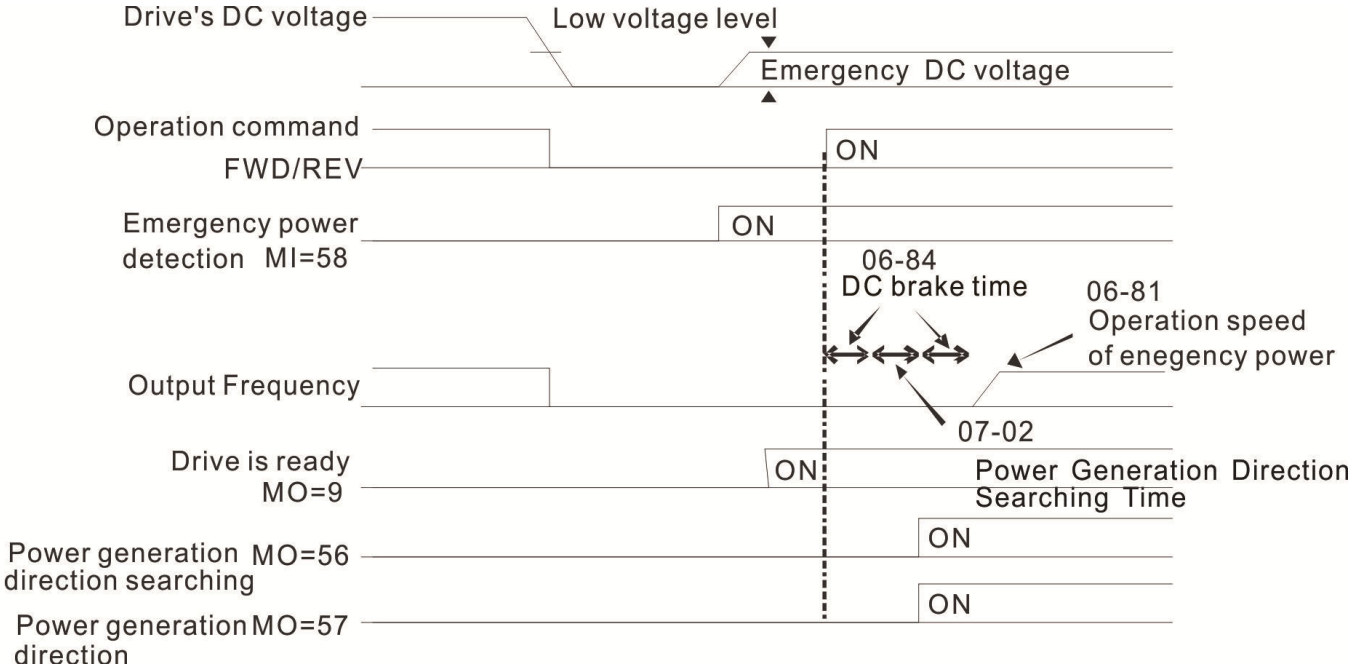
1. Run in normal mode and when reaching the largest power factor, the value of this power factor is recorded in Pr.06-87.

2. The value of the power factor detected at the direction of the power generation is compared to the setting value at Pr.06-86. If the detected power factor is larger than Pr.06-86, the current moving direction (upward or downward) is recorded in Pr.06-88
3. Therefore, when in EPS mode, the elevator moves in the direction stored in Pr.06-88.

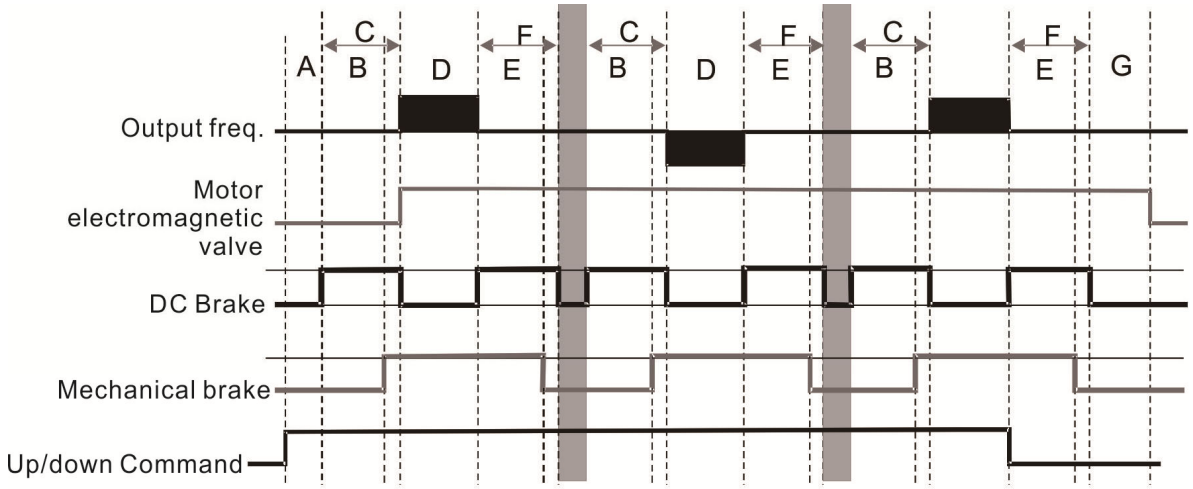
Related parameters: Pr.02-01–Pr.02-07 multi-function input terminal (58: Emergency power mode detection), Pr.02-16–Pr.02-17 multi-function output terminals (56: Power generation direction and status verification, 57: Power generation direction), Pr.02-30 Turn On Delay of Magnetic Contactor between Drive and Motor, Pr.02-31 Turn Off Delay of Magnetic Contactor between Drive and Motor, Pr.02-39 Brake Release Delay Time When Elevator Starts, Pr.02-40 Brake Contracting Delay Time When Elevator Stops, Pr.07-01 DC Brake Current Level, Pr.07-02 DC Brake Time at Start-up and Pr.07-03 DC Brake Time at Stop.

🕮 If parameter = 1, when you enter FWD or REV running signal, the drive automatically detects the elevator's load status to make the elevator run in power re-generation direction (motor is the electricity generator) according to the running direction after detection rather than the user's current command direction in order to avoid voltage decrease in EPS emergency power.

V/F and SVC control mode: within the time limit for Pr.06-84, the drive uses FWD and REV to determine the elevator's load status to make the elevator run in power re-generation direction (motor is the electricity generator). (Refer to the auto-detection time sequence diagram below)




Time Sequence Diagram for Elevators' Emergency Power Supply and Power Generation




A 02-30: Magnetic Contactor (MC) ON Delay Time Between Drive and Motor;
B 02-39: Mechanical Brake Release Delay Time When Elevator Starts;
C 07-02: DC Brake Time at RUN;
D 06-84: Electricity Generation Direction Search Time;
E 02-40: Mechanical Brake Contracting Delay Time When Elevator Stops;
F 07-03: DC Brake Time at Stop;
G 02-31: Magnetic Contactor (MC) OFF Delay Time Between Drive and Motor

Auto-detection Time Sequence Diagram

### 06-84 Power Generation Direction Search Time

Default: 1.0

Settings 0.0–5.0 sec.

🕮 Time for detecting power generation direction.

### 06-85 UPS Output Delay Time

Default: 1.0

Settings 0.0–10.0 sec.

### 06-89 Delay Time on Stopping UPS Output

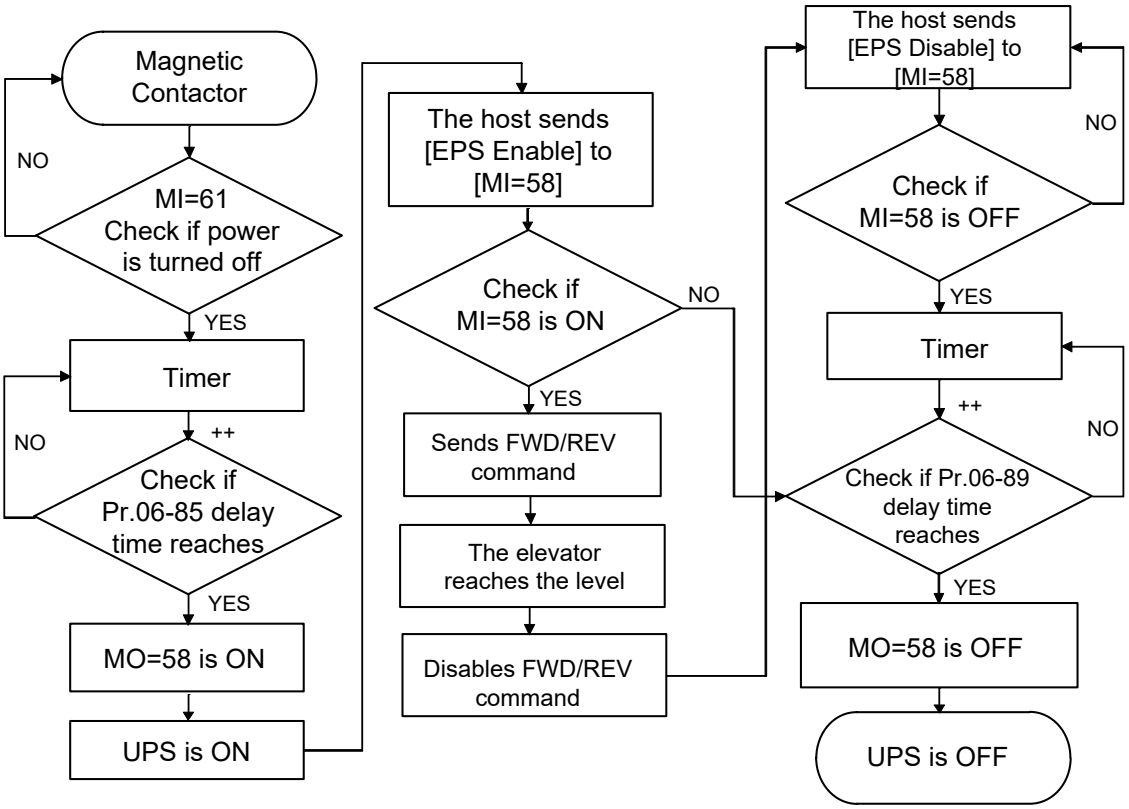
Default: 3.0

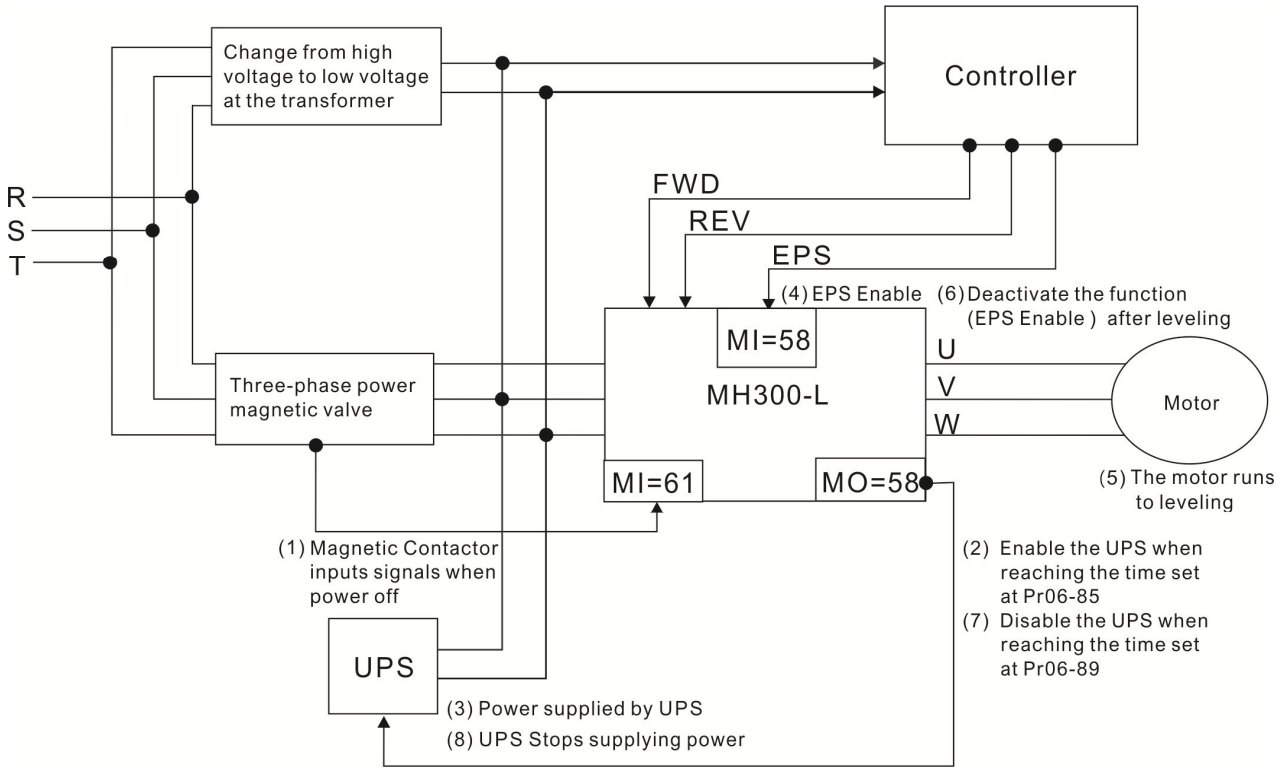
Settings 0.0–60.0 sec.

🕮 Pr.06-85: When the power loses, the magnetic contactor outputs a MI signal to notify the motor drive to enable UPS function. After Pr.06-85 delay time, a MO signal activates the UPS magnetic contactor.

🕮 Pr.06-89: When the controller disables the emergency power mode, the MO signal stops outputting after Pr.06-89 delay time to deactivate the UPS function.

🕮 Related parameters: Pr.02-01–Pr.02-07 multi-function input terminal (61: Power loss signal), Pr.02-16–Pr.02-17 multi-function output terminal (58: EPS mode).




## 06-86 Power Factor Level for Determining the Power Generation Direction

Default: 70.0

Settings 0.0–150.0°

🕮 If power factor is larger than the setting value in this parameter when running, the power generation direction is the running direction.

## 06-87 Reference Level of the Power Factor when Running

Default: Read only

Settings 0.0–200.0 °

🕮 The largest power factor when running.

## 06-88 Power Generation Direction

Default: Read only

Settings 0: Forward running
1: Reverse running

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## 07 Special Parameters

✍ You can set this parameter during operation.

### ✍ 07-00 Software Brake Level

| | | Default: |
|---|---|---|
| Settings | 230 V: 350.0–450.0 $V_{DC}$ | 370.0 |
| | 460 V: 700.0–900.0 $V_{DC}$ | 740.0 |

🕮 Sets the brake transistor level for the DC BUS voltage. Choose a suitable brake resistor to achieve the best deceleration. Refer to Chapter 7 Optional Accessories for information about brake resistors.

### ✍ 07-01 DC Brake Current Level

Default: 30

Settings 0–100 %

🕮 Sets the level of the DC brake current output to the motor during start-up and stop. When you set the DC brake current percentage, the rated current is regarded as 100%. Start with a low DC brake current level, and increase it slowly until the proper brake torque is reached. However, to avoid burning the motor, the DC brake current can NOT exceed the rated current. Therefore, DO NOT use the DC brake for mechanical retention, otherwise injury or accident may occur.

### ✍ 07-02 DC Brake Time at Start-up

Default: 0.7

Settings 0.0–60.0 sec.

🕮 The motor may continue rotating after the drive stops output due to external forces or the inertia of the motor itself. If you use the drive with the motor rotating, it may cause motor damage or trigger drive protection due to over-current. This parameter outputs DC current, generating torque to force the motor stop to get a stable start before motor operation. This parameter determines the duration of the DC brake current output to the motor when the drive starts up. Setting this parameter to 0.0 disables the DC brake at start-up.

### ✍ 07-03 DC Brake Time at Stop

Default: 0.7

Settings 0.0–60.0 sec.

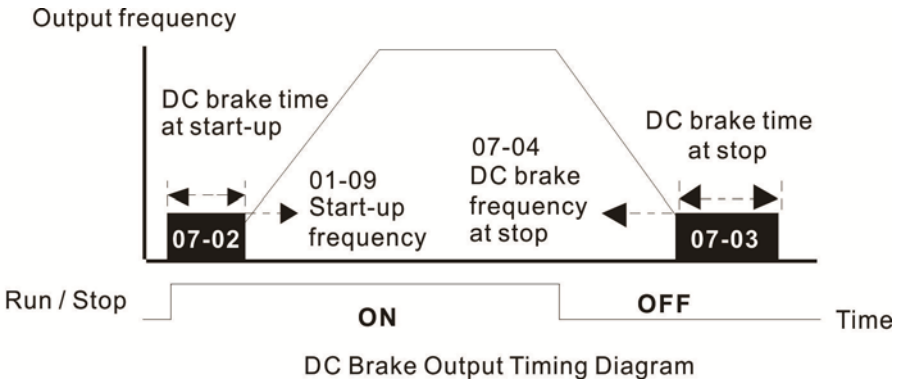
🕮 The motor may continue rotating after the drive stops output due to external forces or the inertia of the motor itself. This parameter outputs DC current, generating torque to force the drive stop after the drive stops output to make sure that the motor stops.

### ✍ 07-04 DC Brake Frequency at STOP

Default: 0.00

Settings 0.00–599.00 Hz

🕮 This parameter determines the start frequency of the DC brake before the drive ramps to stop. When this setting is less than Pr.01-09 (Start-up Frequency), the start frequency of the DC brake starts from the minimum frequency.




DC Brake Output Timing Diagram

- Use the DC brake before running the motor when the load is movable at stop, such as with fans and pumps. The motor is in free operating status and in unknown rotation direction before the drive starts up. Execute the DC brake before you start the motor.
- Use DC Brake at STOP when you need to brake the motor quickly or to control the positioning, such as with cranes or cutting machines.

## 07-05 Voltage Increasing Gain

Default: 100

Settings 1–200 %

- When using speed tracking, adjust Pr.07-05 to slow down the increasing voltage gain if there are errors such as oL or oc; however, the speed tracking time will be longer.

## 07-06 Restart after Momentary Power Loss

Default: 0

Settings 0: Stop operation
1: Speed tracking by the speed before the power loss
2: Speed tracking by the minimum output frequency

- Determines the operation mode when the drive restarts from a momentary power loss.
- The power system connected to the drive may power off momentarily for many reasons. This function allows the drive to keep outputting after the drive is repowered and does not cause the drive to stop.
- 1: Frequency tracking begins before momentary power loss and accelerates to the master Frequency command after the drive output frequency and motor rotator speed are synchronous.
- Use this setting when there is a lot of inertia with little resistance on the motor load. For example, in equipment with a large inertia flywheel, there is NO need to wait until the flywheel stops completely after a restart to execute the operation command; therefore, it saves time.
- 2: Frequency tracking starts from the minimum output frequency and accelerates to the master Frequency command after the drive output frequency and motor rotator speed are synchronous. Use this setting when there is little inertia and large resistance.

## 07-07 Allowed Power Loss Duration

Default: 2.0

Settings 0.0–20.0 sec.

- Determines the maximum time of allowable power loss. If the duration of a power loss exceeds this parameter setting, the AC motor drive stops output.
- Pr.07-06 is valid when the maximum allowable power loss time is ≤ 20 seconds and the AC motor drive

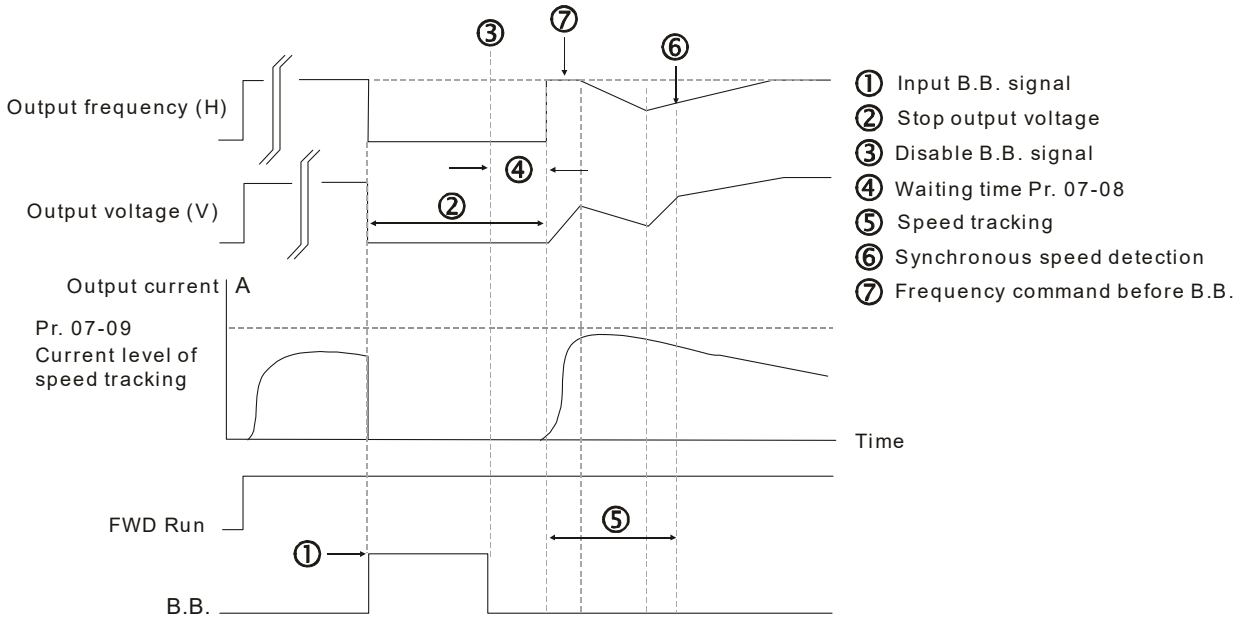
displays “LU”. If the AC motor drive is powered off due to overload, even if the maximum allowable power loss time is ≤ 20 seconds, the operation mode set in Pr.07-06 does not execute.

## 07-08 Base Block Time

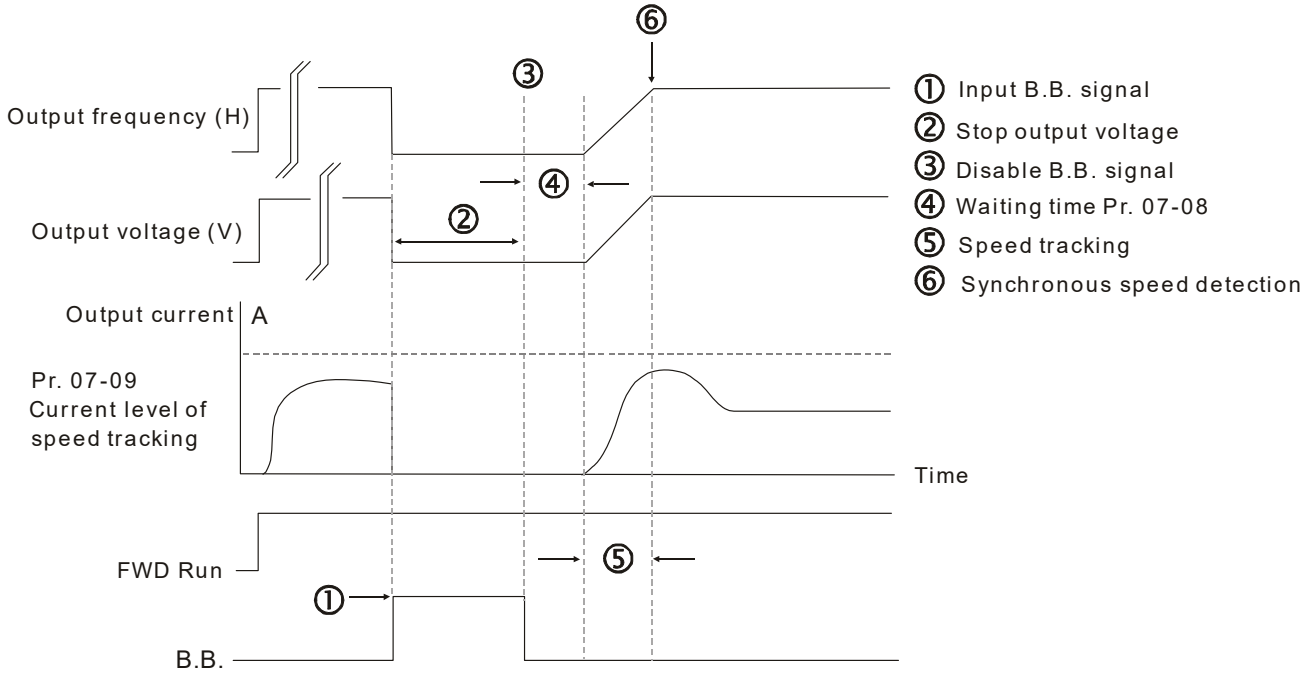
Default: 0.5

Settings 0.1–5.0 sec.

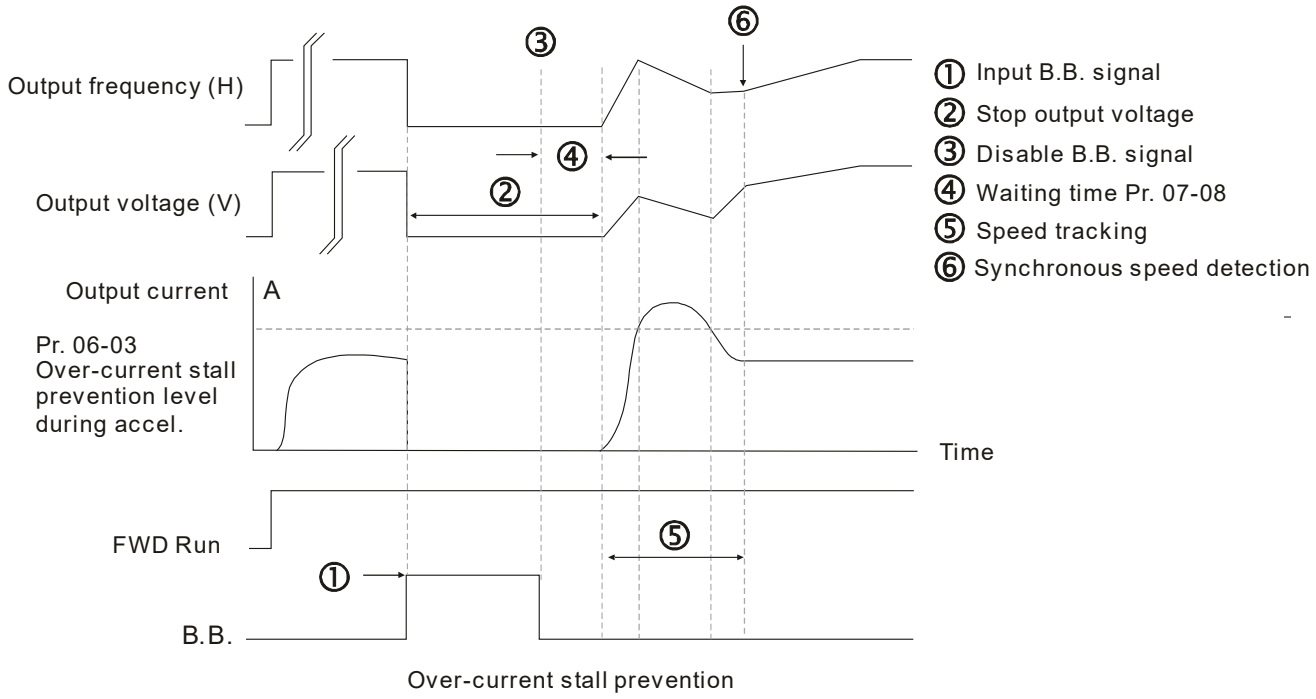
When momentary power loss is detected, the AC motor drive blocks its output and then waits for a specified period of time (determined by Pr.07-08, called Base Block Time) before resuming operation. Set this parameter to the time that allows the residual voltage at the output side to decrease to 0 V before activating the drive again.




B.B. Speed tracking: from last output frequency




B.B. Speed tracking: from minimum output frequency




Over-current stall prevention

## 07-09 Current Limit of Speed Tracking

Default: 100

Settings 20–200 %

- The AC motor drive executes speed tracking only if the output current is greater than the value set in Pr.07-09.
- The maximum current for speed tracking affects the synchronous time. The larger the parameter setting is, the faster the synchronization occurs. However, if the parameter setting is too large, the overload protection function may be activated.

## 07-10 Restart after Fault Action

Default: 0

Settings 0: Stop operation
1: Speed tracking by current speed
2: Speed tracking by minimum output frequency

- Faults include bb, oc, ov, occ. To restart after oc, ov, occ, you can NOT set Pr.07-11 to 0.

## 07-11 Number of Times of Auto-restart after Fault

Default: 0

Settings 0–10

- After fault (allowed fault: oc, ov, occ) occurs, the AC motor drive can be reset / restarted automatically up to 10 times.
- If the number of faults exceeds the Pr.07-11 setting, the drive does not reset and restart until you press “RESET” manually and execute the operation command again.

## 07-12 Speed Tracking during Start-up

Default: 0

Settings 0: Disable
1: Speed tracking by maximum output frequency
2: Speed tracking by motor frequency at start
3: Speed tracking by minimum output frequency

- Speed tracking is suitable for punch, fans and other large inertia loads. For example, a mechanical punch usually has a large inertia flywheel, and the general stop method is coast to stop. If it needs to be restarted again, the flywheel may take 2–5 minutes or longer to stop. This parameter setting allows you to start the flywheel operating again without waiting until the flywheel stops completely.

## 07-13 dEb Function Selection

Default: 0

Settings 0: Disable
1: dEb with auto-acceleration/auto-deceleration, the drive does not output the frequency after the power is restored.
2: dEb with auto-acceleration/ auto-deceleration, the drive outputs the frequency after the power is restored.

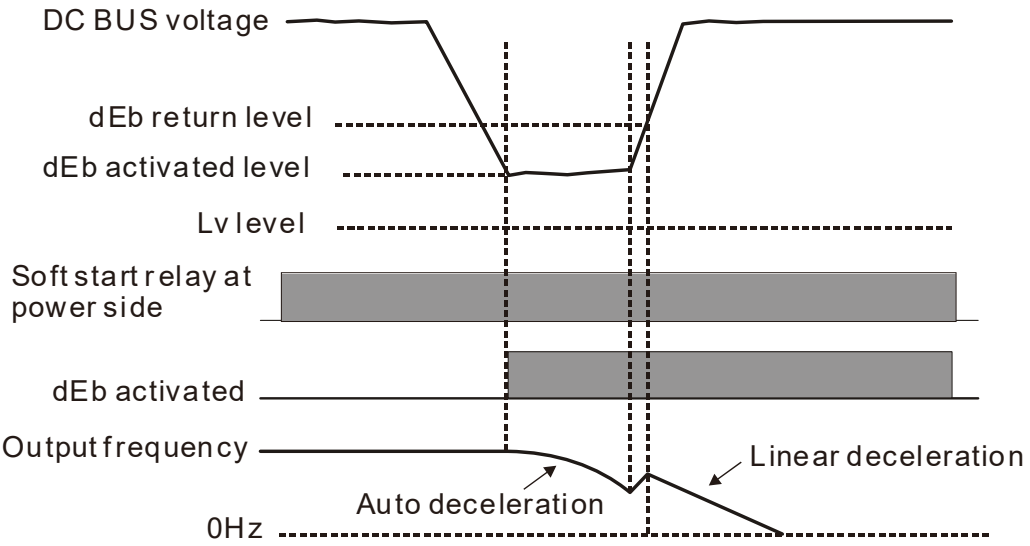
- dEb (Deceleration Energy Backup) lets the motor decelerate to stop when momentary power loss occurs. When the power loss is instantaneous, use this function to let the motor decelerate to zero speed. If the power recovers at this time, the drive restarts the motor after the dEb return time.
- Lv return level: Default value depends on the drive power model.
  Frame C, D = Pr.06-00 + 60 V / 30 V (220V series)
  Frame E and above = Pr.06-00 + 80 V / 40 V (220V series)
- Lv level: Default is Pr.06-00.
- During dEb operation, other protection, such as ryF, ov, oc, occ, and EF may interrupt it, and these error codes are recorded.
- The STOP (RESET) command does not work during the dEb auto-deceleration, and the drive continues decelerating to stop. To make the drive coast to stop immediately, use another function (EF) instead.
- The B.B. function does not work when executing dEb. The B.B. function is enabled after the dEb function finishes.
- Even though the Lv warning does not display during the dEb operation, if the DC BUS voltage is lower than the Lv level, MO = 10 (Low voltage warning) still operates.
- The following explains the dEb action:
  When the DC voltage drops below dEb setting level, the dEb function starts to work (soft start relay remains closed), and the drive executes auto-deceleration.

- **Situation 1:**

  Momentary power loss, or power current too low and unstable, or power supply sliding down because of sudden heavy load.

  Pr.07-13 = 1 and power recovers.

  When the power recovers and DC BUS voltage exceeds the dEb return level, the drive linearly decelerates to 0 Hz and stops. The keypad displays the ”dEb” warning until you manually reset it, so that you can see the reason for the stop.

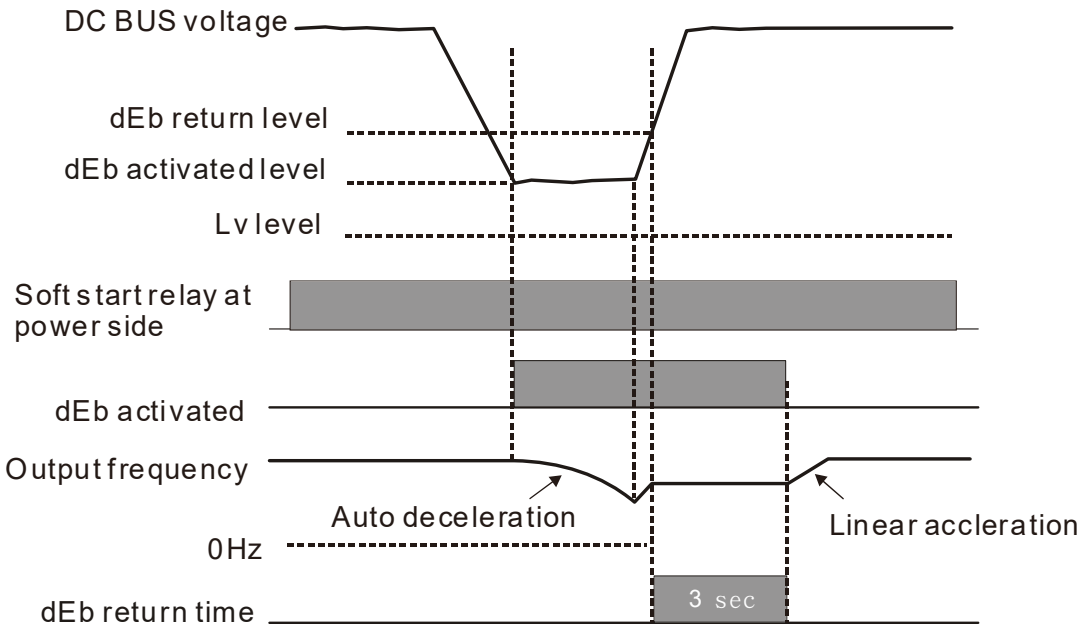



- **Situation 2:**

  Momentary power loss, or power current too low and unstable, or power supply sliding down because of sudden heavy load.

  Pr.07-13 = 2 and power recovers.

  During the dEb deceleration (includes 0 Hz run), if the power recovers higher than dEb return level, the drive maintains the frequency for three seconds and then accelerates again. The dEb warning on the keypad clears automatically.

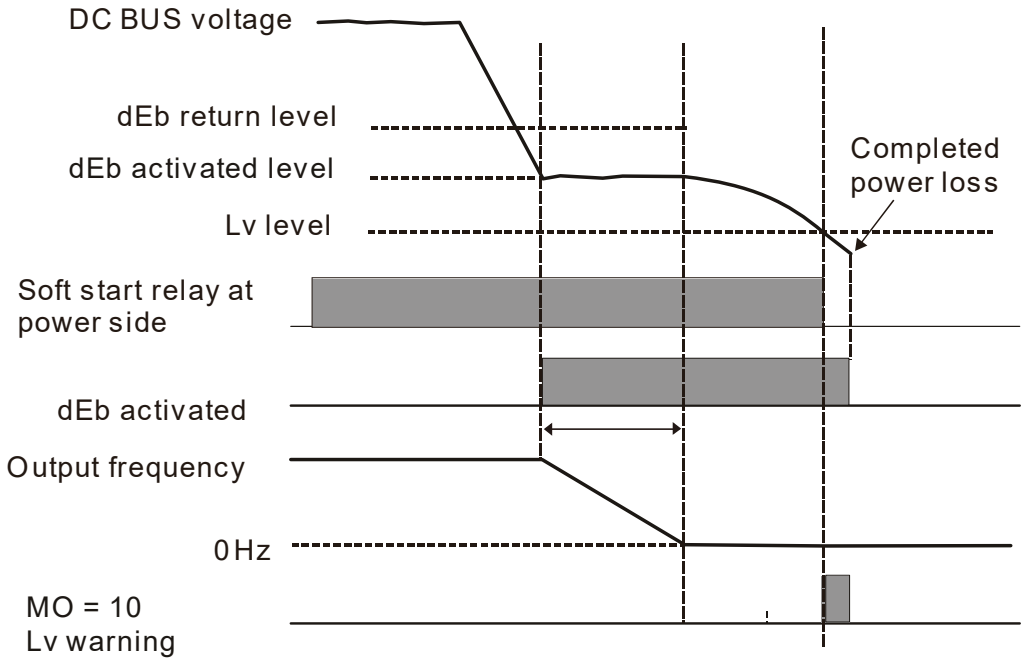


- **Situation 3:**

  Power supply unexpected shut down / power loss.

  Pr.07-13 = 1 and power does not recover.

  The keypad displays the “dEb” warning and stops after decelerating to the lowest running frequency. When the DC BUS voltage is lower than the Lv level, the drive disconnects the soft start relay until the power completely runs out.




- **Situation 4:**

  Power supply unexpected shut down / power loss.

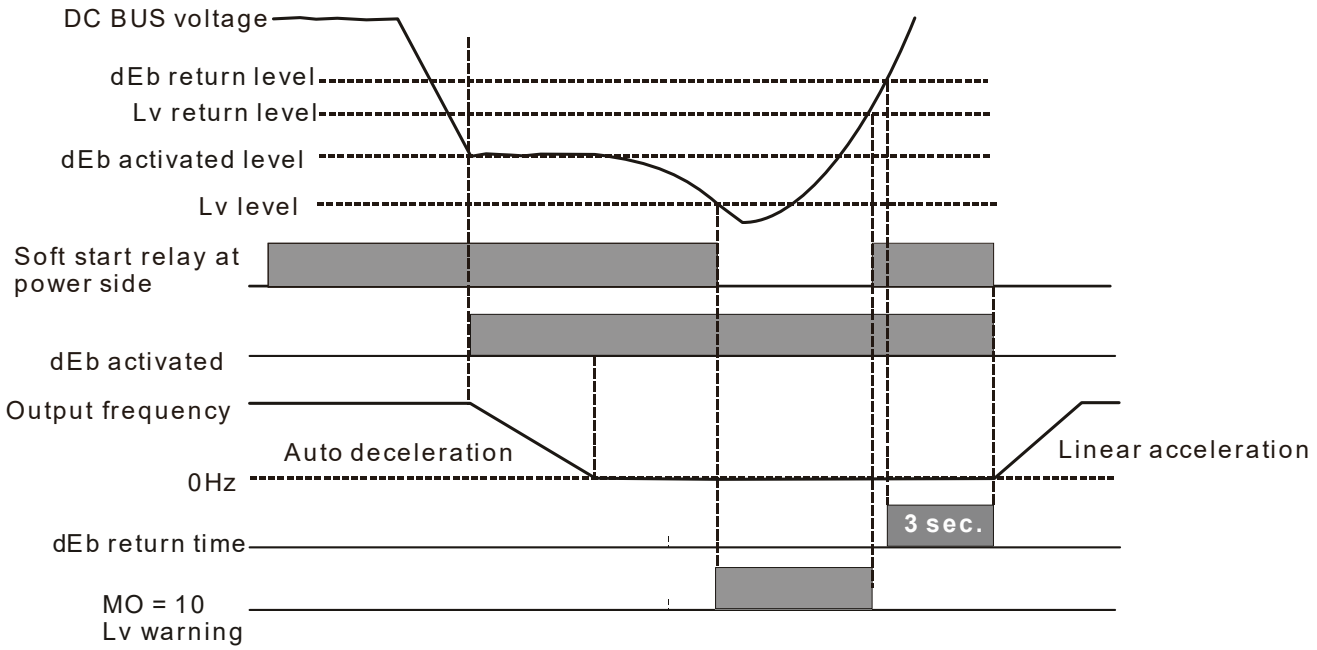
  Pr.07-13 = 2 and power does not recover.

  The drive decelerates to 0 Hz. The DC BUS voltage continues to decrease until the voltage is lower than the Lv level, and then the drive disconnects the soft start relay. The keypad displays “dEb” warning until the drive completely runs out of power.

- **Situation 5:**

  Pr.07-13 = 2 and power recovers after the DC BUS voltage is lower than the Lv level.

  The drive decelerates to 0 Hz. The DC BUS voltage continues to decrease until the voltage is lower than the Lv level, and then the drive disconnects the soft start relay. The soft start relay closes again after the power recovers and the DC BUS voltage is higher than the Lv return level. When the DC BUS voltage is higher than the dEb return level, the drive maintains the frequency for three seconds and starts to accelerate linearly, and the dEb warning on the keypad clears automatically.




## 07-15 Dwell Time at Acceleration

Default: 0.00

Settings 0.00–600.00 sec.

## 07-17 Dwell Time at Deceleration

Default: 0.00

Settings 0.00–600.00 sec.

## 07-16 Dwell Frequency at Acceleration

Default: 0.00

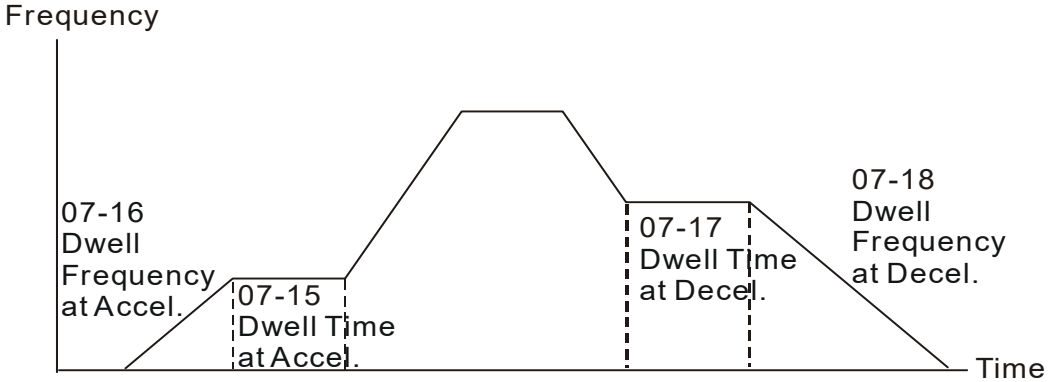
Settings 0.00–599.00 Hz

## 07-18 Dwell Frequency at Deceleration

Default: 0.00

Settings 0.00–599.00 Hz

- The Dwell temporarily maintains stable output frequency. Use this parameter for cranes, elevators, and so on.
- When the load is heavier, use Pr.07-15–Pr.07-18 to avoid OV or OC protection.




Dwell at accel./decel.

## 07-19 Fan Cooling Control

Default: 3

Settings 0: Fan always ON
1: Fan is OFF after the AC motor drive stops for one minute.
2: When the AC motor drive runs, the fan is ON. When the AC motor drive stops, the fan is OFF.
3: Fan turns ON when the temperature reaches around 60°C

- Use this parameter to control the fan.
- 0: Fan runs immediately when the drive power is turned ON.
- 1: Fan runs when AC motor drive runs. One minute after AC motor drive stops, the fan is OFF.
- 2: Fan runs when AC motor drive runs and stops immediately when AC motor drive stops.
- 3: When temperature of the IGBT or capacitance is higher than 60°C, the fan runs.
  When the temperature of the IGBT and capacitance both are lower than 40°C, the fan stops.

## 07-20 Deceleration of Emergency or Forced Stop

Default: 0

Settings 0: Coast to stop
1: Stop by the first deceleration time
2: Stop by the second deceleration time
3: Stop by the third deceleration time
4: Stop by the fourth deceleration time
5: System deceleration
6: Automatic deceleration

- When the multi-function input terminal is set to EF input (setting 10) or forced to stop (setting 18) and the terminal contact is ON, the drive stops according to the setting of this parameter.

## 07-21 Automatic Energy-saving Setting

Default: 0

Settings 0: Disable
1: Enable

- When energy-saving is enabled, the motor acceleration operates with full voltage. During constant speed operation, it automatically calculates the best voltage value according to the load power. This function is not suitable for fluctuating loads or loads which are nearly full during operation.
- When the output frequency is constant (that is, constant operation), the output voltage decreases automatically as the load decreases. Therefore, the drive operates with minimum multiplication of voltage and current (electric power).

## 07-22 Energy-saving Gain

Default: 100

Settings 10–1000 %

- When Pr.07-21 is set to 1, use this parameter to adjust the energy-saving gain. The default is 100%. If the result is not satisfactory, adjust it by decreasing the setting value. If the motor oscillates, then increase the setting value.

In certain applications such as high speed spindles, the temperature rise in the motor is a major concern. When the motor is not in working state, reduce the motor current to a lower level. Reduce this parameter setting to meet this requirement.

## 07-23 Automatic Voltage Regulation (AVR) Function

Default: 0

Settings 0: Enable AVR
1: Disable AVR
2: Disable AVR during deceleration

The rated voltage of a 220V motor is usually AC 200 V, 60 Hz / 50 Hz, and the input voltage of the AC motor drive may vary from AC 180 V to 264 V, 50 Hz / 60 Hz. Therefore, when the AC motor drive is used without the AVR function, the output voltage is the same as the input voltage. When the motor runs at the voltage exceeding 12%–20% of the rated voltage, it causes higher temperatures, damaged insulation, and unstable torque output, which result in losses due to shorter motor lifetime.

The AVR function automatically regulates the output voltage of the AC motor drive to the motor rated voltage. For example, if the V/F curve is set at AC 200 V, 50 Hz and the input voltage is at AC 200–264 V, then the drive automatically reduces the output voltage to the motor to a maximum of AC 200 V, 50 Hz. If the input voltage is at AC 180–200 V, the output voltage to motor and input power are in direct proportion.

0: When the AVR function is enabled, the drive calculates the output voltage according to the actual DC BUS voltage. The output voltage does NOT change when the DC BUS voltage changes.

1: When the AVR function is disabled, the drive calculates the output voltage according to the actual DC BUS voltage. The DC BUS voltage changes the output voltage, and may cause insufficient or over-current or shock.

2: The drive disables the AVR function when decelerating to stop, and may accelerate to brake.

When the motor ramps to stop, the deceleration time is shorter when setting this parameter to 2 with auto-acceleration and deceleration, and the deceleration is quicker and more stable.

## 07-24 Torque Command Filter Time (V/F and SVC Control Mode)

Default: 0.050

Settings 0.001–10.000 sec.

When the setting is too long, the control is stable but the control response is delayed. When the setting is too short, the response is quicker but the control may be unstable. Adjust the setting according to the stability of the control and response time.

## 07-25 Slip Compensation Filter Time (V/F and SVC Control Mode)

Default: 0.100

Settings 0.001–10.000 sec.

Change the compensation response time with Pr.07-24 and Pr.07-25.

If you set Pr.07-24 and Pr.07-25 to 10 seconds, the compensation response time is the slowest; however, the system may be unstable if you set the time too short.

## 07-26 Torque Compensation Gain

Default: 1

Settings 0–10

- With a large motor load, a part of drive output voltage is absorbed by the stator winding resistor; therefore, the air gap magnetic field is insufficient. This causes insufficient voltage at motor induction and results in excessive output current but insufficient output torque. Auto-torque compensation can automatically adjust the output voltage according to the load and keep the air gap magnetic fields stable to get the optimal operation.
- In the V/F control, the voltage decreases in direct proportion with decreasing frequency. It reduces the torque decrease at low speed due to the AC while the DC resistor is unchanged. The auto-torque compensation function increases the output voltage at low frequency to get a higher starting torque.
- When the compensation gain is set too high, it may cause motor over-flux and result in a too large output current, overheating the motor or triggering the protection function.

## 07-27 Slip Compensation Gain (V/F and SVC Control Mode)

Default: 0.00

Settings 0.00–10.00 (Default value is 1 in SVC mode)

- The induction motor needs constant slip to produce magnetic torque. It can be ignored at higher motor speeds, such as rated speed or 2–3 % of slip.
- In operation, the slip and the synchronous frequency are in reverse proportion to produce the same magnetic torque. The slip is larger with the reduction of the synchronous frequency. The motor may stop when the synchronous frequency decreases to a specific value. Therefore, the slip seriously affects the motor speed accuracy at low speed.
- In another situation, when you use an induction motor with the drive, the slip increases when the load increases. It also affects the motor speed accuracy.
- Use this parameter to set the compensation frequency, and reduce the slip to maintain the synchronous speed when the motor runs at the rated current in order to improve the accuracy of the drive. When the drive output current is higher than Pr.05-05 (No-load Current for an Induction Motor (A)), the drive compensates the frequency with this parameter.
- This parameter is set to 1.00 automatically when Pr.00-11 (Speed Control Mode) is changed from V/F mode to vector mode. Apply the slip compensation after load and acceleration. Increase the compensation value from small to large gradually; add the output frequency with motor rated slip * Pr.07-27 (Slip Compensation Gain) when the motor is at the rated load. If the actual speed ratio is slower than expected, increase the parameter setting value; otherwise, decrease it..

## 07-29 Slip Deviation Level

Default: 0

Settings 0.0–100.0 %
0: No detection

### 07-30 Slip Deviation Detection Time

Default: 1.0

Settings 0.0–10.0 sec.

### 07-31 Slip Deviation Action

Default: 0

Settings 0: Warn and continue operation
1: Warn and ramp to stop
2: Warn and coast to stop
3: No warning

🕮 Parameters Pr.07-29–Pr.07-31 set the allowable slip level/time and the over-slip action when the drive is running.

### 07-32 Motor Shock Compensation Factor

Default: 1000

Settings 0–10000

🕮 If there are current wave motions in the motor in some specific area, setting this parameter can effectively improve this situation.

### 07-33 Auto-restart Interval of Fault

Default: 60.0

Settings 0.0–6000.0 sec.

🕮 When a reset/restart occurs after a fault, the drive uses Pr.07-33 as a timer and starts counting the number of faults within this time period. Within this period, if the number of faults does not exceed the setting for Pr.07-11, the counting clears and starts from 0 when the next fault occurs.

### 07-34 Slip Compensation Gain % (power generation mode)
### 07-35 Slip Compensation Gain % (electricity mode)

Default: 0.0

Settings 0.0–100.0 %

🕮 In V/F mode, you do not have to set Pr.07-27. You can set Pr.07-34 and Pr.07-35 directly according to different compensation needs for power generation mode and electricity mode.

🕮 In SVC mode, you must set Pr.07-27 first, and then set Pr.07-34 and Pr.07-35 according to different compensation needs for power generation mode and electricity mode.

🕮 In V/F mode, multiply the result from dividing the output current and rated current by the slip level, and then multiply this result by the percentage of Pr.07-34 and Pr.07-35 again to gain the slip level. In SVC mode, multiply the slip compensation generating from parameters for motor winding, output current, rated current and no-load current by the percentage of Pr.07-34 and Pr.07-35 to gain the slip compensation level.

🕮 Related parameters:

- Pr.05-05 No-load Current for an Induction Motor (A)
- Pr.07-27 Slip Compensation Gain

## 07-36 Maximum Slip Frequency

Default: 0.00

Settings 0.00–200.0 Hz

- Limits the upper limits for the slip.
- If the settings for this parameter are too high, the feedback error malfunctions.

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## 09 Communication Parameters

✍ You can set this parameter during operation.

When using communication devices, connect AC drive with PC by using Delta IFD6530 or IFD 6500.

Modbus RS-485
Pin 1: CAN_H
Pin 2: CAN_L
Pin 3: SGND
Pin 4: SG-
Pin 5: SG+
Pin 6: Reserved
Pin 7: SGND
Pin 8: +10VS

### ✍ 09-00 Communication Address

Default: 1

Settings 1–254

🕮 If RS-485 serial communication controls the AC motor drive, you must set the communication address for this drive in this parameter. Each AC motor drive's communication address must be different.

### ✍ 09-01 COM1 Transmission Speed

Default: 9.6

Settings 4.8–115.2 Kbps

🕮 Sets the transmission speed of the computer and the drive.

🕮 Options are 4.8 Kbps, 9.6 Kbps, 19.2 Kbps, 38.4 Kbps, 57.6 Kbps, or 115.2 Kbps; otherwise, the transmission speed is set to the default 9.6 Kbps.

### ✍ 09-02 COM1 Transmission Fault Treatment

Default: 3

Settings 0: Warn and continue operation
1: Display error and ramp to stop
2: Display error and coast to stop
3: No warning, no error displayed and continue operation

🕮 Sets the response for Modbus communication errors in with the host. Set the detection time in Pr.09-03.

🕮 When a transmission error occurs (for example, the error code CE10 is displayed), the error remains even if the transmission status returns to normal, and does not clear automatically. In this case, set a reset command (Reset) to clear the error.

### ✍ 09-03 COM1 Time-out Detection

Default: 0.0

Settings 0.0–100.0 sec.

🕮 Sets the communication time-out.

## 09-04 COM1 Communication Protocol

Default: 1

Settings
1: 7N2 (ASCII)
2: 7E1 (ASCII)
3: 7O1 (ASCII)
4: 7E2 (ASCII)
5: 7O2 (ASCII)
6: 8N1 (ASCII)
7: 8N2 (ASCII)
8: 8E1 (ASCII)
9: 8O1 (ASCII)
10: 8E2 (ASCII)
11: 8O2 (ASCII)
12: 8N1 (RTU)
13: 8N2 (RTU)
14: 8E1 (RTU)
15: 8O1 (RTU)
16: 8E2 (RTU)
17: 8O2 (RTU)

🕮 Control by PC (Computer Link)

When using the RS-485 serial communication interface, you must specify each drive's communication address in Pr.09-00. The computer then implements control using the drives' individual address.

🕮 Modbus ASCII (American Standard Code for Information Interchange): Each byte data is the combination of two ASCII characters. For example, one byte of data: 64 Hex, shown as '64' in ASCII, consists of '6' (36Hex) and '4' (34Hex).

**1. Code Description**

Communication protocol is in hexadecimal, ASCII: "0" … "9", "A" … "F", every hexadecimal value represent an ASCII code. For example:

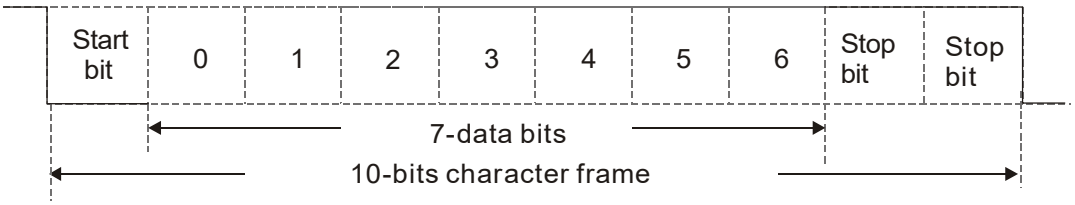
| Character | '0' | '1' | '2' | '3' | '4' | '5' | '6' | '7' |
|---|---|---|---|---|---|---|---|---|
| ASCII code | 30H | 31H | 32H | 33H | 34H | 35H | 36H | 37H |

| Character | '8' | '9' | 'A' | 'B' | 'C' | 'D' | 'E' | 'F' |
|---|---|---|---|---|---|---|---|---|
| ASCII code | 38H | 39H | 41H | 42H | 43H | 44H | 45H | 46H |

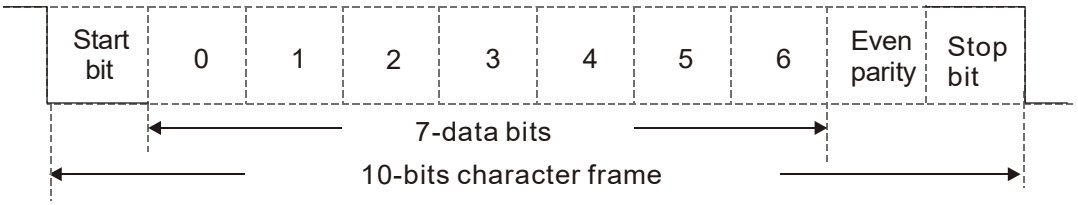
**2. Data Format**

10-bit character frame (For ASCII):

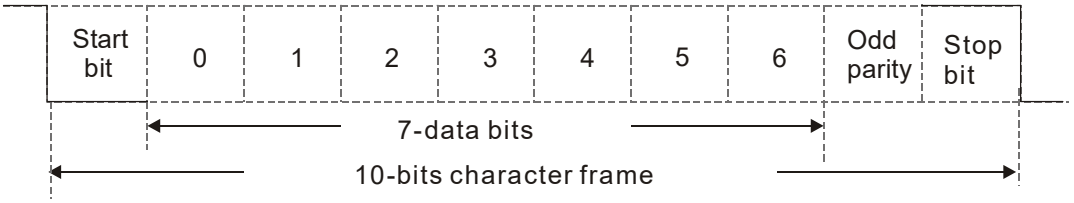
(7, N, 2)




(7, E, 1)

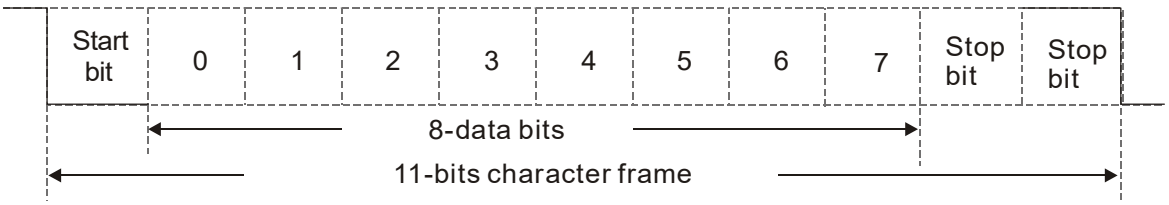



(7, O, 1)

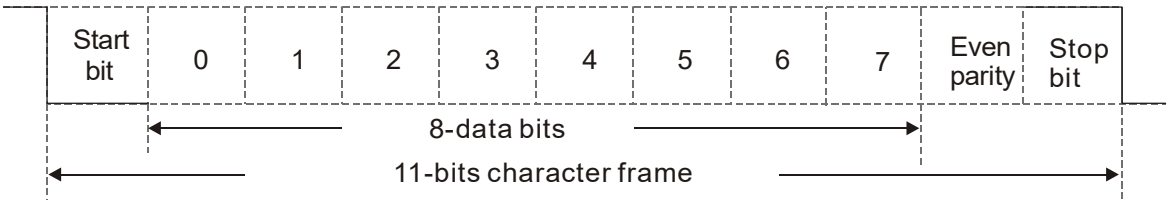



11-bit character frame (For RTU):

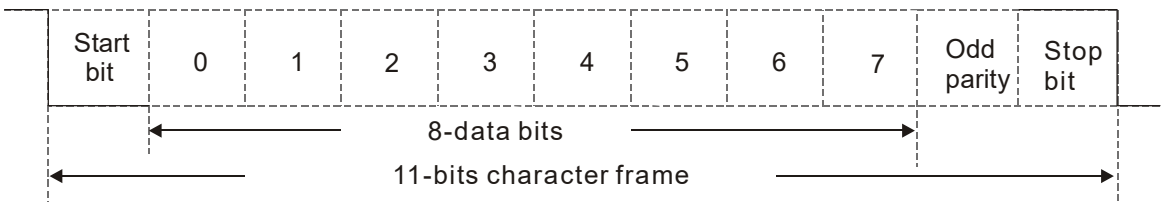
(8, N, 2)




(8, E, 1)




(8, O, 1)




## 3. Communication Protocol

Communication Data Frame

ASCII mode :

| | |
|---|---|
| STX | Start character = ‘ : ’ (3AH) |
| Address Hi | Communication address:<br>one 8-bit address consists of 2 ASCII codes |
| Address Lo | |
| Function Hi | Command code:<br>one 8-bit command consists of 2 ASCII codes |
| Function Lo | |
| DATA (n-1) | Contents of data:<br>N x 8-bit data consists of 2n ASCII codes<br>N ≤ 16, maximum of 32 ASCII codes (20 sets of data) |
| ……. | |
| DATA 0 | |
| LRC CHK Hi | LRC checksum:<br>one 8-bit checksum consists of 2 ASCII codes |
| LRC CHK Lo | |
| END Hi | End characters:<br>END Hi = CR (0DH), END Lo = LF (0AH) |
| END Lo | |

RTU mode:

| | |
|---|---|
| START | Defined by a silent interval of more than 10 ms |
| Address | Communication address: 8-bit address |
| Function | Command code: 8-bit command |
| DATA (n-1) | Contents of data:<br>N × 8-bit data, n ≤16 |
| ……. | |
| DATA 0 | |
| CRC CHK Low | CRC checksum:<br>one 16-bit checksum consists of 2 8-bit characters |
| CRC CHK High | |
| END | Defined by a silent interval of more than 10 ms |

Communication Address (Address)

00H: broadcast to all AC motor drives

01H: AC motor drive of address 01

0FH: AC motor drive of address 15

10H: AC motor drive of address 16

:

FEH: AC motor drive of address 254

Function code (Function) and DATA (Data characters)

03H: read data from a register

06H: write to a single register

Example: Reading two continuous data from register address 2102H. AMD address is 01H.

ASCII mode:

| Command Message | |
|---|---|
| STX | ':' |
| Address | '0' |
| | '1' |
| Function | '0' |
| | '3' |
| Starting register | '2' |
| | '1' |
| | '0' |
| | '2' |
| Number of register (count by word) | '0' |
| | '0' |
| | '0' |
| | '2' |
| LRC Check | 'D' |
| | '7' |
| END | CR |
| | LF |

| Response Message | |
|---|---|
| STX | ':' |
| Address | '0' |
| | '1' |
| Function | '0' |
| | '3' |
| Number of register (count by byte) | '0' |
| | '4' |
| Content of starting register 2102H | '1' |
| | '7' |
| | '7' |
| | '0' |
| Content of register 2103H | '0' |
| | '0' |
| | '0' |
| | '0' |
| LRC Check | '7' |
| | '1' |
| END | CR |
| | LF |

RTU mode:

| Command Message | |
|---|---|
| Address | 01H |
| Function | 03H |
| Starting data register | 21H |
| | 02H |
| Number of register (count by world) | 00H |
| | 02H |
| CRC CHK Low | 6FH |
| CRC CHK High | F7H |

| Response Message | |
|---|---|
| Address | 01H |
| Function | 03H |
| Number of register (count by byte) | 04H |
| Content of register address 2102H | 17H |
| | 70H |
| Content of register address 2103H | 00H |
| | 00H |
| CRC CHK Low | FEH |
| CRC CHK High | 5CH |

06H: single write, write single data to a register.

Example: Writing data 6000 (1770H) to a register 0100H. AMD address is 01H.

ASCII mode:

| Command Message | |
|---|---|
| STX | ':' |
| Address | '0' |
| | '1' |
| Function | '0' |
| | '6' |
| Target register | '0' |
| | '1' |
| | '0' |
| | '0' |
| Register content | '1' |
| | '7' |
| | '7' |
| | '0' |

| Response Message | |
|---|---|
| STX | ':' |
| Address | '0' |
| | '1' |
| Function | '0' |
| | '6' |
| Target register | '0' |
| | '1' |
| | '0' |
| | '0' |
| Register content | '1' |
| | '7' |
| | '7' |
| | '0' |

| | | | |
|---|---|---|---|
| LRC Check | ‘7’ | LRC Check | ‘7’ |
| | ‘1’ | | ‘1’ |
| END | CR | END | CR |
| | LF | | LF |

RTU mode:

| Command Message | | Response Message | |
|---|---|---|---|
| Address | 01H | Address | 01H |
| Function | 06H | Function | 06H |
| Target register | 01H | Target register | 01H |
| | 00H | | 00H |
| Register content | 17H | Register content | 17H |
| | 70H | | 70H |
| CRC CHK Low | 86H | CRC CHK Low | 86H |
| CRC CHK High | 22H | CRC CHK High | 22H |

10H: write multiple registers (write multiple data to registers) The system can write up to 20 sets of data simultaneously.

Example: Set the multi-step speed of an AC motor drive (address is 01H):

Pr.04-00 = 50.00 (1388H), Pr.04-01 = 40.00 (0FA0H)

ASCII Mode:

| Command Message | | Response Message | |
|---|---|---|---|
| STX | ‘:’ | STX | ‘:’ |
| ADR 1 | ‘0’ | ADR 1 | ‘0’ |
| ADR 0 | ‘1’ | ADR 0 | ‘1’ |
| CMD 1 | ‘1’ | CMD 1 | ‘1’ |
| CMD 0 | ‘0’ | CMD 0 | ‘0’ |
| Target register | ‘0’ | Target register | ‘0’ |
| | ‘5’ | | ‘5’ |
| | ‘0’ | | ‘0’ |
| | ‘0’ | | ‘0’ |
| Number of register (count by word) | ‘0’ | Number of register (count by word) | ‘0’ |
| | ‘0’ | | ‘0’ |
| | ‘0’ | | ‘0’ |
| | ‘2’ | | ‘2’ |
| Number of register (count by Byte) | ‘0’ | LRC Check | ‘E’ |
| | ‘4’ | | ‘8’ |
| The first data content | ‘1’ | END | CR |
| | ‘3’ | | LF |
| | ‘8’ | | |
| | ‘8’ | | |
| The second data content | ‘0’ | | |
| | ‘F’ | | |
| | ‘A’ | | |
| | ‘0’ | | |
| LRC Check | ‘9’ | | |
| | ‘A’ | | |
| END | CR | | |
| | LF | | |

RTU mode:

Command Message:

| | |
|---|---|
| ADR | 01H |
| CMD | 10H |
| Target register | 05H |
| | 00H |
| Number of register (count by word) | 00H |
| | 02H |
| Quantity of data (bytes) | 04 |
| The first data content | 13H |
| | 88H |
| The second data content | 0FH |
| | A0H |
| CRC Check Low | '9' |
| CRC Check High | 'A' |

Response Message

| | |
|---|---|
| ADR | 01H |
| CMD 1 | 10H |
| Target register | 05H |
| | 00H |
| Number of register (count by word) | 00H |
| | 02H |
| CRC Check Low | 41H |
| CRC Check High | 04H |

Checksum

ASCII mode:

LRC (Longitudinal Redundancy Check) is calculated by summing up, the values of the bytes from ADR1 to last data character then calculating the hexadecimal representation of the 2's-complement negation of the sum.

Example:

01H + 03H + 21H + 02H + 00H + 02H = 29H, the 2's-complement negation of 29H is **D7**H.

RTU mode:

CRC (Cyclical Redundancy Check) is calculated by the following steps:

**Step 1:** Load a 16-bit register (called CRC register) with FFFFH.

**Step 2:** Exclusive OR the first 8-bit byte of the command message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.

**Step 3:** Examine the LSB of CRC register.

**Step 4:** If the LSB of CRC register is 0, shift the CRC register one bit to the right, fill MSB with zero filling, then repeat step 3. If the LSB of CRC register is 1, shift the CRC register one bit to the right, fill MSB with zero filling, Exclusive OR the CRC register with the polynomial value A001H, then repeat step 3.

**Step 5:** Repeat step 3 and 4 until you perform eight shifts. This processes a complete 8-bit byte will have been processed.

**Step 6:** Repeat step 2 through 5 for the next 8-bit byte of the command message. Continue doing this until all bytes are processed. The final contents of the CRC register are the CRC value. When transmitting the CRC value in the message, the upper and lower bytes of the CRC value must be swapped, that is. the lower order byte is transmitted first.

The following is an example of CRC generation using C language. The function takes two arguments:

Unsigned char* data ← a pointer to the message buffer

Unsigned char length ← the quantity of bytes in the message buffer

The function returns the CRC value as a type of unsigned integer.

```
Unsigned int crc_chk(unsigned char* data, unsigned char length)
 {
        int j;
        unsigned int reg_crc=0Xffff;
        while(length--){
              reg_crc ^= *data++;
              for(j=0;j<8;j++){
                    if(reg_crc & 0x01){    /* LSB(b0)=1 */
                          reg_crc=(reg_crc>>1) ^ 0Xa001;
                    }else{
                          reg_crc=reg_crc >>1;
                    }
              }
        }
        return reg_crc;                        // return register CRC
  }
```

## 4. Address list

| Content | Register | Function | |
|---|---|---|---|
| AC motor drive parameters | GGnnH | GG is the parameter group, nn is the parameter number, for example, the address of Pr.04-01 is 0401H. | |
| Command write only | 2000H | bit 1–0 | 00B: No function |
| | | | 01B: Stop |
| | | | 10B: Run |
| | | | 11B: JOG + RUN |
| | | bit 5–4 | 00B: No function |
| | | | 01B: FWD |
| | | | 10B: REV |
| | | | 11B: Change direction |
| | | bit 7–6 | 00B: 1st acceleration / deceleration |
| | | | 01B: 2nd acceleration / deceleration |
| | | | 10B: 3rd acceleration / deceleration |
| | | | 11B: 4th acceleration / deceleration |
| | | bit 11–8 | 000B: Master speed |
| | | | 0001B: 1st Step speed frequency |
| | | | 0010B: 2nd Step speed frequency |
| | | | 0011B: 3rd Step speed frequency |
| | | | 0100B: 4th Step speed frequency |
| | | | 0101B: 5th Step speed frequency |
| | | | 0110B: 6th Step speed frequency |
| | | | 0111B: 7th Step speed frequency |
| | | | 1000B: 8th Step speed frequency |

| Content | Register | Function | |
|---|---|---|---|
| | | | 1001B: 9th Step speed frequency |
| | | | 1010B: 10th Step speed frequency |
| | | | 1011B: 11th Step speed frequency |
| | | | 1100B: 12th Step speed frequency |
| | | | 1101B: 13th Step speed frequency |
| | | | 1110B: 14th Step speed frequency |
| | | | 1111B: 15th Step speed frequency |
| | | bit 12 | 1: Enable bit 06–11 function |
| | 2001H | Frequency command (XXX.XX Hz) | |
| | 2002H | bit 0 | 1: EF (external fault) on |
| | | bit 1 | 1: Reset |
| | | bit 2 | 1: B.B. ON |
| Status monitor read only | 2100H | High byte: Warn code<br>Low Byte: Error code | |
| | 2101H | bit 1–0 | AC motor drive operation status<br>00B: Drive stops<br>01B: Drive decelerating<br>10B: Drive standby<br>11B: Drive operating |
| | | bit 2 | 1: JOG command |
| | | bit 4–3 | Operation direction<br>00B: FWD run<br>01B: From REV run to FWD run<br>10B: From FWD run to REV run<br>11B: REV run |
| | | bit 8 | 1: Master frequency controlled by communication interface |
| | | bit 9 | 1: Master frequency controlled by analog signal |
| | | bit 10 | 1: Operation command controlled by communication interface |
| | | bit 11 | 1: Parameter locked |
| | | bit 12 | 1: Enable to copy parameters from keypad |
| | 2102H | Frequency command (XXX.XX Hz) | |
| | 2103H | Output frequency (XXX.XX Hz) | |
| | 2104H | Output current (XX.XX A). When current is higher than 655.35, it shifts the decimal as (XXX.X A). The decimal can refer to High byte of 211F. | |
| | 2105H | DC BUS voltage (XXX.X V) | |
| | 2106H | Output voltage (XXX.X V) | |
| | 2107H | Current step number of multi-step speed operation | |
| | 2109H | Counter value | |
| | 210AH | Power factor angle (XXX.X) | |
| | 210FH | Power output (X.XXX kWH) | |
| | 2116H | Multi-function display (Pr.00-04) | |
| | 211BH | Maximum Operation Frequency (Pr.01-00) or Maximum User-defined Value (Pr.00-26)<br>When Pr.00-26 is 0, this value is equal to Pr.01-00 setting<br>When Pr.00-26 is not 0, and the command source is keypad, this value = Pr.00-24 * Pr.00-26 / Pr. 01-00.<br>When Pr.00-26 is not 0, and the command source is 485, this value = Pr.09-10 * Pr.00-26 / Pr.01-00. | |
| | 211FH | High byte: decimal of current value (display) | |
| | 2200H | Display output current (A). When current is higher than 655.35, it shifts the decimal as (XXX.X A). The decimal can refer to High byte of 211F. | |
| | 2201H | Display counter value (c) | |
| | 2202H | Actual output frequency (XXXXX Hz) | |
| | 2203H | DC BUS voltage (XXX.X V) | |
| | 2204H | Output voltage (XXX.X V) | |

| Content | Register | Function |
|---|---|---|
| | 2205H | Power angle (XXX.X) |
| | 2206H | Display actual motor speed kW of U, V, W (XXXXX kW) |
| | 220BH | Display signal of AVI analog input terminal, 0–10 V corresponds to 0.00–100.00% (2.) (see NOTE 2 in Pr.00-04) |
| | 220CH | Display signal of ACI analog input terminal, 4–20 mA / 0–10 V corresponds to 0.00–100.00% (2.) (as Pr.00-04 NOTE 2) |
| | 220EH | IGBT temperature of drive power module (XXX.X °C) |
| | 2210H | The status of digital input (ON / OFF), refer to Pr.02-12 (see NOTE 3 in Pr.00-04) |
| | 2211H | The status of digital output (ON / OFF), refer to Pr.02-18 (see NOTE 4 in Pr.00-04) |
| | 2212H | The multi-step speed that is executing (S) |
| | 2213H | The corresponding CPU pin status of digital input (d.) (see NOTE 3 in Pr.00-04) |
| | 2214H | The corresponding CPU pin status of digital output (O.) (see NOTE 4 in Pr.00-04) |
| | 221AH | GFF (XXX.XX %) |
| | 221BH | DC BUS voltage ripples (XXX.X V) |
| | 221CH | PLC register D1043 data (C) |
| | 221DH | Number of poles of a permanent magnet motor |
| | 221EH | User page displays the value in physical measure |
| | 221FH | Output value of Pr.00-05 (XXX.XX Hz) |
| | 2220H | Number of motor turns when drive operates (saves when drive stops, and resets to zero when operating) |
| | 2221H | Operating position of the motor (saves when drive stops, and resets to zero when operating) |
| | 2222H | Reserved |
| | 2223H | Control mode of the drive 0: speed mode |
| | 2224H | Carrier frequency of the drive (XX kHZ) |
| | 2226H | Drive status<br>bit 1–0 00b: No direction<br>01b: Forward<br>10b: Reverse<br>bit 3–2 01b: Drive ready<br>10b: Error<br>bit 4 00b: Motor drive did not output<br>01b: Motor drive did output<br>bit 5 00b: No alarm<br>01b: Alarm |
| | 2229H | kWH display (XXXX.X) |

**5. Exception response:**

When the drive is using the communication connection, if an error occurs, the drive responds to the error code and sets the highest bit (bit 7) of code to 1 (function code AND 80H) then responds to the control system to signal that an error occurred.

If the keypad displays “CE-XX” as a warning message, “XX” is the error code at that time. Refer to the table of error codes for communication error for reference.

Example:

ASCII mode:

| | |
|---|---|
| STX | ‘:’ |
| Address | ‘0’ |
| | ‘1’ |
| Function | ‘8’ |
| | ‘6’ |

RTU mode:

| | |
|---|---|
| Address | 01H |
| Function | 86H |
| Exception code | 02H |
| CRC CHK Low | C3H |
| CRC CHK High | A1H |

ASCII mode:

| | |
|---|---|
| Exception code | ‘0’ |
| | ‘2’ |
| LRC CHK | ‘7’ |
| | ‘7’ |
| END | CR |
| | LF |

RTU mode:

The explanation of error codes

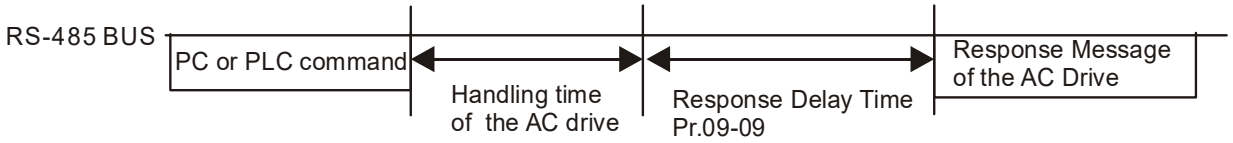
| Error code | Explanation |
|---|---|
| 1 | Function code is not supported or unrecognized. |
| 2 | Address is not supported or unrecognized. |
| 3 | Data is not correct or unrecognized. |
| 4 | Failure to execute this function code |

## 09-09 Communication Response Delay Time

Default: 2.0

Settings 0.0–200.0 ms

Sets the response delay time after the AC motor drive receives a communication command as shown in the following.




## 09-33 PLC Command Force to 0

Default：0

Setting 0–65535

Defines whether the Frequency command or the Speed command must be cleared to zero or not before the PLC starts the next scan.

| bit | Explanation |
|---|---|
| bit 0 | Before PLC scan, set the PLC target frequency = 0 |
| bit 1 | Before PLC scan, set the PLC target torque = 0 |
| bit 2 | Before PLC scan, set the speed limit of torque control mode = 0 |

## 09-35 PLC Address

Default: 2

Settings 1–254

## 09-36 CANopen Slave Address

Default: 0

Settings 0: Disable
1–127

## 09-37 CANopen Speed

Default: 0

Settings 0: 1 Mbps
1: 500 kbps
2: 250 kbps
3: 125 kbps
4: 100 kbps (Delta only)
5: 50 kbps

## 09-39 CANopen Warning Record

Default: 0

Settings bit 0: CANopen software disconnection 1 (CANopen Guarding Time-out)
bit 1: CANopen software disconnection 2 (CANopen Heartbeat Time-out)
bit 3: CANopen SDO time-out
bit 4: CANopen SDO buffer overflow
bit 5: CANopen hardware disconnection warning (Can Bus OFF)
bit 6: Error protocol for CANopen

## 09-40 CANopen Decoding Method

Default: 1

Settings 0: Use Delta-defined decoding method
1: Use CANopen Standard DS402 protocol

## 09-41 CANopen Communication Status

Default: Read Only

Settings 0: Node Reset State
1: Com Reset State
2: Boot up State
3: Pre-operation State
4: Operation State
5: Stop State

## 09-42 CANopen Control Status

Default: Read Only

Settings
0: Not ready for use state
1: Inhibit start state
2: Ready to switch on state
3: Switched on state
4: Enable operation state
7: Quick stop active state
13: Error reaction activation state
14: Error state

## 09-43 CANopen Reset Index

Default: 65535

Settings
bit 0: CANopen reset, the internal address 20XX is 0
bit 1: CANopen reset, the internal address 264X is 0
bit 2: CANopen reset, the internal address 26AX is 0
bit 3: CANopen reset, the internal address 60XX is 0

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# 11 Advanced Parameters

✓ You can set this parameter during operation.

In this parameter group, ASR stands for Adjust Speed Regulator

## 11-41 PWM Mode Selection

Default: 0

Settings 0: Two-phase
2: Space vector

📖 Two-phase mode: effectively reduces the drive power component losses and provides better performance in long wire applications.

📖 Space vector mode: effectively reduces the power loss and electromagnetic noise of the motor.

## ✓ 11-42 System Control Flag

Default: 0000

Settings 0000–FFFFh

| bit No. | Function | Description |
|---|---|---|
| 0 | Reserved | |
| 1 | FWD / REV action control | 0: FWD / REV cannot be controlled by Pr.02-12 bit 0 & 1.<br>1: FWD / REV can be controlled by Pr.02-12 bit 0 & 1. |
| 2–15 | Reserved | |

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# Chapter 13 Warning Codes

## KPMH-LC01 digital keypad

| ID No. | Display | Descriptions |
|---|---|---|
| 1 | CE 1 | Modbus function code error (illegal function code)<br>Corrective Actions<br>■ Check if the function code is correct.<br>(function code must be 03, 06, 10, 63) |
| 2 | CE2 | Modbus data address error (illegal data address (00 H to 254 H))<br>Corrective Actions<br>■ Check if the communication address is correct. |
| 3 | CE3 | Modbus data error (illegal data value)<br>Corrective Actions<br>■ Check if the data value exceeds the maximum or minimum value. |
| 4 | CE4 | Modbus communication error (data is written to read-only address)<br>Corrective Actions<br>■ Check if the communication address is correct. |
| 5 | CE 10 | Modbus transmission time-out |
| 6 | CP 10 | Keypad transmission time-out |
| 7 | SE 1 | Keypad COPY error 1<br>Keypad simulation error: includes communication delays, communication error (keypad received error FF86) and parameter value error. |
| 8 | SE2 | Keypad COPY error 2<br>Keypad simulation done: parameter write error. |

<table>
<tr><th>ID No.</th><th>Display</th><th>Descriptions</th></tr>
<tr><td>9</td><td>oH 1</td><td>IGBT is over-heated above protection level 3~10 HP: 90°C
<table>
<tr><th>Frame</th><th>MH300-L</th><th>OH1</th></tr>
<tr><td>C</td><td>VFD11AMH23ANSLA</td><td>100</td></tr>
<tr><td>C</td><td>VFD17AMH23ANSLA</td><td rowspan="2">105</td></tr>
<tr><td>D</td><td>VFD25AMH23ANSLA</td></tr>
<tr><td>E</td><td>VFD33AMH23ANSLA</td><td rowspan="3">115</td></tr>
<tr><td>E</td><td>VFD49AMH23ANSLA</td></tr>
<tr><td>F</td><td>VFD65AMH23ANSLA</td></tr>
<tr><td>C</td><td>VFD9A0MH43ANSLA</td><td rowspan="2">115</td></tr>
<tr><td>C</td><td>VFD9A0MH43AFSLA</td></tr>
<tr><td>D</td><td>VFD13AMH43ANSLA</td><td rowspan="2">105</td></tr>
<tr><td>D</td><td>VFD13AMH43AFSLA</td></tr>
<tr><td>D</td><td>VFD17AMH43ANSLA</td><td rowspan="2">110</td></tr>
<tr><td>D</td><td>VFD17AMH43AFSLA</td></tr>
<tr><td>E</td><td>VFD25AMH43ANSLA</td><td rowspan="4">115</td></tr>
<tr><td>E</td><td>VFD25AMH43AFSLA</td></tr>
<tr><td>E</td><td>VFD32AMH43ANSLA</td></tr>
<tr><td>E</td><td>VFD32AMH43AFSLA</td></tr>
</table>
Corrective Actions<br>
■ Ensure that the ambient temperature falls within the specified temperature range.<br>
■ Make sure the ventilation holes are not obstructed.<br>
■ Remove any foreign objects from the heat sink and check for possible dirt in the heat sink.<br>
■ Check the fan and clean it.<br>
■ Provide enough space for adequate ventilation.</td></tr>
<tr><td>12</td><td>AnL</td><td>ACI signal loss when Pr.03-19 is set to 1 or 2.</td></tr>
<tr><td>13</td><td>uC</td><td>Low current</td></tr>
<tr><td>14</td><td>AUE</td><td>Motor parameters auto-tuning error<br>Corrective Actions<br>■ Verify that the motor wiring is correct.<br>■ Verify that the motor capacity and parameters are correct.</td></tr>
<tr><td>19</td><td>PHL</td><td>Input phase loss</td></tr>
</table>

| ID No. | Display | Descriptions |
|---|---|---|
| 20 | oL 1 | When the output current exceeds the over-torque detection level (Pr.06-07) and also exceeds Pr.06-08; when Pr.06-06 is set as 1 or 3, the keypad displays a warning without an error record; when Pr.06-06 is set as 2 or 4, it displays an error, stops running and displays an error record.<br>Corrective Actions<br>■ Check if the motor is overloaded.<br>■ Verify that the motor rated current in Pr.05-01 is correct.<br>■ Increase the motor capacity. |
| 22 | oH3 | Motor over-heating |
| 24 | oSL | Over-slip |
| 25 | tUn | Auto tuning processing |
| 28 | OPHL | Output phase loss |
| 30 | SE3 | Keypad COPY error 3<br>Keypad copy between different power range drives |
| 36 | CGdn | CANopen guarding time-out 1 |
| 37 | CHbn | CANopen heartbeat time-out 2 |
| 39 | CbFn | CANopen bus off |
| 40 | CIdn | CANopen index error |
| 41 | CAdn | CANopen station address error |
| 42 | CFrn | CANopen memory error |
| 43 | CSdn | CANopen SDO transmission time-out |
| 44 | CSbn | CANopen SDO received register overflow |
| 45 | CbtN | CANopen boot up fault |
| 46 | CPtn | CANopen protocol format error |

| ID No. | Display | Descriptions |
|---|---|---|
| 50 | PLod | PLC download error, opposite data defect. |
| 51 | PLSu | PLC download and save error |
| 52 | PLdA | Data error during PLC operation |
| 53 | PLFn | PLC download function code error |
| 54 | PLor | PLC register overflow |
| 55 | PLFF | PLC operation function code error |
| 56 | PLSn | PLC check_sum error |
| 57 | PLEd | PLC end command is missing |
| 58 | PLCr | PLC MCR command error |
| 59 | PLdF | PLC download failure |
| 60 | PLSF | PLC scan time failure |
| 75 | ECFF | Default setting error |
| 76 | ECiF | Serious internal error |
| 90 | CPLP | Copy PLC: password error |
| 91 | CPL0 | Copy PLC: read mode error |
| 92 | CPL 1 | Copy PLC: write mode error |
| 93 | CPLu | Copy PLC: version error |
| 94 | CPLS | Copy PLC: capacity size error |
| 95 | CPLF | Copy PLC: you must disable the PLC function. |
| 96 | CPLt | Copy PLC: time-out |

# Chapter 14 Error Codes

## KPMH-LC01 digital keypad

* Refer to settings for Pr.06-17–Pr.06-22.

| ID No. | Display | Descriptions |
|---|---|---|
| 1 | ocA | Over-current during acceleration<br>(output current exceeds triple the rated current during acceleration).<br>Corrective Actions<br>■ Short-circuit at motor output: check for possible poor insulation at the output.<br>■ Acceleration time is too short: increase acceleration time.<br>■ AC motor drive output power is too low: replace the AC motor drive with a higher power model. |
| 2 | ocd | Over-current during deceleration<br>(output current exceeds triple the rated current during deceleration).<br>Corrective Actions<br>■ Short-circuit at motor output: check for possible poor insulation at the output.<br>■ Deceleration time is too short: increase the deceleration time.<br>■ AC motor drive output power is too low: replace the AC motor drive with a higher power model. |
| 3 | ocn | Over-current during steady operation<br>(output current exceeds triple the rated current during constant speed).<br>Corrective Actions<br>■ Short-circuit at motor output: check for possible poor insulation at the output.<br>■ AC motor drive output power is too low: replace the AC motor drive with a higher power model. |

| ID No. | Display | Descriptions |
|---|---|---|
| 4 | GFF | Ground fault. When one of the output terminal(s) is grounded, the short circuit current is more than 50% of the AC motor drive rated current.<br>NOTE: the short circuit protection is provided for the AC motor drive protection, not to protect you.<br>Corrective Actions<br>■ Check the wiring connections between the AC motor drive and the motor for possible short circuits, as well as the connections to ground.<br>■ Check whether the IGBT power module is damaged.<br>■ Check for possible poor insulation at the output. |
| 6 | ocS | Over-current at stop. Hardware failure in current detection.<br>Corrective Actions<br>■ Return the unit to the default. |
| 7 | ouA | DC BUS over-voltage during acceleration (230V: 450 $V_{DC}$; 460V: 900 $V_{DC}$)<br>Corrective Actions<br>■ Check if the input voltage spiked above the rated AC motor drive input voltage range.<br>■ Check for possible voltage transients.<br>■ If the DC BUS is over-voltage due to the regenerative voltage, increase the acceleration time or add an optional brake resistor. |
| 8 | oud | DC BUS over-voltage during deceleration (230V: 450 $V_{DC}$; 460V: 900 $V_{DC}$)<br>Corrective Actions<br>■ Check if the input voltage spiked above the rated AC motor drive input voltage range.<br>■ Check for possible voltage transients.<br>■ If the DC BUS is over-voltage due to regenerative voltage, increase the deceleration time or add an optional brake resistor. |
| 9 | oun | DC BUS over-voltage at constant speed (230V: 450 $V_{DC}$; 460V: 900 $V_{DC}$)<br>Corrective Actions<br>■ Check if the input voltage spiked above the rated AC motor drive input voltage range.<br>■ Check for possible voltage transients. |
| 10 | ouS | Over-voltage at stop. Hardware failure in voltage detection.<br>Corrective Actions<br>■ Check if the input voltage spiked above the rated AC motor drive input voltage range.<br>■ Check for possible voltage transients. |

| ID No. | Display | Descriptions |
|---|---|---|
| 11 | LuA | DC BUS voltage is less than Pr.06-00 during acceleration.<br>Corrective Actions<br>■ Check if the input voltage is normal.<br>■ Check for possible sudden changes in load.<br>■ Check the setting of Pr.06-00. |
| 12 | Lud | DC BUS voltage is less than Pr.06-00 during deceleration.<br>Corrective Actions<br>■ Check if the input voltage is normal.<br>■ Check for possible sudden changes in load.<br>■ Check the setting of Pr.06-00. |
| 13 | Lun | DC BUS voltage is less than Pr.06-00 at constant speed.<br>Corrective Actions<br>■ Check if the input voltage is normal.<br>■ Check for possible sudden changes in load.<br>■ Check the setting of Pr.06-00. |
| 14 | LuS | DC BUS voltage is less than Pr.06-00 at stop.<br>Corrective Actions<br>■ Check if the input voltage is normal.<br>■ Check for possible sudden changes in load.<br>■ Check the setting of Pr.06-00. |
| 15 | orP | Phase loss protection<br>Corrective Actions<br>■ Check if there is any phase loss in the three-phase model or in the one-phase input application. |
| 16 | oH 1 | IGBT is overheated above the protection level.<br>Corrective Actions<br>■ Ensure that the ambient temperature falls within the specified temperature range.<br>■ Make sure the ventilation holes are not obstructed.<br>■ Remove any foreign objects from the heat sink and check for possible dirt in the heat sink.<br>■ Check the fan and clean it.<br>■ Provide enough space for adequate ventilation. |
| 18 | tH 1o | IGBT Hardware Error<br>Corrective Actions<br>■ Return the unit to the default. |

| ID No. | Display | Descriptions |
|---|---|---|
| 21 | oL | Overload; the AC motor drive detects excessive drive output current.<br>Corrective Actions<br>■ Check if the motor is overloaded.<br>■ Change to the next power level with a higher value for the AC motor drive model. |
| 22 | EoL 1 | Electronic thermal relay 1 protection<br>Corrective Actions<br>■ Check the setting of the electronic thermal relay (Pr.06-14).<br>■ Change to the next power level with a higher value for the motor model. |
| 26 | ot 1 | When the output current exceeds the over-torque detection level (Pr.06-07) and also exceeds Pr.06-08; when Pr.06-06 is set as 1 or 3, the keypad displays a warning without an error record; when Pr.06-06 is set as 2 or 4, it displays an error, stops running, and displays an error record.<br>Corrective Actions<br>■ Check if the motor is overloaded.<br>■ Verify that the motor rated current in Pr.05-01 is correct.<br>■ Increase the motor capacity. |
| 28 | uC | Low current detection.<br>Corrective Actions<br>■ Check Pr. 06-71, Pr. 06-72, Pr. 06-73. |
| 31 | cF2 | Cannot read internal EEPROM.<br>Corrective Actions<br>■ Press the RESET key to reset to the default.<br>■ If the fault code still displays on the keypad, return the unit to the default. |
| 33 | cd1 | U-phase current error<br>Corrective Actions<br>■ Cycle the power to the drive.<br>■ If the fault code still displays on the keypad, return the unit to the default. |
| 34 | cd2 | V-phase current error<br>Corrective Actions<br>■ Cycle the power to the drive.<br>■ If the fault code still displays on the keypad, return the unit to the default. |
| 35 | cd3 | W-phase current error<br>Corrective Actions<br>■ Cycle the power to the drive.<br>■ If the fault code still displays on the keypad, return the unit to the default |
| 36 | Hd0 | CC (current clamp) hardware error<br>Corrective Actions<br>■ Cycle the power.<br>■ If the fault code still displays on the keypad, return the unit to the default. |

| ID No. | Display | Descriptions |
|---|---|---|
| 37 | Hd 1 | OC hardware error<br>Corrective Actions<br>■ Cycle the power.<br>■ If the fault code still displays on the keypad, return the unit to the default. |
| 40 | AUE | Motor parameters auto-tuning error<br>Corrective Actions<br>■ Verify that the motor wiring is correct.<br>■ Verify that the motor capacity and parameters are correct.<br>■ Try auto-tuning again. |
| 48 | ACE | ACI loss<br>Corrective Actions<br>■ Check the wiring for ACI.<br>■ Check if the ACI signal is less than 4 mA. |
| 49 | EF | External Fault: when the multi-function input terminal (EF) is active, the AC motor drive stops output.<br>Corrective Actions<br>■ Press the RESET key after you clear the fault. |
| 50 | EF1 | Emergency stop: when the multi-function input terminal (EF1) is active, the AC motor drive stops output.<br>Corrective Actions<br>■ Press the RESET key after you clear the fault. |
| 51 | bb | External Base Block: when the multi-function input terminal (B.B.) is active, the AC motor drive stops output.<br>Corrective Actions<br>■ Deactivate the external input terminal (B.B.) to operate the AC motor drive again. |
| 52 | Pcod | Keypad is locked after you enter the wrong password three times.<br>Corrective Actions<br>■ Refer to Pr.00-07 and Pr.00-08.<br>■ Cycle the power, and then enter the correct password. |
| 54 | CE1 | Modbus function code error (illegal function code)<br>Corrective Actions<br>■ Check if the function code is correct (function code must be 03, 06, 10, 63). |
| 55 | CE2 | Modbus data address error (illegal data address 00 H–254 H)<br>Corrective Actions<br>■ Check if the data address is correct. |
| 56 | CE3 | Modbus data error (illegal data value)<br>Corrective Actions<br>■ Check if the data value exceeds the maximum or minimum value. |

| ID No. | Display | Descriptions |
|---|---|---|
| 57 | CE4 | Modbus communication error (data is written to read-only address)<br>Corrective Actions<br>■ Check if the communication address is correct. |
| 58 | CE 10 | Modbus transmission time-out<br>Corrective Actions<br>■ Check if the host controller transmits the communication command within the setting time (Pr.09-03).<br>■ Check the communication wiring and grounding. Use a 90-degree wiring layout or separation from main circuit to prevent interference.<br>■ Check that the setting for Pr.09-02 is the same as the host controller.<br>■ Check the condition of the communication cable or replace with a new cable. |
| 59 | CP 10 | Keypad transmission time-out |
| 61 | ydc | Y-connection / Δ-connection switch error<br>Corrective Actions<br>■ Check the wiring of the Y-connection / Δ-connection.<br>■ Check the parameter settings. |
| 62 | dEb | Pr.07-13 is not set to 0 and there is a momentary power off or power cut. The keypad displays dEb during acceleration or deceleration to stop.<br>Corrective Actions<br>■ Set Pr.07-13 to 0.<br>■ Check if the input power is stable. |
| 63 | oSL | Motor slip exceeds Pr.07-29 setting and exceeds Pr.07-30 time setting.<br>Corrective Actions<br>■ Check if the motor parameter is correct and decrease the load if overloaded.<br>■ Check the settings for Pr.07-29 and Pr.07-30. |
| 71 | MBF2 | Mechanical brake error 2<br>Corrective Actions<br>■ Check if the mechanical brake signal is correct.<br>■ Check if the detection time setting of mechanical brake (Pr.02-33) is correct. |
| 72 | STL 1 | S1–DCM internal loop detection error<br>Corrective Actions<br>■ Check the wiring of the S1 terminal.<br>■ Reset the emergency switch (ON: activated) and cycle the power.<br>■ Check that the input voltage maintains at least 11 V.<br>■ Check the wiring of the S1 and +24 V terminals.<br>■ After you make sure all the wiring is correct, if STL1 fault still exists after cycling the power, please contact Delta. |

| ID No. | Display | Descriptions |
|---|---|---|
| 74 | MCF | Magnetic contactor error<br>Corrective Actions<br>■ Check if the signal of magnetic contactor is correct.<br>■ Check if the setting of Pr.02-32 is correct. |
| 75 | MBF | Mechanical brake error<br>Corrective Actions<br>■ Check if the mechanical brake signal is correct.<br>■ Check if the detection time setting of mechanical brake (Pr.02-33) is correct. |
| 76 | STo | Safe Torque Off function active<br>Corrective Actions<br>■ Check the wiring of the S1 and S2 terminals.<br>■ Reset the emergency switch (ON: activated) and cycle the power.<br>■ Check that the input voltage maintains at least 11 V.<br>■ Check the wiring of the S1 / S2 and +24 V terminals.<br>■ After you make sure all the wiring is correct, if STO fault still exists after cycling the power, please contact Delta. |
| 77 | STL2 | S2–DCM internal loop detection error<br>Corrective Actions<br>■ Check the wiring of the S2 terminal.<br>■ Reset the emergency switch (ON: activated) and cycle the power.<br>■ Check that the input voltage maintains at least 11 V.<br>■ Check the wiring of the S2 and +24 V terminals.<br>■ After you make sure all the wiring is correct, if STL2 fault still exists after cycling the power, please contact Delta. |
| 78 | STL3 | S1–DCM & S2–DCM internal loop detection error<br>Corrective Actions<br>■ After you make sure all the wiring is correct, if STL3 fault still exists after cycling the power, please contact Delta. |
| 79 | Aoc | U-phase short circuit |
| 80 | boc | V-phase short circuit |
| 81 | coc | W-phase short circuit |

| ID No. | Display | Descriptions |
|---|---|---|
| 82 | oPL 1 | Output phase loss 1 (Phase U)<br>Output phase loss 2 (Phase V)<br>Output phase loss 3 (Phase W)<br>Corrective Actions<br>■ Check the motor internal wiring and change the motor if there is still an error.<br>■ Check the cable condition.<br>■ Choose a three-phase motor, and make sure the capacity of the drive and motor match.<br>■ Check the control board cable.<br>■ Verify that the three-phase current is balanced. If it is balanced and the OPHL fault still exists, return the unit to the default. |
| 83 | oPL2 | |
| 84 | oPL3 | |
| 87 | oL3 | Over-load protection at low frequency |
| 101 | CGdE | CANopen guarding error<br>Corrective Actions<br>■ Increase the guarding time (Index 100C).<br>■ Check the communication wiring and grounding. Use a 90-degree wiring layout or separation from the main circuit to prevent interference.<br>■ Make sure the communication wiring is serial.<br>■ Use a dedicated CANopen cable and install a terminating resistor.<br>■ Check the condition of the communication cable or replace with a new cable. |
| 102 | CHbE | CANopen heartbeat error<br>Corrective Actions<br>■ Increase the Heartbeat time (Index 1016).<br>■ Check the communication wiring and grounding. Use a 90-degree wiring layout or separation from the main circuit to prevent interference.<br>■ Make sure the communication wiring is serial.<br>■ Use a dedicated CANopen cable and install a terminating resistor.<br>■ Check the condition of the communication cable or replace with a new cable. |
| 104 | CbFE | CANopen bus off error<br>Corrective Actions<br>■ Re-install the CANopen card.<br>■ Check the communication wiring and grounding. Use a 90-degree wiring layout or separation from the main circuit to prevent interference.<br>■ Make sure the communication wiring is serial.<br>■ Use a dedicated CANopen cable and install a terminating resistor.<br>■ Check the condition of the communication cable or replace with a new cable. |

| ID No. | Display | Descriptions |
|---|---|---|
| 105 | CIdE | CANopen index error<br>Corrective Actions<br>■ Reset the CANopen index (Pr.00-02 = 7). |
| 106 | CAdE | CANopen station address error<br>Corrective Actions<br>■ Disable CANopen (Pr.09-36 = 0).<br>■ Reset the CANopen setting (Pr.00-02 = 7).<br>■ Reset the station address (Pr.09-36). |
| 107 | CFrE | CANopen memory error<br>Corrective Actions<br>■ Disable CANopen (Pr.09-36 = 0).<br>■ Reset the CANopen setting (Pr.00-02 = 7).<br>■ Reset the station address (Pr.09-36). |
| 111 | tCtE | InnerCOM time-out failure |
| 121 | CP20 | Internal communication error<br>Corrective Actions<br>■ If the fault still appears after pressing RESET, return the unit to the default. |
| 123 | CP22 | Internal communication error<br>Corrective Actions<br>■ If the fault still appears after pressing RESET, return the unit to the default. |
| 124 | CP30 | Internal communication error<br>Corrective Actions<br>■ If the fault still appears after pressing RESET, return the unit to the default. |
| 126 | CP32 | Internal communication error<br>Corrective Actions<br>■ If the fault still appears after pressing RESET, return the unit to the default. |
| 127 | CP33 | Firmware version error |
| 140 | Hd6 | GFF detected at power on |
| 141 | b4GFF | GFF occurs before running |
| 142 | AuE 1 | Auto-tune error 1 (in DC test stage) |
| 143 | AuE2 | Auto-tune error 2 (high frequency test stage) |
| 144 | AuE3 | Auto-tune error 3 (rotary test stage) |

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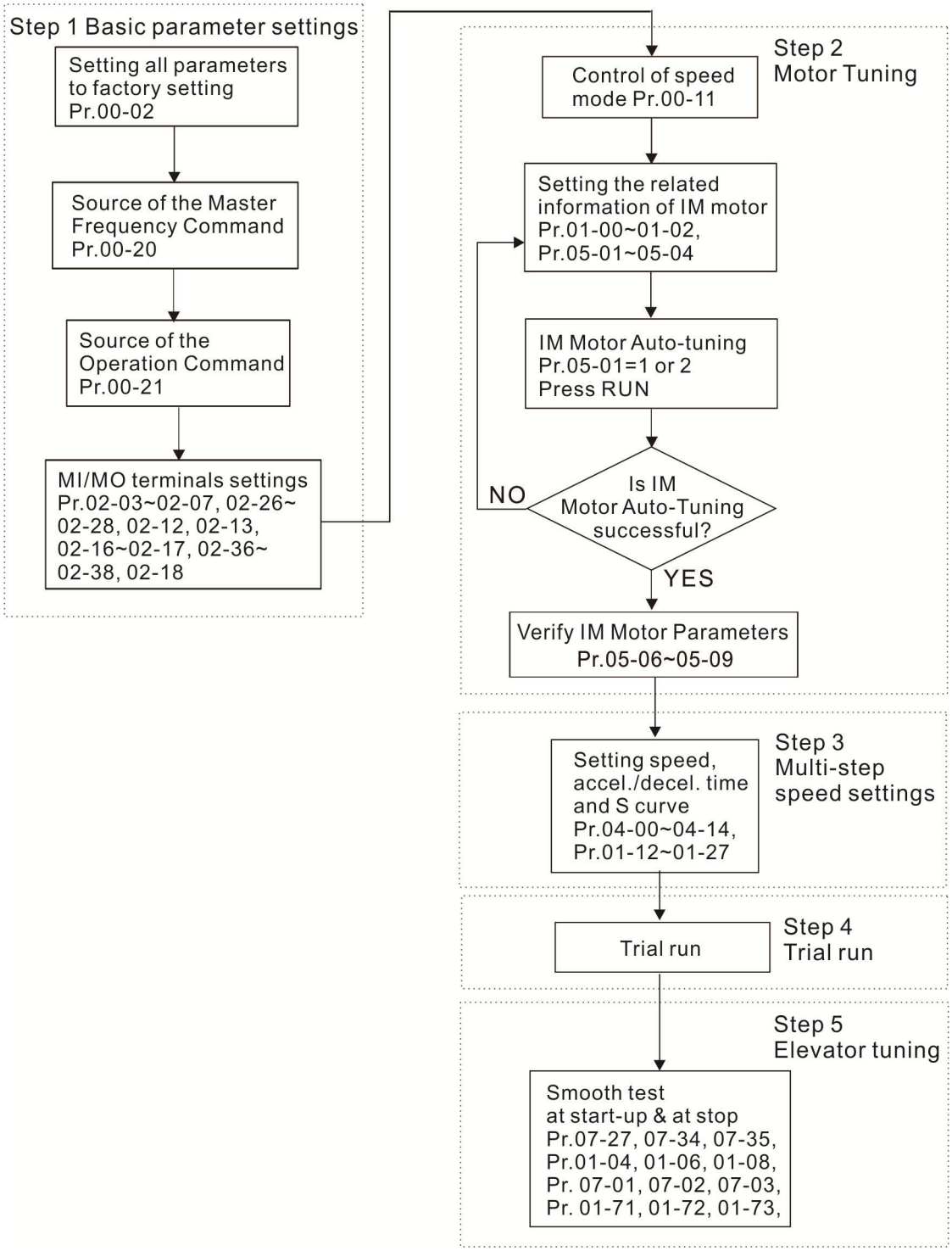
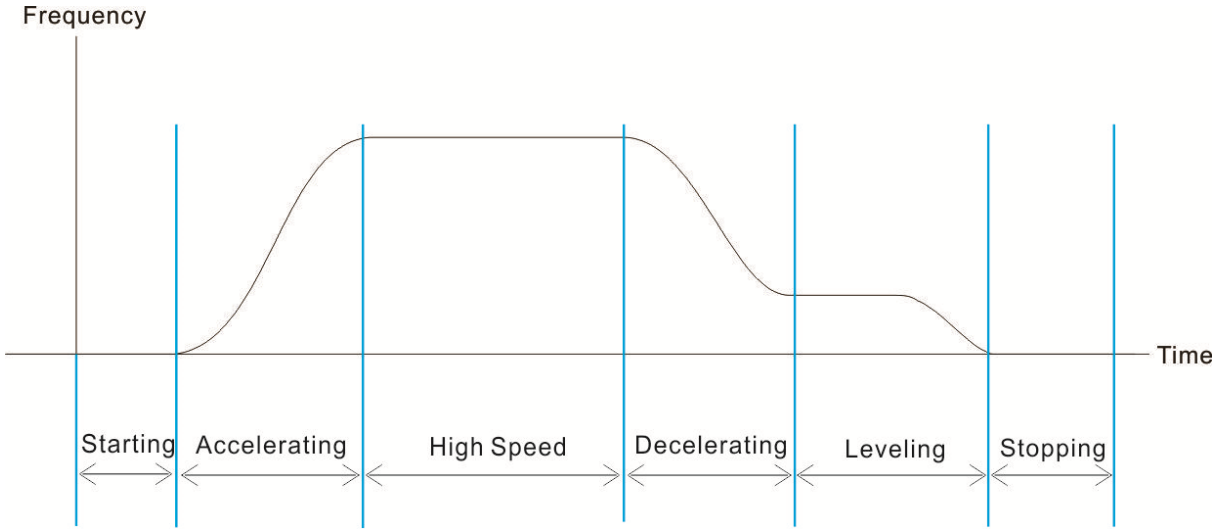
# Chapter 15 Auto-tuning Process

## ■ Flow chart



## ■ Fine-tuning for Elevators' Performance




| Stage | Function | Pr. | Explanation | Settings | Default |
|---|---|---|---|---|---|
| Starting | Delay Time | 02-30 | Turn On Delay of Magnetic Contactor between Drive and Motor | 0.010–65.000 sec. | 0.200 |
| | | 02-39 | Brake Release Delay Time When Elevator Starts | 0.010–65.000 sec. | 0.250 |
| | Roll Back Adjustment | 07-01 | DC Brake Current Level | 0–100 % | 30 |
| | | 07-02 | DC Brake Time at Start-up | 0.0–60.0 sec. | 0.7 |
| | | 02-42 | Brake Release Function Option | Bit 0 = 0: No function<br>Bit 0 = 1: Check torque output function switch<br>Bit 1 = 0: No function<br>Bit 1 = 1: Brake control by frequency threshold function switch | 0000h |
| | Start-up Adjustment | 01-04 | Mid-point Voltage 1 of Motor 1 | 230V series:0.0–240.0 V<br>460V series:0.0–480.0 V | 11.0<br>22.0 |
| | | 01-06 | Mid-point Voltage 2 of Motor 1 | 230V series:0.0–240.0 V<br>460V series:0.0–480.0 V | 2.0<br>4.0 |
| | | 01-08 | Minimum Output Voltage of Motor 1 | 230V series:0.0–240.0 V<br>460V series:0.0–480.0 V | 0.0<br>0.0 |
| | Torque | 02-41 | Output Current Level Setting | 0–100% | 0 |

| Stage | Function | Pr. | Explanation | Settings | Default |
|---|---|---|---|---|---|
| | Check | | for External Terminals | | |
| Accelerating | Multi-Step Speed | 01-12 | Acceleration Time 1 | 0.00–600.00 sec. | 2.00 |
| | | 01-24 | S-curve Acceleration Begin Time S1 | 0.00–25.00 sec. | 1.00 |
| | | 01-25 | S-curve Acceleration Arrival Time S2 | 0.00–25.00 sec. | 1.00 |
| Decelerating | Multi-Step Speed | 01-13 | Deceleration Time 1 | 0.00–600.00 sec. | 2.00 |
| | | 01-26 | S-curve Deceleration Begin Time S3 | 0.00–25.00 sec. | 1.00 |
| | | 01-27 | S-curve Deceleration Arrival Time S4 | 0.00–25.00 sec. | 1.00 |
| Leveling | Elevator Parking | 01-71 | Leveling Speed Switch | 0.00–599.00 Hz | 0.00 |
| | | 01-72 | Lower than Leveling Speed S5 | 0.00–25.00 sec. | 1.00 |
| | | 01-73 | Deceleration Time when Operating without RUN Command | 0.00–25.00 sec. | 2.00 |
| Stopping | Delay Time | 02-40 | Brake Contracting Delay Time When Elevator Stops | 0.010–65.000 sec. | 0.250 |
| | | 02-31 | Turn Off Delay of Magnetic Contactor between Drive and Motor | 0.010–65.000 sec. | 0.200 |
| | Roll Back Adjustment | 07-01 | DC Brake Current Level | 0–100 % | 30 |
| | | 07-03 | DC Brake Time at Stop | 0.0–60.0 sec. | 0.7 |
| | | 02-42 | Brake Release Function Option | Bit 0 = 0: No function<br>Bit 0 = 1: Check torque output function switch<br>Bit 1 = 0: No function<br>Bit 1 = 1: Brake control by frequency threshold function switch | 0000h |
| | Torque Check | 02-41 | Output Current Level Setting for External Terminals | 0–100% (Rated current of drive %) | 0 |

# ■ Explanations for the Auto-tuning Steps

## Step1. Basic Parameters Settings

- Make sure that Pr.00-00 (identity code of the AC motor drive) matches with the nameplate indicated on the AC motor drive.
- Reset all parameters to defaults (set Pr.00-02 to 9 or 10).

| | |
|---|---|
| Pr.00-02<br>Parameter Reset | 0: No function<br>1: Parameter write protection<br>5: Reset kWH display to 0<br>6: Reset PLC<br>7: Reset CANopen index (slave)<br>9: All parameters are reset to defaults.<br>(Base frequency = 50 Hz)<br>10: All parameters are reset to defaults.<br>(Base frequency = 60 Hz) |

- Master Frequency Command Source: User-defined. (Pr.00-20)

| | |
|---|---|
| Pr.00-20<br>Master Frequency Command Source | 0: Digital keypad<br>1: RS-485 serial communication<br>2: External analog input (Refer to Pr.03-00)<br>3: External UP / DOWN terminal<br>6: CANopen input<br>Note: It is valid only when using with KPC-CC01. |

- Operation Command Source: User-defined. (Pr.00-21)

| | |
|---|---|
| Pr.00-21<br>Operation Command Source | 0: Digital keypad<br>1: External terminals<br>2: Communication RS-485 input<br>3: CANopen input<br>Note: it is valid only when using with KPC-CC01. |

- MI/MO External Terminal Settings

  Refer to Pr.02-01–Pr.02-07 for the external input terminals MI1–MI7.

  **NOTE:** The default for Pr.02-07 is 49 (Enable Drive). Disable this function if you do not need to use it.

| | |
|---|---|
| Pr.02-01–Pr.02-07 | 0: No function<br>1: multi-step speed command 1 / multi-step position command 1<br>2: multi-step speed command 2 / multi-step position command 2<br>3: multi-step speed command 3 / multi-step position command 3<br>4: multi-step speed command 4 / multi-step position command 4 |

| | |
|---|---|
| | 5: Reset<br>6: JOG operation<br>7: Acceleration / deceleration speed inhibit<br>8: 1st, 2nd acceleration / deceleration time selection<br>9: 3rd, 4th acceleration / deceleration time selection<br>10: EF input (Pr.07-20)<br>11: Base Block (B.B.) input from external<br>12: Output stop<br>15: Rotating speed command form AVI<br>16: Rotating speed command form ACI<br>18: Forced to stop (Pr.07-20)<br>24: FWD JOG command<br>25: REV JOG command<br>28: Emergency stop (EF1)<br>29: Signal confirmation for Y-connection<br>30: Signal confirmation for Δ-connection<br>38: Disable EEPROM writing function<br>40: Force coasting to stop<br>49: Enable Drive<br>51: Selection for PLC mode bit 0<br>52: Selection for PLC mode bit 1<br>53: Trigger CANopen quick stop<br>58: Emergency power mode detection<br>59: Magnetic contactor error detection<br>60: Mechanical brake error detection<br>61: Power loss signal<br>62: Mechanical brake error detection 2 |

Refer to Pr.02-16 and Pr.02-17 for the settings for MO1–MO7.

| | |
|---|---|
| Pr.02-16–Pr.02-17 | 0: No function<br>1: Indication during RUN<br>2: Operation speed reached<br>3: Desired frequency reached 1 (Pr.02-22)<br>4: Desired frequency reached 2 (Pr.02-24)<br>5: Zero speed (Frequency command)<br>6: Zero speed, include STOP (Frequency command)<br>7: Over-torque (Pr.06-06–06-08)<br>9: Drive is ready<br>10: Low voltage warning (LV) (Pr.06-00)<br>11: Malfunction indication<br>12: Mechanical brake signal (Pr.02-39, Pr.02-40)<br>13: Over-heat warning (Pr.06-15) |

| | |
|---|---|
| | 16: Slip error (oSL)<br>19: External interrupt B.B. input (Base Block)<br>20: Warning output<br>21: Over-voltage<br>22: Over-current stall prevention<br>23: Over-voltage stall prevention<br>24: Operation source<br>25: Forward command<br>26: Reverse command<br>27: Output when current ≥ Pr.02-41<br>28: Output when current < Pr.02-41<br>31: Y-connection for the motor coil<br>32: △-connection for the motor coil<br>33: Zero speed (actual output frequency)<br>34: Zero speed includes stop (actual output frequency)<br>35: Error output selection 1 (Pr.06-23)<br>36: Error output selection 2 (Pr.06-24)<br>37: Error output selection 3 (Pr.06-25)<br>38: Error output selection 4 (Pr.06-26)<br>40: Speed reached (including STOP)<br>44: Low current output (use with Pr.06-71–Pr.06-73)<br>45: UVW output magnetic contactor ON/OFF switch<br>50: Output control for CANopen<br>56: Power generation direction and status verification<br>57: Power generation direction<br>58: EPS MODE<br>67: Analog input level reached<br>75: Motor-controlled magnetic contactor output |

## Step 2. Motor tuning

- Set the parameters according to the motor type (IM)
- Motor auto-tuning: Set the Operation Command source to the digital keypad (Pr.00-21=0, refer to step 1)
- Control method: Set Pr.00-11.

| | |
|---|---|
| Pr.00-11<br>Speed Control Mode | 0: VF (IM V/F control)<br>2: SVC |

- Enter the motor nameplate information into Pr.01-00–01-02.

| | |
|---|---|
| Pr.01-00<br>Maximum Operation Frequency of Motor 1 | 0.00–599.00 Hz |

| | |
|---|---|
| Pr.01-01<br>Output Frequency of Motor 1 | 0.00–599.00 Hz |

| | |
|---|---|
| Pr.01-02<br>Output Voltage of Motor 1 | 230V series: 0.0–255.0 V<br>460V series: 0.0–510.0 V |

**【IM (Induction Motor)】**

- Motor auto-tuning: Set the Operation Command source to the digital keypad (Pr.00-21=0, refer to step 1) and set Pr.05-00=2

| | |
|---|---|
| Pr.05-00<br>Motor Parameter Auto-tuning | 0: No function<br>1: Dynamic test for an induction motor (IM)<br>2: Static test for an induction motor (IM) |

**NOTE 1:** You do not need to release the brake in this auto-tuning operation. Make sure that the magnetic contactor is ON when it is installed between the AC motor drive and the motor. When Pr.05-00 is set to 2, you must enter the motor no-load current in Pr.05-05. The digital keypad displays the warning message “Auto tuning” until auto-tuning is finished. Then, it saves the measured results in Pr.05-06–Pr.05-09.

**NOTE 2:** The automatic measurement of an IM motor (induction motor) can also perform dynamic measurements.

| | |
|---|---|
| Pr.05-01<br>Full-load Current for an Induction Motor (A) | 10–120 % of the drive’s rated current |
| Pr.05-02<br>Rated Power for an Induction Motor (kW) | 0.00–655.35 kW |

| | |
|---|---|
| Pr.05-03<br>Rated Speed for an Induction Motor (rpm) | 0–6553 rpm |

| | |
|---|---|
| Pr.05-04<br>Number of Poles for an Induction Motor | 2–20 |

## Step 3. Multi-Step Speed settings

### Multi-step speed settings

- Confirm the total number of speed steps (high speed, middle speed, low speed, creep, inspection and level auto-learning)
- Make sure that the step speed settings and the corresponding terminal actions for the multi-function input commands are correct (MI3–MI6).
- Set the multi-step speeds in Pr.04-00–Pr.04-14

| | | |
|---|---|---|
| Pr.04-00 to Pr.04-14 settings | 1st Step Speed Frequency | 0.00–599.00 Hz |
| | 2nd Step Speed Frequency | 0.00–599.00 Hz |
| | 3rd Step Speed Frequency | 0.00–599.00 Hz |
| | 4th Step Speed Frequency | 0.00–599.00 Hz |
| | 5th Step Speed Frequency | 0.00–599.00 Hz |
| | 6th Step Speed Frequency | 0.00–599.00 Hz |
| | 7th Step Speed Frequency | 0.00–599.00 Hz |
| | 8th Step Speed Frequency | 0.00–599.00 Hz |
| | 9th Step Speed Frequency | 0.00–599.00 Hz |
| | 10th Step Speed Frequency | 0.00–599.00 Hz |
| | 11th Step Speed Frequency | 0.00–599.00 Hz |
| | 12th Step Speed Frequency | 0.00–599.00 Hz |
| | 13th Step Speed Frequency | 0.00–599.00 Hz |
| | 14th Step Speed Frequency | 0.00–599.00 Hz |
| | 15th Step Speed Frequency | 0.00–599.00 Hz |

**NOTE:**

It is recommended that you set the maximum operating frequency to the half of maximum operating frequency before confirming each step speed setting and the corresponding terminal actions for the multi-function input commands.

- Set the acceleration/deceleration with Pr.01-23 = 08 (first and second acceleration/ deceleration time selection) and = 09 (third and fourth acceleration/deceleration time selection) for the multi-function input command Pr.02-01–02-07.
- Set the acceleration/deceleration time: Pr.01-12–Pr.01-19.

| | | |
|---|---|---|
| Pr.01-12 to Pr.01-19 settings | Acceleration Time 1 | 0.00–600.00 sec. |
| | Deceleration Time 1 | 0.00–600.00 sec. |
| | Acceleration Time 2 | 0.00–600.00 sec. |
| | Deceleration Time 2 | 0.00–600.00 sec. |
| | Acceleration Time 3 | 0.00–600.00 sec. |
| | Deceleration Time 3 | 0.00–600.00 sec. |
| | Acceleration Time 4 | 0.00–600.00 sec. |
| | Deceleration Time 4 | 0.00–600.00 sec. |

**NOTE:**

It is recommended that you set the Pr.01-73 (deceleration time) to the smallest value for the

trial run to ensure all the actions are correct, then increase it for the final test.

- JOG Acceleration/Deceleration Time Setting: Pr.01-20–Pr.01-22

| | | |
|---|---|---|
| Pr.01-20 to Pr.01-22 settings | JOG Acceleration Time | 0.00–600.00 sec. |
| | JOG Deceleration Time | 0.00–600.00 sec. |
| | JOG Frequency | 0.00–600.00 sec. |

- S-curve Setting: Pr.01-24–Pr.01-34, Pr.01-71, Pr.01-72

| | | |
|---|---|---|
| Pr.01-24–Pr.01-34, Pr.01-71, Pr.01-72 settings | S-curve Acceleration Begin Time S1 | 0.00–25.00 sec. |
| | S-curve Acceleration Arrival Time S2 | 0.00–25.00 sec. |
| | S-curve Deceleration Begin Time S3 | 0.00–25.00 sec. |
| | S-curve Deceleration Arrival Time S4 | 0.00–25.00 sec. |
| | Zero-speed mode | 0: Output waiting<br>1: Zero-speed operation<br>2: Fmin (refer to Pr.01-07) |
| | Leveling Speed Switch | 0.00–599.00 Hz |
| | Lower than Leveling Speed S5 | 0.00–25.00 sec. |

**NOTE:**

It is recommended that you set the S-curve time to 0 for the trial run to ensure all the actions are correct, and then increase it for the final test.

## Step 4. Trial run

Use the trial run after you complete Step 1 to Step 3 above to check if the motor runs normally after executing the inspection with a loaded motor. At the same time, check if the multi-function output terminal operations are correct (such as whether the action of the brake release and magnetic contactor match the host controller).

Also check the speed, current value, and check for noise in the carriage and other noise sources when switching between each step.

## Step 5. Elevator tuning

1. **Enable slip compensation**

   To disable the slip compensation, set Pr.07-27 = 0, Pr.07-34 = 0 and Pr.07-35 = 0.
   To enable the slip compensation, set Pr.07-27 > 0, Pr.07-34 > 0 and Pr.07-35 > 0.
   Adjust the settings in Pr.07-27, Pr.07-34 and Pr.07-35.

| | |
|---|---|
| Pr.07-27<br>Slip Compensation Gain | 0.00–10.00 |

| | |
|---|---|
| Pr.07-34<br>Slip compensation gain %<br>(Power generation mode) | 0.0–100.0% |

| | |
|---|---|
| Pr.07-35<br>Slip compensation gain %<br>(Electricity mode) | 0.0–100.0% |

**2. Start-up Adjustment**

Adjust the minimum output voltage to avoid start-up failure.
V/F control: Adjust settings in Pr.01-04, Pr.01-06, Pr.01-08.
SVC control: Adjust settings in Pr.01-08.

| | |
|---|---|
| Pr.01-04<br>Mid-point voltage 1 of motor 1 | 230 V series : 0.0 V–240.0 V<br>460 V series : 0.0 V–480.0 V |

| | |
|---|---|
| Pr.01-06<br>Mid-point voltage 2 of motor 1 | 230 V series : 0.0 V–240.0 V<br>460 V series : 0.0 V–480.0 V |

| | |
|---|---|
| Pr.01-08<br>Minimum output voltage of motor 1 | 230 V series : 0.0 V–240.0 V<br>460 V series : 0.0 V–480.0 V |

### 3. Adjust DC brake

Adjust settings in Pr.07-01, Pr.07-02, Pr.07-03.

| | |
|---|---|
| Pr.07-01<br>DC brake current level | 0–100 % |

| | |
|---|---|
| Pr.07-02<br>DC brake time at start-up | 0.0–60.0 sec. |

| | |
|---|---|
| Pr.07-03<br>DC brake time at stop | 0.0–60.0 sec. |

### 4. Adjust elevator parking

Adjust settings in Pr.01-71, Pr.01-72, Pr.01-73.

| | |
|---|---|
| Pr.01-71<br>Leveling Speed Switch | 0.00–599.00 Hz |

| | |
|---|---|
| Pr.01-72<br>Lower than Leveling Speed S5 | 0.00–25.00 sec. |

| | |
|---|---|
| Pr.01-73<br>Deceleration Time when Operating without RUN Command | 0.00–25.00 sec. |

## ■ Frequently Asked Questions (FAQs)

■ Roll-Back Solution :

1. Bit1: See the elevator timing diagram on page 12-02-15 in Parameter Group 2 in Chapter 12.
2. Set contactor delay and DC brake (Pr.07-01 and Pr.07-03) constant time during stop.
3. Set Pr.02-42 Bit 1=1.
4. Set frequencies for brake release and brake engage (Pr.02-43 and Pr.02-44) to solve roll-back issue.

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# Chapter 16 CANopen Overview

16-1 CANopen Overview

16-2 Wiring for CANopen

16-3 CANopen Communication Interface Descriptions

16-3-1 CANopen Control Mode Selection

16-3-2 DS402 Standard Control Mode

16-3-3 By Using Delta Standard

16-3-4 DI/DO AI are controlled through CANopen

16-4 CANopen Supporting Index

16-5 CANopen Fault Codes

16-6 CANopen LED Function

The built-in CANopen function is a kind of remote control. You can control the AC motor drive using the CANopen protocol. CANopen is a CAN-based higher layer protocol that provides standardized communication objects, including real-time data (Process Data Objects, PDO), configuration data (Service Data Objects, SDO), and special functions (Time Stamp, Sync message, and Emergency message). It also has network management data, including Boot-up message, NMT message, and Error Control message. Refer to the CiA website http://www.can-cia.org/ for details. The content of this instruction sheet may be revised without prior notice. Consult our distributors or download the most updated version at http://www.delta.com.tw/industrialautomation.

**Delta CANopen supported functions:**

- Supports CAN2.0A Protocol
- Supports CANopen DS301 V4.02
- Supports DSP-402 V2.0

**Delta CANopen supported services:**

- PDO (Process Data Objects): PDO1–PDO4
- SDO (Service Data Objects):
  Initiate SDO Download;
  Initiate SDO Upload;
  Abort SDO;
  You can use the SDO message to configure the slave node and access the Object Dictionary in every node.
- SOP (Special Object Protocol):
  Supports default COB-ID in Predefined Master/Slave Connection Set in DS301 V4.02;
  Supports SYNC service;
  Supports Emergency service.
- NMT (Network Management):
  Supports NMT module control;
  Supports NMT Error control;
  Supports Boot-up.

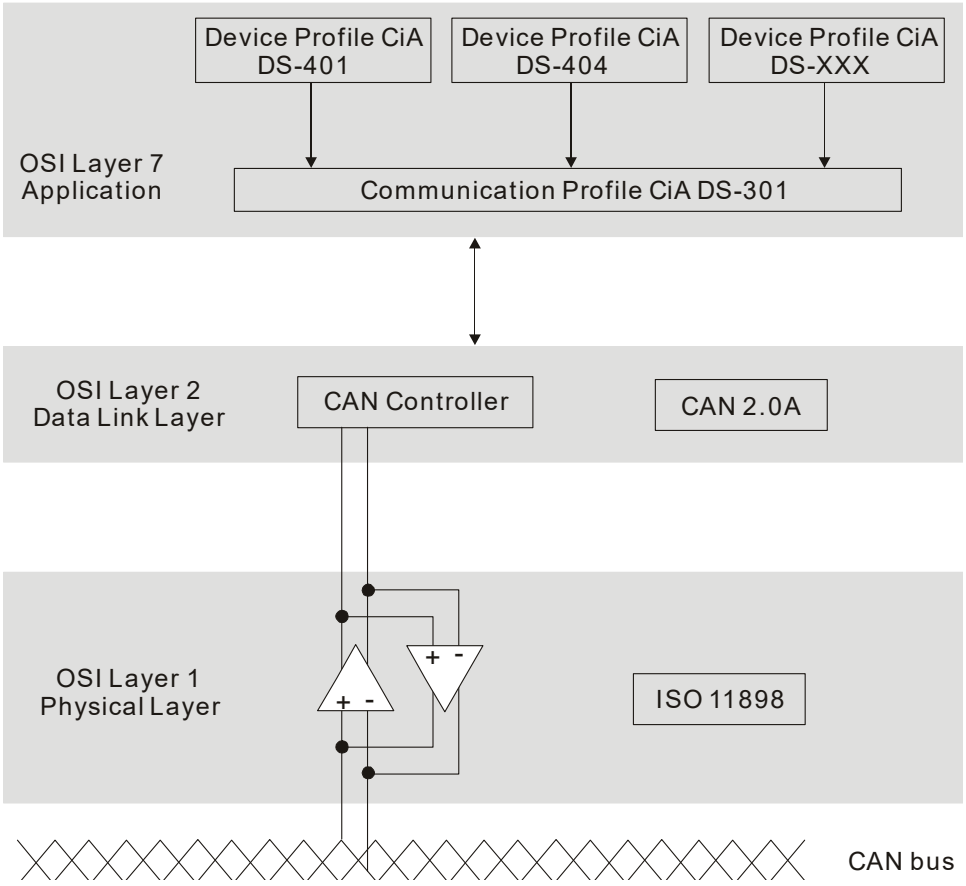
**Delta CANopen does not support this service:**

- Time Stamp service

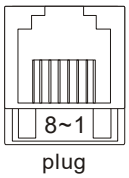
# 16-1 CANopen Overview

## ● CANopen Protocol

CANopen is a CAN-based higher layer protocol, and was designed for motion-oriented machine control networks such as handling systems. Version 4.02 of CANopen (CiA DS301) is standardized as EN50325-4. The CANopen specifications cover the application layer and communication profile (CiA DS301), as well as a framework for programmable devices (CiA 302), recommendations for cables and connectors (CiA 303-1) and SI units and prefix representations (CiA 303-2).




**RJ45 Pin Definition**



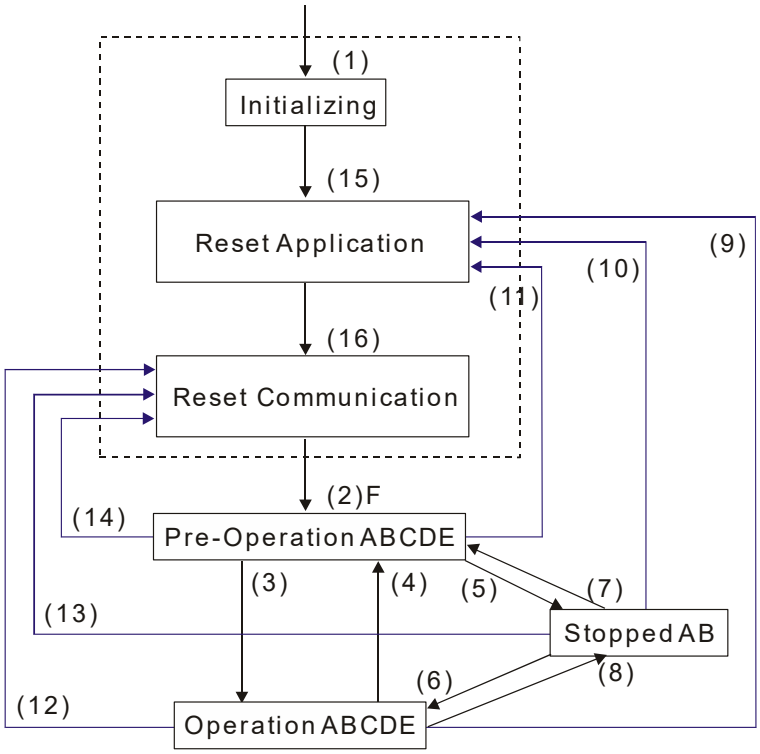

| PIN | Signal | Description |
|---|---|---|
| 1 | CAN_H | CAN_H bus line (dominant high) |
| 2 | CAN_L | CAN_L bus line (dominant low) |
| 3 | CAN_GND | Ground / 0 V /V- |
| 6 | CAN_GND | Ground / 0 V /V- |

**CANopen Communication Protocol** contains the following services:

- NMT (Network Management Object)
- SDO (Service Data Objects)
- PDO (Process Data Objects)
- EMCY (Emergency Object)

## NMT (Network Management Object)

The Network Management (NMT) follows a Master/Slave structure for executing NMT service. A network has only one NMT master, and the other nodes are slaves. All CANopen nodes have a present NMT state, and the NMT master can control the state of the slave nodes. The following shows the state diagram of a node:




(1) After power is applied, start in the auto-initialization state
(2) Automatically enter the pre-operational state
(3) (6) Start remote node
(4) (7) Enter the pre-operational state
(5) (8) Stop remote node
(9) (10) (11) Reset node
(12) (13) (14) Reset communication
(15) Automatically enter reset application state
(16) Automatically enter reset communication state

A: NMT
B: Node Guard
C: SDO
D: Emergency
E: PDO
F: Boot-up

| | Initializing | Pre-Operational | Operational | Stopped |
|---|---|---|---|---|
| PDO | | | ○ | |
| SDO | | ○ | ○ | |
| SYNC | | ○ | ○ | |
| Time Stamp | | ○ | ○ | |
| EMCY | | ○ | ○ | |
| Boot-up | ○ | | | |
| NMT | | ○ | ○ | ○ |

## SDO (Service Data Objects)

Use SDO to access the Object Dictionary in every CANopen node using the Client/Server model. One SDO has two COB-IDs (request SDO and response SDO) to upload or download data between two nodes. There is no data limit for SDOs to transfer data, but it must transfer data by segment when the data exceeds four bytes with an end signal in the last segment. The MH300-L series does not currently support segment transmission.

The Object Dictionary (OD) is a group of objects in a CANopen node. Every node has an OD in the system, and OD contains all parameters describing the device and its network behavior. The access path in the OD is the index and sub-index; each object has a unique index in the OD, and has a sub-index if necessary. The following shows the request and response frame structure of SDO communication:

## PDO (Process Data Objects)

PDO communication can be described by the producer/consumer model. Each node of the network listens to the messages of the transmission node and distinguishes whether the message has to be processed or not after receiving the message. A PDO can be transmitted from one device to one another device or to many other devices. Every PDO has two PDO services: a TxPDO and an RxPDO. PDOs are transmitted in a non-confirmed mode. All transmission types are listed in the following table:

| Type Number | PDO | | | | |
|---|---|---|---|---|---|
| | Cyclic | Acyclic | Synchronous | Asynchronous | RTR only |
| 0 | | ○ | ○ | | |
| 1–240 | ○ | | ○ | | |
| 241–251 | Reserved | | | | |
| 252 | | | ○ | | ○ |
| 253 | | | | ○ | ○ |
| 254 | | | | ○ | |
| 255 | | | | ○ | |

Type number 0 indicates the synchronous aperiodic message between two PDO transmissions.
Type number 1-240 indicates the number of SYNC message between two PDO transmissions.
Type number 252 indicates the data is updated (but not sent) immediately after receiving SYNC.
Type number 253 indicates the data is updated immediately after receiving RTR.
Type number 254: Delta CANopen does not support this transmission format.
Type number 255 indicates the data is an asynchronous aperiodic transmission.

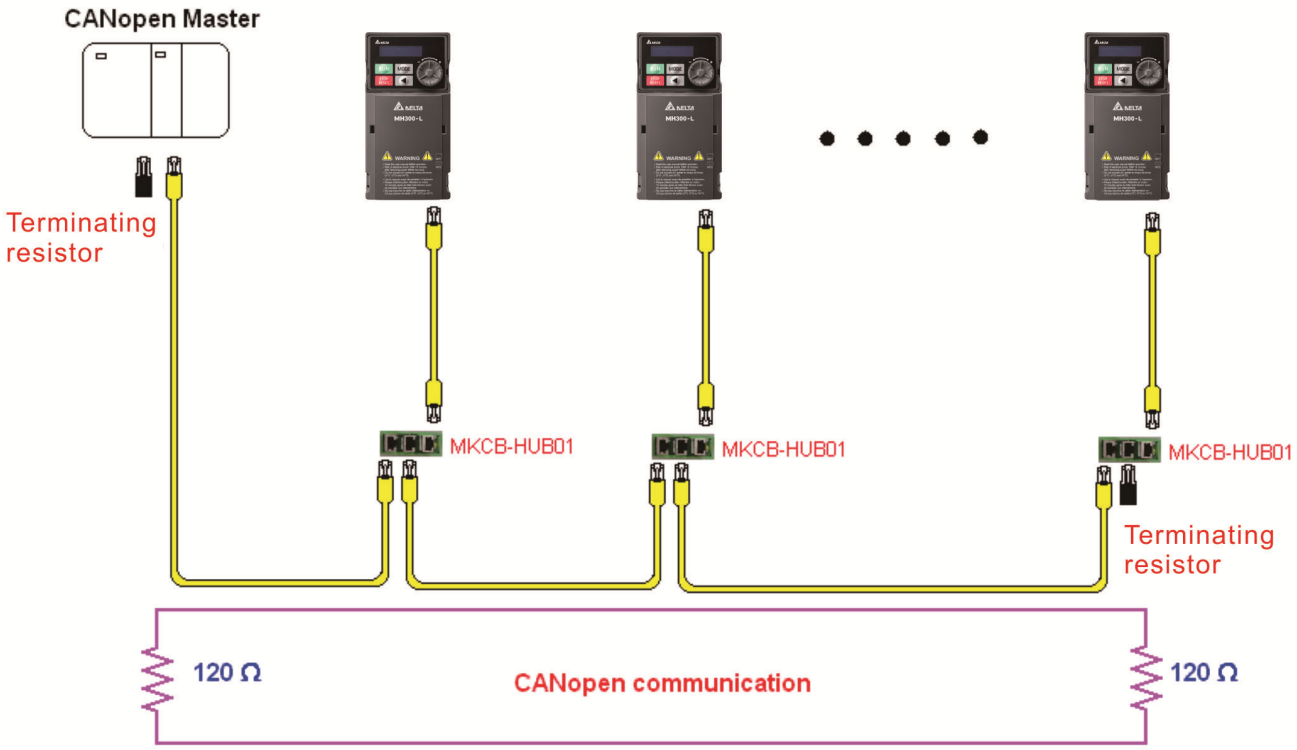
All PDO transmission data must be mapped to the index with Object Dictionary.

## EMCY (Emergency Object)

When errors occur inside the hardware, an emergency object is triggered. An emergency object is only sent when an error occurs. As long as there is nothing wrong with the hardware, there is no emergency object warning of an error message.

## 16-2 Wiring for CANopen

Use an external CANopen communication splitter box (MKCB-HUB01) for built-in CANopen wiring to connect CANopen to an MH300-L. The link uses an RJ45 cable. You must terminate the two farthest ends with 120 Ω terminating resistors as shown in the picture below.



# 16-3 CANopen Communication Interface Descriptions

## 16-3-1 CANopen Control Mode Selection

There are two control modes for CANopen: the DS402 standard (Pr.09-40 set to 1) is the default, and the Delta's standard setting (Pr.09-40 set to 0). The following table shows the control mode definitions:

| CANopen control mode | Control mode Speed | | Operation control | | Other | |
|---|---|---|---|---|---|---|
| | Index | Description | Index | Description | Index | Description |
| DS402 Pr.09-40=1 | 6042-00 | Target rotating speed (RPM) | 6040-00 | Operation Command | 605A-00 | Quick stop processing mode |
| | ----- | ----- | ----- | ----- | 605C-00 | Disable operation processing mode |
| Delta Standard Pr.09-40=0 | 2060-03 | Target rotating speed (Hz) | 2060-01 | Operation Command | ----- | ----- |
| | ----- | ----- | ----- | ----- | ----- | ----- |

You can use some indices in either DS402 or Delta's standard.

For example:

1. Indices that are defined as RO attributes.
2. The corresponding index of available parameter groups: (2000-00–200E-XX)
3. Accelerating/Decelerating Index: 604F 6050

## 16-3-2 DS402 Standard Control Mode

### 16-3-2-1 Related set up for an AC motor drive (following the DS402 standard)

If you want to use the DS402 standard to control the motor drive, follow these steps:

1. Wire the hardware (refer to Section 16-2 Wiring for CANopen).
2. Set the operation source: set Pr.00-21 to 3 for CANopen communication card control.
3. Set the frequency source: set Pr.00-20 to 6. Choose the source for the Frequency command from the CANopen setting.
4. Set DS402 for the control mode: Pr.09-40 = 1
5. Set the CANopen station: set the CANopen station (range 1–127, 0 is the disable CANopen slave function) with Pr.09-36. Note: set Pr.00-02 = 7 to reset if the station number error CAdE or CANopen memory error CFrE appears.
6. Set the CANopen baud rate: set Pr.09-37 (CANBUS Baud Rate: 1 M (0), 500 K (1), 250 K (2), 125 K (3), 100 K (4) or 50 K (5)).
7. Set the multiple input functions to Quick Stop. You can also choose enable or disable; the default setting is disabled. If it is necessary to enable the function, set MI terminal to 53 in one of the following parameters: Pr.02-01–02-07 or Pr.02-26–02-28. Note: This function is available in DS402 only.

## 16-3-2-2 The status of the motor drive (by following DS402 standard)

According to the DS402 definition, the motor drive is divided into 3 blocks and 9 statuses as described below.

**3 blocks**

1. Power Disable: without PWM output
2. Power Enable: with PWM output
3. Fault: one or more errors have occurred.

**9 status**

1. Start: power on
2. Not Ready to Switch On: the motor drive is initiating.
3. Switch On Disable: occurs when the motor drive finishes initiating.
4. Ready to Switch On: warming up before running.
5. Switch On: the motor drive has the PWM output, but the reference command is not effective.
6. Operation Enable: able to control normally.
7. Quick Stop Active: when there is a Quick Stop request, stop running the motor drive.
8. Fault Reaction Active: the motor drive detects conditions which might trigger error(s).
9. Fault: one or more errors have occurred in the motor drive.

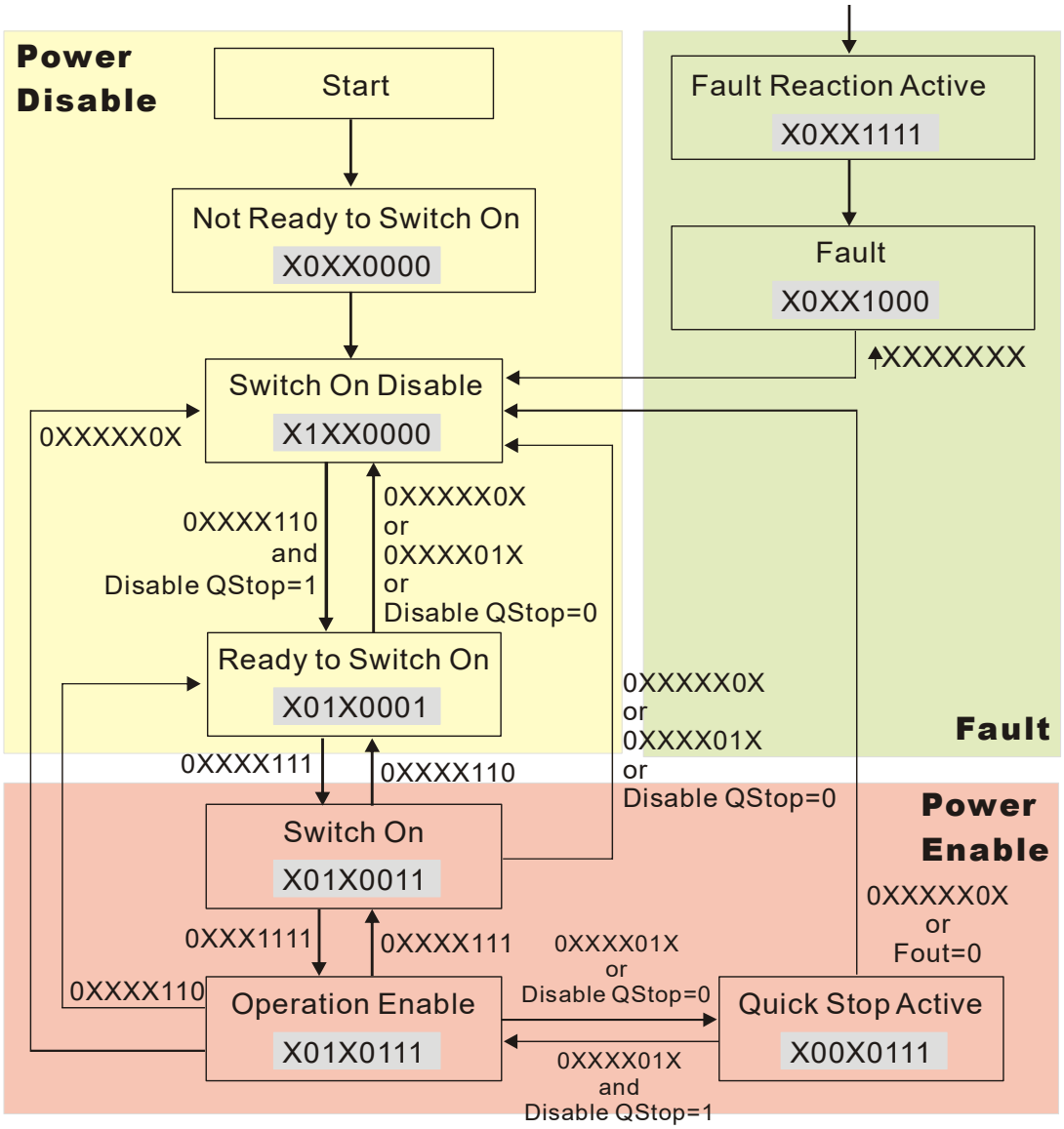
When the motor drive turns on and finishes the initiation, it remains in Ready to Switch On status. To control the operation of the motor drive, change to Operation Enable status. To do this, set the control word's bit0–bit3 and bit7 of the Index 6040H and pair with Index Status Word (Status Word 0X6041). The control steps and index definition are described below:

Index 6040

| 15–9 | 8 | 7 | 6–4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserved | Halt | Fault Reset | Operation | Enable operation | Quick Stop | Enable Voltage | Switch On |

Index 6041

| 15–14 | 13–12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | Operation | Internal limit active | Target reached | Remote | Reserved | Warning | Switch on disabled | Quick stop | Voltage enabled | Fault | Operation enable | Switch on | Ready to switch on |




Set command 6040 = 0xE, and then set another command 6040 = 0xF. Then you can switch the motor drive to Operation Enable. The Index 605A determines the direction of the lines from Operation Enable when the control mode changes from Quick Stop Active. When the setting value is 5–7, both lines are active, but when the setting value of 605A is not 5–7, once the motor drive is switched to Quick Stop Active, it is not able to switch back to Operation Enable.

| Index | Sub | Definition | Default | R/W | Size | Unit | PDO Map | Mode | note |
|---|---|---|---|---|---|---|---|---|---|
| 605Ah | 0 | Quick stop option code | 2 | RW | S16 | | No | | 0: Disable drive function<br>1: Slow down on slow down ramp<br>2: Slow down on quick stop ramp<br>5: Slow down on slow down ramp and stay in Quick Stop<br>6: Slow down on quick stop ramp and stay in Quick Stop<br>7: Slow down on the current limit and stay in Quick Stop |

When the control section switches from Power Enable to Power Disable, use 605C to define the stop method.

| Index | Sub | Definition | Default | R/W | Size | Unit | PDO Map | Mode | note |
|---|---|---|---|---|---|---|---|---|---|
| 605Ch | 0 | Disable operation option code | 1 | RW | S16 | | No | | 0: Disable drive function<br>1: Slow down with slow down ramp; disable the drive function. |

## 16-3-2-3 Various mode control method (by following DS402 standard)

**Speed mode:**

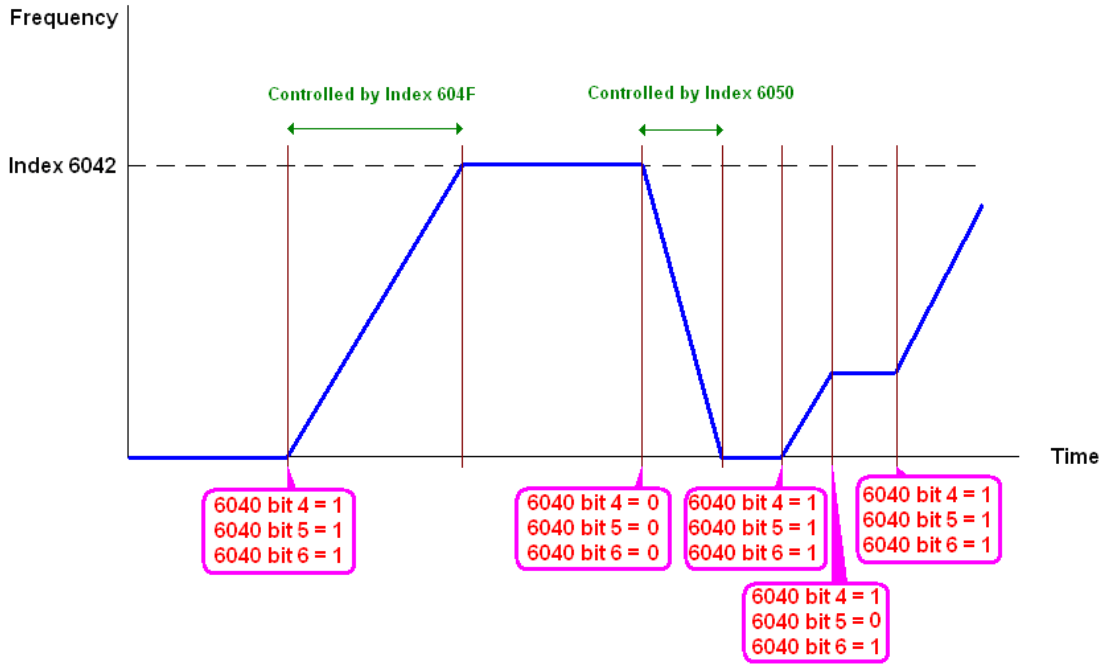
1. Set MH300-L to speed control mode: set Index6060 to 2.
2. Switch to Operation Enable mode: set 6040 = 0xE, and then set 6040 = 0xF.
3. Set the target frequency: set target frequency for 6042, since the operation unit of 6042 is rpm, a transform is required:

   $$n = f \times \frac{120}{p}$$

   n: rotation speed (rpm) (rounds/minute)
   p: number of poles in the motor (Pole)
   f: rotation frequency (Hz)

   For example:
   Set 6042H = 1500 (rpm), if the number of poles is 4 (Pr.05-04 or Pr.05-16), then the motor drive's operation frequency is 1500 (120/4) = 50 Hz. The 6042 is defined as a signed operation. The plus or minus sign means to rotate clockwise or counter-clockwise.
4. To set acceleration and deceleration: use 604F (Acceleration) and 6050 (Deceleration).
5. Trigger an ACK signal: in the speed control mode, the bit 6–4 of Index 6040 needs to be controlled. It is defined below:

| | Index 6040 | | | SUM |
|---|---|---|---|---|
| | bit 6 | bit 5 | bit 4 | |
| Speed mode (Index 6060 = 2) | 1 | 0 | 1 | Locked at the current signal. |
| | 1 | 1 | 1 | Run to reach targeting signal. |
| | Other | | | Decelerate to 0 Hz. |




NOTE 01: Read 6043 to get the current rotation speed (unit: rpm).

NOTE 02: Read bit 10 of 6041 to find if the rotation speed has reached the targeting value (0: Not reached; 1: Reached).

## 16-3-3 By Using Delta Standard

### 16-3-3-1 Related set up for an AC motor drive

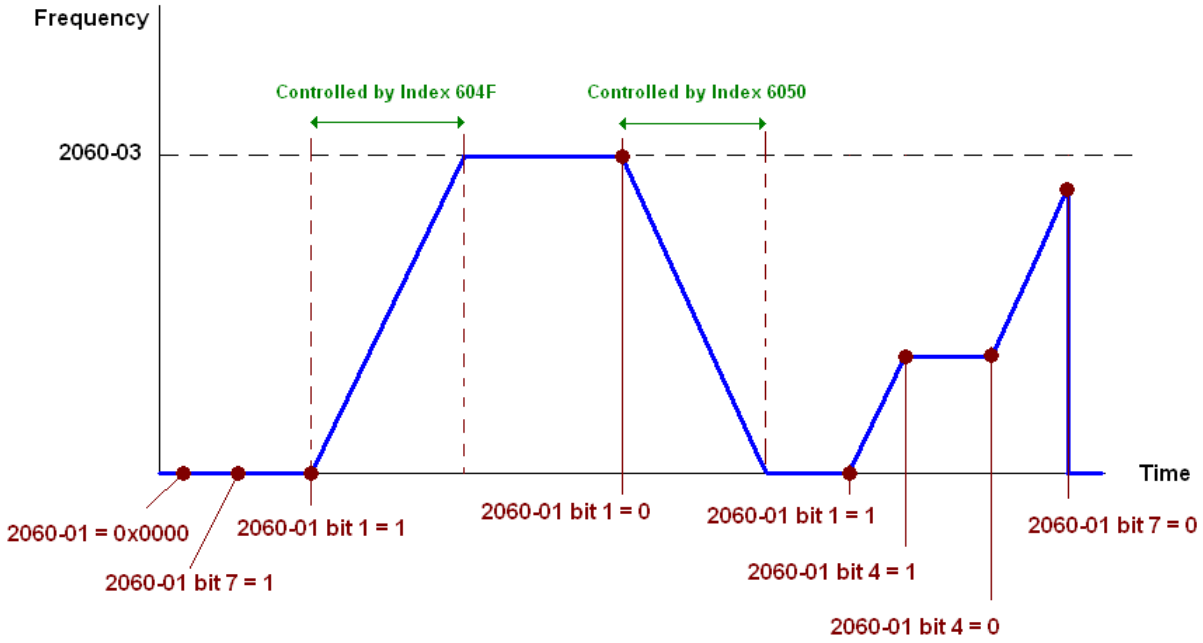
Follow the steps below:

1. Wire the hardware (refer to Section 16-2 Wiring for CANopen).
2. Set the operation source: set Pr.00-21 to 3 for CANopen communication card control.
3. Set the frequency source: set Pr.00-20 to 6. Choose the source for the Frequency command from the CANopen setting.
4. Set Delta Standard as the control mode: Pr.09-40 = 0.
5. Set the CANopen station: set Pr.09-36; the range is between 1–127. When Pr.09-36 = 0, the CANopen slave function is disabled. Note: if an error appears (CAdE or CANopen memory error) as you complete the station setting, set Pr.00-02 = 7 to reset.
6. Set the CANopen baud rate: set Pr.09-37 (CANBUS Baud Rate: 1 M (0), 500 K (1), 250 K (2), 125 K (3), 100 K (4) and 50 K (5)).

### 16-3-3-2 Various mode control method

**Speed Mode:**

1. Set MH300-L to speed control mode: set index 6060 = 2 or index 2060-02 = 0.
2. Set the target frequency: set 2060-03, unit is Hz, with 2 decimal places. For example 1000 is 10.00 Hz.
3. Operation control: set 2060-01 = 008H for server on, and set 2060-01 = 0081H for running.




## 16-3-4 DI/DO AI are controlled through CANopen

To control the DO of the motor drive through CANopen, follow these steps:

1. Define the DO to be controlled by CANopen. For example, set Pr.02-13 = 50 to control RY1.
2. To control DO, use control Index 2026-41. To set RY1 as ON, set bit 0 of Index 2026-41 = 1, then RY1 outputs 1. To control AFM output = 50.00%, set Index 2026-A1 = 5000, then AFM outputs 50%.

The following table shows the mapping of CANopen DI DO AI:

DI:

| Terminal | Related Parameters | R/W | Mapping Index |
|---|---|---|---|
| MI 1 | Pr.02-01 | RO | 2026-01 bit 2 |
| MI 2 | Pr.02-02 | RO | 2026-01 bit 3 |
| MI 3 | Pr.02-03 | RO | 2026-01 bit 4 |
| MI 4 | Pr.02-04 | RO | 2026-01 bit 5 |
| MI 5 | Pr.02-05 | RO | 2026-01 bit 6 |
| MI 6 | Pr.02-06 | RO | 2026-01 bit 7 |
| MI 7 | Pr.02-07 | RO | 2026-01 bit 8 |
| MI 10 | Pr.02-26 | RO | 2026-01 bit 10 |
| MI 11 | Pr.02-27 | RO | 2026-01 bit 11 |
| MI 12 | Pr.02-28 | RO | 2026-01 bit 12 |

DO:

| Terminal | Related Parameters | R/W | Mapping Index |
|---|---|---|---|
| RY1 | Pr.02-13 = 50 | RW | 2026-41 bit 0 |
| MO1 | Pr.02-16 = 50 | RW | 2026-41 bit 3 |
| MO2 | Pr.02-17 = 50 | RW | 2026-41 bit 4 |
| MO10 (RY10) | | RW | 2026-41 bit 5 |
| MO11 (RY11) | | RW | 2026-41 bit 6 |
| MO12 (RY12) | | RW | 2026-41 bit 7 |

AI:

| Terminal | Related Parameters | R/W | Mapping Index |
|---|---|---|---|
| AVI | == | RO | Value of 2026-61 |
| ACI | == | RO | Value of 2026-62 |
| AI10 | == | RO | Value of 2026-64 |
| AI11 | == | RO | Value of 2026-65 |

# 16-4 CANopen Supporting Index

CANopen Remote IO mapping

| Index | Sub | R/W | Definition |
|---|---|---|---|
| 2026H | 01h | R | Each bit corresponds to different input terminals. |
| | 02h | R | Each bit corresponds to different input terminals. |
| | 03h–40h | R | Reserved |
| | 41h | RW | Each bit corresponds to different output terminals. |
| | 42h–60h | R | Reserved |
| | 61h | R | AVI (%) |
| | 62h | R | ACI (%) |
| | 63h | R | Reserved |
| | 64h | | AI10 (%) |
| | 65h | | AI11 (%) |
| | 66h–A0h | R | Reserved |
| | A1h | RW | AFM (%) |

| Index 2026-01 | bit 0 | bit 1 | bit 2 | bit 3 | bit 4 | bit 5 | bit 6 | bit 7 | bit8 | bit9 | bit10 | bit11 | bit12 | bit13 | bit14 | bit15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MI1 | MI2 | MI3 | MI4 | MI5 | MI6 | MI7 | | | | | | | | | |
| 2 | | | | | | | | | | | MI10 | MI11 | MI12 | | | |

1: Control broad I/O

2: Add external card, EMM-D3R2CA (D1022 = 9)

| Index 2026-41 | bit 0 | bit 1 | bit 2 | bit 3 | bit 4 | bit 5 | bit 6 | bit 7 | bit8 | bit9 | bit10 | bit11 | bit12 | bit13 | bit14 | bit15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | RY1 | | | MO1 | MO2 | | | | | | | | | | | |
| 2 | | | | | | RY10 | RY11 | | | | | | | | | |

1: Control broad I/O

2: Add external card, EMM-D3R2CA (D1022 = 9)

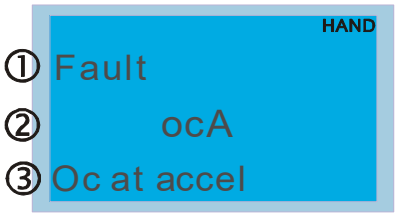
## Delta Standard Mode

| Index | sub | R/W | Size | Descriptions | | | Speed Mode |
|---|---|---|---|---|---|---|---|
| | | | | bit | Definition | Priority | |
| 2060h | 00h | R | U8 | | | | |
| | 01h | RW | U16 | 0 | Ack | 4 | 0: fcmd =0<br>1: fcmd = Fset (Fpid) |
| | | | | 1 | Dir | 4 | 0: FWD run command<br>1: REV run command |
| | | | | 2 | | | |
| | | | | 3 | Halt | | 0: Drive runs until target speed is reached<br>1: Drive stops by declaration setting |
| | | | | 4 | Hold | | 0: Drive runs until target speed is reached<br>1: Frequency stop at current frequency |
| | | | | 5 | JOG | | 0:JOG OFF<br>Pulse 1: JOG RUN |
| | | | | 6 | QStop | | Quick Stop |
| | | | | 7 | Power | | 0: Power OFF<br>1: Power ON |
| | | | | 14–8 | Cmd SW | | Multi-step frequency switching |
| | | | | 15 | | | Pulse 1: Fault code cleared |
| | 02h | RW | U16 | | | | |
| | 03h | RW | U16 | | | | Speed command (unsigned decimal) |
| | 04h | RW | U16 | | | | |
| | 05h | RW | S32 | | | | |
| | 06h | RW | | | | | |
| | 07h | RW | U16 | | | | |
| | 08h | RW | U16 | | | | |
| 2061h | 01h | R | U16 | 0 | Arrive | | Frequency reached |
| | | | | 1 | Dir | | 0: Motor FWD run<br>1: Motor REV run |
| | | | | 2 | Warn | | Warning |
| | | | | 3 | Error | | Error detected |
| | | | | 4 | | | |
| | | | | 5 | JOG | | JOG |
| | | | | 6 | QStop | | Quick stop |
| | | | | 7 | Power ON | | Switch ON |
| | | | | 15–8 | | | |
| | 02h | R | | | | | |
| | 03h | R | U16 | | | | Actual output frequency |
| | 04h | R | | | | | |
| | 05h | R | S32 | | | | Actual position (absolute) |
| | 06h | R | | | | | |
| | 07h | R | S16 | | | | Actual torque |

## DS402 Standard

| Index | Sub | Definition | Default | R/W | Size | Unit | PDO Map | Mode | Note |
|---|---|---|---|---|---|---|---|---|---|
| 6007h | 0 | Abort connection option code | 2 | RW | S16 | | Yes | | 0: No action<br>2: Disable voltage<br>3: Quick Stop |
| 603Fh | 0 | Error code | 0 | R0 | U16 | | Yes | | |
| 6040h | 0 | Control word | 0 | RW | U16 | | Yes | | |
| 6041h | 0 | Status word | 0 | R0 | U16 | | Yes | | |
| 6042h | 0 | vl target velocity | 0 | RW | S16 | rpm | Yes | vl | |
| 6043h | 0 | vl velocity demand | 0 | RO | S16 | rpm | Yes | vl | |
| 6044h | 0 | vl control effort | 0 | RO | S16 | rpm | Yes | vl | |
| 604Fh | 0 | vl ramp function time | 10000 | RW | U32 | 1ms | Yes | vl | Unit must be 100 ms, and check if the setting is 0. |
| 6050h | 0 | vl slow down time | 10000 | RW | U32 | 1ms | Yes | vl | |
| 6051h | 0 | vl quick stop time | 1000 | RW | U32 | 1ms | Yes | vl | |
| 605Ah | 0 | Quick stop option code | 2 | RW | S16 | | No | | 0: Disable drive function<br>1: Slow down on slow down ramp<br>2: Slow down on quick stop ramp<br>5: Slow down on slow down ramp and stay in QUICK STOP<br>6: Slow down on quick stop ramp and stay in QUICK STOP |
| 605Ch | 0 | Disable operation option code | 1 | RW | S16 | | No | | 0: Disable drive function<br>1: Slow down with slow down ramp; disable the drive function |
| 6061h | 0 | Mode of operation display | 2 | RO | S8 | | Yes | | Same as above |

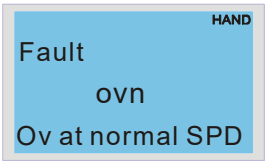
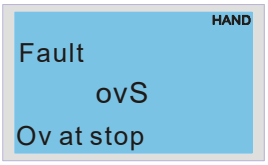
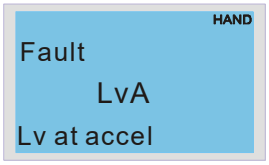
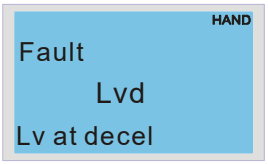
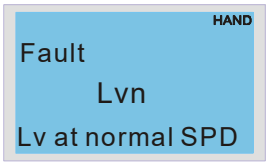
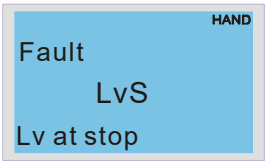
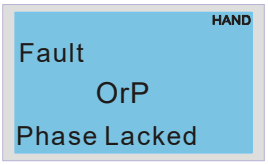
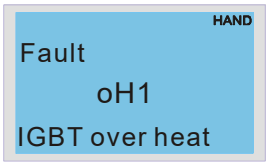
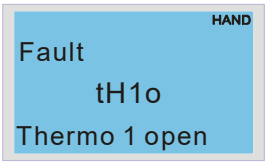
## 16-5 CANopen Fault Codes

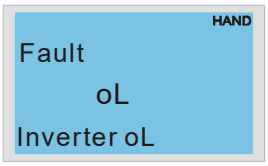
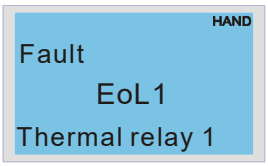
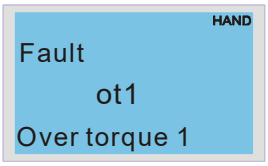
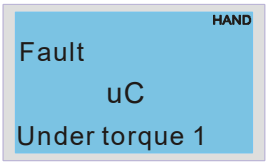
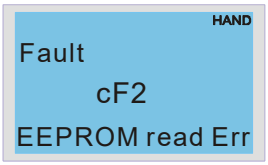
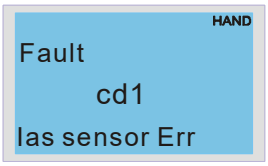
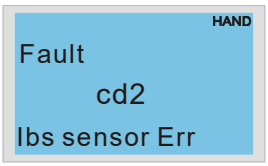
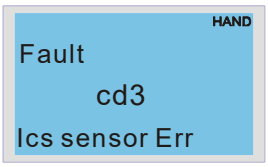


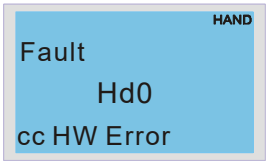
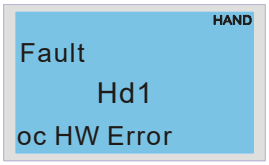
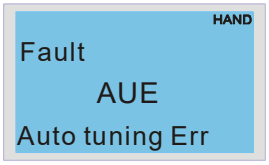
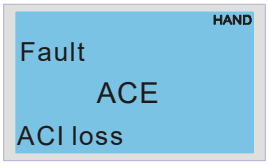
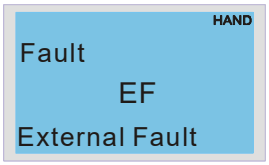
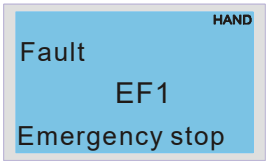
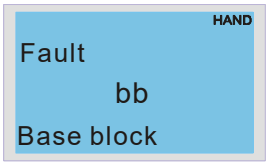
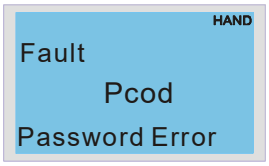
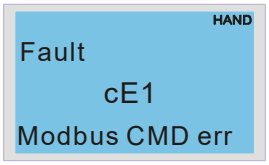

① Display error signal
② Abbreviation for error code
The code displays as shown on KPMH-LC01
③ Display error description

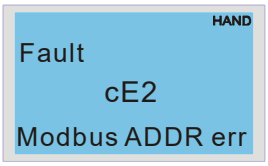
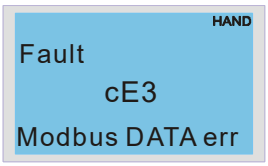
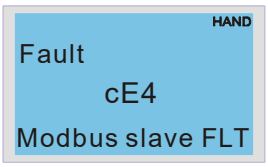
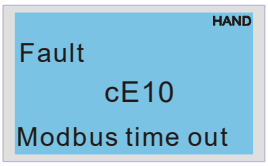
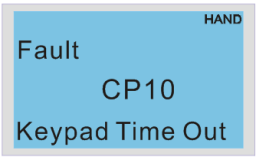
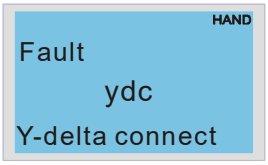
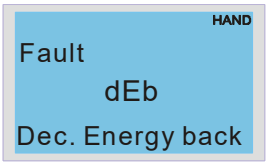
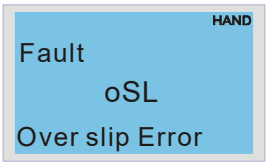
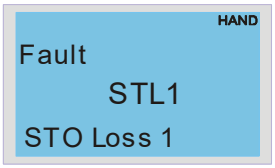
* Refer to settings for Pr.06-17–Pr.06–22.

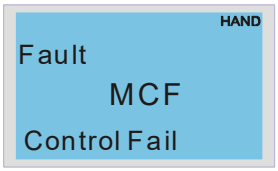
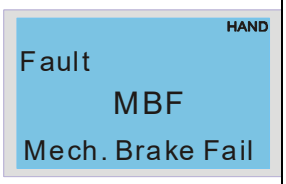
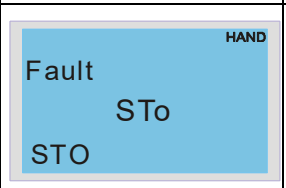
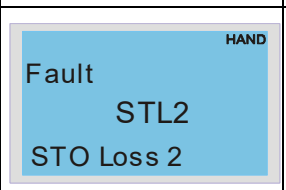
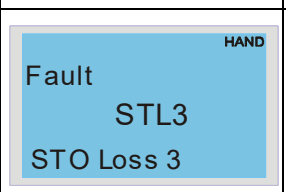
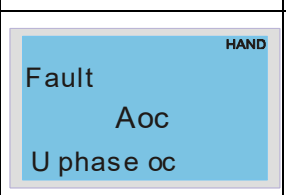
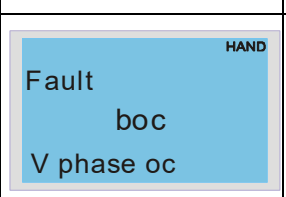
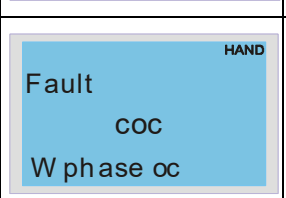
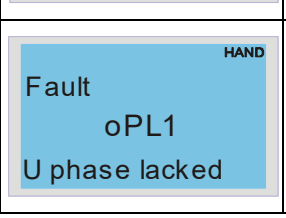
| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 1 | HAND<br>Fault<br>ocA<br>Oc at accel | 0001H | Over-current during acceleration | 1 | 2213H |
| 2 | HAND<br>Fault<br>ocd<br>Oc at decel | 0002H | Over-current during deceleration | 1 | 2213H |
| 3 | HAND<br>Fault<br>ocn<br>Oc at normal SPD | 0003H | Over-current during steady operation | 1 | 2214H |
| 4 | HAND<br>Fault<br>GFF<br>Ground fault | 0004H | Ground fault. When one of the output terminal(s) is grounded, the short circuit current is more than 50% of the AC motor drive rated current.<br>Note: the short circuit protection is provided for the AC motor drive protection, not to protect you. | 1 | 2240H |
| 6 | HAND<br>Fault<br>ocS<br>Oc at stop | 0006H | Over-current at stop. Hardware failure in current detection. | 1 | 2214H |
| 7 | HAND<br>ovA<br>Ov at accel | 0007H | Over-current during acceleration. Hardware failure in current detection. | 2 | 3210H |
| 8 | HAND<br>Fault<br>ovd<br>Ov at decel | 0008H | Over-current during deceleration. Hardware failure in current detection. | 2 | 3210H |

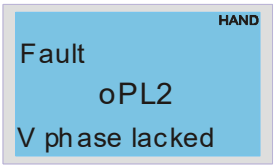
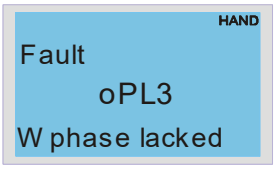
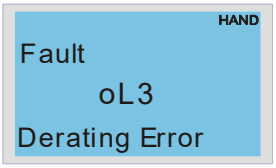
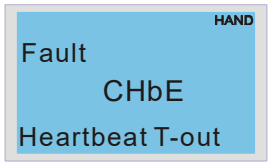
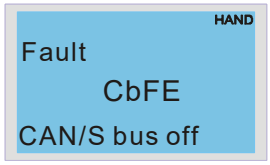
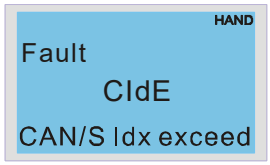
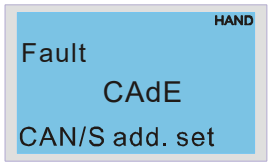
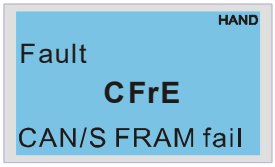
| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 9 |  | 009H | DC BUS over-voltage at constant speed. | 2 | 3210H |
| 10 |  | 000AH | Over-voltage at stop. Hardware failure in voltage detection. | 2 | 3210H |
| 11 |  | 000BH | DC BUS voltage is less than Pr.06-00 during acceleration. | 2 | 3220H |
| 12 |  | 000CH | DC BUS voltage is less than Pr.06-00 during deceleration. | 2 | 3220H |
| 13 |  | 000DH | DC BUS voltage is less than Pr.06-00 at constant speed. | 2 | 3220H |
| 14 |  | 000EH | DC BUS voltage is less than Pr.06-00 at stop. | 2 | 3220H |
| 15 |  | 000FH | Phase loss protection | 2 | 3130H |
| 16 |  | 0010H | IGBT is overheated above the protection level. | 3 | 4310H |
| 18 |  | 0012H | IGBT over-heating protection error | 3 | FF00H |

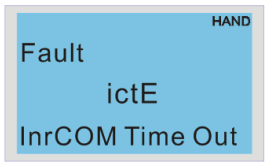
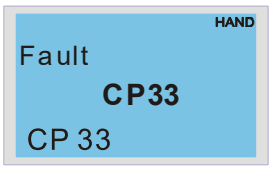
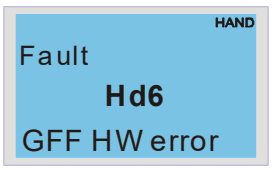
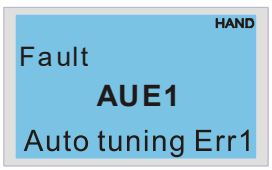
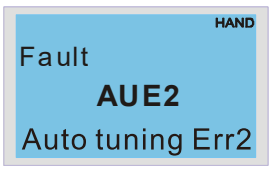
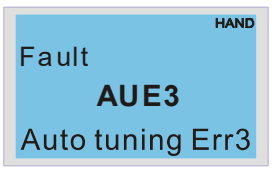
| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 21 |  | 0015H | Overload; the AC motor drive detects excessive drive output current. | 1 | 2310H |
| 22 |  | 0016H | Electronic thermal relay 1 protection | 1 | 2310H |
| 26 |  | 001AH | When the output current exceeds the over-torque detection level (Pr.06-07) and also exceeds Pr.06-08; when Pr.06-06 is set as 1 or 3, the keypad displays a warning without an error record; when Pr.06-06 is set as 2 or 4, it displays an error, stops running and displays an error record. | 3 | 8311H |
| 28 |  | 001CH | Low current detection | 1 | 8321H |
| 31 |  | 001FH | Cannot read internal EEPROM. | 5 | 5530H |
| 33 |  | 0021H | U-phase current error | 1 | FF04H |
| 34 |  | 0022H | V-phase current error | 1 | FF05H |
| 35 |  | 0023H | W-phase current error | 1 | FF06H |

| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 36 |  | 0024H | CC (current clamp) hardware error | 5 | FF07H |
| 37 |  | 0025H | OC hardware error | 5 | FF08H |
| 40 |  | 0028H | Motor parameters auto-tuning error | 1 | FF21H |
| 48 |  | 0030H | ACI loss | 1 | FF25H |
| 49 |  | 0031H | External Fault; when the multi-function input terminal (EF) is active, the AC motor drive stops output. | 5 | 9000H |
| 50 |  | 0032H | Emergency stop; when the multi-function input terminal (EF1) is active, the AC motor drive stops output. | 5 | 9000H |
| 51 |  | 0033H | External Base Block; when the multi-function input terminal (B.B.) is active, the AC motor drive stops output. | 5 | 9000H |
| 52 |  | 0034H | Keypad is locked after you enter the wrong password three times. | 5 | FF26H |
| 54 |  | 0036H | Modbus function code error (illegal function code) | 4 | 7500H |

| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 55 |  | 0037H | Modbus data address error [illegal data address (00 H–254 H)] | 4 | 7500H |
| 56 |  | 0038H | Modbus data error (illegal data value) | 4 | 7500H |
| 57 |  | 0039H | Modbus communication error (data is written to read-only address) | 4 | 7500H |
| 58 |  | 003AH | Modbus transmission time-out | 4 | 7500H |
| 59 |  | 003BH | Keypad transmission time-out | 4 | 7500H |
| 61 |  | 003DH | Y-connection / Δ-connection switch error | 2 | 3330H |
| 62 |  | 003EH | Energy regeneration when decelerating | 2 | FF27H |
| 63 |  | 003FH | Motor slip exceeds Pr.07-29 setting and exceeds Pr.07-30 time setting. | 7 | FF28H |
| 72 |  | 0048H | S1–DCM internal loop detection error | 5 | FF30H |

| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 74 |  | 004AH | Magnetic contactor error | 5 | FF2FH |
| 75 |  | 004BH | Mechanical brake error | 5 | 7110H |
| 76 |  | 004CH | Safe Torque Off function active | 5 | FF31H |
| 77 |  | 004DH | S2–DCM internal loop detection error | 5 | FF32H |
| 78 |  | 004EH | S1–DCM & S2–DCM internal loop detection error | 5 | FF33H |
| 79 |  | 0050H | U-phase short circuit | 1 | FF2BH |
| 80 |  | 0051H | V-phase short circuit | 1 | FF2CH |
| 81 |  | 0050H | W-phase short circuit | 1 | FF2DH |
| 82 |  | 0052H | Output phase loss 1 (Phase U) | 2 | 2331H |

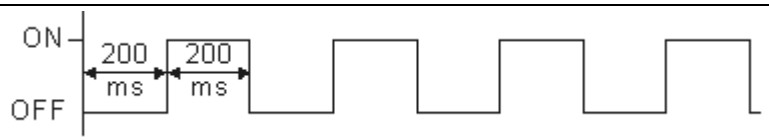
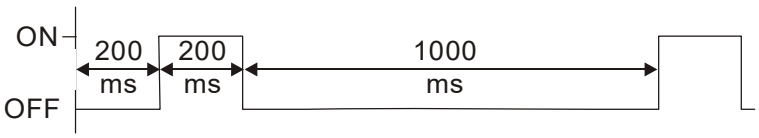
| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 83 |  | 0053H | Output phase loss 2 (Phase V) | 2 | 2332H |
| 84 |  | 0054H | Output phase loss 3 (Phase W) | 2 | 2333H |
| 87 |  | 0057H | Over-load protection at low frequency | 0 | 8A00H |
| 101 | | 0065H | CANopen guarding error | 4 | 8130H |
| 102 |  | 0066H | CANopen heartbeat error | 4 | 8130H |
| 104 |  | 0068H | CANopen bus off error | 4 | 8140H |
| 105 |  | 0069H | CANopen index error | 4 | 8100H |
| 106 |  | 006AH | CANopen station address error | 4 | 8100H |
| 107 |  | 006BH | CANopen memory error | 4 | 8100H |

| Setting* | Display | Fault code | Description | CANopen fault register (bit 0–7) | CANopen fault code |
|---|---|---|---|---|---|
| 111 |  | 006FH | InrCOM internal communication special error code | 4 | 7500H |
| 127 |  | 0081H | Firmware version error | 7 | FF3CH |
| 140 |  | 008EH | GFF detected at power on | 1 | 2240H |
| 141 | | 0090H | GFF occurs before running | 1 | 2240H |
| 142 |  | 0091H | Auto-tune error 1 (in DC test stage) | 1 | FF3DH |
| 143 |  | 0092H | Auto-tune error 2 (high frequency test stage) | 1 | FF3EH |
| 144 |  | 0093H | Auto-tune error 3 (rotary test stage) | 1 | FF3FH |

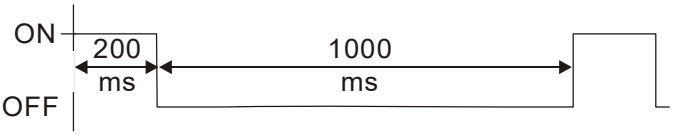
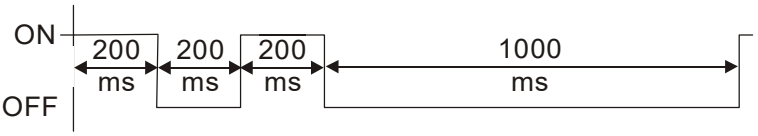
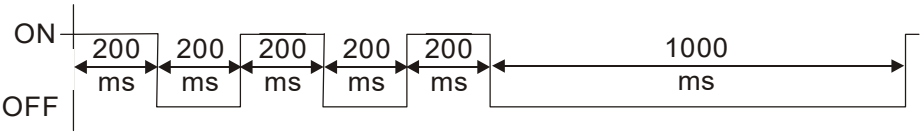
## 16-6 CANopen LED Function

There are two CANopen flash signs: RUN and ERR.

RUN LED:

| LED status | Condition | CANopen Status |
|---|---|---|
| OFF | Keep lighting off | Initial |
| Blinking |  | Pre-operation |
| Single flash |  | Stopped |
| ON | Keep lighting on | Operation |

ERR LED:

| LED status | Condition / Status |
|---|---|
| OFF | No Error |
| Single flash | One Message failure<br>  |
| Double flash | Guarding failure or heartbeat failure<br>  |
| Triple flash | SYNC failure<br>  |
| ON | Bus off |

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# Chapter 17 PLC Function Applications

17-1 PLC Summary

17-2 Notes Before Using a PLC

17-3 Turn on

17-4 Basic Principles of PLC Ladder Diagrams

17-5 Various PLC Device Functions

17-6 Introduction to the Command Window

17-7 Error Display and Handling

17-8 Explanation of Each PLC Speed Mode

Control 17-9 Count Function Using Pulse Input

# 17-1 PLC Summary

## 17-1-1 Introduction

The commands provided by the MH300-L built-in PLC functions, including the ladder diagram editing tool WPLSoft, as well as the use of basic commands and application commands, follow the operating methods of Delta's PLC DVP series.

## 17-1-2 WPLSoft ladder diagram editing tool

WPLSoft is Delta's software program for the DVP and MH300-L programmable controllers in Windows operating system environment. In addition to general PLC program design and general Windows editing functions (such as cut, paste, copy, and multiple windows), WPLSoft also provides many features such as Chinese/English annotation editing, registry editing, settings, file reading, saving, and contact graphic monitoring and settings.

Table 17-1 lists the basic requirements for installing the WPLSoft editing software:

| Item | System requirements |
|---|---|
| Operating system | Windows® XP / Vista / 7 (32-bit / 64-bit) / 8 / 10 (64-bit) |
| CPU | At least Pentium 90 |
| Memory | At least 16 MB (it is recommend at least 32 MB) |
| Hard drive | Hard drive capacity: at least 100 MB of free space<br>One optical drive (to install this software) |
| Display | Resolution: 640×480, at least 16 colors; it is recommended that the screen area be set at 800×600 pixels. |
| Mouse | Ordinary mouse or Windows-compatible pointing device |
| Printer | Printer with Windows driver software |
| RS-485 port | Must have at least an RS-485 port to link to the PLC |
| USB port | The USB port on the drive can be connected to the PLC |

Table 17-1

## 17-2 Notes Before Using a PLC

1. The MH300-L provides two communication serial ports that you can use to download programs to the PLC (see Figure 17-1 below).
2. Channel 1 (USB port) communication format is the same as channel 2.
3. Channel 2 has a preset communication format of 7, N, 2, 9600; you can change to ASCII in Pr.09-01 (transmission speed) and Pr.09-04 (communication protocol).
4. The PLC preset is node 2; you can change the PLC node in Pr.09-35 (PLC address), but this address may not be the same as the drive's address setting in Pr.09-00 (communication address).

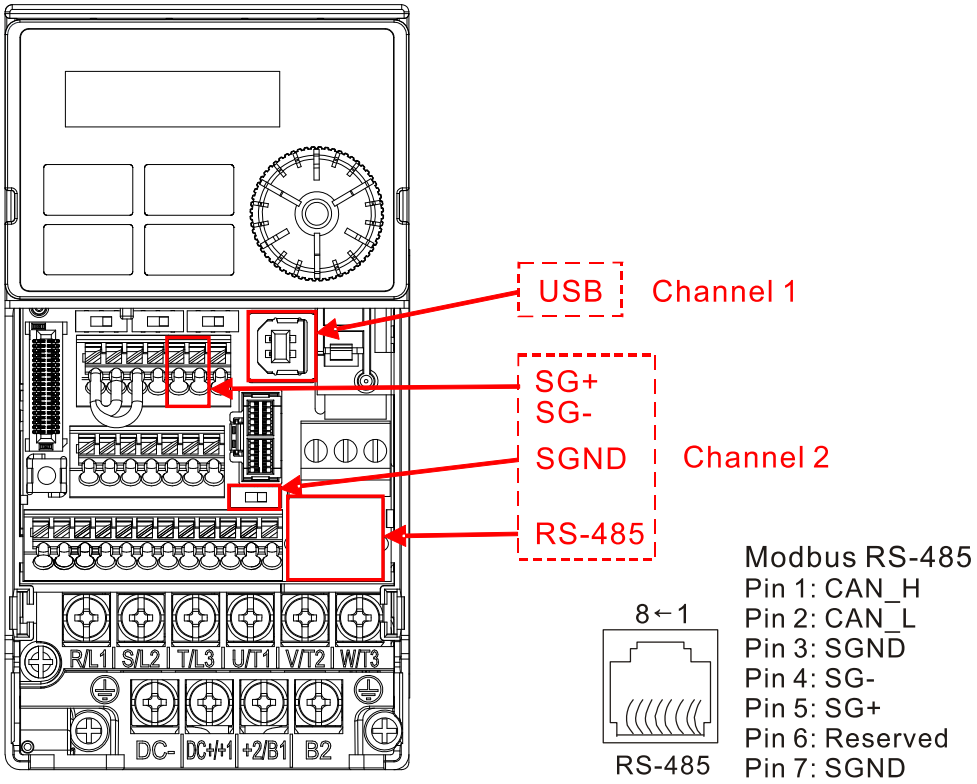



Figure 17-1

5. The host controller can simultaneously access data from the drive and the internal PLC, using the identifier for the node. For instance, if the drive node is 1 and the internal PLC node is 2, then the host controller command depends on the node address:
   - 01 (node) 03 (read) 0400 (address) 0001 (1 data item), indicating that it must read the data in drive Pr.04-00.
   - 02 (node) 03 (read) 0400 (address) 0001 (1 data item), indicating that it must read the data in internal PLC X0.
6. The PLC program is disabled when uploading/downloading programs.
7. Note that when using WPR commands to write parameters, you may modify values up to a maximum of $10^9$ times; otherwise, a memory write error occurs. The number of modifications depends on whether the parameter value has changed. If you do not change the value, it does not change the number of modifications; however, if the entered value is different from before, the number of modifications increases by one.
8. In the PLC Run and PLC Stop mode, you cannot set Pr.00-02 to the values 9 or 10, and cannot be

reset to the default value.

9. You can reset the PLC to the default value when you set Pr.00-02 to 6.
10. The corresponding MI function is disabled when the PLC writes to input contact X.
11. When the PLC controls the drive operation, the control commands are entirely controlled by the PLC and are not affected by the setting for Pr.00-21.
12. When the PLC controls the drive's Frequency commands (FREQ commands), the Frequency commands are entirely controlled by the PLC, and are not affected by the setting for Pr.00-20 or the HAND ON/OFF configuration.
13. When the PLC controls the drive operation, if the keypad STOP setting is valid, this triggers an FStP error and causes the drive to stop.

## 17-3 Turn on

### 17-3-1 Connect the Drive to the PC

You start operating the PLC functions with the following steps:

After pressing the MENU key and choosing 4: PLC on the KPC-CC01 digital keypad (optional), press the ENTER key (see Figure 17-3 below).

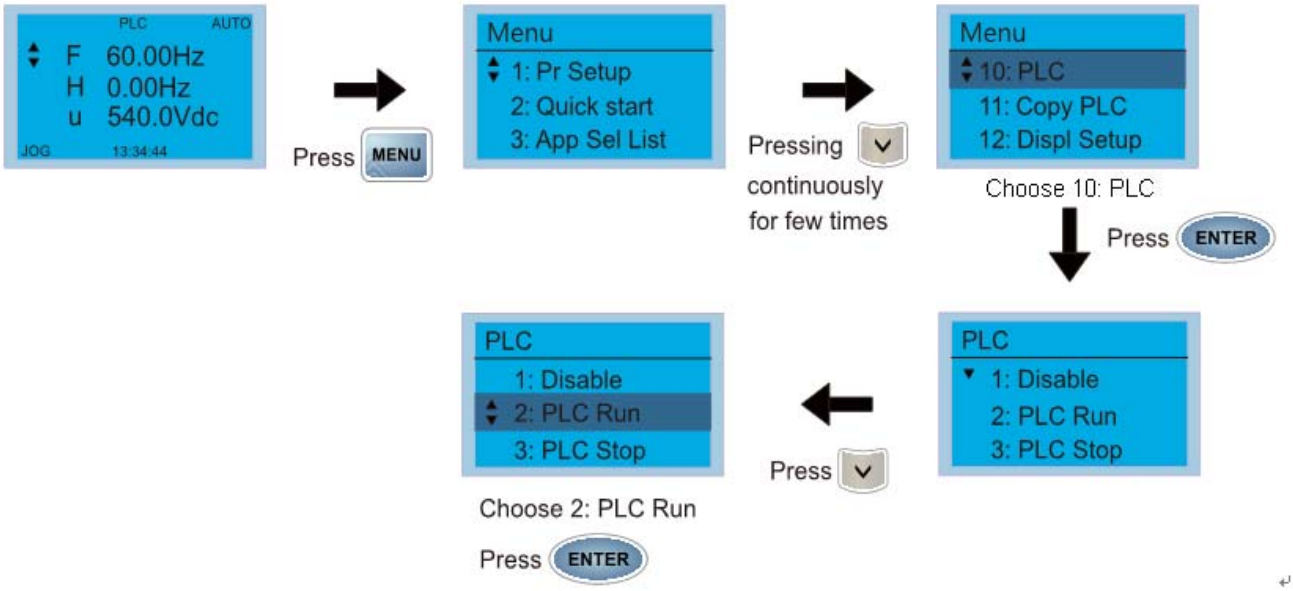



Figure 17-3

1. Wiring: Connect the drive's RJ45 communication interface to a PC through the RS-485 cable.

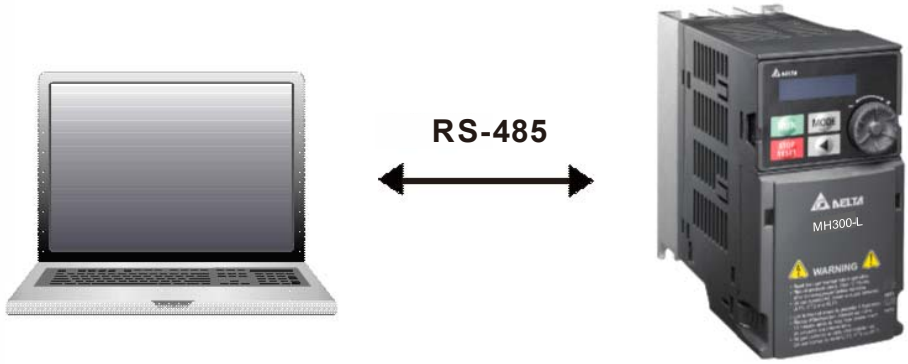



Figure 17-4

2. PLC function usage

Digital keypad KPC-CC01 (optional)

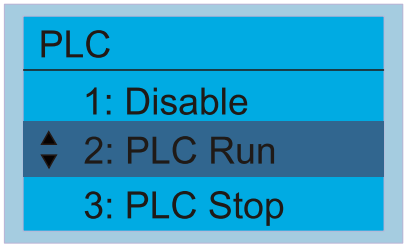



Figure 17-5

PLC functions are as shown in Figure 17-5 on the left; select item 2 PLC Run to enable the PLC functions.

1: No function (Disable)

2: Enable PLC (PLC Run)

3: Stop PLC functions (PLC Stop)

Digital keypad (KPMH-LC01)

Figure 17-6

Select PLC1 to enter PLC mode setting.
PLC 0: Do not implement PLC functions
PLC 1: Initiate PLC Run
PLC 2: Initiate PLC Stop

- The MH300-L automatically switches to PLC mode when the external multifunctional input terminals (MI1–MI7) are in PLC Mode selection bit 0 (51) or PLC Mode selection bit1 (52), and the terminal contact is closed or open. In this case, keypad switching is ineffective. The corresponding actions are listed in the following table.

| PLC mode | | PLC Mode selection bit1 (52) | PLC Mode selection bit0 (51) |
|---|---|---|---|
| Using KPC-CC01 (optional) | Using KPMH-LC01 | | |
| Disable | PLC 0 | OFF | OFF |
| PLC Run | PLC 1 | OFF | ON |
| PLC Stop | PLC 2 | ON | OFF |
| Maintain previous state | Maintain previous state | ON | ON |

Table 17-2

Using the MH300-L digital keypad to implement the PLC functions

☑ When the PLC screen switches to the PLC1 screen, this triggers one PLC action, and you control the PLC program start/stop by communications with WPLSoft.

☑ When the PLC screen switches to the PLC2 screen, this triggers one PLC stop, and you control the PLC program start/stop by communications with WPLSoft.

☑ The external terminal control method is the same as shown in Table 17-2 above.

**NOTE**

- When the input/output terminals (MI1–MI7 Relay MO) are included in the PLC program, these input/output terminals are used only by the PLC. For example, when the PLC program controls Y0 during PLC operation (PLC1 or PLC2), the corresponding output terminal relay (RA/RB/RC) operates according to the program. At this time, the multifunctional input/output terminal setting has no effect. Because these terminal functions are already being used by the PLC, you can determine the DI / DO / AO in use by the PLC by looking at Pr.02-52, 02-53, and 03-30.
- When the PLC's procedures use special register D1040, the corresponding AO contact AFM is occupied.
- Pr.03-30 monitors the state of action of the PLC function analog output terminals; bit 1 corresponds to the AFM action state.

## 17-3-2 I/O device explanation

Input devices:

| Serial No. | X0 | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X10 | X11 | X12 | X13 | X14 | X15 | X16 | X17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | MI1 | MI2 | MI3 | MI4 | MI5 | MI6 | MI7 | | | | | | | | | |
| **2** | | | | | | | | | | | MI10 | MI11 | MI12 | | | |

1: Control I/O

2: Extension card EMM-D3R2CA (D1022=9)

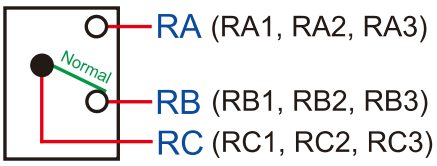
Output devices:

| Serial No. | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | Y10 | Y11 | Y12 | Y13 | Y14 | Y15 | Y16 | Y17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | RY1 | | | MO1 | MO2 | | | | | | | | | | | |
| **2** | | | | | | RY10 | RY11 | | | | | | | | | |

1: Control I/O |

2: Extension card EMM-D3R2CA (D1022=9)

**RY1 / RY2 / RY3**




**RY10 / RY11 / RY12**

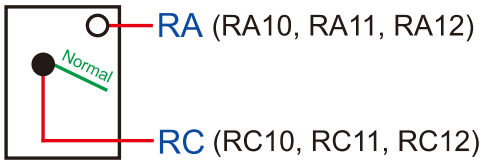



Figure 17-7

### 17-3-3 Installing WPLSoft

See Delta's website where you can download the WPLSoft editing software:
http://www.delta.com.tw/product/em/download/download_main.asp?act=3&pid=3&cid=1&tpid=3
After you install WPLSoft, the WPLSoft program is located in the folder "C:\Program Files\Delta Industrial Automation\WPLSoft x.xx".

### 17-3-4 Writing programs in WPLSoft

STEP 1:
You can run the editing software by double-clicking the WPL icon.

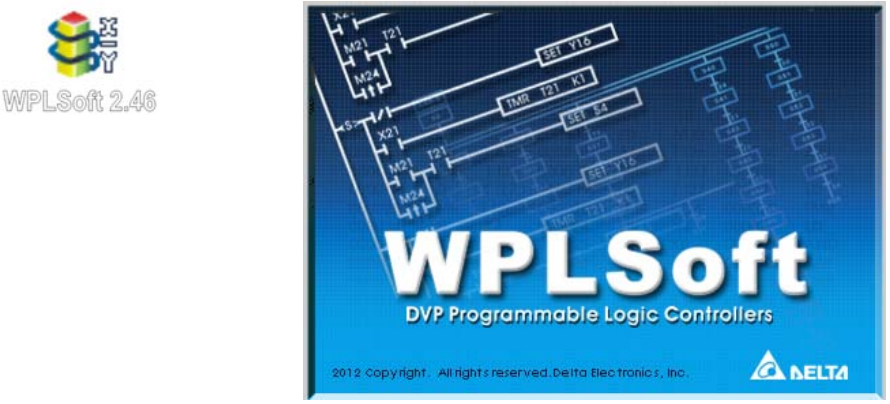



Figure 17-8

STEP 2:
The WPL editing window appears after three seconds. When running WPLSoft for the first time, before you create a new project file, the menu bar shows only **File**, **View**, **Communication, Options**, and **Help** menus.

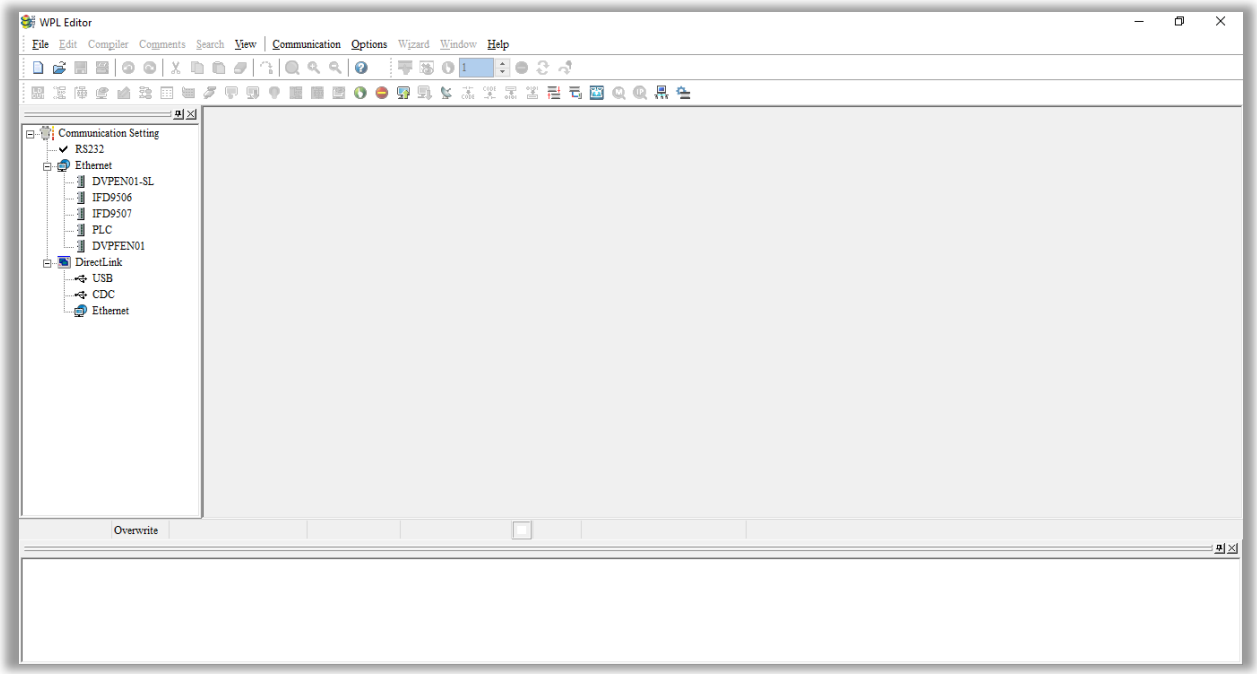



Figure 17-9

NOTE

The next time you run WPLSoft, the program opens the last project file you edited. Figure 17-10 describes the main parts of the WPLSoft editing window.

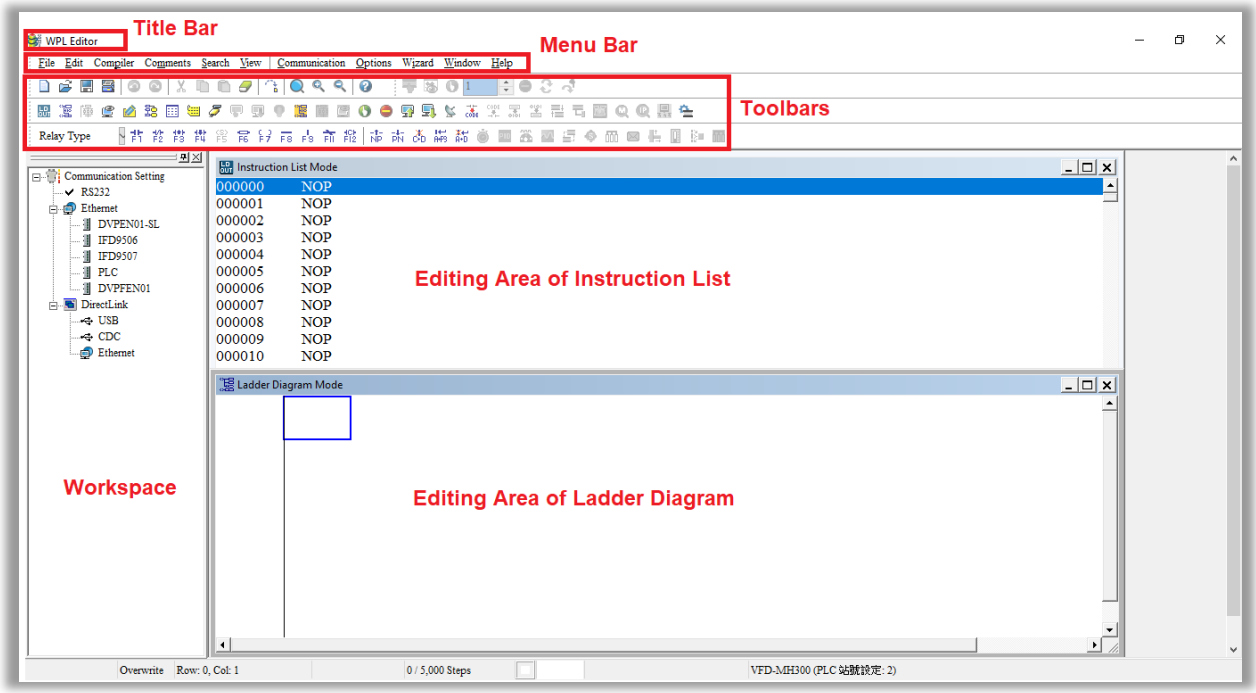



Figure 17-10

STEP 3:

To open a new project file, on the Toolbar, click the New button (or press Ctrl+N).

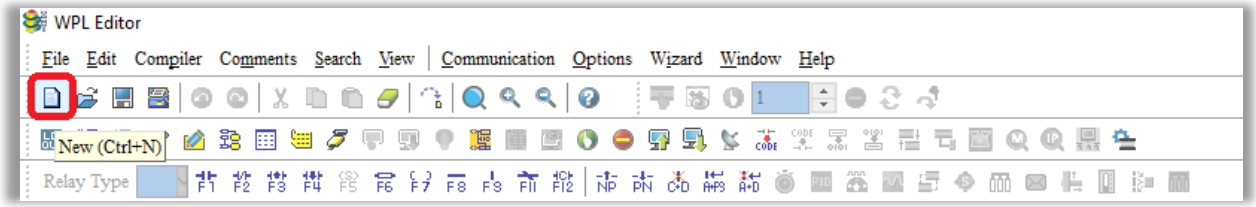



Figure 17-11

NOTE

Alternatively, on the **File** menu, click **New** (Ctrl+N).

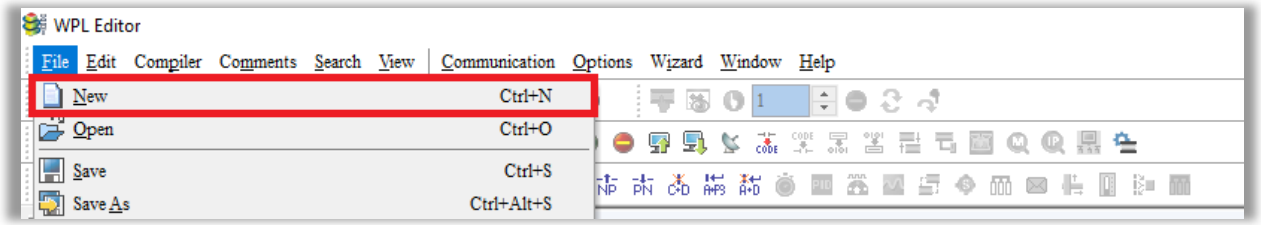



Figure 17-12

STEP 4:

This displays the **Select a PLC Model** dialog box where you can enter the **Program Title**, **File Name**, and select the device and communication settings.

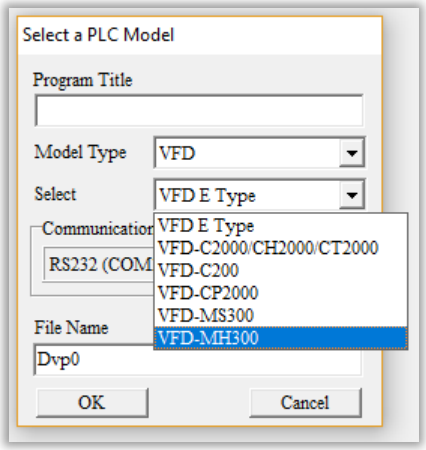



Figure 17-13

In the **Communication Setting** dialog box, define the communication settings and then click **OK**.

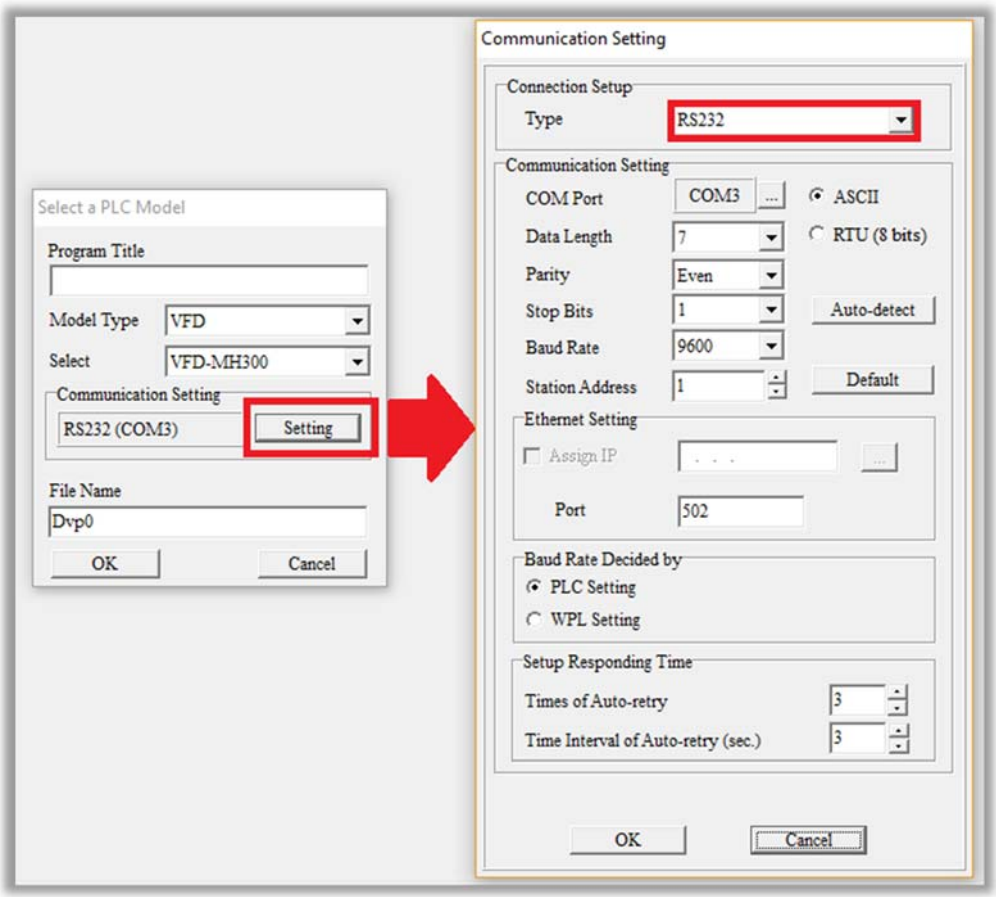



Figure 17-14

NOTE

You must select RS232 for the type of connection setup in the **Communication Setting** dialog box when using USB to connect the motor drive (MH300-L series).

STEP 5:

You can then begin editing the program. There are two program editing methods: you can edit in the command mode, or edit in the ladder diagram mode.

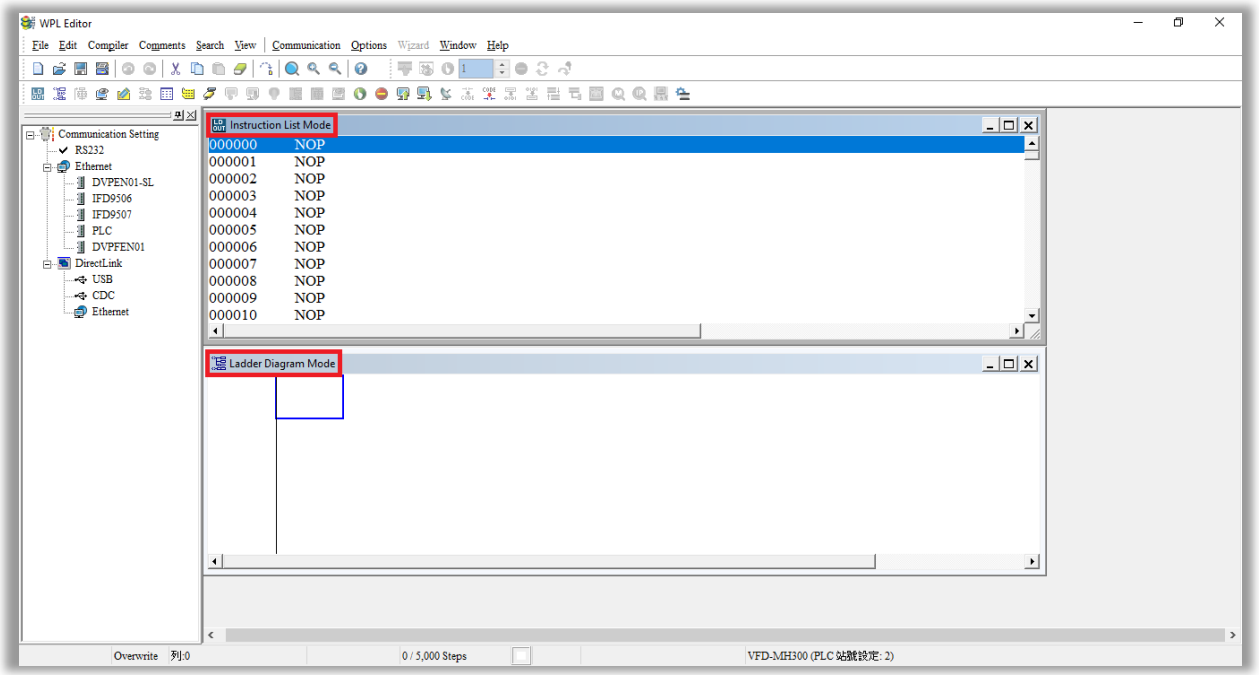



Figure 17-15

NOTE

In the ladder diagram mode, you use the buttons on the function icon row on the toolbar.

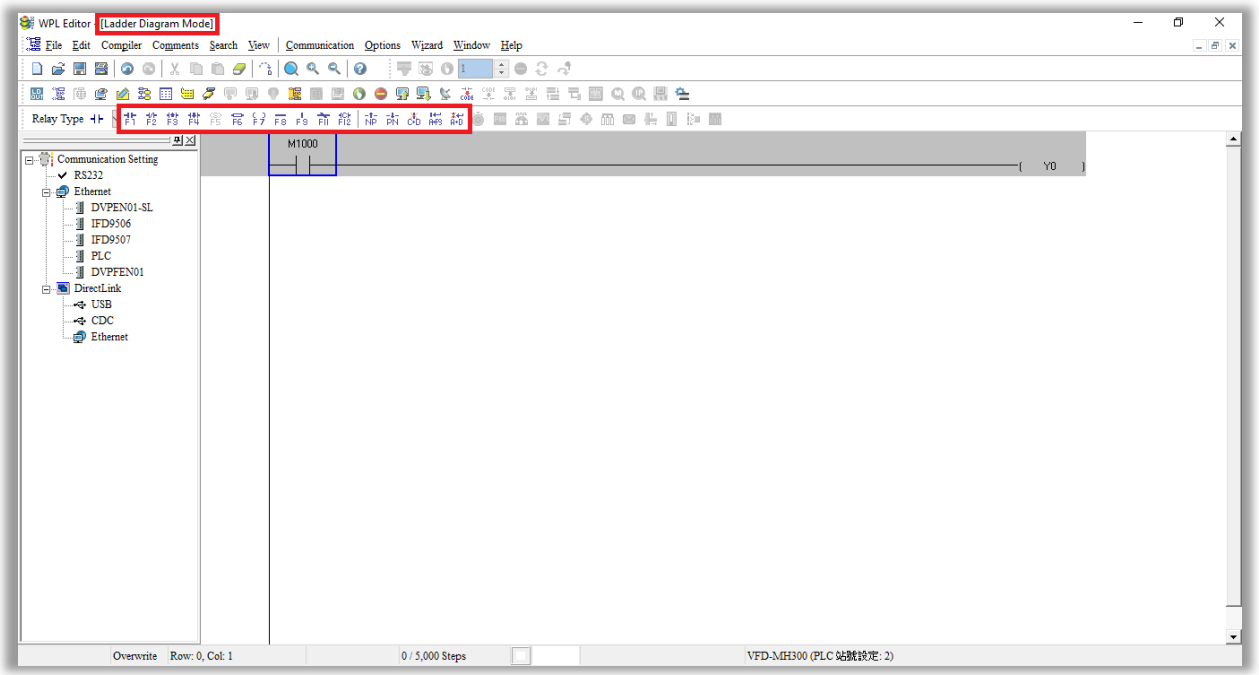



Figure 17-16

## Basic Operation

Example: Create the ladder diagram in the following picture.

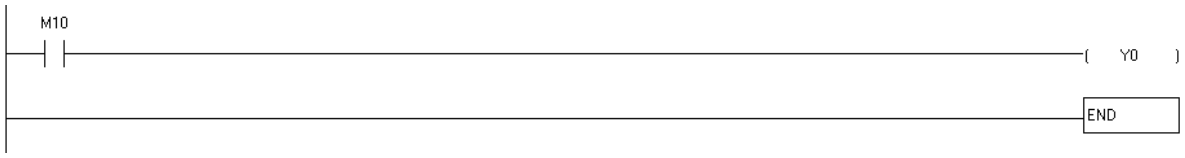



Figure 17-17

Use the following steps to create the ladder diagram. These steps show you how to use both the mouse and the keyboard (F1–F12) to add functions.

1. The following picture shows the WPLSoft program after you create a new project file.

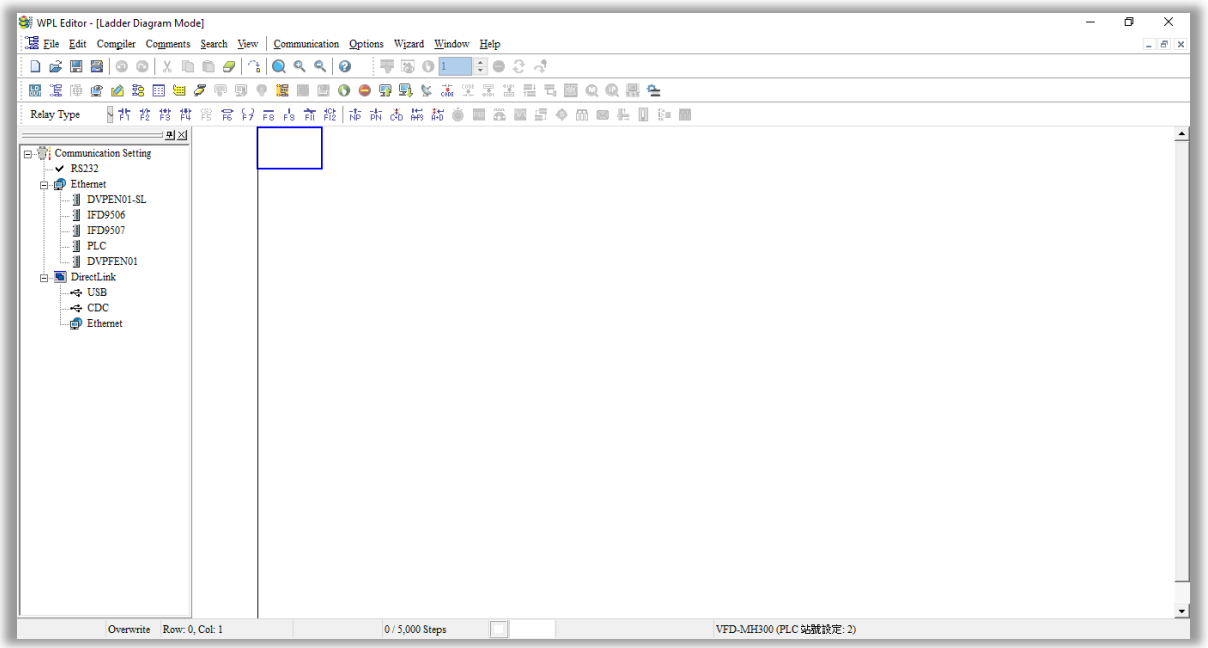



Figure 17-18

2. Add an always-open switch. On the toolbar click the always-open switch button or press F1.

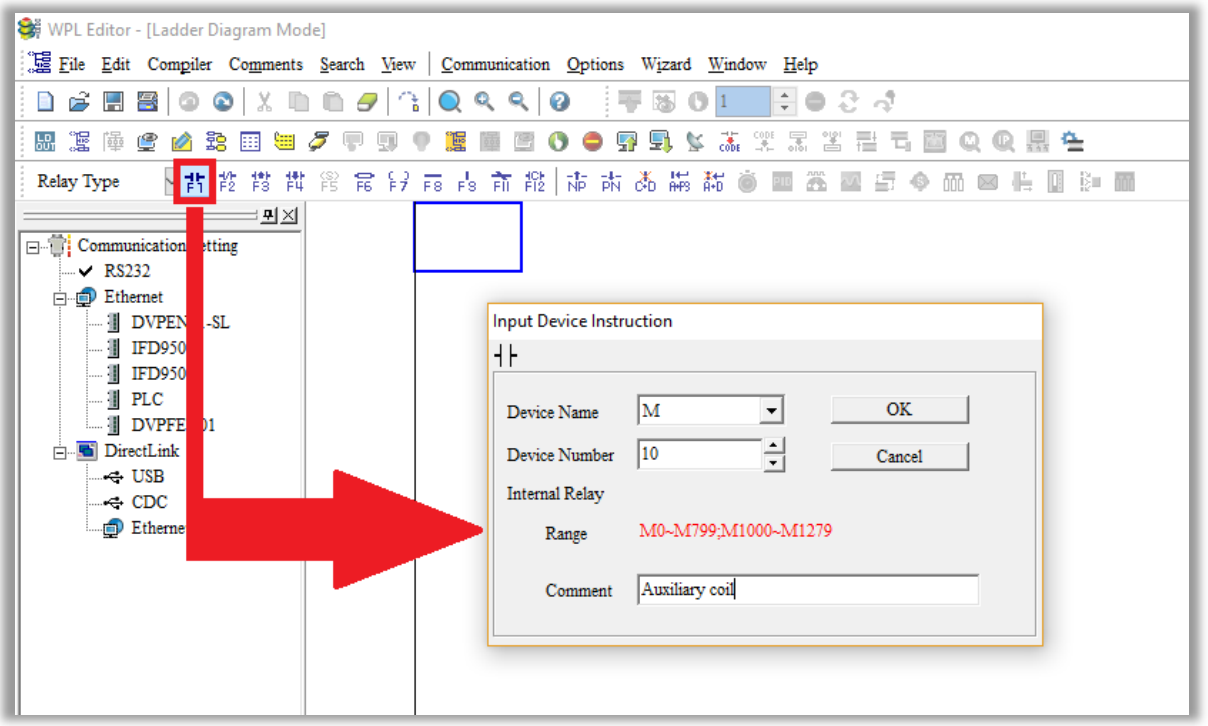



Figure 17-19

In the **Input Device Instruction** dialog box, select the device name (such as **M**), device number (such as **10**) and enter comments (such as **auxiliary coil**). Click **OK** when finished.

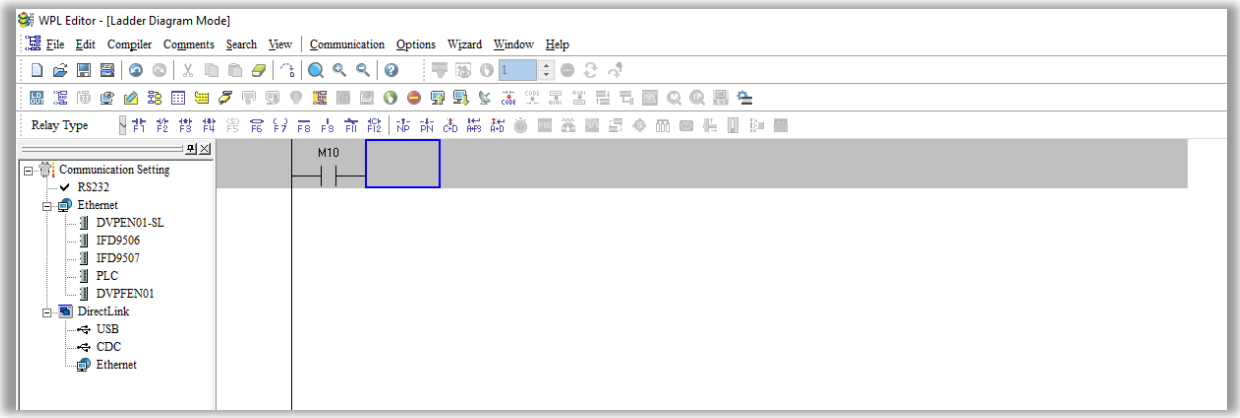



Figure 17-20

3. Add an output coil. Click the output coil button or press F7.

   In the **Input Device Instruction** dialog box, select the device name (such as **Y**), the device number (such as **0**) and enter comments (such as **output coil**).Click **OK** when finished.

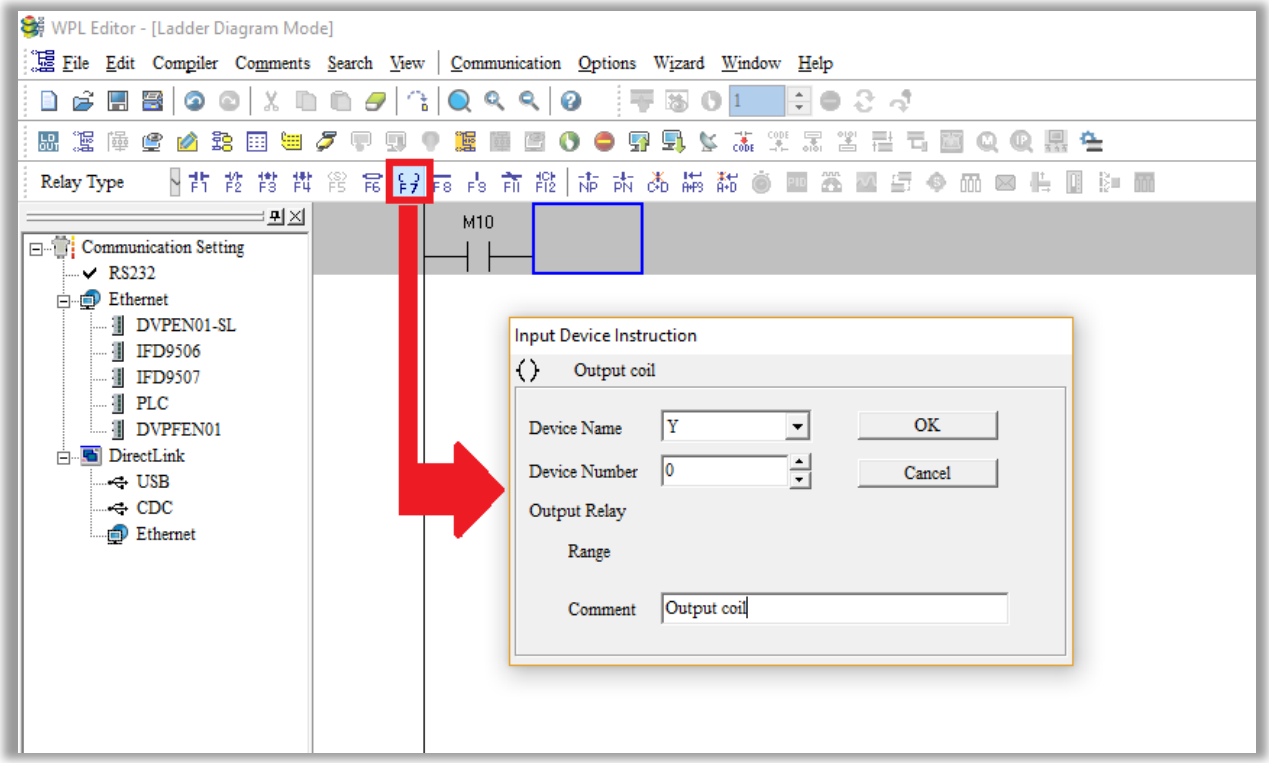



Figure 17-21

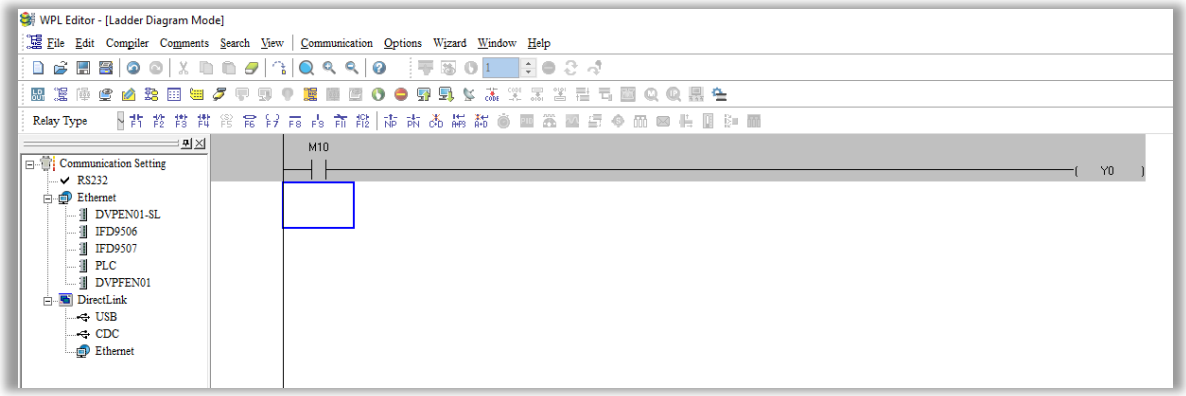



Figure 17-22

4. Press Enter, and **Input Instruction** box appears. In the **Input Instruction** box, select **END**, or use the keyboard to type “END”, and then click **OK**, as shown in Figure 17-23 and Figure 17-24.

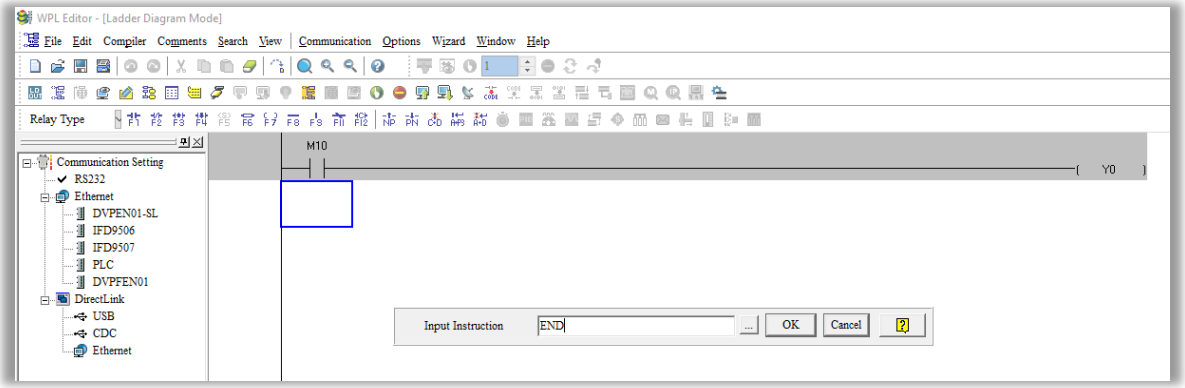



Figure 17-23

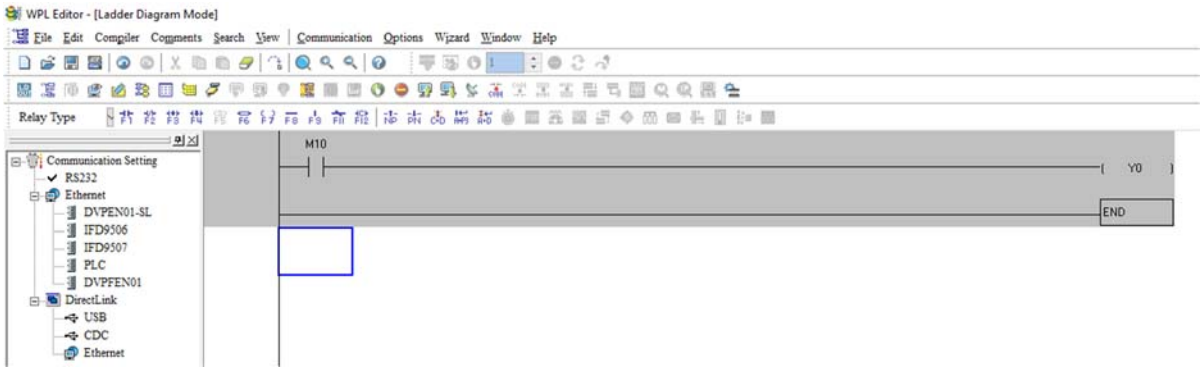



Figure 17-24

5. Compile the program. On the toolbar, click the Compile button to compile the edited ladder diagram into a command program. After compiling, the number of rungs appear on the left side of the busbar.

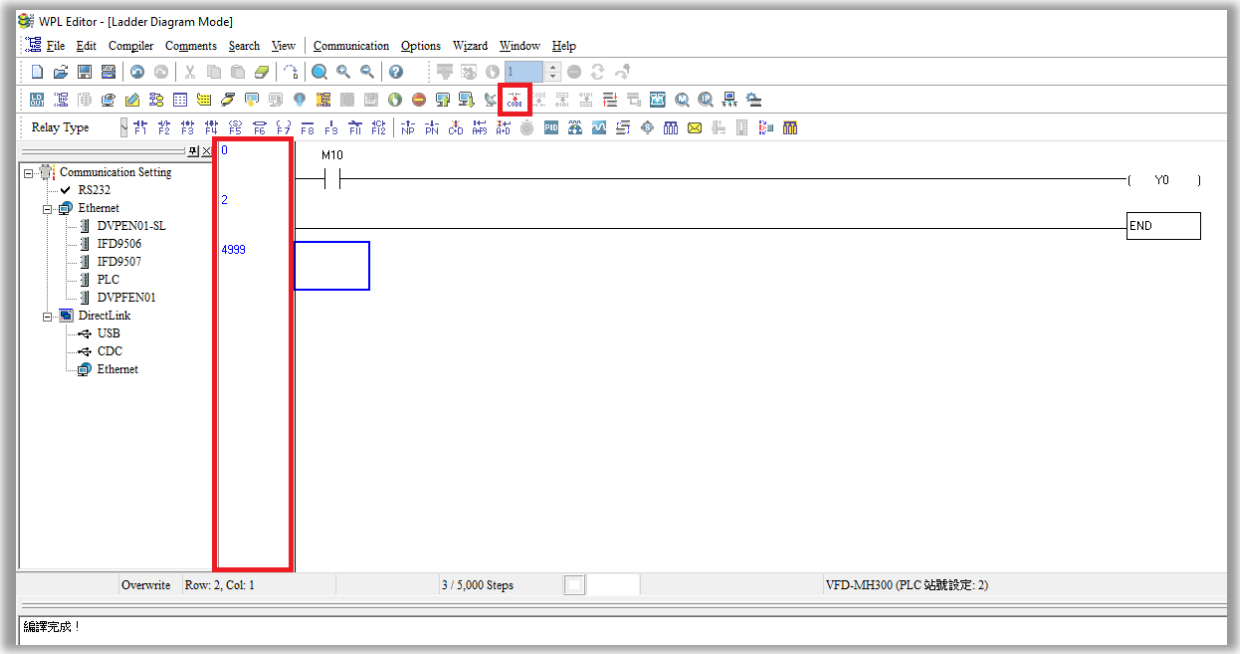



Figure 17-25

## 17-3-5 Program download

After you compile your program, download it to the device. Click the Download button . WPLSoft downloads the program to the online PLC in the communication format that you specified for the communication settings.

## 17-3-6 Program monitoring

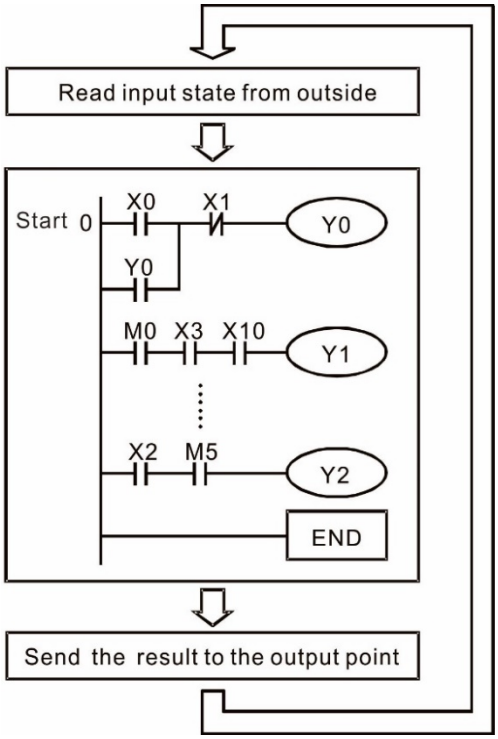
After you download the program, confirm that the PLC is in Run mode. On the Communication menu, click Online Mode , and then click **Start Ladder Diagram Control** (as shown in Figure 17-26). This allows you to supervise and operate the ladder diagram while online.

Figure 17-26

# 17-4 Basic Principles of PLC Ladder Diagrams

## 17-4-1 Schematic diagram for PLC ladder diagram program scanning

Output results are calculated on the basis of the ladder diagram configuration (internal devices have real-time output before results are sent to an external output point)




Repeated program scans

Figure 17-27

## 17-4-2 Introduction to ladder diagrams

Ladder diagrams use a graphic language widely applied in automatic controls. They employ common electrical control circuit symbols. After you use a ladder diagram editor to create a ladder diagram program, the PLC program design is complete. Using a graphic format to control processes is very intuitive and is readily accepted by personnel who are familiar with electrical control circuit technology. Many of the basic symbols and actions in a ladder diagram mimic common electrical devices in conventional automatic control power distribution panels, such as buttons, switches, relays, timers, and counters.

Internal PLC devices: The types and quantities of internal PLC devices vary in different brands of products. Although these internal devices use the same names as the conventional electrical control circuit elements (such as relays, coils, and contacts), a PLC does not actually contain these physical devices, and they instead correspond to basic elements in the PLC's internal memory (bits). For instance, if a bit is 1, this may indicate that a coil is electrified; and if that bit is 0, it indicates that the coil is not electrified. You can use a N.O. contact (Normally Open, or contact A) to directly read the value of the corresponding bit, and use a N.C. contact (Normally Closed, or contact B) to get the inverse of the bit's value. Multiple relays occupy multiple bits, and eight bits comprise one byte. Two bytes comprise one word, and two words comprise a double word. When multiple relays are processing at the same time (as in addition/subtraction or displacement), it can use a byte, a word, or a double word. Furthermore, a PLC contains two types of internal devices: a timer and a counter. It not only has a coil, but can count time and numerical values. Because of this, when it is necessary to process numerical values, these values are usually in the form of bytes, words, or double words (internally in the PLC).

The various internal devices in a PLC use a certain amount of memory in the PLC's storage area. When

you use these devices, the content of the corresponding storage area is read in the form of bits, bytes, or words.

The following table describes the internal devices in a PLC

| Device Type | Description of Function |
|---|---|
| Input Relay | An input relay constitutes the basic unit of storage in a PLC's internal memory, and corresponds to an external input point. It serves as a terminal connecting with an external input switch and receiving external input signals. It is driven by external input signals, to which it assigns values of 0 or 1. A program design method cannot change the input relay status, and therefore cannot rewrite the corresponding basic units of an input relay. You cannot use WPLSoft to manually perform ON/OFF actions. You can use a relay's contacts (contacts A and B) an unlimited number of times in a program. An input relay with no input signal must be left idle and cannot be used for some other purpose.<br>☑ Input devices are indicated by X0, X1, X7, X10, X11, and so on. These devices are indicated with the symbol X, and a device's order is indicated with an octal number. Input point numbers are indicated in the main PLC and in extension devices. |
| Output Relay | An output relay constitutes the basic unit of storage in a PLC's internal memory, and corresponds to an external output point. It connects with an external load. It can be driven by an input relay contact, a contact on another internal device, or its own contacts. It uses one N.O. contact to connect with external loads or other contacts, and like the input contacts, you can use the output relay's contacts an unlimited number of times in a program. An output relay with no input signal is idle, but can be used by an internal relay if needed.<br>☑ Output devices are indicated by Y0, Y1, Y7, Y10, Y11, and so on. These devices are indicated with the symbol Y, and a device's order is indicated with an octal number. Output point numbers are indicated in the main PLC and in extension devices. |
| Internal Relay | Internal relays have no direct connection with the outside. These relays are auxiliary relays inside a PLC. Their function is the same as that of an auxiliary (central) relay in an electrical control circuit: Each auxiliary relay corresponds to a basic unit of internal storage; they can be driven by input relay contacts, output relay contacts, and the contacts of other internal devices. You can use an internal auxiliary relay's contacts an unlimited number of times in a program. Internal relays have no outputs to the outside, and their status must output through an output point.<br>☑ Internal relay devices are indicated by: M0, M1–M799, and so on. These devices are indicated with the symbol M, and the device's order is indicated with a decimal number. |
| Counter | Counters perform counting operations. The setting value for a counter (such as the number of pulses to be counted) must be assigned when a counter is used. A counter contains a coil, contact, and a counting storage device. When the coil goes from OFF ON, this indicates that the counter receives an input pulse, and adds one to its count. There are 16 bits available in the counter.<br>☑ Counter device are indicated by: C0, C1–C79, and so on. These devices are indicated by the symbol C, and the device's order is indicated with a decimal number. |
| Timer | Timers perform timing for operations. The timer contains a coil, contact, and a time value register. When the coil is electrified, and the setting value for the timer is reached, the contact is actuated (contact A closes, contact B opens), and the timer's fixed value is given by the setting value. A timer has a regulated clock cycle (timing units: 100 ms). As soon as power to the coil is cut off, the contact is no longer be actuated (contact A opens, contact B closes), and the original timing value returns to zero.<br>☑ Timer devices are indicated by: T0, T1–T159, and so on. These devices are indicated by the symbol T, and the device's order is indicated with a decimal number. |
| Data Register | Data registers are used exclusively to store data and various parameters. When you use a PLC is to perform various types of sequence control, set time values, and count value controls, the PLC performs data processing and numerical operations and stores the operands, parameters, and results in data registers. Each data register contains 16 bits of binary data (one word). Two data registers with adjacent numbers can process double words.<br>☑ Data register devices are indicated by: D0, D1–D399, and so on. These devices are indicated by the symbol D, and the device's order is indicated with a decimal number. |

## Ladder diagram images and explanations

See the Section 17-4-2 “Introduction to ladder diagrams” for descriptions of devices.

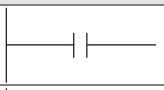
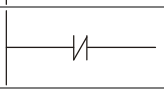
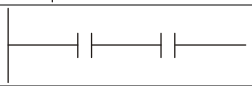
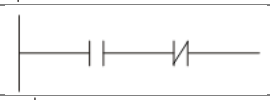
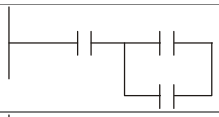
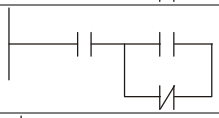
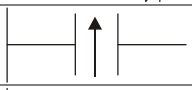
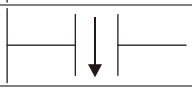
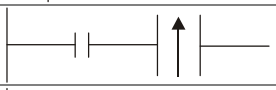
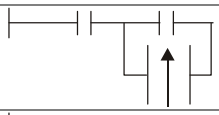
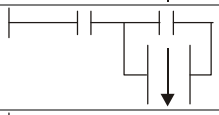
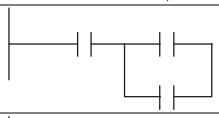
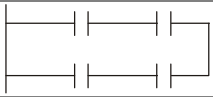
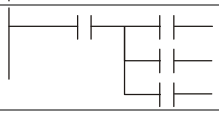
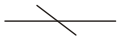
| Ladder diagram structures | Explanation of commands | Command | Using Device |
|---|---|---|---|
|  | N.O. switch, contact A | LD | X, Y, M, T, C |
|  | N.C. switch, contact B | LDI | X, Y, M, T, C |
|  | Series N.O. | AND | X, Y, M, T, C |
|  | Series N.C. | ANI | X, Y, M, T, C |
|  | Parallel N.O. | OR | X, Y, M, T, C |
|  | Parallel N.C. | ORI | X, Y, M, T, C |
|  | Rising edge-triggered switch | LDP | X, Y, M, T, C |
|  | Falling edge-triggered switch | LDF | X, Y, M, T, C |
|  | Rising edge-triggered series | ANDP | X, Y, M, T, C |
| | Falling edge-triggered series | ANDF | X, Y, M, T, C |
|  | Rising edge-triggered parallel | ORP | X, Y, M, T, C |
|  | Falling edge-triggered parallel | ORF | X, Y, M, T, C |
|  | Block series | ANB | N/A |
|  | Block parallel | ORB | N/A |
|  | Multiple outputs | MPS<br>MRD<br>MPP | N/A |
|  | Coil driven output commands | OUT | Y, M |
| | Some basic commands, application commands. | Some basic commands, application commands. | |
|  | Inverted logic | INV | N/A |

Table 17-6

## 17-4-3 Overview of PLC ladder diagram editing

The program editing method in WPLSoft begins from the left busbar and proceeds to the right busbar (the right busbar is not visible in WPLSoft). Continue to the next row after completing each row; there are a maximum of 11 contacts on each row. If this is not sufficient, WPLSoft generates a continuous line to indicate the continued connection, so that you can add more devices. A continuous series of numbers is generated automatically and you can use identical input points repeatedly (as shown in Figure 17-28).

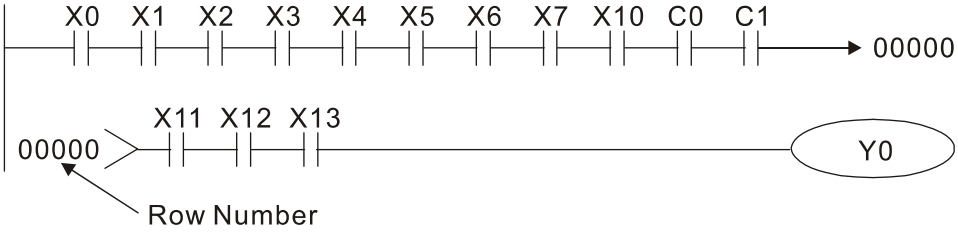



Figure 17-28

The PLC scans a ladder diagram programs from the upper left corner to the lower right corner. The coils and application command computing box are handled in the output, and in ladder diagram are placed on the farthest right of a rung. Taking Figure 17-29 below as an example, we can analyze the procedural sequence of the ladder diagram. The number in the upper right corner gives the sequential order.

Explanation of command sequence

| | | | |
|---|---|---|---|
| 1 | LD | X0 | |
| 2 | OR | M0 | |
| 3 | AND | X1 | |
| 4 | LD | X3 | |
| | AND | M1 | |
| | ORB | | |
| 5 | LD | Y1 | |
| | AND | X4 | |
| 6 | LD | T0 | |
| | AND | M3 | |
| | ORB | | |
| 7 | ANB | | |
| 8 | OUT | Y1 | |
| | TMR | T0 | K10 |

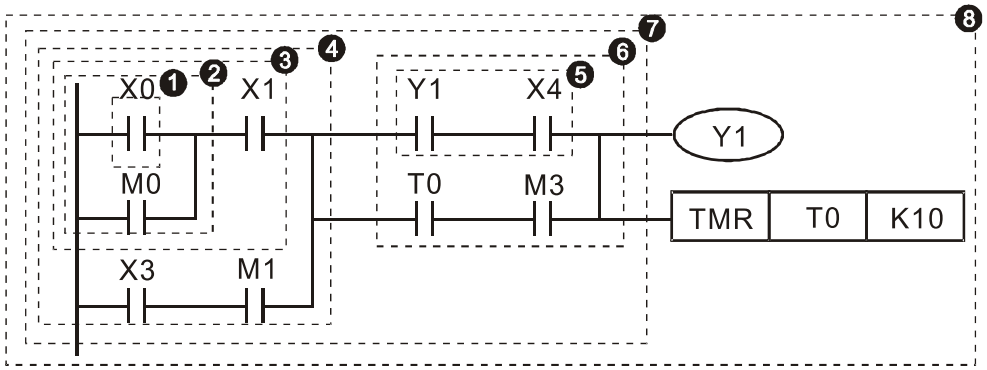



Figure 17-29

Explanation of basic structure of ladder diagrams

**LD (LDI) command:** an LD or LDI command appears at the start of a block. See Figure 17-30.

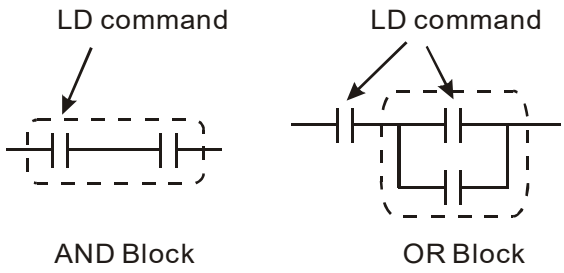



Figure 17-30

LDP and LDF use this command structure, but there are differences in their action state. LDP, LDF only act at the rising or falling edge of a conducting contact (see Figure 17-31).

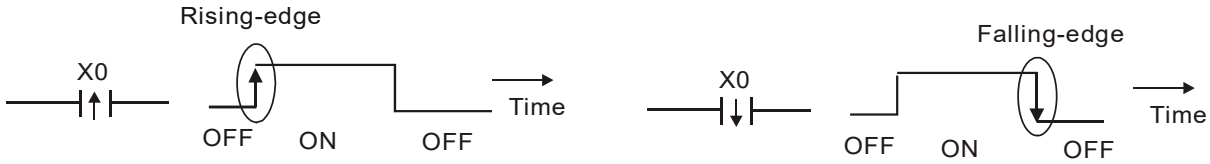



Figure 17-31

**AND (ANI) command:** a series configuration in which a single device is connected with one device or a block. See Figure 17-32.

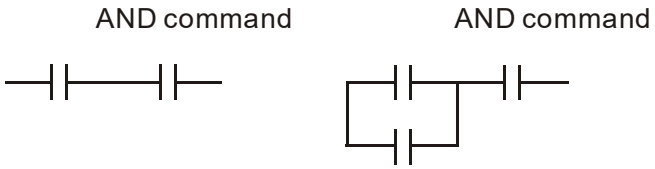



Figure 17-32

NOTE

ANDP, ANDF use this structure, but their action occurs at the rising and falling edge of a conducting contact.

**OR (ORI) command:** a single device is connected with one device or a block. See Figure 17-33.

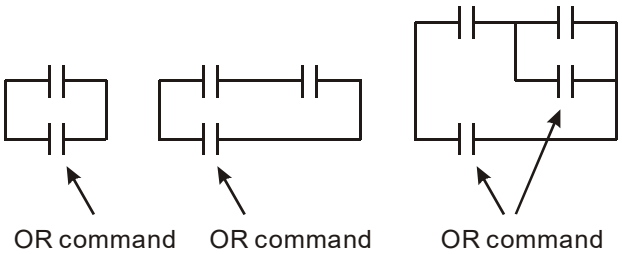



Figure 17-33

NOTE

ORP, ORF use this structure, but their action occurs at the rising and falling edge of a conduction contact.

**ANB command:** a configuration in which one block is in series with one device or block. See Figure 17-34.

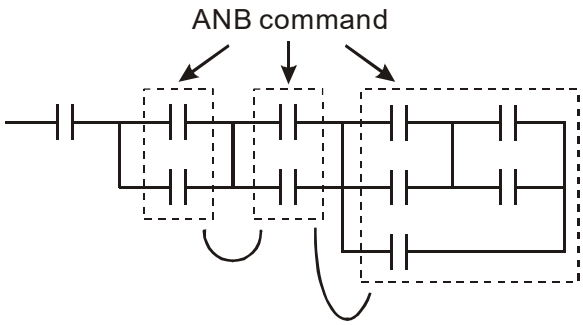



Figure 17-34

**ORB command:** a configuration in which one block is in parallel with one device or block. See Figure 17-35.

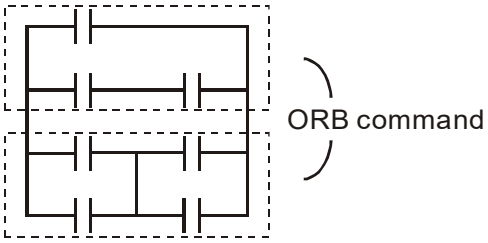



Figure 17-35

NOTE

In the case of ANB and ORB operations that connect a number of blocks, they should be combined to form a block or network from the top down or from left to right.

**MPS, MRD, MPP commands:** branching point memory for multiple outputs that enable multiple different outputs. The MPS command begins at a branching point, which refers to the intersection of horizontal and vertical lines. Control relies on the contact status along a single vertical line to determine whether the next contact can give a memory command. While each contact is basically able to give memory commands, in view of convenience and the PLC's capacity restrictions, this can be omitted from some places when editing a ladder diagram. You can use the structure of the ladder diagram to judge what kinds of contact memory commands are used.

MPS is indicated by use of the ┬ symbol. You can use this command consecutively up to eight times.

The MRD command is read from branching point memory; because logic states along any one vertical line must be the same, in order to continue analysis of other parts of the ladder diagram, the original contact status must be read. MRD is indicated by the ├ symbol.

The MPP command is read from the starting state of the uppermost branching point, and it is read from the stack (pop operation); because it is the final command along a vertical line, it indicates that the state of the vertical line can be concluded. MPP is indicated by the └ symbol.

Although there should basically be no errors when using the foregoing analytical approach, the compiling program may sometimes omit identical state output, as shown in Figure 17-36.

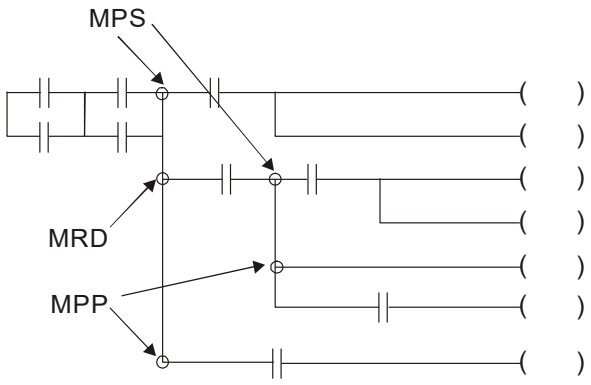



Figure 17-36

## 17-4-4 Common basic program design examples

### Start, stop, and protection circuits

Some applications may require a brief close or brief break using a button to start and stop equipment. A protective circuit must therefore be designed to maintain continued operation in these situations. This protective circuit may employ one of the following methods.

Example 1: Priority stop protective circuit

When the start N.O. contact X1=ON, and the stop N.C. contact X2=OFF, Y1=ON. If X2 switches to ON, coil Y1 is no longer electrified, and this is therefore referred to as priority stop. See Figure 17-37.

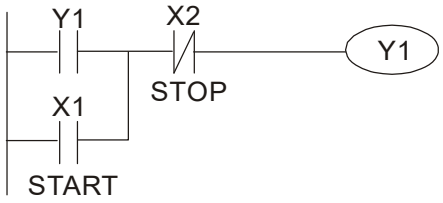



Figure 17-37

Example 2: Priority start protective circuit

When the start N.O. contact X1=ON, and the stop N.C. contact X2 = OFF, Y1=ON, and coil Y1 is electrified and protected. If X2 switches to ON, coil Y1 still protects the contact and continues to be electrified, and this is therefore referred to as priority start. See Figure 17-38.

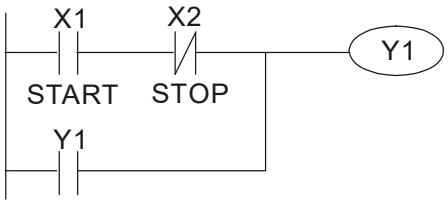



Figure 17-38

Example 3: Setting (SET) and reset (RST) command protective circuit

Figure 17-39 shows a protective circuit composed of RST and SET commands.

- **A priority stop** occurs when you place the RST command after the SET command. Because the PLC executes programs from the top down, at the end of the program the state of Y1 indicates whether coil Y1 is electrified. When X1 and X2 both actuate, Y1 loses power, and this is therefore referred to as priority stop.
- **A priority start** occurs when you place the SET command after the RST command. When X1 and X2 both actuate, Y1 electrifies, and this is therefore referred to as priority start.

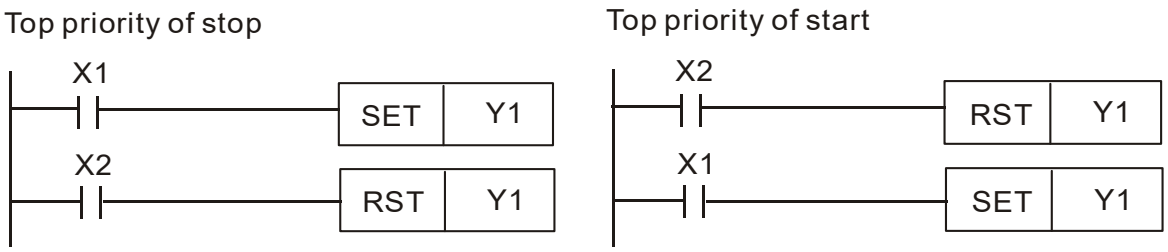



Figure 17-39

## Commonly-used control circuits

Example 4: Conditional control

X1 and X3 respectively start and stop Y1; and X2 and X4 respectively start and stop Y2. All have protective circuits. Because Y1's N.O. contact is in series with Y2's circuit, it becomes an AND condition for the actuation of Y2. The action of Y1 is therefore a condition for the action of Y2, and Y1 must actuate before Y2 can actuate. See Figure 17-40.

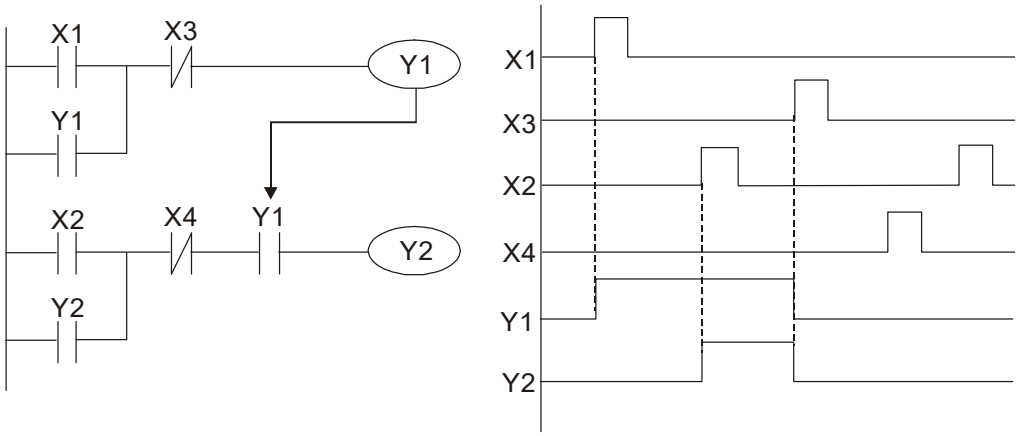



Figure 17-40

Example 5: Interlocking control

Figure 17-41 shows an interlocking control circuit. Depending on which of the start contacts X1 or X2 becomes valid first, the corresponding output Y1 or Y2 actuates, and when one actuates, the other does not actuate. Y1 and Y2 cannot actuate at the same time (interlocking effect). Even if both X1 and X2 are valid at the same time, because the ladder diagram program is scanned from the top down, it is impossible for Y1 and Y2 to actuate at same time. This ladder

diagram assigns priority only to Y1.

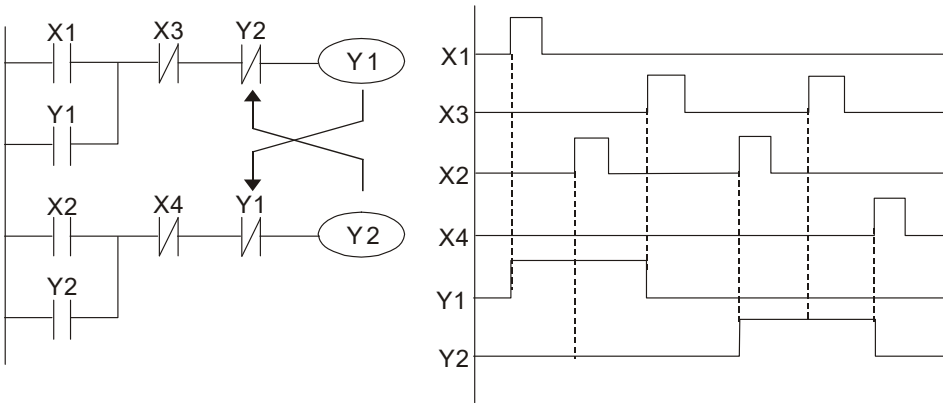



Figure 17-41

Example 6: Sequence control

If the N.C. contact of Y2 in the interlocking control configuration from example 5 is put in series with the Y1 circuit, to create an AND condition for actuation of Y1 (see Figure 17-42), not only is Y1 a condition for the actuation of Y2 in this circuit, but the actuation of Y2 also stops the actuation of Y1. This configuration confirms the actuation order of Y1 and Y2.

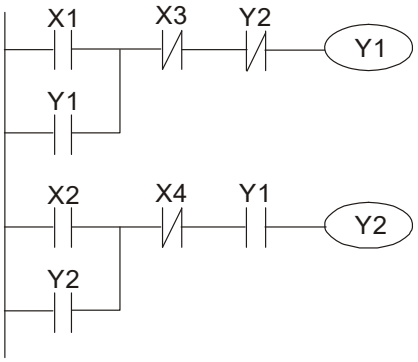



Figure 17-42

Example 7: Oscillating circuit

Oscillating circuit with a period of ΔT+ΔT

Figure 17-43 shows a very simple ladder diagram. When starting to scan the Y1 N.C. contact, because the Y1 coil has lost power, the Y1 N.C. contact is closed. When the Y1 coil is then scanned, it is electrified, and the output is 1. When the Y1 N.C. contact is scanned in the next scanning cycle, because the Y1 coil is electrified, the Y1 NC contact is open, the Y1 coil then loses power, and the output is 0. Following repeated scanning, the output of Y1 coil has an oscillating waveform with a period of ΔT(ON)+ΔT(OFF).

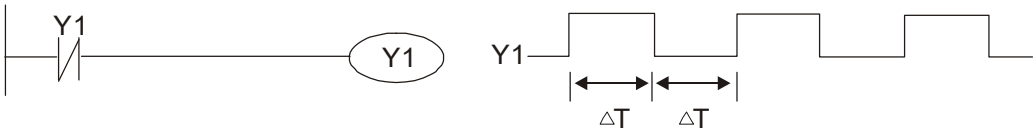



Figure 17-43

Oscillating circuit with a period of nT+ΔT

The ladder diagram (Figure 17-44) shown below uses timer T0 to control coil Y1's electrified time. After Y1 is electrified, it causes timer T0 to close during the next scanning cycle, which causes the output from Y1 to oscillate as shown in the diagram below. The constant n is the timer's decimal setting value, and T is the clock cycle of the timer.

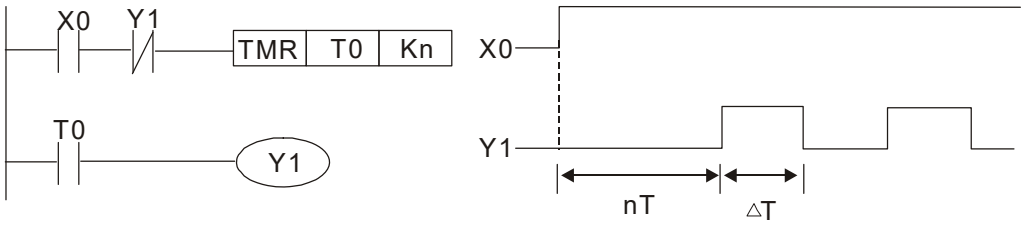



Figure 17-44

Example 8: Flashing circuit

Figure 17-45 shows an oscillating circuit of a type commonly used to cause an indicator to flash or a buzzer to buzz. It uses two timers to control the ON and OFF time of Y1 coil. Here constants n1 and n2 are the setting values of timers T1 and T2, and T is the clock cycle of the timer.

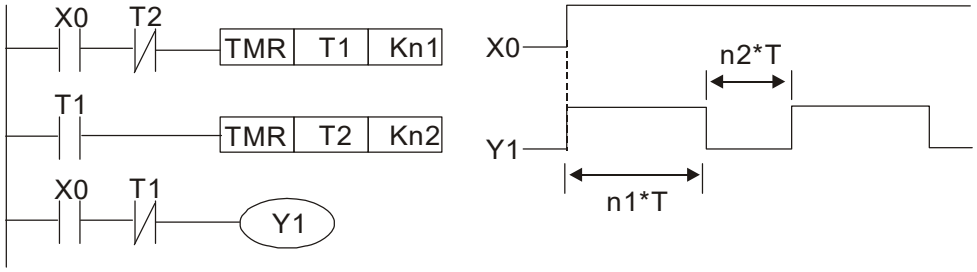



Figure 17-45

Example 9: Triggering circuit

In Figure 17-46, a rising edge in input X0 causes coil M0 to generate a single pulse for ΔT (length of one scanning cycle), and coil Y1 is electrified during this scanning cycle. Coil M0 loses power during the next scanning cycle, and N.C. contact M0 and N.C. contact Y1 are both closed. This causes coil Y1 to stay in an electrified state until there is another rising edge in input X0. This again causes the electrification of coil M0 and the start of another scanning cycle, while also causing coil Y1 to lose power, and so on. You can see the sequence of these actions in the figure below. This type of circuit is commonly used to enable one input to perform two alternating actions. You can see from the time sequence in the diagram below that when input X0 is a square wave signal with a period of T, the output of coil Y1 is a square wave signal with a period of 2T.

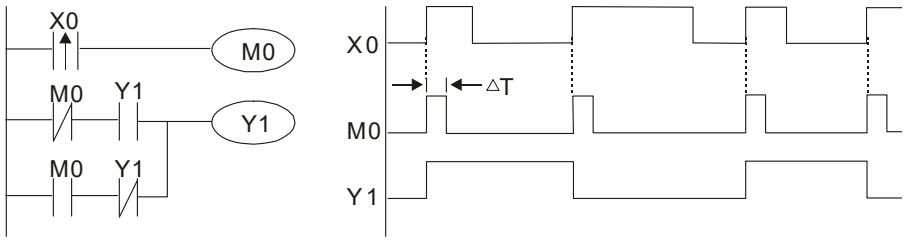


Figure 17-46

Example 10: Delay circuit

When input X0 is ON, because the corresponding NC contact is OFF, the timer T10 is in a no power state, and output coil Y1 is electrified. T10 receives power and begins to count the time only after input X0 is OFF, and output coil Y1 is delayed for 100 seconds (K1000*0.1 sec. = 100 sec.) before losing power. You can see the sequence of actions in Figure 17-47.

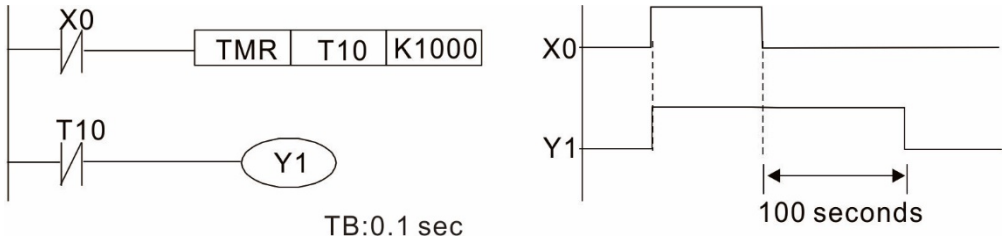



Figure 17-47

Example 11: The open/close delay circuit is composed of two timers; output Y4 has a delay no matter input X0 is ON or OFF. See Figure 17-48.

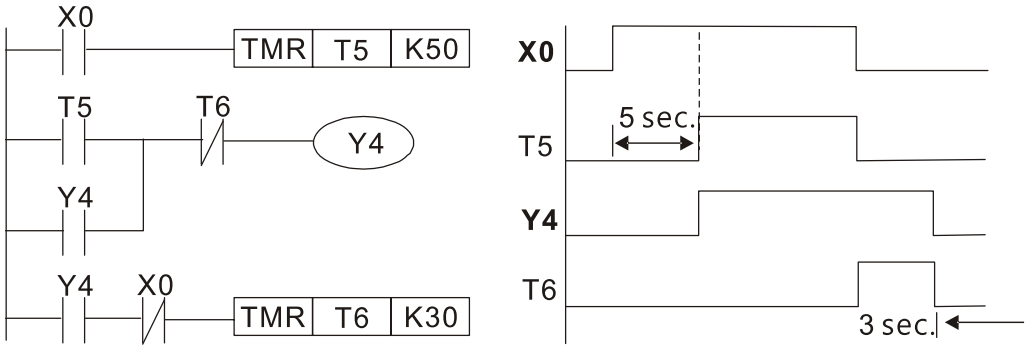



Figure 17-48

Example 12: Extended timing circuit

In the circuit in the ladder diagram (Figure 17-49) on the left, the total delay time from the moment input X0 closes to the time output Y1 is electrified is (n1+n2)*T, where T is the clock cycle. The timers are T11 and T12, and the clock cycle is T.

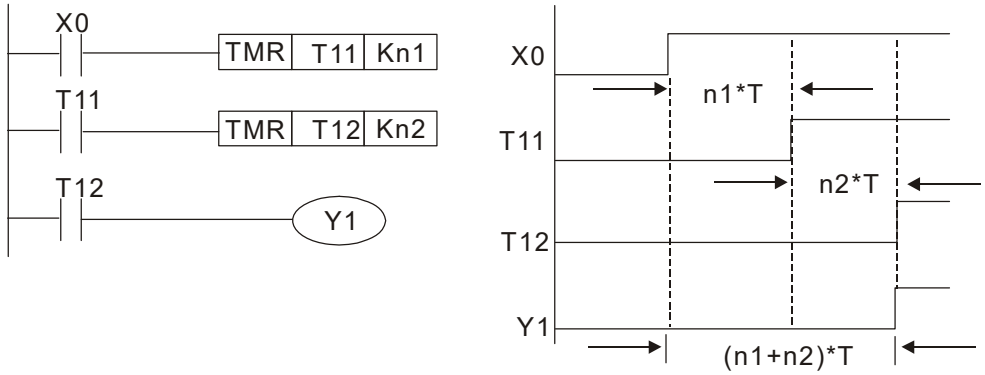



Figure 17-49

# 17-5 Various PLC Device Functions

| Item | Specifications | Notes |
|---|---|---|
| Algorithmic control method | The program is stored internally, alternating back-and-forth scanning method. | |
| Input/output control method | When the scan starts again after ending (after execution to the END command), the input/output is immediately refreshed. | |
| Algorithmic processing speed | Basic commands (several μs) | Application command (1 to several tens of μs) |
| Programming language | Command + ladder diagram | |
| Program capacity | 5000 steps | |
| Input/output terminal | Digital input (X): 7, digital output (Y): 3<br>Analog input AI: 2, analog output AO: 1 | |

Table 17-7

| Type | Device | Item | | Range | | Function |
|---|---|---|---|---|---|---|
| Relay bit form | X | External input relay | | X0–X17, 16 points, octal number | Total 32 points | Corresponds to external input point |
| | Y | External output relay | | Y0–Y17, 16 points, octal number | | Corresponds to external output point |
| | M | Auxiliary Relay | General Use | M0–M799, 800 points | Total 1080 points | Contact can switch ON/OFF within the program |
| | | | Special purpose | M1000–M1279, 280 points | | |
| | T | Timer | 100 ms timer | T0–T59, 160 points | Total 160 points | Timers referred to by the TMR command; T contact with the same number switches ON when the time is reached. |
| | C | Counter | 16-bit counter, general use | C0–C79, 80 points | Total 80 points | Counter referred to by the CNT command; contact of the C with the same number switches ON when the count is reached. |
| Register word data | T | Current timer value | | T0–T159, 160 points | | The contact switches ON when the time is reached. |
| | C | Current counter value | | C0–C79, 16-bit counter 80 points | | The counter contact switches ON when the count is reached. |
| | D | Data Register | Used to maintain power OFF | D0–D99, 100 points | Total 1020 points | Used as data storage memory area |
| | | | Special purpose | D100–D399, 300 points<br>D1000–D1619, 620 points | | |
| Constant | K | Decimal | Single-byte | Setting Range: K-32,768–K32,767 | | |
| | | | Double-byte | Setting Range: K-2,147,483,648–K2,147,483,647 | | |
| | H | Hexadecimal | Single-byte | Setting Range: H0000–HFFFF | | |
| | | | Double-byte | Setting Range: H00000000–HFFFFFFFF | | |
| Serial communications port (program write/read) | | | | RS-485/USB/keypad port | | |
| Input/output | | | | Two built-in analog inputs and one analog output | | |
| High-speed counting | | | | One built-in (MI7 or MI6+MI7 ) 32-bit high-speed counter | | |
| Function extension module | | | Optional Accessories | EMM-D3R2CA | | |
| Communication extension module | | | Built-in | CANopen (slave) | | |
| | | | Optional Accessories | | | |

Table 17-8

## 17-5-1 Introduction to device functions

### Input/output contact functions

Input contact X has this function: input contact X is connected with an input device, and reads input signals entering the PLC. There are no restrictions on the number of times that the input contact A or B appear in the program. The ON/OFF state of input contact X changes as the input device switches between ON and OFF; you cannot use a peripheral device (WPLSoft) to force contact X ON or OFF.

### Output contact Y functions

The output contact Y sends an ON/OFF signal to drive the load connected to output contact Y. There are two types of output contacts: relays and transistors. There are no restrictions on the number of times that contact A or B of an output contact Y appear in a program, but it is recommended that you use the number of output coil Y only once in a program; otherwise the output state when the PLC performs program scanning is determined by the program's final output Y circuit.

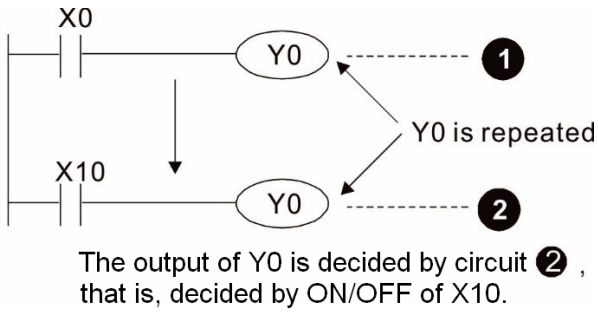



Figure 17-50

Numerical value, constant [K] / [H]

| | | | | |
|---|---|---|---|---|
| Constant | Single-byte | K | Decimal | K-32,768–K32,767 |
| | Double-byte | | | K-2,147,483,648–K2,147,483,647 |
| | Single-byte | H | Hexadecimal | H0000–HFFFF |
| | Double-byte | | | H00000000–HFFFFFFFF |

Table 17-9

The PLC uses five types of numerical values to implement calculations based on its control tasks; the following topics explain the use and function of the different numerical types.

Binary Number, BIN

The PLC's numerical operations and memory employ binary numbers. Table 17-10 below explains terms related to binary numbers.

| | |
|---|---|
| bit | Bits are the fundamental units of binary values, and have a state of either 1 or 0. |
| Nibble | Comprised of a series of four bits (such as b3–b0); can be used to express a one-nibble decimal number 0–9 or hexadecimal number 0–F. |
| Byte | Comprised of a series of two nibbles (i.e. 8 bits, b7–b0); can express a hexadecimal number: 00–FF. |
| Word | Comprised of a series of two bytes (i.e. 16 bits, b15–b0); can express a hexadecimal number with four nibbles: 0000–FFFF. |
| Double Word | Comprised of a series of two words (i.e. 32 bits, b31–b0); can express a hexadecimal number with eight nibbles: 00000000–FFFFFFFF |

Table 17-10

The following diagram shows the relationship between bits, digits, nibbles, words, and double words in a binary system (see Figure 17-51).

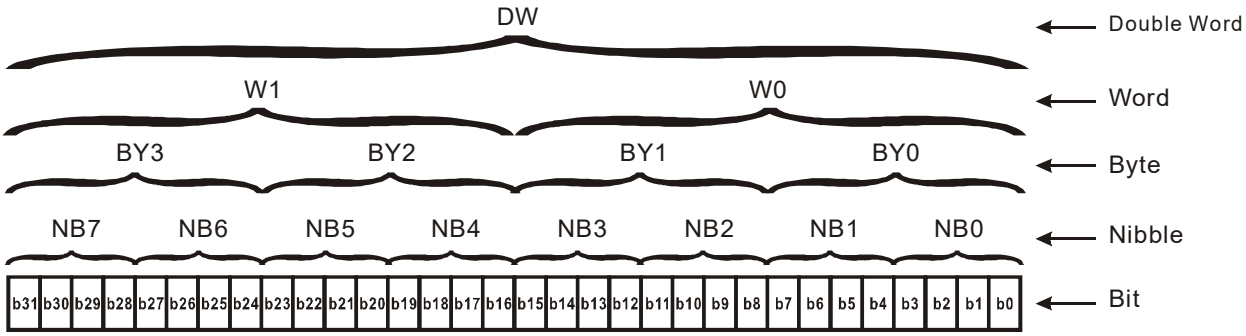



Figure 17-51

### Octal Number, OCT

The external input and output terminals of a DVP-PLC are numbered using octal numbers.

Example: External input: X0–X7, X10–X17…(Device number table)

External output: Y0–Y7, Y10–Y17…(Device number table)

### Decimal Number, DEC

A PLC uses decimal numbers for the following purposes:

- ☑ The setting values of timer T or counter C, such as TMR C0 K50 (K constant).
- ☑ The numbers of devices including M, T, C, or D, such as M10 or T30 (device number).
- ☑ An operand in an application command, such as MOV K123 D0 (K constant).

### Binary Coded Decimal, BCD

Uses one nibble or four bits to express the data in a decimal number; a series of 16 bits can therefore express a decimal number with four nibbles. These are used to read the input value of a rotating numerical switch to input or output a numerical value to a seven-segment display drive.

### Hexadecimal Number, HEX

A PLC uses hexadecimal numbers as operands in application commands, such as MOV H1A2B D0 (H constant).

### Constant K

PLC's usually prefixed decimal numbers with K, such as K100. This indicates that it is a decimal number with a numeric value of 100.

Exceptions: You can combine K with a bit device X, Y, M, or S to produce data in the form of a nibble, byte, word, or double word, such as in the case of K2Y10 or K4M100. Here K1 represents a 4-bit combination, and K2–K4 represent 8-, 12-, and 16-bit combinations.

### Constant H

PLC's usually prefixed hexadecimal numbers with H, such as in the case of H100. This indicates a hexadecimal number with a numeric value of 100.

## Functions of auxiliary relays

Like an output relay Y, an auxiliary relay M has an output coil and contacts A and B, and you can use the output relay contacts any number of times in a program. You can use an auxiliary relay M to configure the control circuit, but cannot use the auxiliary relay to directly drive an external load. There are two types of auxiliary relays:

Ordinary auxiliary relays: ordinary auxiliary relays all revert to the OFF state when a power outage occurs while the PLC is running, and remains in the OFF state when power is restored.

Special purpose auxiliary relays: each special purpose auxiliary relay has its own specific use. Do not use any undefined special purpose auxiliary relays.

## Timer functions

Timers use 100 ms as their timing unit. When the timing method is an upper time limit, and the current timer value = setting value, the timer output coil is energized. Timer setting values use decimal K values; you can also use the data register D as a setting value.

Actual timer setting time = timing units * set value

## Counter features

| Item | 16-bit counter |
|---|---|
| Type | General Type |
| CT Direction: | Up |
| Setting | 0–32,767 |
| Designation of set value | Constant K or data register D |
| Change in current value | When the count reaches the setting value, it stops counting. |
| Output contact | When the count reaches the setting value, the contact switches ON and stays ON. |
| Reset | The current value reverts to 0 when an RST command is executed, and the contact reverts to OFF. |
| Contact actuation | All are actuated after the end of scanning. |

## Counter functions

When a counter's counting pulse input signal switches from OFF to ON, if the counter's current value is equal to the setting value, the output coil switches ON. The setting value can be either a decimal K or a data register D.

16-bit counter:

- ☑ 16-bit counter setting range: K0–K32,767. When K0 and K1 are identical, the output contact is immediately ON during the first count.
- ☑ The current counter value is cleared from an ordinary counter when power to the PLC turns OFF.
- ☑ If you use the MOV command or WPLSoft to transmit a value greater than the setting value to the C0 current value register, when the next X1 switches from OFF to ON, the C0 counter contact changes to ON, and the current value changes to the setting value.
- ☑ You can set a counter's setting value directly using a constant K, or indirectly using the value in register D (not including special data registers D1000–D1199 or D2000–D2799).
- ☑ If the setting value is a constant K, the value must be a positive number. If the setting value is from data register D, the value can be either a positive or negative number. If using a data register, and the current value is 32,767, incrementing the count causes the count value to roll over to -32,768 as the count continues to accumulate.

Example

```
LD      X0
RST     C0
LD      X1
CNT     C0   K5
LD      C0
OUT     Y0
```

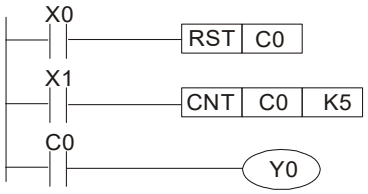



Figure 17-52

1. When X0 = ON and the RST command is executed, the current value of C0 reverts to 0, and the output contact reverts to OFF.
2. When X1 switches from OFF to ON, the current value of the counter is incremented by one (add one).
3. When the count in C0 reaches the set value K5, the contact C0 switches to ON, and the current value of C0 = setting value = K5. Afterwards, additional changes in X1 do not affect the count value, and C0 remains at K5.

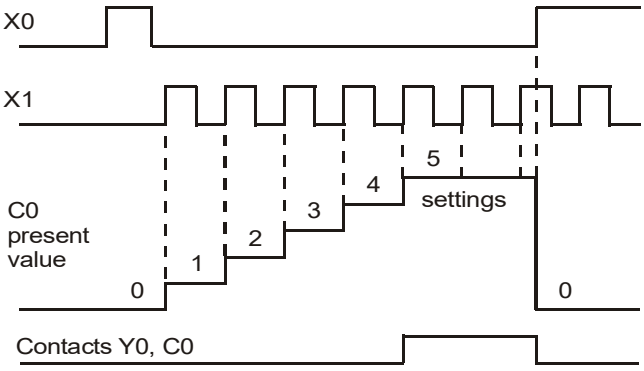



Figure 17-53

## 17-5-2 Introduction to special relay functions (special M)

R/W column: RO means read only; RW means read and write.

| Special M | Function Descriptions | R/W |
|---|---|---|
| M1000 | Monitors N.O. contact (contact A). N.O. while RUN, contact A. This contact is ON while in the RUN state. | RO |
| M1001 | Monitors N.C. contact (contact B). N.C. while RUN, contact B. This contact is OFF while in the RUN state. | RO |
| M1002 | Initiates a forward pulse (the instant RUN is ON). Initial pulse, contact A. Produces a forward pulse when RUN begins; pulse width = scan cycle. | RO |
| M1003 | Initiates a reverse pulse (the instant RUN is OFF). Initial pulse, contact A. Produces a reverse pulse when RUN ends; pulse width = scan cycle. | RO |
| M1004 | -- | RO |
| M1005 | Drive malfunction instructions | RO |
| M1006 | Drive has no output | RO |
| M1007 | Drive direction FWD (0) / REV (1) | RO |
| M1008 – M1010 | -- | -- |
| M1011 | 10ms clock pulse, 5 ms ON / 5 ms OFF. | RO |
| M1012 | 100ms clock pulse, 50 ms ON / 50 ms OFF. | RO |
| M1013 | 1 sec. clock pulse, 0.5 s ON / 0.5 s OFF. | RO |
| M1014 | 1 min. clock pulse, 30 s ON / 30 s OFF. | RO |
| M1015 | Frequency reached (when used with M1025) | RO |
| M1016 | Parameter read/write error | RO |
| M1017 | Parameter write successful | RO |
| M1018 | -- | -- |
| M1019 | -- | -- |
| M1020 | Zero flag | RO |
| M1021 | Borrow flag | RO |
| M1022 | Carry flag | RO |
| M1023 | Divisor is 0 | RO |
| M1024 | -- | -- |
| M1025 | Drive frequency = set frequency (ON)<br>Drive frequency = 0 (OFF) | RW |
| M1026 | Drive operating direction FWD (OFF) / REV (ON) | RW |
| M1027 | Drive Reset | RW |
| M1028 | -- | -- |
| M1029 | -- | -- |
| M1030 | -- | -- |
| M1031 | -- | -- |
| M1032 | -- | -- |
| M1033 | -- | -- |
| M1034 | -- | -- |
| M1035 | -- | -- |
| M1036 | -- | -- |
| M1037 | -- | -- |
| M1038 | MI7 single-phase or MI6+MI7 AB-phase count begins | RW |
| M1039 | Reset MI7 single-phase or MI6+MI7 AB-phase count value | RW |
| M1040 | Hardware power (Servo On) | RW |
| M1041 | -- | -- |
| M1042 | Quick Stop | RW |
| M1043 | -- | -- |
| M1044 | Pause (Halt) | RW |
| M1045 – M1047 | -- | -- |

| Special M | Function Descriptions | R/W |
|---|---|---|
| M1048 | -- | -- |
| M1049 | -- | -- |
| M1050 | -- | -- |
| M1051 | -- | -- |
| M1052 | Lock frequency (lock, frequency locked at the current operating frequency) | RW |
| M1053 | -- | -- |
| M1054 | -- | -- |
| M1055 | -- | -- |
| M1056 | Hardware already has power (Servo On Ready) | RO |
| M1057 | -- | -- |
| M1058 | On Quick Stopping | RO |
| M1059 – M1062 | -- | -- |
| M1063 | -- | RO |
| M1064 – M1076 | -- | -- |
| M1077 | 485 read/write completed | RO |
| M1078 | 485 read/write error | RO |
| M1079 | 485 communication time-out | RO |

Table 17-11

## 17-5-3 Introduction to special register functions (special D)

R/W column: RO means read only; RW means read and write.

| Special D | Function Descriptions | R/W |
|---|---|---|
| D1000 | -- | -- |
| D1001 | Device system program version | RO |
| D1002 | Program capacity | RO |
| D1003 | Total program memory content | RO |
| D1004 – D1009 | -- | -- |
| D1010 | Current scan time (units: 0.1 ms) | RO |
| D1011 | Minimum scan time (units: 0.1 ms) | RO |
| D1012 | Maximum scan time (units: 0.1 ms) | RO |
| D1013 – D1017 | -- | -- |
| D1018 | Current integral value | RO |
| D1019 | Force setting for PID I integral | RW |
| D1020 | Output frequency (0.00–599.00 Hz) | RO |
| D1021 | Output current (####.#A) | RO |
| D1022 | AI AO DI DO extension card number<br>9: EMM-D3R2CA | -- |
| D1023 | Communication extension card number<br>0: No extension card | RO |
| D1024 – D1026 | -- | -- |
| D1027 | -- | RO |
| D1028 | AVI value (0.00–100.00%) | RO |
| D1029 | ACI value (0.00–100.00%) | RO |
| D1030 | -- | -- |
| D1031 | AI10 value (0.00–100.00%) | RO |

| Special D | Function Descriptions | R/W |
|---|---|---|
| D1032 | AI11 value (0.00–100.00%) | RO |
| D1033 – D1034 | -- | -- |
| D1035 | -- | -- |
| D1036 | Servo error bit | RO |
| D1037 | Drive output frequency | RO |
| D1038 | DC BUS voltage | RO |
| D1039 | Output voltage | RO |
| D1040 | Analog output value AFM (-100.00–100.00%) | RW |
| D1041 | Analog output value AO10 (0.00–100.00%) | RW |
| D1042 | Analog output value AO11 (0.00–100.00%) | RW |
| D1043 | -- | -- |
| D1044 | -- | - |
| D1045 | -- | -- |
| D1046 – D1049 | -- | -- |
| D1050 | Actual operation mode<br>0: Speed | RO |
| D1051 | -- | -- |
| D1052 | -- | -- |
| D1053 | -- | RO |
| D1054 | MI7 current calculated count value (low word) | RO |
| D1055 | MI7 current calculated count value (high word) | RO |
| D1056 | Rotational speed corresponding to MI7 | RO |
| D1057 | MI7's rotating speed ratio | RW |
| D1058 | MI7 refresh rate (ms) corresponding to rotating speed | RW |
| D1059 | Number of nibbles of rotating speed corresponding to MI7 (0–3) | RW |
| D1060 | Operation mode setting<br>0: Speed | RW |
| D1061 | 485 COM1 communications time-out time (ms) | RW |

Table 17-12

## 17-5-4 PLC Communication address

| Device | Range | Type | Address (Hex) |
|---|---|---|---|
| X | 00–17 (Octal) | bit | 0400–040FF |
| Y | 00–17 (Octal) | bit | 0500–050F |
| T | 00–159 | bit/word | 0600–069F |
| M | 000–799 | bit | 0800–0B1F |
| M | 1000–1279 | bit | 0BE8–0CFF |
| C | 0–79 | bit/word | 0E00–0E4F |
| D | 00–399 | word | 1000–118F |
| D | 1000–1619 | word | 13E8–1653 |

Table 17-13

Command codes

| Function Code | Function Descriptions | Function target |
|---|---|---|
| H1 | Coil status read | Y, M, T, C |
| H2 | Input status read | X, Y, M, T, C |
| H3 | Read single unit of data | T, C, D |
| H5 | Force single coil status change | Y, M, T, C |

| | | |
|---|---|---|
| H6 | Write single unit of data | T, C, D |
| HF | Force multiple coil status change | Y, M, T, C |
| H10 | Write multiple units of data | T, C, D |

Table 17-14

**NOTE**

When PLC functions have been activated, the MH300-L can match the PLC and drive parameters; this method uses different addresses for drives (default station number is 1; PLC sets station number as 2).

# 17-6 Introduction to the Command Window

## 17-6-1 Overview of basic commands

- Ordinary commands

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| LD | Load contact A | X, Y, M, T, C | 0.8 |
| LDI | Load contact B | X, Y, M, T, C | 0.8 |
| AND | Connect contact A in series | X, Y, M, T, C | 0.8 |
| ANI | Connect contact B in series | X, Y, M, T, C | 0.8 |
| OR | Connect contact A in parallel | X, Y, M, T, C | 0.8 |
| ORI | Connect contact B in parallel | X, Y, M, T, C | 0.8 |
| ANB | Series circuit block | N/A | 0.3 |
| ORB | Parallel circuit block | N/A | 0.3 |
| MPS | Save to stack | N/A | 0.3 |
| MRD | Stack read (pointer does not change) | N/A | 0.3 |
| MPP | Read stack | N/A | 0.3 |

Table 17-15

- Output command

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| OUT | Drive coil | Y, M | 1 |
| SET | Action continues (ON) | Y, M | 1 |
| RST | Clear contact or register | Y, M, T, C, D | 1.2 |

Table 17-16

- Timer, counter

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| TMR | 16-bit timer | T-K or T-D commands | 1.1 |
| CNT | 16-bit counter | C-K or C-D (16-bit) | 0.5 |

Table 17-17

- Main control command

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| MC | Common series contact connection | N0–N7 | 0.4 |
| MCR | Common series contact release | N0–N7 | 0.4 |

Table 17-18

- Contact rising edge/falling edge detection command

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| LDP | Start of rising edge detection action | X, Y, M, T, C | 1.1 |
| LDF | Start of falling edge detection action | X, Y, M, T, C | 1.1 |
| ANDP | Rising edge detection series connection | X, Y, M, T, C | 1.1 |
| ANDF | Falling edge detection series connection | X, Y, M, T, C | 1.1 |
| ORP | Rising edge detection parallel connection | X, Y, M, T, C | 1.1 |
| ORF | Falling edge detection parallel connection | X, Y, M, T, C | 1.1 |

Table 17-19

- Upper/lower differential output commands

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| PLS | Upper differential output | Y, M | 1.2 |
| PLF | Lower differential output | Y, M | 1.2 |

Table 17-20

- Stop command

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| END | Program conclusion | N/A | 0.2 |

Table 17-21

- Other commands

| Command code | Function | OPERAND | Execution speed (μs) |
|---|---|---|---|
| NOP | No action | N/A | 0.2 |
| INV | Inverse of operation results | N/A | 0.2 |
| P | Index | P | 0.3 |

Table 17-22

## 17-6-2 Detailed explanation of basic commands

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **LD** | Load contact A | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: Use the LD command for contact A starting at the left busbar or contact A starting at a contact circuit block; its function is to save current content and save the acquired contact status in the cumulative register.

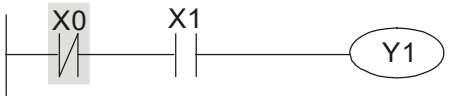
Example: Ladder diagram:

| Command code: | | Description: |
|---|---|---|
| **LD** | **X0** | Load Contact A of X0 |
| AND | X1 | Create a series connection to contact A of X1 |
| OUT | Y1 | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **LDI** | Load contact B | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: Use the LDI command for contact B starting at the left busbar or contact B starting at a contact circuit block; its function is to save current content and save the acquired contact status in the cumulative register.

Example: Ladder diagram:

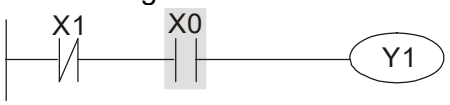



| Command code: | | Description: |
|---|---|---|
| **LDI** | **X0** | Load Contact B of X0 |
| AND | X1 | Create a series connection to contact A of X1 |
| OUT | Y1 | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **AND** | Connect contact A in series | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: Use the AND command to create a series connection to contact A; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform “AND” operation; saves the results in the cumulative register.

Example: Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LDI | X1 | Load Contact B of X1 |
| **AND** | **X0** | Create a series connection to contact A of X0 |
| OUT | Y1 | Drive Y1 coil |

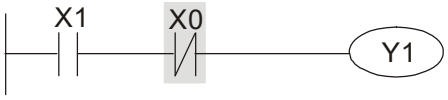
| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **ANI** | Connect contact B in series | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation

Use the ANI command to create a series connection to contact B; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform “AND” operation; saves the results in the cumulative register.

Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X1 | Load Contact A of X1 |
| **ANI** | **X0** | Create a series connection to contact B of X0 |
| OUT | Y1 | Drive Y1 coil |

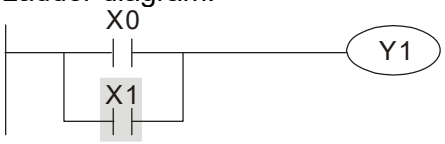
| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **OR** | Connect contact A in parallel | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation

Use the OR command to establish a parallel connection to contact A; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform “OR” operation; saves the results in cumulative register.

Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **OR** | **X1** | Create a series connection to contact A of X1 |
| OUT | Y1 | Drive Y1 coil |

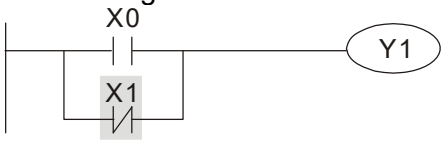
| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **ORI** | Connect contact B in parallel | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation

Use the ORI command to establish a parallel connection to contact B; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform “OR” operation; saves the results in cumulative register.

Example

Ladder diagram:

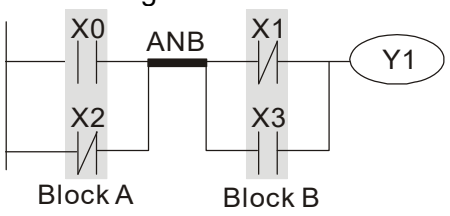



| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **ORI** | **X1** | Create a series connection to contact B of X1 |
| OUT | Y1 | Drive Y1 coil |

| Command | Function |
|---|---|
| **ANB** | Series circuit block |
| Operand | N/A |

Explanation: ANB performs an “AND” operation on the previously saved logic results and the current cumulative register content.

Example: Ladder diagram:

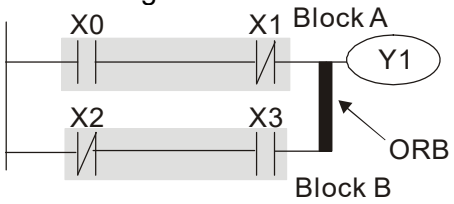



| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| ORI | X2 | Establish a parallel connection to contact B of X2 |
| LDI | X1 | Load Contact B of X1 |
| OR | X3 | Establish a parallel connection to contact A of X3 |
| **ANB** | | Series circuit block |
| OUT | Y1 | Drive Y1 coil |

| Command | Function |
|---|---|
| **ORB** | Parallel circuit block |
| Operand | N/A |

Explanation: ORB performs an “OR” operation on the previously saved logic results and the current cumulative register content.

Example: Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| ANI | X1 | Establish a parallel connection to contact B of X1 |
| LDI | X2 | Load Contact B of X2 |
| AND | X3 | Establish a parallel connection to contact A of X3 |
| **ORB** | | Parallel circuit block |
| OUT | Y1 | Drive Y1 coil |

| Command | Function |
|---|---|
| **MPS** | Save to stack |
| Operand | N/A |

Explanation: Saves the current content of the cumulative register to the stack (add one to the stack pointer).

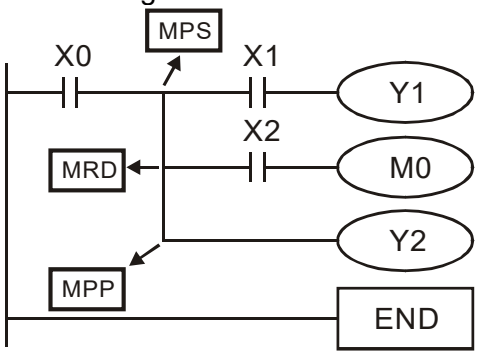
| Command | Function |
|---|---|
| **MRD** | Read stack (pointer does not change) |
| Operand | N/A |

Explanation: Reads the stack content and saves to the cumulative register (the stack pointer does not change).

| Command | Function |
|---|---|
| **MPP** | Read stack |
| Operand | N/A |

Explanation: Retrieves the result of the previously-saved logical operation from the stack, and saves to the cumulative register (subtract one from stack pointer).

Example: Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **MPS** | | Save to the stack |
| AND | X1 | Create a series connection to contact A of X1 |
| OUT | Y1 | Drive Y1 coil |
| **MRD** | | Read the stack (pointer does not change) |
| AND | X2 | Create a series connection to contact A of X2 |
| OUT | M0 | Drive M0 coil |
| **MPP** | | Read stack |
| OUT | Y2 | Drive Y2 coil |
| END | | Program conclusion |

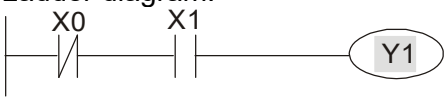
| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **OUT** | Drive coil | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | - | | | - | - | - |

Explanation: Outputs the result of the logical operation before the OUT command to the designated element.

Coil contact action:

| Result: | Out command | | |
|---|---|---|---|
| | Coil | Access Point: | |
| | | Contact A (N.O.) | Contact B (N.C.) |
| FALSE | OFF | Not conducting | Conducting |
| TRUE | ON | Conducting | Not conducting |
| | | | |

Example: Ladder diagram:

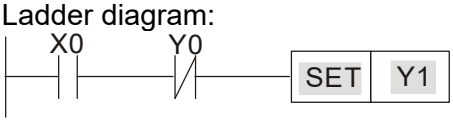



| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact B of X0 |
| AND | X1 | Establish a parallel connection to contact A of X1 |
| **OUT** | **Y1** | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **SET** | Action continues (ON) | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | - | | | - | - | - |

Explanation: Sets the designated element to ON, and maintains it in an ON state, regardless of whether the SET command is still driven. Use the RST command to set the element as OFF.

Example: Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| AN | Y0 | Establish a parallel connection to contact B of Y0 |

| | | |
|---|---|---|
| **SET** | **Y1** | Action continues (ON) |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **RST** | Clear contact or register | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | - | | | | | |

Explanation

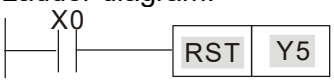
Resets the designated element as described.

| Element | Mode |
|---|---|
| Y, M | Both coil and contact are set to OFF. |
| T, C | Sets the current timing or count value to 0 and both the coil and contact are set to OFF. |
| D | Sets the content value to 0. |

If the RST command is not executed, the status of the designated element remains unchanged.

Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **RST** | **Y5** | Clear the contact or register |

| Command | Function | |
|---|---|---|
| **TMR** | 16-bit timer | |
| Operand | T-K | T0–T159, K0–K32,767 |
| | T-D | T0–T159, D0–D399 |

Explanation

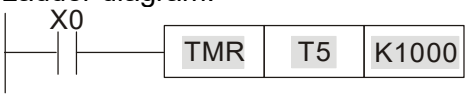
Electrifies the designated timer coil, and the timer begins timing. The contact's action is as follows when the timing value reaches the designated setting value (timing value ≥ setting value):

| | |
|---|---|
| N.O. (Normally Open) contact | Closed |
| N.C. (Normally Closed) contact | Open |

If the RST command is not executed, the status of the designated element remains unchanged.

Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **TMR** | **T5 K1000** | T5 timer<br>Set value as K1000 |

| Command | Function | |
|---|---|---|
| **CNT** | 16-bit counter | |
| Operand | C-K | C0–C79, K0–K32,767 |
| | C-D | C0–C79, D0–D399 |

Explanation

When you execute the CNT command from OFF to ON, switch the designated counter coil from no power to electrified and add one to the counter's count value. When the count reaches the designated value (count value = setting value), the contact has the following action:

| | |
|---|---|
| N.O. (Normally Open) contact | Closed |
| N.C. (Normally Closed) contact | Open |

After reaching the count value, the contact and count value both remain unchanged even with continued count pulse input. Use the RST command to restart or clear the count.

Example

Ladder diagram:

| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **CNT** | **C2 K100** | C2 counter<br>Set value as K100 |

| Command | Function |
|---|---|
| **MC/MCR** | Connect/release a common series contact |
| Operand | N0–N7 |

Explanation

MC is the main control initiation command, and any command between MC and MCR is executed normally. When the MC command is OFF, any command between MC and MCR acts as follows:

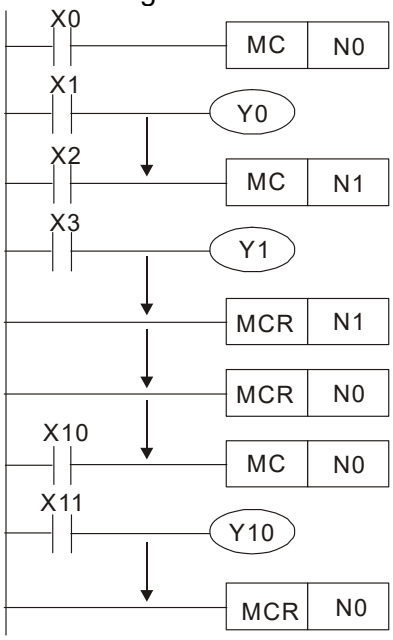
| Determination of commands | Description |
|---|---|
| Ordinary timer | The timing value reverts to 0, the coil loses power, and the contact does not operate. |
| Counter | The coil loses power, and the count value and contact stay in their current state. |
| Coil driven by OUT command | None receive power. |
| Elements driven by SET, RST commands. They remain in their current state. | |
| Application commands | None are actuated. |

MCR is the main control stop command, and is placed at the end of the main control program. There may not be any contact command prior to the MCR command.

The MC-MCR main control program commands support a nested program structure with a maximum of only eight levels; use in the order N0–N7. Refer to the following program example:

Example

Ladder diagram:



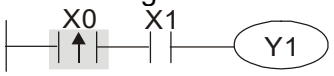

| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **MC** | **N0** | Connection of N0 common series contact |
| LD | X1 | Load Contact A of X1 |
| OUT | Y0 | Drive Y0 coil |
| : | | |
| LD | X2 | Load Contact A of X2 |
| **MC** | **N1** | Connection of N1 common series contact |
| LD | X3 | Load Contact A of X3 |
| OUT | Y1 | Drive Y1 coil |
| : | | |
| **MCR** | **N1** | Release N1 common series contact |
| : | | |
| **MCR** | **N0** | Release N0 common series contact |
| : | | |
| LD | X10 | Load Contact A of X10 |
| MC | **N0** | Connection of N0 common series contact |
| LD | X11 | Load Contact A of X11 |
| OUT | Y10 | Drive Y10 coil |
| : | | |
| **MCR** | **N0** | Release N0 common series contact |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **LDP** | Start of rising edge detection action | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: The LDP command has the same use as LD, but its action is different. Its function is to save the current content while also saving the detected state of the rising edge of the contact to the cumulative register.

Example

Ladder diagram:



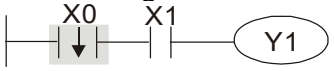

| Command code: | | Description: |
|---|---|---|
| **LDP** | **X0** | Start of X0 rising edge detection action |
| AND | X1 | Create a series connection to contact A of X1 |
| OUT | Y1 | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **LDF** | Start of falling edge detection action | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: The LDF command has the same use as LD, but its action is different. Its function is to save the current content while also saving the detected state of the falling edge of the contact to the cumulative register.

Example

Ladder diagram:



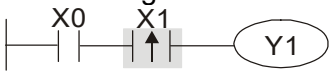

| Command code: | | Description: |
|---|---|---|
| **LDF** | **X0** | Start of X0 falling edge detection action |
| AND | X1 | Create a series connection to contact A of X1 |
| OUT | Y1 | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **ANDP** | Rising edge detection series connection | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: Use the ANDP command for a contact rising edge detection series connection.

Example

Ladder diagram:



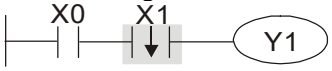

| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **ANDP** | **X1** | X1 Rising edge detection series connection |
| OUT | Y1 | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **ANDF** | Falling edge detection series connection | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: Use the ANDF command for a contact falling edge detection series connection.

Example:

Ladder diagram:



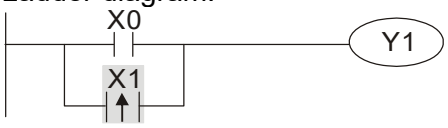

| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **ANDF** | **X1** | X1 Falling edge detection series connection |
| OUT | Y1 | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **ORP** | Rising edge detection parallel connection | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: Use the ORP command for a contact rising edge detection parallel connection.

Example:

Ladder diagram:



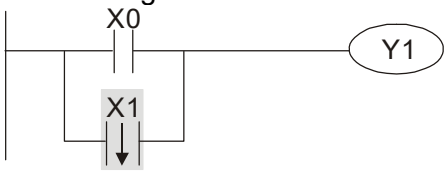

| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **ORP** | **X1** | X1 Rising edge detection parallel connection |
| OUT | Y1 | Drive Y1 coil |

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **ORF** | Falling edge detection parallel connection | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | | | | | | - |

Explanation: Use the ORF command for a contact falling edge detection parallel connection.

Example:

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **ORF** | **X1** | X1 Falling edge detection parallel connection |
| OUT | Y1 | Drive Y1 coil |

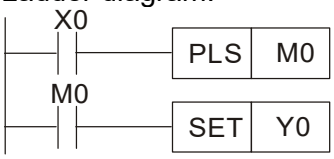
| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **PLS** | Upper differential output | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | - | | | - | - | - |

Explanation

Upper differential output command: when X0 switches from OFF to ON (rising edge-triggered), the PLS command is executed, and M0 sends one pulse with the pulse length consisting of one scanning period.

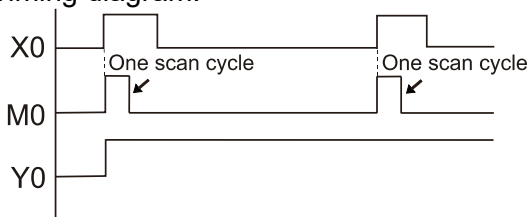
Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **PLS** | **M0** | M0 Upper differential output |
| LD | M0 | Load Contact A of M0 |
| SET | Y0 | Y0 Action continues (ON) |

Timing diagram:



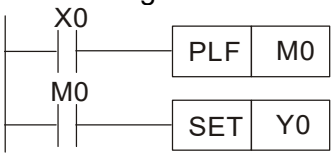

| Command | Function | | | | | |
|---|---|---|---|---|---|---|
| **PLF** | Lower differential output | | | | | |
| Operand | X0–X17 | Y0–Y17 | M0–M799 | T0–159 | C0–C79 | D0–D399 |
| | - | | | - | - | - |

Explanation

Lower differential output command: when X0 switches from ON to OFF (falling edge-triggered), the PLF command is executed, and M0 sends one pulse with the pulse length consisting of one scanning period.

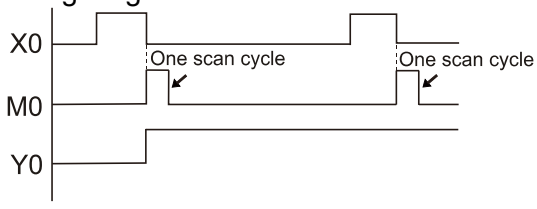
Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **PLF** | **M0** | M0 Lower differential output |
| LD | M0 | Load Contact A of M0 |
| SET | Y0 | Y0 Action continues (ON) |

Timing diagram:




| Command | Function |
|---|---|
| **END** | End of Program |
| Operand | N/A |

Explanation

An END command must be added to the end of a ladder diagram program or command program. The PLC scans the program from address 0 to the END command, and then returns to address 0 and begins scanning again.

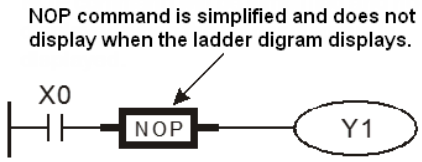
| Command | Function |
|---|---|
| **NOP** | No action |
| Operand | N/A |

Explanation

The NOP command does not perform any operation in the program. Because execution of this command retains the original logical operation results, you can use it in the following situation: use the NOP command instead of a command that is deleted without changing the program length.

Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact B of X0 |
| **NOP** | | No action |
| OUT | Y1 | Drive Y1 coil |

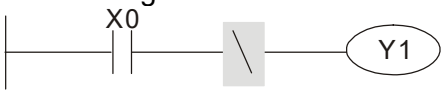
| Command | Function |
|---|---|
| **INV** | Inverse of operation results |
| Operand | N/A |

Explanation

Saves the result of the logic inversion operation prior to the INV command in the cumulative register.

Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| **INV** | | Inverse of operation results |
| OUT | Y1 | Drive Y1 coil |

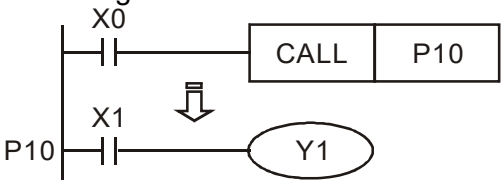
| Command | Function |
|---|---|
| **P** | Pointer |
| Operand | P0–P255 |

Explanation

Use pointer P as the target in a subprogram call (command API 01 CALL). Using P does not require starting from zero, but the number cannot be used repeatedly; otherwise, an unpredictable error occurs.

Example

Ladder diagram:




| Command code: | | Description: |
|---|---|---|
| LD | X0 | Load Contact A of X0 |
| CALL | P10 | Call command CALL to P10 |
| : | | |
| **P10** | | Pointer P10 |
| LD | X1 | Load Contact A of X1 |
| OUT | Y1 | Drive Y1 coil |

## 17-6-3 Overview of application commands

| Classification | API | Command code | | P command | Function | STEPS | |
|---|---|---|---|---|---|---|---|
| | | 16 bit | 32 bit | | | 16 bit | 32 bit |
| Circuit control | 01 | CALL | - | | Call a subprogram | 3 | - |
| | 2 | SRET | - | - | End a subprogram | 1 | - |
| | 06 | FEND | - | - | End a main program | 1 | - |
| Send comparison | 10 | CMP | DCMP | | Compare set output | 7 | 13 |
| | 11 | ZCP | DZCP | | Range comparison | 9 | 17 |
| | 12 | MOV | DMOV | | Move data | 5 | 9 |
| | 15 | BMOV | – | | Send all | 7 | – |
| Four logical operations | 20 | ADD | DADD | | BIN addition | 7 | 13 |
| | 21 | SUB | DSUB | | BIN subtraction | 7 | 13 |
| | 22 | MUL | DMUL | | BIN multiplication | 7 | 13 |
| | 23 | DIV | DDIV | | BIN division | 7 | 13 |
| | 24 | INC | DINC | | BIN add one | 3 | 5 |
| | 25 | DEC | DDEC | | BIN subtract one | 3 | 5 |
| Rotational displacement | 30 | ROR | DROR | | Right rotation | 5 | – |
| | 31 | ROL | DROL | | Left rotation | 5 | – |
| Data Process | 40 | ZRST | – | | Clear range | 5 | - |
| | 49 | – | DFLT | | Convert BIN whole number to binary floating point number | - | 9 |
| Floating point operation | 110 | – | DECMP | | Compare binary floating point numbers | – | 13 |
| | 111 | – | DEZCP | | Compare binary floating point number range | – | 17 |
| | 116 | – | DRAD | | Convert angle to diameter | – | 9 |
| | 117 | – | DDEG | | Convert diameter to angle | – | 9 |
| | 120 | – | DEADD | | Add binary floating point numbers | – | 13 |
| | 121 | – | DESUB | | Subtract binary floating point numbers | – | 13 |
| | 122 | – | DEMUL | | Multiply binary floating point numbers | – | 13 |
| | 123 | – | DEDIV | | Divide binary floating point numbers | – | 13 |
| | 124 | – | DEXP | | Find exponent of a binary floating point number | – | 9 |
| | 125 | – | DLN | | Find natural logarithm of a binary floating point number | – | 9 |
| | 127 | – | DESQR | | Find the square root of a binary floating point number | – | 9 |
| | 129 | – | DINT | | Convert binary floating point number to BIN whole number | – | 9 |
| | 130 | – | DSIN | | Find the sine of a binary floating point number | – | 9 |
| | 131 | – | DCOS | | Find the cosine of a binary floating point number | – | 9 |
| | 132 | – | DTAN | | Find the tangent of a binary floating point number | – | 9 |
| | 133 | – | DASIN | | Find the arcsine of a binary floating point number | – | 9 |
| | 134 | – | DACOS | | Find the arccosine of a binary floating point number | – | 9 |
| | 135 | – | DATAN | | Find the arctangent of a binary floating point number | – | 9 |
| Floating point operation | 136 | – | DSINH | | Find the hyperbolic sine of a binary floating point number | – | 9 |
| | 137 | – | DCOSH | | Find the hyperbolic cosine of a binary floating point number | – | 9 |
| | 138 | – | DTANH | | Find the hyperbolic tangent of a binary floating point number | – | 9 |

| Classification | API | Command code | | P command | Function | STEPS | |
|---|---|---|---|---|---|---|---|
| | | 16 bit | 32 bit | | | 16 bit | 32 bit |
| Communication | 150 | MODRW | – | | Modbus read/write | 7 | – |
| Calendar | 160 | TCMP | – | | Compare calendar data | 11 | – |
| | 161 | TZCP | – | | Compare calendar data range | 9 | – |
| | 162 | TADD | – | | Calendar data addition | 7 | – |
| | 163 | TSUB | – | | Calendar data subtraction | 7 | – |
| | 166 | TRD | – | | Calendar data read | 3 | – |
| GRAY code | 170 | GRY | DGRY | | Convert BIN to GRAY code | 5 | 9 |
| | 171 | GBIN | DGBIN | | Convert GRAY code to BIN | 5 | 9 |
| Contact form logical operation | 215 | LD& | DLD& | - | Contact form logical operation LD# | 5 | 9 |
| | 216 | LD\| | DLD\| | - | Contact form logical operation LD# | 5 | 9 |
| | 217 | LD^ | DLD^ | - | Contact form logical operation LD# | 5 | 9 |
| | 218 | AND& | DAND& | - | Contact form logical operation AND# | 5 | 9 |
| | 219 | AND\| | DAND\| | - | Contact form logical operation AND# | 5 | 9 |
| | 220 | AND^ | DAND^ | - | Contact form logical operation AND# | 5 | 9 |
| | 221 | OR& | DOR& | - | Contact form logical operation OR# | 5 | 9 |
| | 222 | OR\| | DOR\| | - | Contact form logical operation OR# | 5 | 9 |
| | 223 | OR^ | DOR^ | - | Contact form logical operation OR# | 5 | 9 |
| Contact form comparison command | 224 | LD = | DLD = | - | Contact form compare LD* | 5 | 9 |
| | 225 | LD < | DLD < | - | Contact form compare LD* | 5 | 9 |
| | 226 | LD > | DLD > | - | Contact form compare LD* | 5 | 9 |
| | 228 | LD < > | DLD < > | - | Contact form compare LD* | 5 | 9 |
| | 229 | LD = > | DLD = > | - | Contact form compare LD* | 5 | 9 |
| | 230 | LD = < | DLD = < | - | Contact form compare LD* | 5 | 9 |
| | 232 | AND = | DAND = | - | Contact form compare AND* | 5 | 9 |
| | 233 | AND < | DAND < | - | Contact form compare AND* | 5 | 9 |
| | 234 | AND > | DAND > | - | Contact form compare AND* | 5 | 9 |
| | 236 | AND < > | DAND < > | - | Contact form compare AND* | 5 | 9 |
| | 237 | AND = > | DAND = > | - | Contact form compare AND* | 5 | 9 |
| | 238 | AND = < | DAND = < | - | Contact form compare AND* | 5 | 9 |
| | 240 | OR = | DOR = | - | Contact form compare OR* | 5 | 9 |
| | 241 | OR < | DOR < | - | Contact form compare OR* | 5 | 9 |
| | 242 | OR > | DOR > | - | Contact form compare OR* | 5 | 9 |
| | 244 | OR < > | DOR < > | - | Contact form compare OR* | 5 | 9 |
| | 245 | OR = > | DOR = > | - | Contact form compare OR* | 5 | 9 |
| | 246 | OR = < | DOR = < | - | Contact form compare OR* | 5 | 9 |

| Classification | API | Command code | | P command | Function | STEPS | |
|---|---|---|---|---|---|---|---|
| | | 16 bit | 32 bit | | | 16-bit | 32-bit |
| Floating point contact form | 275 | - | FLD = | - | Floating point number contact form compare LD* | - | 9 |
| | 276 | - | FLD < | - | Floating point number contact form compare LD* | - | 9 |
| | 277 | - | FLD > | - | Floating point number contact form compare LD* | - | 9 |
| Comparison command | 278 | - | FLD < > | - | Floating point number contact form compare LD* | - | 9 |
| | 279 | - | FLD = > | - | Floating point number contact form compare LD* | - | 9 |
| | 280 | - | FLD = < | - | Floating point number contact form compare LD* | - | 9 |
| | 281 | - | FAND = | - | Floating point number contact form compare AND* | - | 9 |
| | 282 | - | FAND < | - | Floating point number contact form compare AND* | - | 9 |
| | 283 | - | FAND > | - | Floating point number contact form compare AND* | - | 9 |
| | 284 | - | FAND < > | - | Floating point number contact form compare AND* | - | 9 |
| | 285 | - | FAND = > | - | Floating point number contact form compare AND* | - | 9 |
| | 286 | - | FAND = < | - | Floating point number contact form compare AND* | - | 9 |
| | 287 | - | FOR = | - | Floating point number contact form compare OR* | - | 9 |
| | 288 | - | FOR < | - | Floating point number contact form compare OR* | - | 9 |
| | 289 | - | FOR > | - | Floating point number contact form compare OR* | - | 9 |
| | 290 | - | FOR < > | - | Floating point number contact form compare OR* | - | 9 |
| | 291 | - | FOR = > | - | Floating point number contact form compare OR* | - | 9 |
| | 292 | - | FOR = < | - | Floating point number contact form compare OR* | - | 9 |
| Drive special command | 139 | RPR | – | | Read servo parameter | 5 | – |
| | 140 | WPR | – | | Write servo parameter | 5 | – |
| | 262 | – | DPOS | | Set target | - | 5 |

## 17-6-4 Detailed explanation of application commands

| API | | | | |
|---|---|---|---|---|
| 01 | **CALL** | **P** | (S) | Call a subprogram |

| bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| X | Y | M | K | H | KnX | KnY | KnM | T | C | D |

Notes on operand usage:
The S operand can designate P.
MH300-L series device: The S operand can designate P0-P63.

16-bit command (3 STEP)

| | | | |
|---|---|---|---|
| CALL | Continuous execution type | CALLP | Pulse execution type |

32-bit command

| | | | |
|---|---|---|---|
| - | - | - | - |

Flag signal: none

Explanation

- **S**: Call subprogram pointer
- Write the subprogram after the FEND command.
- The subprogram must end after the SRET command.
- Refer to the FEND command explanation and sample content for detailed command functions.

| API | | | | |
|---|---|---|---|---|
| 02 | **SRET** | | - | End of subprogram |

| bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| X | Y | M | K | H | KnX | KnY | KnM | T | C | D |

Notes on operand usage:
No operand
A contact-driven command is not needed.

16-bit command (1 STEP)

| | | | |
|---|---|---|---|
| FEND | Continuous execution type | - | - |

32-bit command

| | | | |
|---|---|---|---|
| - | - | - | - |

Flag signal: none

Explanation

- A contact-driven command is not needed. Automatically returns next command after CALL command.
- Indicates end of subprogram. After end of subprogram, SRET returns to main program, and executes next command after the original call subprogram CALL command.
- Refer to the FEND command explanation and sample content for detailed command functions.

| API 06 | | FEND | | - | End of a main program |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |

Notes on operand usage:
No operand
A contact-driven command is not needed.

| 16-bit command (1 STEP) | | | |
|---|---|---|---|
| FEND | Continuous execution type | - | - |

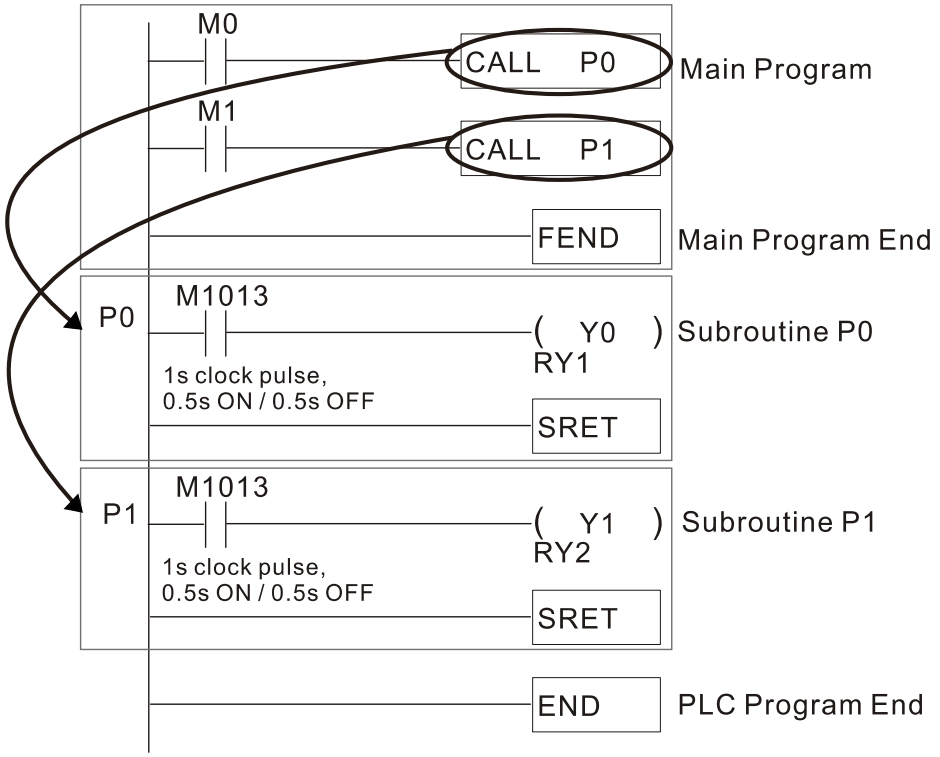
| 32-bit command | | | |
|---|---|---|---|
| - | - | - | - |

Flag signal: none

Explanation

- This command indicates the end of the main program. It is the same as the END command when the PLC executes this command.
- The CALL command program must be written after the FEND command, and the SRET command is added to the end of the subprogram.
- When using the FEND command, an END command is also needed. However, the END command must be placed at the end, after the main program and subprogram.

CALL command process



| API | | | | | |
|---|---|---|---|---|---|
| 10 | D | **CMP** | P | (S1) (S2) (D) | Compare set output |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |
| D | | * | * | | | | | | | | |

Notes on operand usage:
The operand D occupies three consecutive points

| 16-bit command (7 STEP) | | | |
|---|---|---|---|
| CMP | Continuous execution type | CMPP | Pulse execution type |

| 32-bit command (13 STEP) | | | |
|---|---|---|---|
| DCMP | Continuous execution type | DCMPP | Pulse execution type |

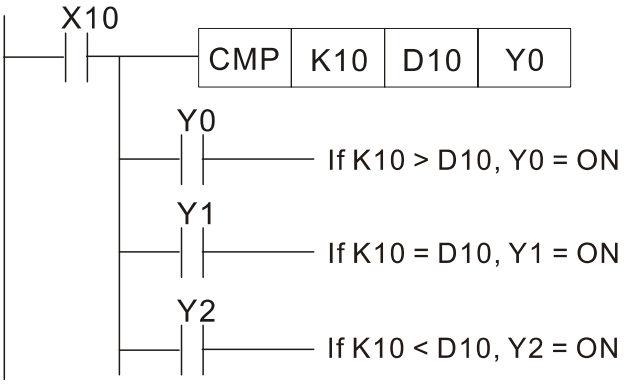
Flag signal: none

Explanation

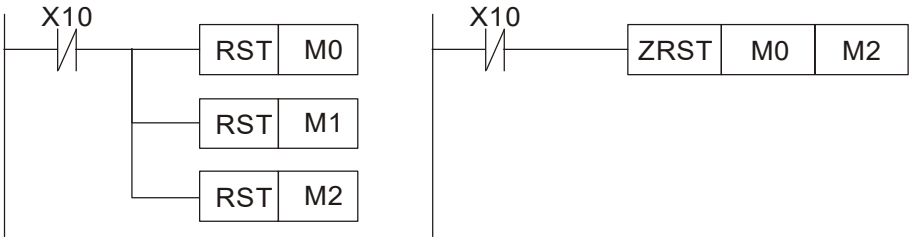
- **S1**: Compare value 1. **S2**: Compare value 2. **D**: Results of comparison.
- Compares the size of the content of operand **S1** and **S2**; stores the results of the comparison in **D**.
- Size comparison is performed algebraically. All data is compared in the form of numerical binary values. Because this is a 16-bit command, when b15 is 1, this indicates a negative number.

Example

- When the designated device is Y0, it automatically occupies Y0, Y1 and Y2.
- When X10=ON, the CMP command executes, and Y0, Y1 or Y2 is ON. When X10=OFF, the CMP command does not execute, and the state of Y0, Y1 and Y2 remain in the state prior to X10=OFF.
- For ≥, ≤, or ≠ comparison results, use series and parallel connections among Y0–Y2.




- To clear results of comparison, use the RST or ZRST command.



| API 11 | D | ZCP | P | (S1) (S2) (S) (D) | Range comparison |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |
| S | | | | * | * | * | * | * | * | * | * |
| D | | * | * | | | | | | | | |

Notes on operand usage:
The content value of operand S1 is less than the content value of S2 operand.
The operand D occupies three consecutive points.

| 16-bit command (9 STEP) | | | |
|---|---|---|---|
| ZCP | Continuous execution type | ZCPP | Pulse execution type |

| 32-bit command (17 STEP) | | | |
|---|---|---|---|
| DZCP | Continuous execution type | DZCPP | Pulse execution type |

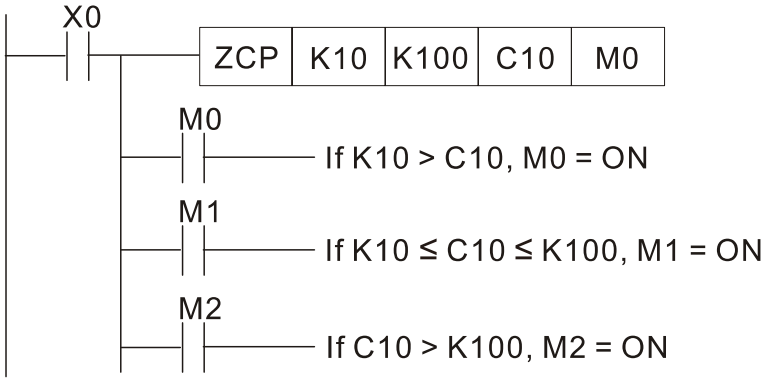
Flag signal: none

Explanation

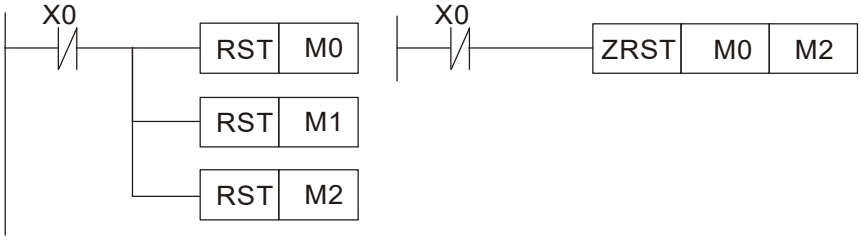
- **S1**: Lower limit of range comparison. **S2**: Upper limit of range comparison. **S** : Comparative value. **D**: Results of comparison.
- Compares value **S** with the lower limit **S1** and upper limit **S2**, and stores the results of the comparison in **D**.
- When lower limit **S1** > upper limit **S2**, the command uses the lower limit **S1** to perform the comparison with **S1** as the upper and lower limit.
- Size comparison is performed algebraically. All data is compared in the form of numerical binary values. Because this is a 16-bit command, when b15 is 1, this indicates a negative number.

Example

- When the designated device is M0, it automatically occupies M0, M1 and M2.
- When X0=ON, the ZCP command executes, and M0, M1 or M2 is ON. When X0=OFF, the ZCP command does not execute, and the state of M0, M1 or M2 remains in the state prior to X0=OFF.
- For ≥, ≤, or ≠ comparison results, use series and parallel connections of M0–M2.




- To clear results of comparison, use the RST or ZRST command.



| API 12 | D | MOV | P | (S) (D) | Move data |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage: none

16-bit command (5 STEP)

| MOV | Continuous execution type | MOVP | Pulse execution type |
|---|---|---|---|

32-bit command (9 STEP)

| DMOV | Continuous execution type | DMOVP | Pulse execution type |
|---|---|---|---|

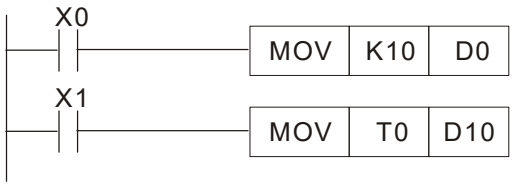
Flag signal: none

Explanation

- **S**: Data source. **D**: Destination of data movement.
- Moves the content in **S** to **D**. When the command does not execute, the content of **D** does not change.

Example

- When X0=OFF, the content of D10 does not change; if X0=ON, the value K10 is moved to data register D10.
- When X1=OFF, the content of D10 does not change; if X1=ON, the current value of T0 is moved to data register D10.



| API 15 | | BMOV | P | S D n | Send all |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | | | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |
| n | | | | * | * | | | | * | * | |

Notes on operand usage:

n operand scope n = 1 to 512

16-bit command (7 STEP)

| BMOV | Continuous execution type | BMOVP | Pulse execution type |
|---|---|---|---|

32-bit command

| - | - | - | - |
|---|---|---|---|

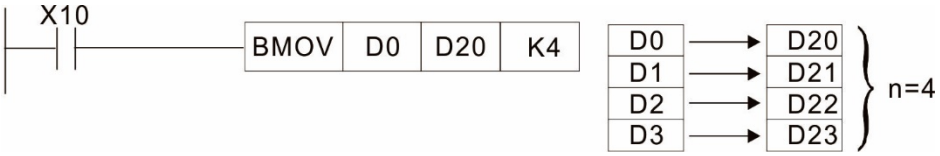
Flag signal: none

Explanation

- **S**: Initiate source device. **D**: Initiate destination device. **n**: Send block length.
- Sends the content of n registers starting from the initial number of the device designated by **S** to the n registers starting from the initial number of the device designated by **n**; if the number of points referred to by n exceeds the range used by that device, sends only points within the valid range.

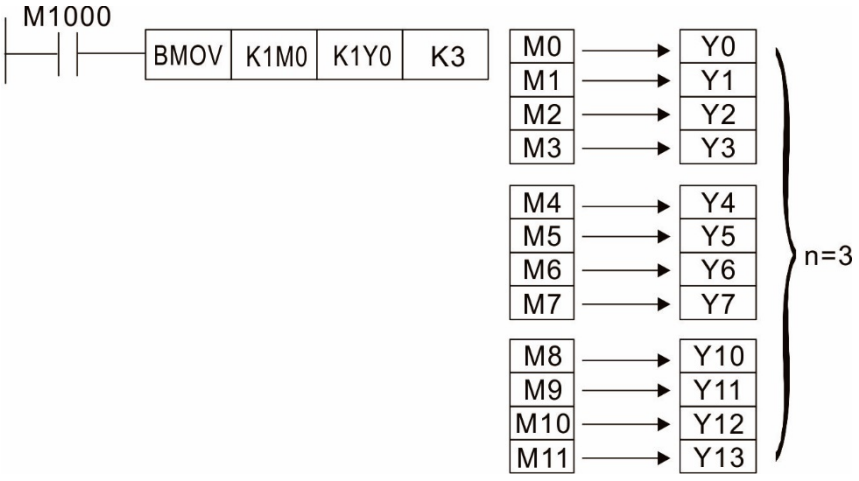
Example 1

- When X10=ON, sends the content of registers D0–D3 to the four registers D20–D23.




Example 2

- When sending from designated bit devices KnX, KnY, and KnM, **S** and **D** must have the same number of nibbles, which means n must be identical for source and destination.



| API 20 | D | ADD | P | (S1) (S2) (D) | BIN addition |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage: none

| 16-bit command (7 STEP) | | | |
|---|---|---|---|
| ADD | Continuous execution type | ADDP | Pulse execution type |

| 32-bit command (13 STEP) | | | |
|---|---|---|---|
| DADD | Continuous execution type | DADDP | Pulse execution type |

Flag signal: M1020 Zero flag
M1021 Borrow flag
M1022 Carry flag
Refer to the following supplementary explanation

Explanation

- **S1**: Augend. **S2**: Addend. **D**: Sum.
- Adds **S1** and **S2** using the BIN method and stores result in **D**.
- The highest bit of any data defines the sign: bit=0 indicates (positive) bit=1 indicates (negative); enables the use of algebraic addition operations (for instance: 3+ (-9) =-6).
- Flag changes connected with the addition.
  1. When calculation results are 0, the zero flag M1020 is ON.
  2. When calculation results are less than -32,768, the borrow flag M1021 is ON.
  3. When calculation results are greater than 32,767, the carry flag M1022 is ON.

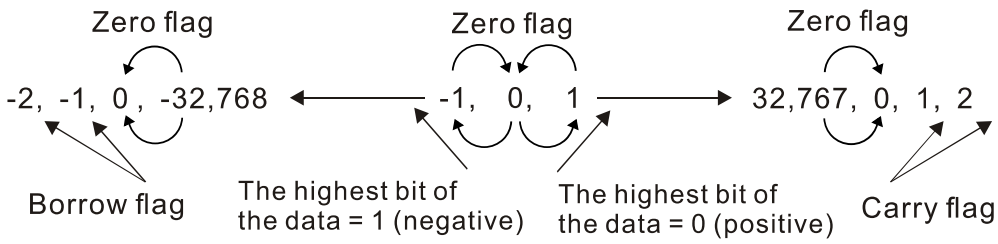
Example

- 16-bit BIN addition: When X0=ON, saves the result of the content of addend D0 plus the content of augend D10 in the content of D20.

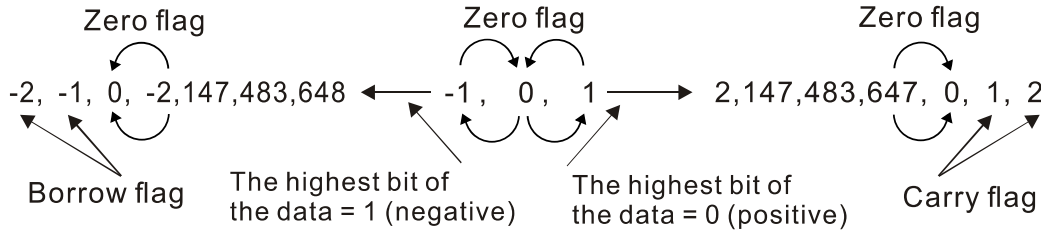
Remarks

- Relationship between flag actions and negative/positive numbers:

16-bit:




32-bit:



| API | | | | |
|---|---|---|---|---|
| 21 | D | **SUB** | P | (S1) (S2) (D) |

BIN subtraction

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage: none

16-bit command (7 STEP)

| SUB | Continuous execution type | SUBP | Pulse execution type |
|---|---|---|---|

32-bit command (13 STEP)

| DSUB | Continuous execution type | DSUBP | Pulse execution type |
|---|---|---|---|

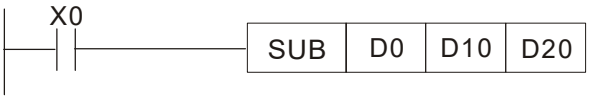
Flag signal: M1020 Zero flag
M1021 Borrow flag
M1022 Carry flag
Refer to the following supplementary explanation

Explanation

- **S1**: Minuend. **S2**: Subtrahend. **D**: Difference.
- Subtracts **S2** from **S1** using the BIN method and stores result in **D**.
- The highest bit of any data defines the sign bit=0 indicates (positive) bit=1 indicates (negative); enables the use of algebraic subtraction operations.
- Flag changes connected with subtraction.
  1. When calculation results are 0, the zero flag M1020 is ON.
  2. When calculation results are less than -32,768, the borrow flag M1021 is ON.
  3. When calculation results are greater than 32,767, the carry flag M1022 is ON.

Example

- 16-bit BIN subtraction: When X0=ON, subtracts the content of D10 from the content of D0, and stores the difference in D20.



| API 22 | D | MUL | P | (S1) (S2) (D) | BIN multiplication |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage:
The 16-bit command operand D occupies two consecutive points.

16-bit command (7 STEP)

| MUL | Continuous execution type | MULP | Pulse execution type |
|---|---|---|---|

32-bit command (13 STEP)

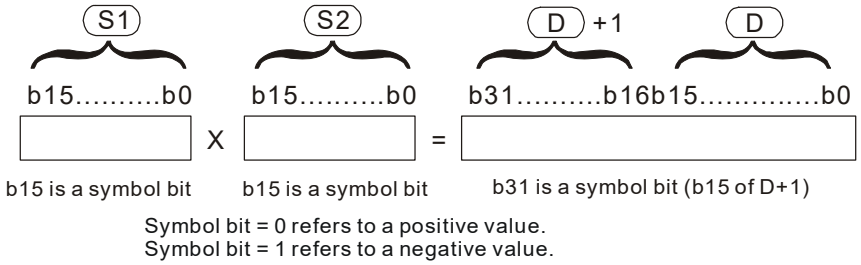
| DMUL | Continuous execution type | DMULP | Pulse execution type |
|---|---|---|---|

Flag signal: none

Explanation

- **S1**: Multiplicand. **S2**: Multiplier. **D**: Product.
- Multiplies **S1** and **S2** using the BIN method, and stores the product in **D**.

16-bit BIN multiplication operation:

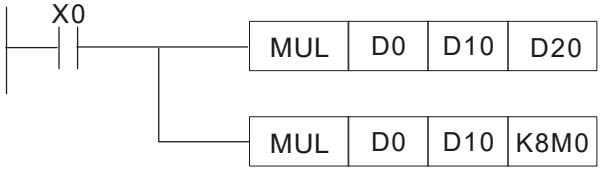



Symbol bit = 0 refers to a positive value.
Symbol bit = 1 refers to a negative value.

When **D** is a bit device, K1–K4 can be designated as a hexadecimal number, which occupies two consecutive units.

Example

- When 16-bit DO is multiplied by 16-bit D10, the result is a 32-bit product; the upper 16 bits are stored in D21, and the lower 16 bits are stored in D20. The bit at the farthest left indicates the sign of the result.



| API 23 | D | DIV | P | (S1) (S2) (D) | BIN division |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage:
The 16-bit command operand D occupies two consecutive points.

16-bit command (7 STEP)

| DIV | Continuous execution type | DIVP | Pulse execution type |
|---|---|---|---|

32-bit command (13 STEP)

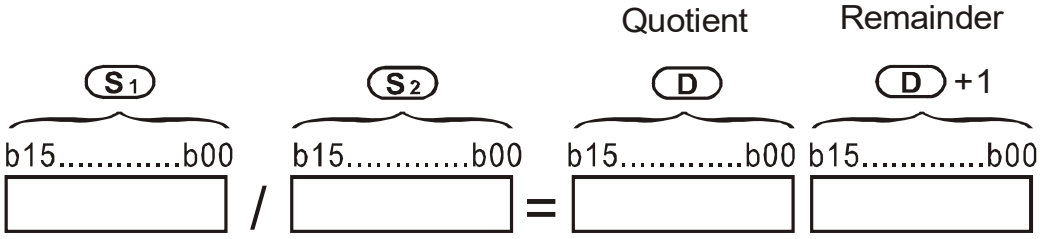
| DDIV | Continuous execution type | DDIVP | Pulse execution type |
|---|---|---|---|

Flag signal: none

Explanation

- **S1**: Dividend. **S2**: Divisor. **D**: Quotient and remainder.
- Divides **S1** by **S2** and stores the quotient and remainder in **D** using the BIN method. The sign bit for **S1**, **S2** and **D** must be kept in mind when performing a 16-bit operation.

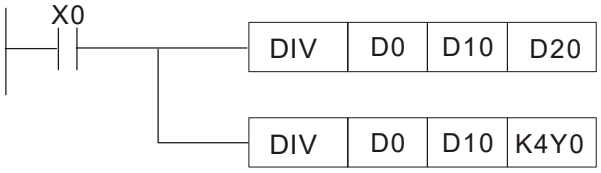
16-bit BIN division:




If **D** is a bit device, K1–K4 can be designated as 16 bits, which occupy two consecutive units and yield the quotient and remainder.

Example

- When X0=ON, stores the quotient resulting from division of dividend D0 by divisor D10 in D20, and the remainder in D21. The highest bit indicates the sign of the result.



| API 24 | D | INC | ☺ P | (D) | BIN add one |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage: none

16-bit command (3 STEP)

| INC | Continuous execution type | INCP | Pulse execution type |
|---|---|---|---|

32-bit command (5 STEP)

| DINC | Continuous execution type | DINCP | Pulse execution type |
|---|---|---|---|

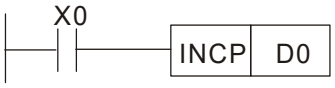
Flag signal: none

Explanation

- **D**: Destination device.
- If a command is not the pulse execution type, adds 1 to the content of device **D** during each scanning cycle.
- Generally use this command as a pulse execution type command (INCP).
- During 16-bit operation, 32,767 +1 rolls over to -32,768. During 32 bit operation, 2,147,483,647 +1 rolls over to -2,147,483,648.

Example

- When X0 switches from OFF to ON, adds 1 to the content of D0.




| API 25 | D | DEC | P | (D) | BIN subtract one |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| D | | | | * | * | * | * | * | | | |

Notes on operand usage: none

16-bit command (3 STEP)

| DEC | Continuous execution type | DECP | Pulse execution type |
|---|---|---|---|

32-bit command (5 STEP)

| DDEC | Continuous execution type | DDECP | Pulse execution type |
|---|---|---|---|

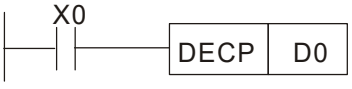
Flag signal: none

Explanation

- **D**: Destination device.
- If a command is not the pulse execution type, adds 1 to the content of device **D** during each scanning cycle.
- Generally use this command as a pulse execution type command (DECP).
- During 16-bit operation, -32,768 -1 rolls over to 32,767. During 32 bit operation, -2,147,483,648 -1 rolls over to 2,147,483,647.

Example

- When X0 switches OFF to ON, subtracts 1 from the content of D0.



| API | | | ☺ | | |
|---|---|---|---|---|---|
| 30 | D | **ROR** | P | (D) (n) | Right rotation |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| D | | | | | | | * | * | * | * | * |
| n | | | | * | * | | | | | | |

Notes on operand usage:
K4 (16-bit) is only valid if the operand D is designated as KnY or KnM.
n operand n=K1-K16 (16-bit)

16-bit command (5 STEP)

| ROR | Continuous execution type | RORP | Pulse execution type |
|---|---|---|---|

32-bit command (9 STEP)

| DROR | Continuous execution type | DRORP | Pulse execution type |
|---|---|---|---|

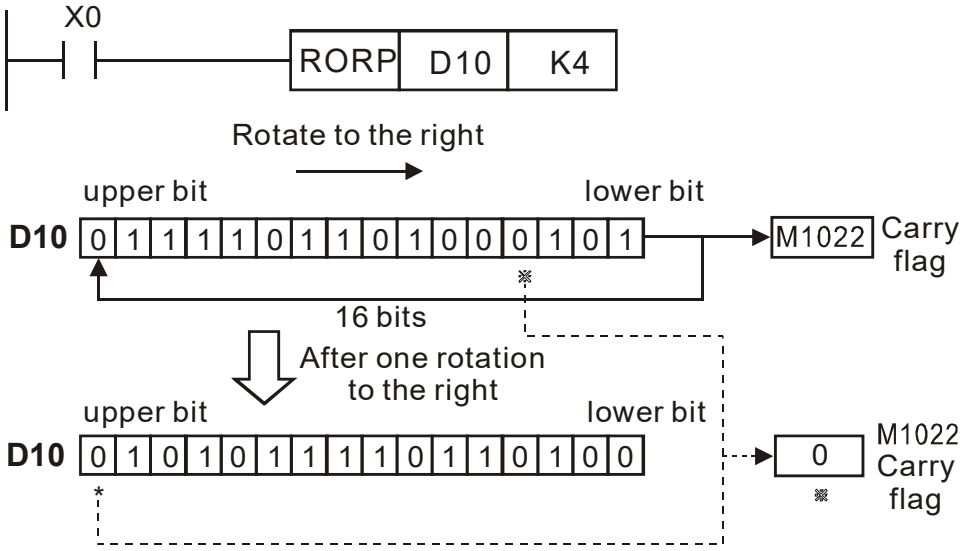
Flag signal: M1022 Carry flag

Explanation

- **D**: Device to be rotated. **n**: Number of bits for one rotation.
- Rotates the device designated by **D** to the right **n** bits.
- Generally use this command as a pulse execution type command (RORP).

Example

- When X0 switches OFF to ON, 4 of the 16 bits in D10 specify a right rotation; the content of the bit indicated with * (see figure below) is sent to the carry flag signal M1022.



| API | | | ☺ | | |
|---|---|---|---|---|---|
| 31 | D | ROL | P | (D) (n) | Left rotation |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| D | | | | | | | * | * | * | * | * |
| n | | | | * | * | | | | | | |

Notes on operand usage:
K4 (16-bit) is only valid if the operand D is designated as KnY or KnM.
n operand n=1 to 16 (16-bit)

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| ROL | Continuous execution type | ROLP | Pulse execution type |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DROL | Continuous execution type | DROLP | Pulse execution type |

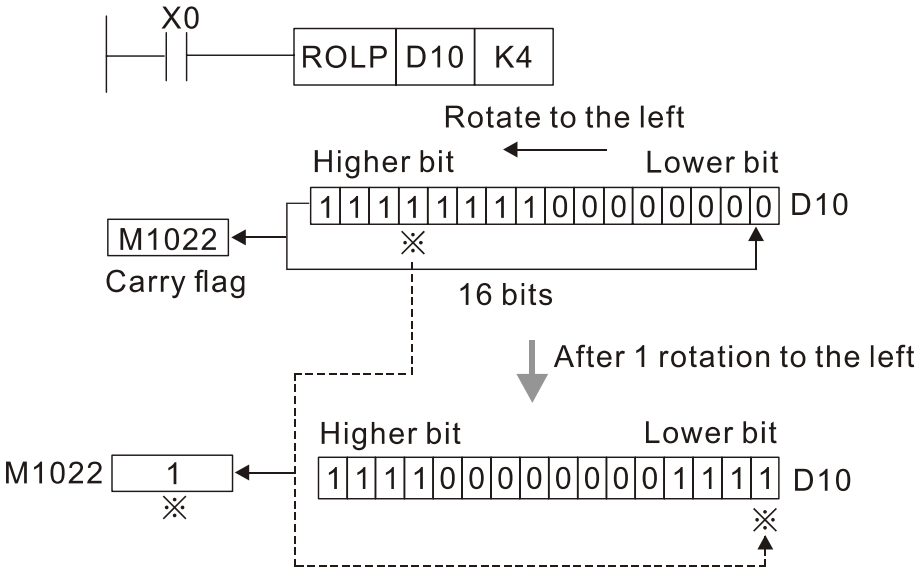
Flag signal: M1022 Carry flag

Explanation

- **D**: Device to be rotated. **n**: Number of bits for one rotation.
- Rotates the device designated by **D** to the left **n** bits.
- Generally use this command as a pulse execution type command (ROLP).

Example

- When X0 switches OFF to ON, 4 of the 16 bits in D10 specify a left rotation; the content of the bit indicated with * (see figure below) is sent to the carry flag signal M1022.



| API 40 | | ZRST | ☺ P | (D1) (D2) | Clear range |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| D1 | | * | * | | | | | | * | * | * |
| D2 | | * | * | | | | | | * | * | * |

Notes on operand usage:
Number of operand $D_1$ operand ≤ number of operand $D_2$.
Operands $D_1$, $D_2$ must designate the same type of device. Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| ZRST | Continuous execution type | ZRSTP | Pulse execution type |

| 32-bit command | | | |
|---|---|---|---|
| - | - | - | - |

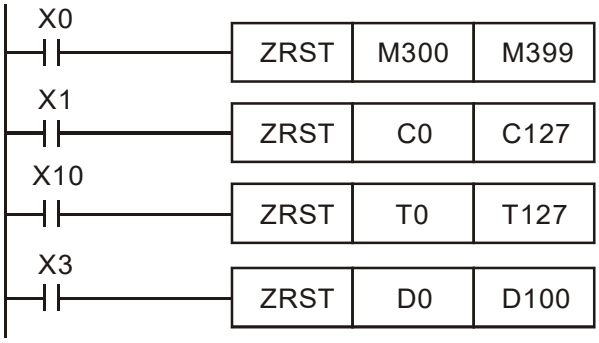
Flag signal: none

Explanation

- **D1**: Clear range's initial device. **D2**: Clear range's final device.
- When the number of operand **D1** > number of operand **D2**, only the operand designated by **D2** is cleared.

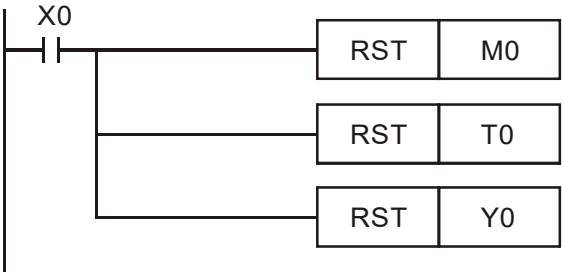
Example

- When X0 is ON, clears auxiliary relays M300–M399, changes them to OFF.
- When X1 is ON, 16-bit clears counters C0–C127 (writes 0, and clears and changes contact and coil to OFF).
- When X10 is ON, clears timer T0–T127 (writes 0, and clears and changes contact and coil to OFF).
- When X3 is ON, clears the data in data registers D0–D100 (sets to 0).




Remarks

- Devices such as bit device Y, M and word device T, C, D can independently use the clear command (RST).



| API | | | | |
|---|---|---|---|---|
| 49 | D | FLT | P | (S) (D) |

Convert BIN whole number to binary decimal

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | * | * | | | | | | * | * | * |
| D | | * | * | | | | | | * | * | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.
The operand D occupies two consecutive points.

16-bit command

| | | | |
|---|---|---|---|
| - | - | - | - |

32-bit command (9steps)

| | | | |
|---|---|---|---|
| DFLT | Continuous execution type | DFLTP | Pulse execution type |

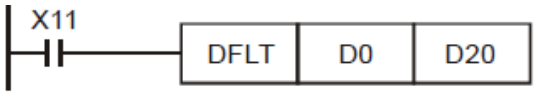
Flag signal: none

Explanation

- **S**: Source device. **D**: Result device.
- Converts a BIN whole number into a binary decimal value.

Example

- When X11 is ON, converts the whole number corresponding to D0 and D1 into floating point numbers, and stores the result in D20 and D21.



| API 110 | D | ECMP | P | (S1) (S2) (D) | Compare binary floating point numbers |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D | |
| S1 | | | | * | * | | | | | | * | |
| S2 | | | | * | * | | | | | | * | |
| D | | | | * | * | | | | | | * | |

Notes on operand usage:
The operand D occupies three consecutive points. Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (13 STEP) | | | |
|---|---|---|---|
| DECMP | Continuous execution type | DECMPP | Pulse execution type |

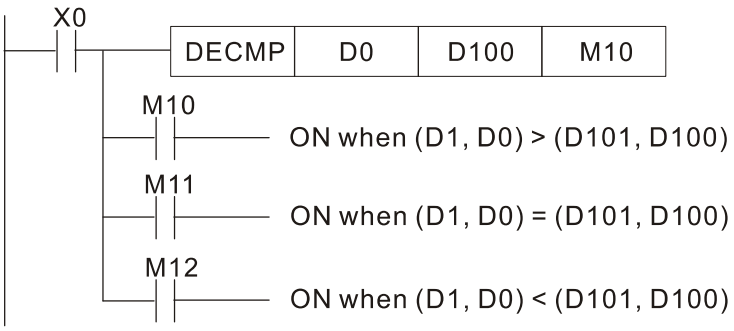
Flag signal: none

Explanation

- **$S_1$**: Binary floating point number 1. **$S_2$**: Binary floating point number 2. **D**: Results of comparison, occupies three consecutive points.
- Compares binary floating point number 1 with binary floating point number 2, and stores the result of comparison (>, =, <) in **D**.
- **If the source operand $S_1$** or **$S_2$** designates a constant K or H, the command converts the constant to a binary floating point number for the purpose of comparison.

Example

- When the designated device is M10, it automatically occupies M10–M12.
- When X0=ON, the DECMP command executes, and one of M10–M12 is ON. When X0=OFF, the DECMP command does not execute, and M10–M12 remains in the X0=OFF state.
- For ≥, ≤, or ≠ comparison, use series and parallel connections for M10–M12.
- Use the RST or ZRST command to clear the result.



| API | | | | | |
|---|---|---|---|---|---|
| 111 | D | EZCP | P | $S_1$ $S_2$ S D | Compare binary floating point number range |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | | | | | | * |
| S2 | | | | * | * | | | | | | * |
| S | | | | * | * | | | | | | * |
| D | | * | * | | | | | | | | |

Notes on operand usage:
The operand D occupies three consecutive points. Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| | | | |
|---|---|---|---|
| - | - | - | - |

32-bit command (17 STEP)

| | | | |
|---|---|---|---|
| DEZCP | Continuous execution type | DEZCPP | Pulse execution type |

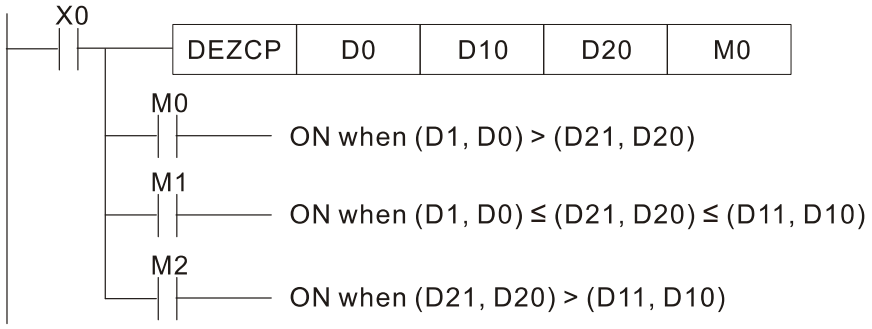
Flag signal: none

Explanation

- **$S_1$**: Lower limit for binary floating point number in range comparison. **$S_2$**: Upper limit for binary floating point number in range comparison. **S**: Comparison of binary floating point numerical values. **D**: Results of comparison, occupies three consecutive points.
- Compares binary floating point number **S** with the lower limit value **$S_1$** and the upper limit value **$S_2$**; stores the results of comparison in **D**.
- **If the source operand $S_1$** or **$S_2$** designates a constant K or H, the command converts the constant to a binary floating point number for the purpose of comparison.
- When the lower limit **$S_1$** is greater than the upper limit **$S_2$**, a command issues to perform comparison using the lower limit value **$S_1$** as the upper and lower limit.

Example

- When the designated device is M0, it automatically occupies M0–M2.
- When X0=ON, the DEZCP command executes, and one of M0–M2 is ON. When X0=OFF, the EZCP command does not execute, and M0–M2 remains in the X0=OFF state.
- Use the RST or ZRST command to clear the result.



| API | | | | |
|---|---|---|---|---|
| 116 | D | RAD | P | (S) (D) |

Convert angle to diameter

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| | | | |
|---|---|---|---|
| - | - | - | - |

32-bit command (9 STEP)

| | | | |
|---|---|---|---|
| DRAD | Continuous execution type | DRADP | Pulse execution type |

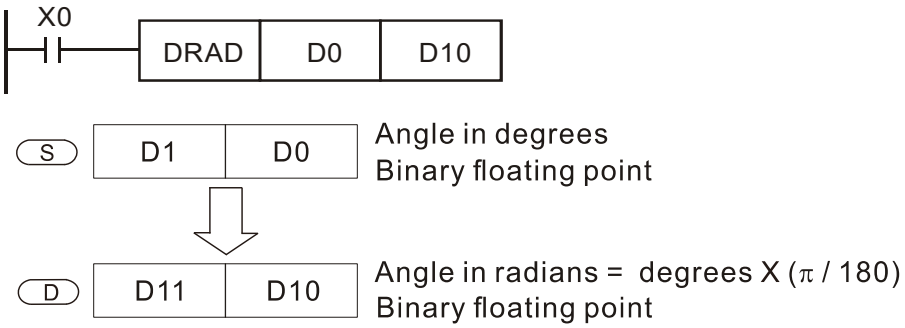
Flag signal: none

Explanation

- **S**: data source (angle). **D**: result of transformation (diameter).
- Uses the following formula to convert angles to radians.
  Diameter = Angle × (π/180)

Example

- When X0=ON, converts the angle of the designated binary floating point number (D1, D0) to radians and stores the result in (D11, D10); the result is a binary floating point number.



| API | | | | |
|---|---|---|---|---|
| 117 | D | **DEG** | P | (S) (D) |

Convert diameter to angle

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| | | | |
|---|---|---|---|
| - | - | - | - |

32-bit command (9 STEP)

| | | | |
|---|---|---|---|
| DDEG | Continuous execution type | DDEGP | Pulse execution type |

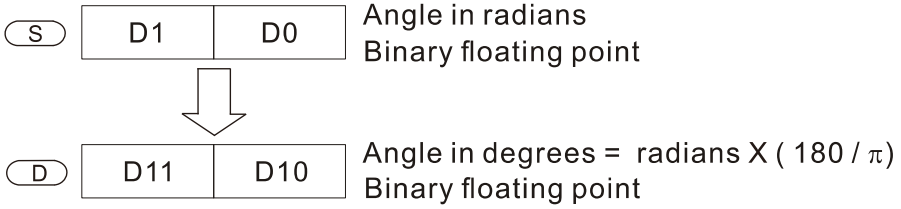
Flag signal: none

Explanation

- **S**: data source (diameter). **D**: results of transformation (angle).
- Uses the following formula to convert radians to an angle.
- Angle = Diameter × (180/π)

Example

- When X0=ON, angle of the designated binary floating point number (D1, D0) in radians is converted to an angle and stored in (D11, D10), with the content consisting of a binary floating point number.



| API | | | | | |
|---|---|---|---|---|---|
| 120 | D | EADD | P | (S1) (S2) (D) | Add binary floating point numbers |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | | | | | | * |
| S2 | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DEADD | Continuous execution type | DEADDP | Pulse execution type |

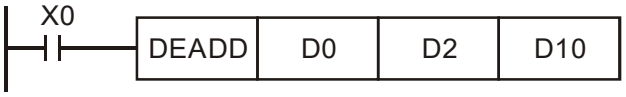
Flag signal: none

Explanation

- **$S_1$**: addend. **$S_2$**: augend. **D**: sum.
- Adds the content of the register designated by **$S_2$** to the content of the register designated by **$S_1$**, and stores the result in the register designated by **D**. Addition is performed entirely using binary floating point numbers.
- **If the source operand $S_1$** or **$S_2$** designates a constant K or H, the command converts that constant into a binary floating point number for use in addition.
- **In the situation when $S_1$** and **$S_2$** designate identical register numbers, if a "continuous execution" command is employed, when the conditional contact is ON, the register performs addition once during each scan. You generally use pulse execution type commands (DEADDP) under ordinary circumstances.

Example

- When X0=ON, adds a binary floating point number (D1, D0) to a binary floating point number (D3, D2), and stores the results in (D11, D10).




- When X2 =ON, adds a binary floating point number (D11, D10) to K1234 (which is automatically converted to a binary floating point number), and stores the results in (D21, D20).

| API | | | | | |
|---|---|---|---|---|---|
| 121 | D | ESUB | P | (S1) (S2) (D) | Subtract binary floating point numbers |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | | | | | | * |
| S2 | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| - | - | - | - |
|---|---|---|---|

32-bit command (13 STEP)

| DESUB | Continuous execution type | DESUBP | Pulse execution type |
|---|---|---|---|

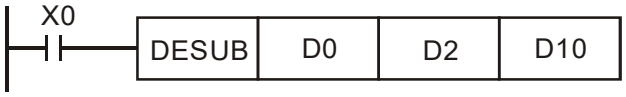
Flag signal: none

Explanation

- **$S_1$**: minuend. **$S_2$**: subtrahend. **D**: difference.
- Subtracts the content of the register designated by **$S_2$** from the content of the register designated by **$S_1$**, and stores the difference in the register designated by **D**; subtraction is performed entirely using binary floating point numbers.
- **If the source operand $S_1$** or **$S_2$** designates a constant K or H, the command converts that constant into a binary floating point number for use in subtraction.
- **In the situation when $S_1$** and **$S_2$** designate identical register numbers, if a "continuous execution" command is employed, when conditional contact is ON, the register performs subtraction once during each scan. You generally use pulse execution type commands (DESUBP) under ordinary circumstances.

Example

- When X0=ON, subtracts a binary floating point number (D1, D0) from a binary floating point number (D3, D2), and stores the results in (D11, D10).




- When X2 =ON, subtracts the binary floating point number (D1, D0) from K1234 (which is automatically converted to a binary floating point number), and stores the results in (D11, D10).

| API | | | | | |
|---|---|---|---|---|---|
| 122 | D | EMUL | P | (S1) (S2) (D) | Multiply binary floating point numbers |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | | | | | | * |
| S2 | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| - | - | - | - |
|---|---|---|---|

32-bit command (13 STEP)

| DEMUL | Continuous execution type | DEMULP | Pulse execution type |
|---|---|---|---|

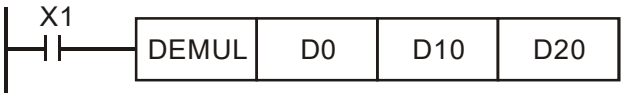
Flag signal: none

Explanation

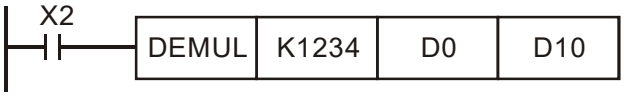
- **$S_1$**: multiplicand. **$S_2$**: multiplier. **D**: product.
- Multiplies the content of the register designated by **$S_1$** by the content of the register designated by **$S_2$**, and stores the product in the register designated by **D**; multiplication is performed entirely using binary floating point numbers.
- **If the source operand $S_1$** or **$S_2$** designates a constant K or H, the command converts that constant into a binary floating point number for use in multiplication.
- **In the situation when $S_1$** and **$S_2$** designate identical register numbers, if you employ a “continuous execution” command, when conditional contact is ON, the register performs multiplication once during each scan. You generally use pulse execution type commands (DEMULP) under ordinary circumstances.

Example

- When X1=ON, multiplies the binary floating point number (D1, D0) by the binary floating point number (D11, D10), and stores the product in the register designated by (D21, D20).




- When X2 =ON, multiplies the binary floating point number (D1, D0) by K1234 (which is automatically converted to a binary floating point number), and stores the results in (D11, D10).



| API | | | | |
|---|---|---|---|---|
| 123 | D | **EDIV** | P | (S1) (S2) (D) |

Divide binary floating point numbers

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | | | | | | * |
| S2 | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| - | - | - | - |
|---|---|---|---|

32-bit command (13 STEP)

| DEDIV | Continuous execution type | DEDIVP | Pulse execution type |
|---|---|---|---|

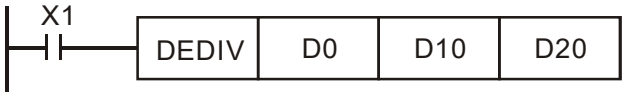
Flag signal: none

Explanation

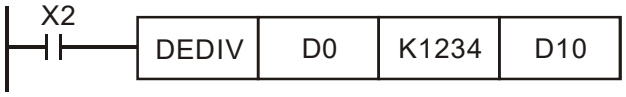
- **$S_1$**: dividend. **$S_2$**: divisor. **D**: quotient.
- Divides the content of the register designated by **$S_1$** by the content of the register designated by **$S_2$** and stores the quotient in the register designated by **D**; division is performed entirely using binary floating point numbers.
- **If the source operand $S_1$** or **$S_2$** designates a constant K or H, the command converts that constant into a binary floating point number for use in division.

Example

- When X1=ON, divides the binary floating point number (D1, D0) by the binary floating point number (D11, D10), and stores the quotient in the register designated by (D21, D20).




- When X2 =ON, divides the binary floating point number (D1, D0) by K1,234 (which is automatically converted to a binary floating point number), and stores the results in (D11, D10).



| API | | | | |
|---|---|---|---|---|
| 124 | D | EXP | P | (S) (D) |

Find the exponent of a binary floating point number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DEXP | Continuous execution type | DEXPP | Pulse execution type |

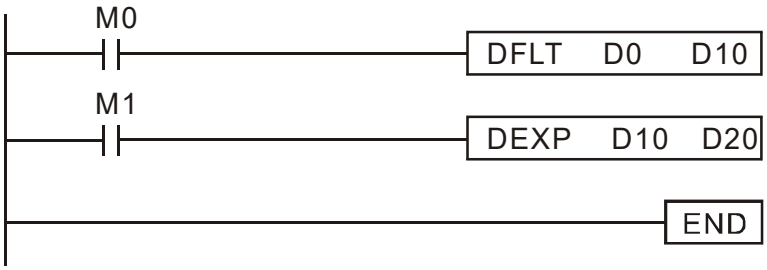
Flag signal: none

Explanation

- **S**: operation source device. **D**: operation results device.
- Taking e =2.71828 as a base, **S** is the exponent in the EXP operation:
- [ **D** +1, **D** ]=EXP [ **S** +1, **S** ]
- Valid regardless of whether the content of **S** has a positive or negative value. The designated register D must have a 32-bit data format. Performs the operation using floating point numbers, and converts **S** to a floating point number.
- Content of operand **D** =e S ; e=2.71828, **S** is the designated source data.

Example

- When M0 is ON, converts the value of (D1, D0) to a binary floating point number, and stores the result in register (D11, D10).
- When M1 is ON, performs the EXP operation on the exponent of (D11, D10), converts the result to a binary floating point number and stores it in register (D21, D20).



| API 125 | D | LN | P | (S) (D) | Find the natural logarithm of a binary floating point |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| - | - | - | - |
|---|---|---|---|

32-bit command (9 STEP)

| DLN | Continuous execution type | DLNP | Pulse execution type |
|---|---|---|---|

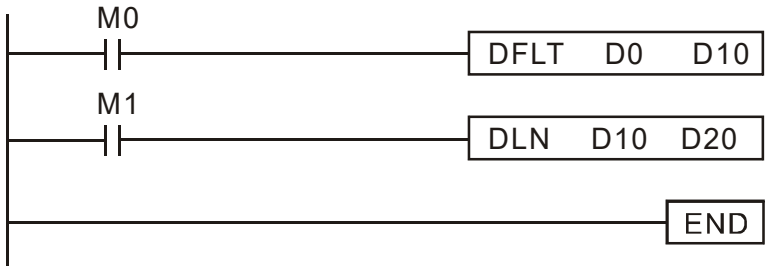
Flag signal: none

Explanation

- **S**: operation source device. **D**: operation results device.
- Taking e =2.71828 as a base, **S** is the exponent in the EXP operation.
- [ **D** +1, **D** ]=EXP [ **S** +1, **S** ]
- Valid regardless of whether the content of **S** has a positive or negative value. The designated register D must have a 32-bit data format. Performs the operation using floating point numbers, and converts **S** to a floating point number.
- Content of operand **D** =e $^{S}$ ; e=2.71828, **S** is the designated source data.

Example

- When M0 is ON, converts the value of (D1, D0) to a binary floating point number, and stores the result in register (D11, D10).
- When M1 is ON, performs the EXP operation on the exponent of (D11, D10); converts the result to a binary floating point number and stores it in register (D21, D20).



| API | | | | |
|---|---|---|---|---|
| 127 | D | ESQR | P | (S) (D) |

Find the square root of a binary floating point number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DESQR | Continuous execution type | DESQR P | Pulse execution type |

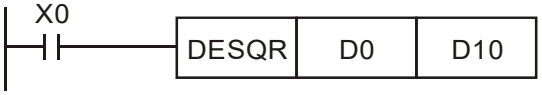
Flag signal: none

Explanation

- **S**: source device for which square root is desired. **D**: result of finding square root.
- Finds the square root of the content of the register designated by **S**, stores the result in the register designated by **D**. Square roots are performed entirely using binary floating point numbers.
- If the source operand **S** refers to a constant K or H, the command converts that constant into a binary floating point number for use in the operation.

Example

- When X0=ON, finds the square root of the binary floating point number (D1, D0), and stores the result in the register designated by (D11, D10).




$\sqrt{(D1 \cdot D0)} \longrightarrow (D11 \cdot D10)$

Binary floating point  Binary floating point

- When X2 =ON, finds the square root of K1,234 (which is automatically converted to a binary floating point number), and stores the result in (D11, D10).

| API | | | | |
|---|---|---|---|---|
| 129 | D | INT | P | (S) (D) |

Convert binary floating point number to BIN whole number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | | | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| - | - | - | - |
|---|---|---|---|

32-bit command (9 STEP)

| DINT | Continuous execution type | DINTP | Pulse execution type |
|---|---|---|---|

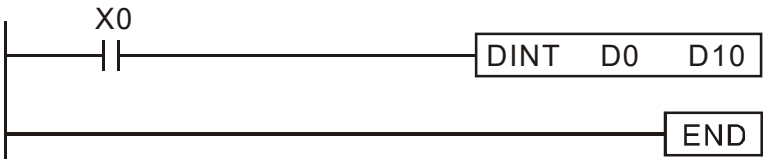
Flag signal: none

Explanation

- **S**: the source device to be converted. **D**: results of conversion.
- Converts the content of the register designated by **S** from a binary floating point number format to a BIN whole number, and stores the results in **D**. The BIN whole number floating point number is discarded.
- The action of this command is the opposite of that of command API 49 (FLT).

Example

- When X0=ON, converts the binary floating point number (D1, D0) into a BIN whole number, and stores the result in (D10); the BIN whole number floating point number is discarded.



| API | | | | |
|---|---|---|---|---|
| 130 | D | SIN | P | (S) (D) |

Find the sine of a binary floating point number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

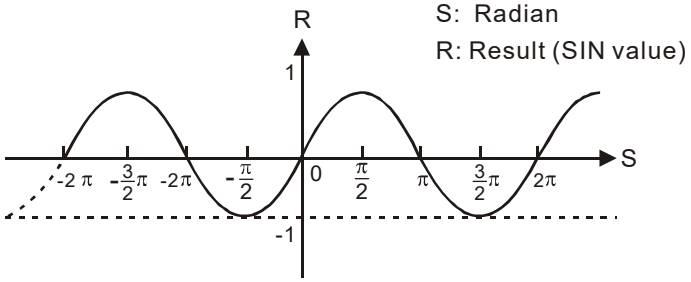
| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DSIN | Continuous execution type | DSINP | Pulse execution type |

Flag signal: none

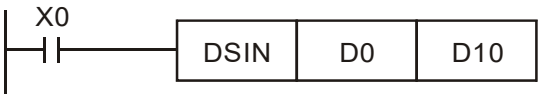
Explanation

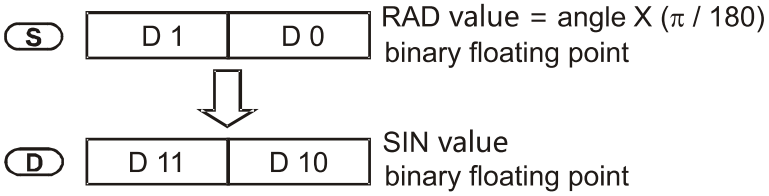
- **S**: the designated source value. **D**: the SIN value result.
- **S** is the designated source in radians.
- The value in radians (RAD) is equal to (angle × π/180).
- Finds the SIN from the source value designated by **S** and stores the result in **D**. The following figure displays the relationship between the arc and SIN results:




Example

- When X0=ON, finds the SIN value of the designated binary floating point number (D1, D0) in radians (RAD) and stores the result in (D11, D10), as a binary floating point number.



| API 131 | D | COS | P | (S) (D) | Find the cosine of a binary floating point number |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| - | - | - | - |
|---|---|---|---|

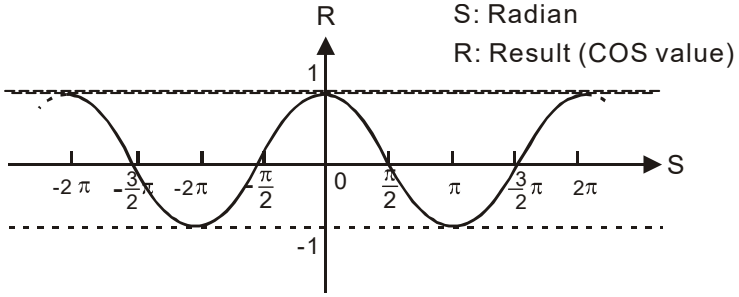
32-bit command (9 STEP)

| DCOS | Continuous execution type | DCOSP | Pulse execution type |
|---|---|---|---|

Flag signal: none

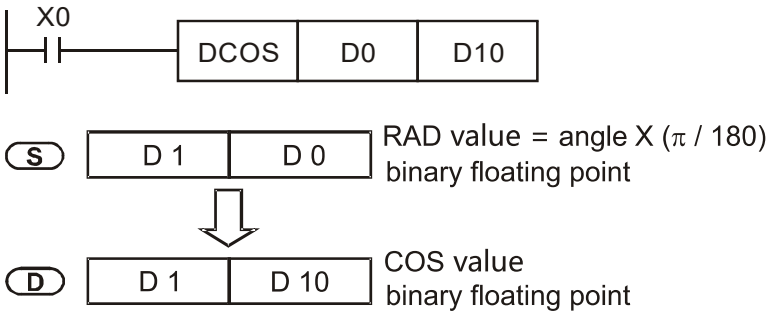
Explanation

- **S**: the designated source value. **D**: the COS value result.
- Finds the COS of the source value designated by **S** and stores it in **D**.
  The following figure displays the relationship between the arc and COS results:




Example

- When X0=ON, finds the COS value of the designated binary floating point number (D1, D0) in radians and stores the result in (D11, D10), as a binary floating point number.



| API | | | | |
|---|---|---|---|---|
| 132 | D | TAN | P | (S) (D) |

Find the tangent of a binary floating point number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

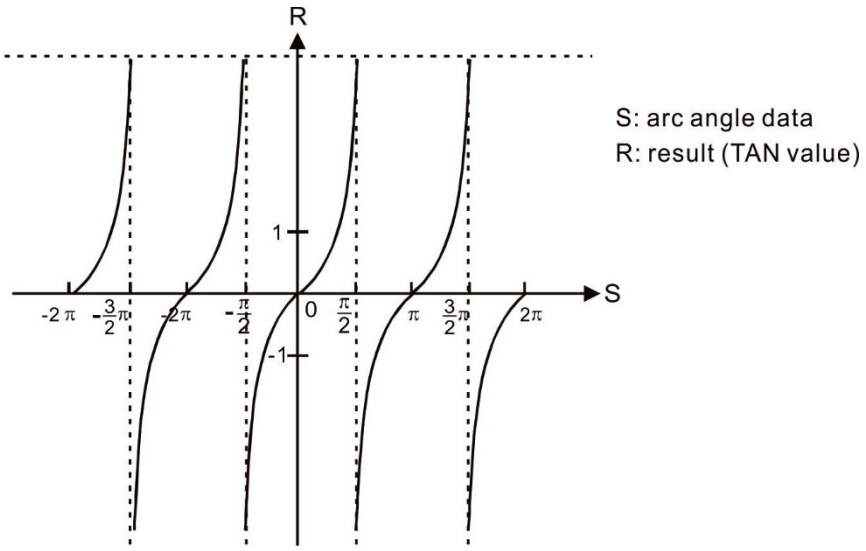
| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DTAN | Continuous execution type | DTANP | Pulse execution type |

Flag signal: none

Explanation

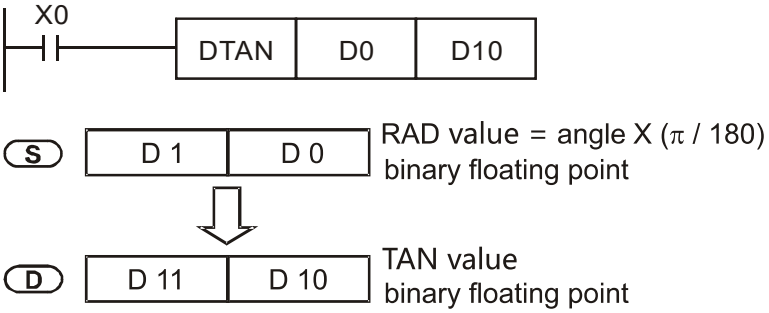
■ **S**: the designated source value. **D**: the TAN value result.

■ Finds the TAN of the source value designated by **S** and stores it in **D**.
The following figure displays the relationship between the arc and TAN results:




Example

■ When X0=ON, finds the TAN value of the designated binary floating point number (D1, D0) in radians (RAD) and stores the result in (D11, D10), as a binary floating point number.



| API 133 | D | ASIN | P | (S) (D) | Find the arcsine of a binary floating point number |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

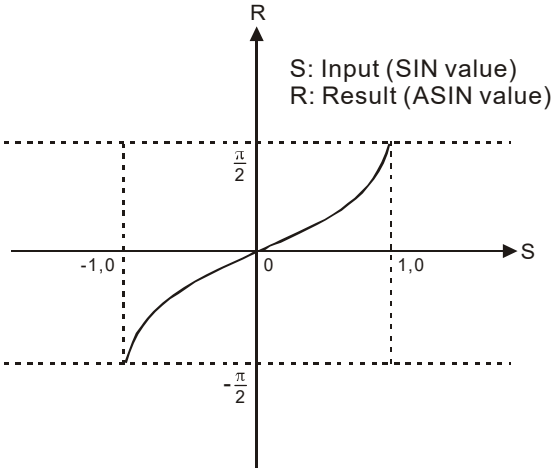
| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DASIN | Continuous execution type | DASINP | Pulse execution type |

Flag signal: none

Explanation

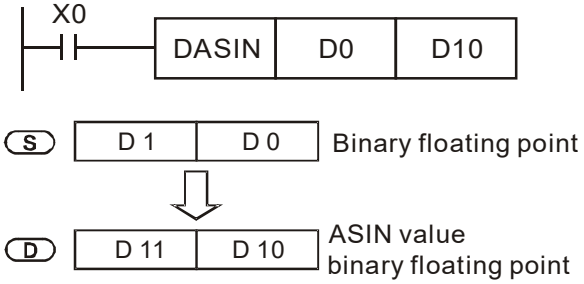
- **S**: the designated source (binary floating point number). **D**: the ASIN value result.
- ASIN value =$\sin^{-1}$

The figure below shows the relationship between input data and result:




Example

- When X0=ON, finds the ASIN value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



| API 134 | D | ACOS | P | (S) (D) | Find the arccosine of a binary floating point number |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage

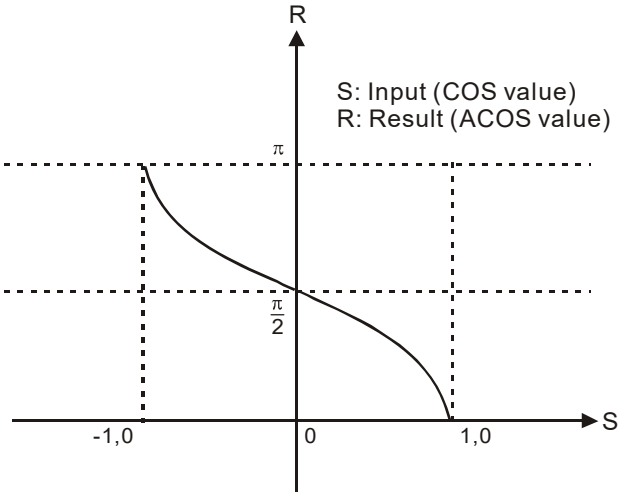
| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DACOS | Continuous execution type | DACOS P | Pulse execution type |

Flag signal: none

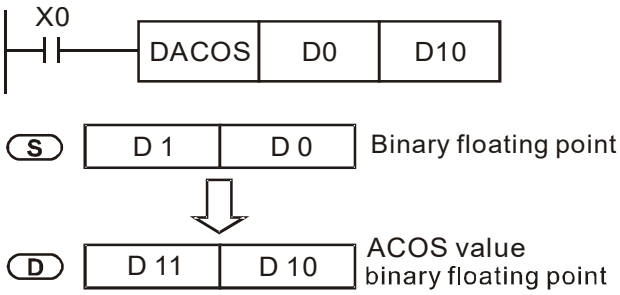
Explanation

- **S**: the designated source (binary floating point number). **D**: the ACOS value result.
- ACOS value =$\cos^{-1}$
  The figure below shows the relationship between input data and result:




Example

- When X0=ON, finds the ACOS value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



| API | | | | |
|---|---|---|---|---|
| 135 | D | **ATAN** | P | (S) (D) |

Find the arctangent of a binary floating point number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

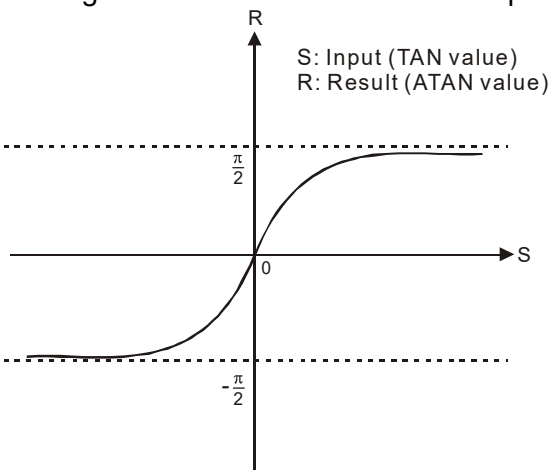
| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DATAN | Continuous execution type | DATANP | Pulse execution type |

Flag signal: none

Explanation

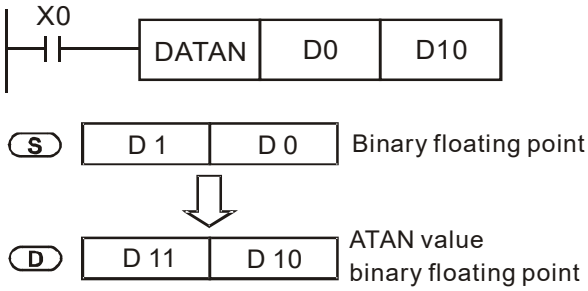
- **S**: the designated source (binary floating point number). **D**: the ATAN value result.
- ATAN value =$\tan^{-1}$

The figure below shows the relationship between input data and result:




Example

- When X0=ON, finds the ATAN value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



| API | | | | |
|---|---|---|---|---|
| 136 | D | SINH | P | (S) (D) |

Find the hyperbolic sine of at binary floating point number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DSINH | Continuous execution type | DSINHP | Pulse execution type |

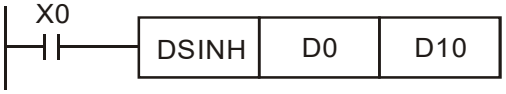
Flag signal: none

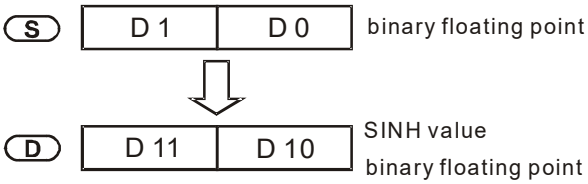
Explanation

- **S**: the designated source (binary floating point number). **D**: the SINH value result.
- SINH value =$(e^{s}-e^{-s})/2$

Example

- When X0=ON, finds the SINH value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



| API 137 | D | COSH | P | (S) (D) | Find the hyperbolic cosine of a binary floating point number |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DCOSH | Continuous execution type | DCOSHP | Pulse execution type |

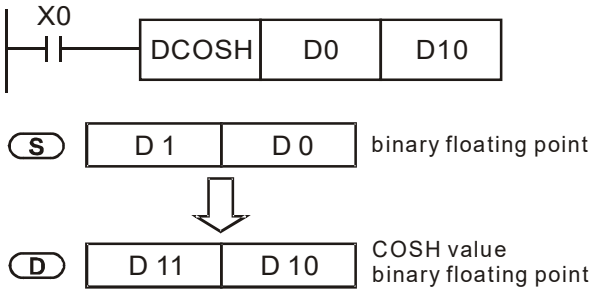
Flag signal: none

Explanation

- **S**: the designated source (binary floating point number). **D**: the COSH value result.
- COSH value $=(e^{s}+e^{-s})/2$

Example

- When X0=ON, finds the COSH value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



| API | | | | |
|---|---|---|---|---|
| 138 | D | TANH | P | (S) (D) |

Find the hyperbolic tangent of a binary floating point number

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | | | | | | * |
| D | | | | | | | | | | | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

| | | | |
|---|---|---|---|
| - | - | - | - |

32-bit command (9 STEP)

| | | | |
|---|---|---|---|
| DTANH | Continuous execution type | DTANHP | Pulse execution type |

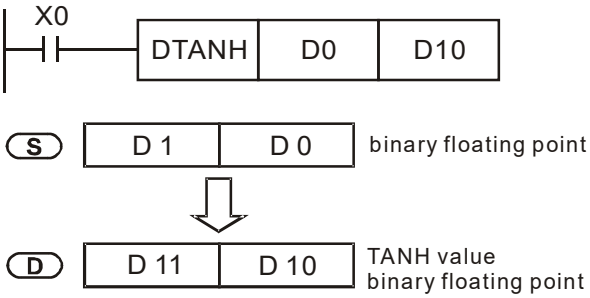
Flag signal: none

Explanation

- **S**: the designated source (binary floating point number). **D**: the TANH value result.
- TANH value $=(e^{s}-e^{-s})/(e^{s}+e^{-s})$

Example

- When X0=ON, finds the TANH value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



| API 170 | D | GRY | P | (S) (D) | Convert BIN to GRAY code |
|---|---|---|---|---|---|

| | Bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

| GRY | Continuous execution type | GRYP | Pulse execution type |
|---|---|---|---|

32-bit command (9 STEP)

| DGRY | Continuous execution type | DGRYP | Pulse execution type |
|---|---|---|---|

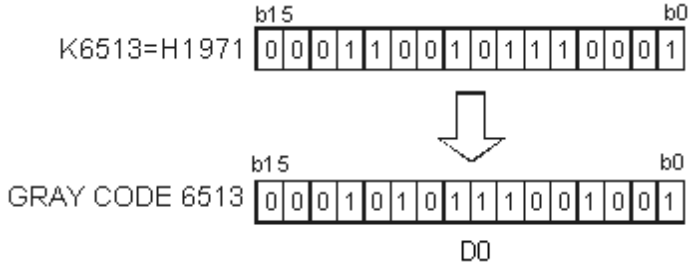
Flag signal: none

Explanation

- **S**: source device. **D**: device storing GRAY code.
- Converts the BIN value of the device designated by **S** to a GRAY code, and stores the result in the device designated by **D**.
- The valid range for **S** is as shown below; if you exceed this range, it is an error, and the command does not execute.
  16-bit command: 0–32,767
  32-bit command: 0–2,147,483,647

Example

- When X0=ON, converts the constant K6513 to a GRAY code and stores it in D0.



| API | | | | |
|---|---|---|---|---|
| 171 | D | **GBIN** | P | (S) (D) |

Convert GRAY code to BIN

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S | | | | * | * | * | * | * | * | * | * |
| D | | | | | | | * | * | * | * | * |

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

| GBIN | Continuous execution type | GBINP | Pulse execution type |
|---|---|---|---|

32-bit command (9 STEP)

| DGBIN | Continuous execution type | DGBINP | Pulse execution type |
|---|---|---|---|

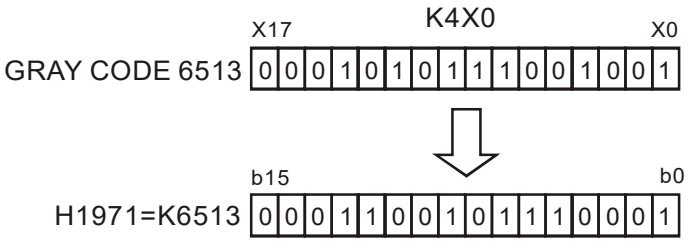
Flag signal: none

Explanation

- **S**: source device storing GRAY code. **D**: device storing BIN value after conversion.
- Converts the GRAY code corresponding to the value of the device designated by **S** that is transformed into a BIN value, and stores it in the device designated by **D**.
- This command converts the value of the absolute position encoder connected with the PLC's input (this encoder usually has an output value in the form of GRAY code) into a BIN value, and stores it in the designated register.
- The valid range of **S** is as shown below; if you exceed this range, it is an error, and the command does not execute.
  16-bit command: 0–32,767
  32-bit command: 0–2,147,483,647

Example

- When X20=ON, converts the GRAY code of the absolute position encoder connected with input points X0–X17 to a BIN value and stores it in D10.



| API | | | | |
|---|---|---|---|---|
| 215–217 | D | **LD#** | (S1) (S2) | Contact form logical operation LD# |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |

Notes on operand usage: #, :, &, |, ^

Refer to the function specifications table for each device in series for the range of device usage.

16-bit command (5 STEP)

| | | | |
|---|---|---|---|
| LD# | Continuous execution type | - | - |

32-bit command (9 STEP)

| | | | |
|---|---|---|---|
| DLD# | Continuous execution type | - | - |

Flag signal: none

Explanation

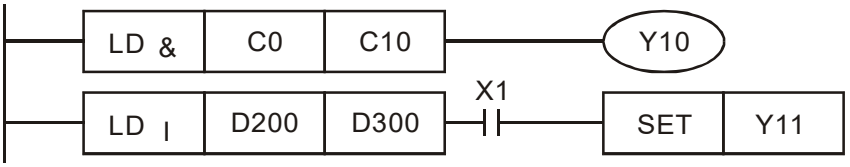
- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. When the result of comparison is not 0, this command activates; when the result of comparison is 0, this command does not activate.
- You can use the LD# command directly to connect with the busbar.

| API No. | 16-bit commands | 32-bit commands | Conditions for activation | | | | Conditions for inactivation | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 215 | LD& | **D**LD& | $S_1$ | & | $S_2$ | ≠0 | $S_1$ | & | $S_2$ | =0 |
| 216 | LD\| | **D**LD\| | $S_1$ | \| | $S_2$ | ≠0 | $S_1$ | \| | $S_2$ | =0 |
| 217 | LD^ | **D**LD^ | $S_1$ | ^ | $S_2$ | ≠0 | $S_1$ | ^ | $S_2$ | =0 |

&: logical AND operation.
|: logical OR operation.
^: logical XOR operation.

Example

- When you compare the contents of C0 and C10 with the logical AND operation, and the result is not equal to 0, then Y10=ON.
- When you compare the content of D200 and D300 with the logical OR operation, and the result is not equal to 0, and X1=ON, then Y11=ON and remains in that state.



| API 218–220 | D | AND# | | (S1) (S2) | Contact form logical operation AND# |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |

Notes on operand usage: #, :, &, |, ^

Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| AND# | Continuous execution type | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DAND# | Continuous execution type | - | - |

Flag signal: none

Explanation

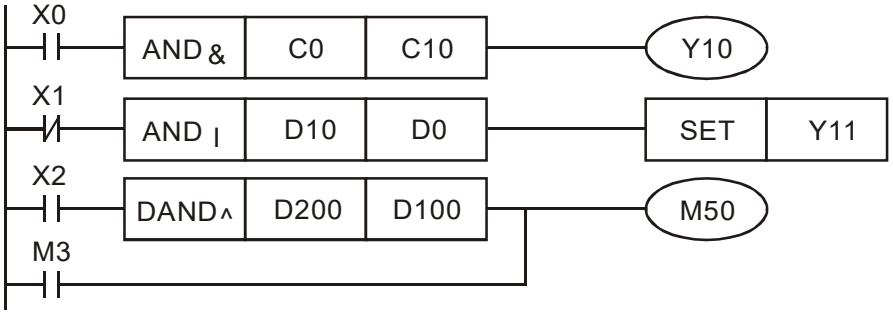
- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. When the result of comparison is not 0, this command activates; when the result of comparison is 0, this command does not activate.
- The AND# command is an operation command in series with the contact.

| API No. | 16-bit commands | 32-bit commands | Conditions for activation | | | | Conditions for inactivation | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 218 | AND& | **D**AND& | $S_1$ | & | $S_2$ | ≠0 | $S_1$ | & | $S_2$ | =0 |
| 219 | AND\| | **D**AND\| | $S_1$ | \| | $S_2$ | ≠0 | $S_1$ | \| | $S_2$ | =0 |
| 220 | AND^ | **D**AND^ | $S_1$ | ^ | $S_2$ | ≠0 | $S_1$ | ^ | $S_2$ | =0 |

&: logical AND operation.
|: logical OR operation.
^: logical XOR operation.

Example

- When X0=ON and you compare the contents of C0 and C10 with the logical AND operation, and the result is not equal to 0, then Y10=ON.
- When X1=OFF and you compare the contents D10 and D0 with the logical OR operation, and the result is not equal to 0, then Y11=ON and remains in that state.
- When X2 =ON and compare the contents of the 32-bit register D200 (D201) and the 32-bit register D100 (D101) with the logical XOR operation, and the result is not equal to 0 or M3=ON, then M50=ON.



| API | | | | |
|---|---|---|---|---|
| 221–223 | D | **OR#** | (S1) (S2) | Contact form logical operation OR# |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |

Notes on operand usage: #, :, &, |, ^

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

| | | | |
|---|---|---|---|
| OR# | Continuous execution type | - | - |

32-bit command (9 STEP)

| | | | |
|---|---|---|---|
| DOR# | Continuous execution type | - | - |

Flag signal: none

Explanation

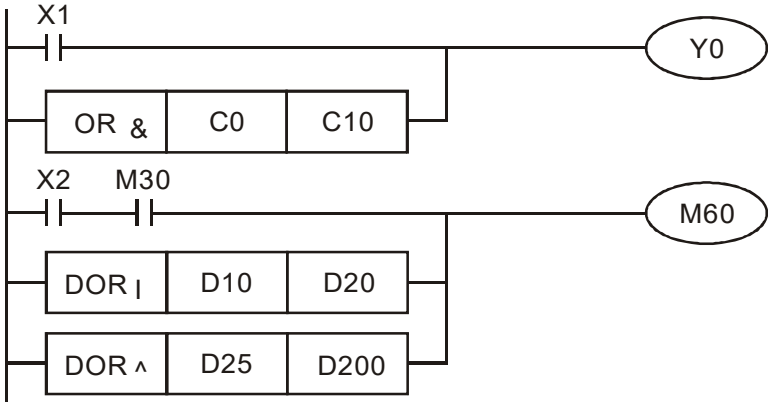
- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. When the result of comparison is not 0, this command activates; when the result of comparison is 0, this command does not activate.
- The OR# command is an operation command in series with the contact.

| API No. | 16-bit commands | 32-bit commands | Conditions for activation | | | | Conditions for inactivation | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 221 | OR& | **D**OR& | $S_1$ | & | $S_2$ | ≠0 | $S_1$ | & | $S_2$ | =0 |
| 222 | OR\| | **D**OR\| | $S_1$ | \| | $S_2$ | ≠0 | $S_1$ | \| | $S_2$ | =0 |
| 223 | OR^ | **D**OR^ | $S_1$ | ^ | $S_2$ | ≠0 | $S_1$ | ^ | $S_2$ | =0 |

&: logical AND operation.
|: logical OR operation.
^: logical XOR operation.

Example

- When X1=ON and you compare the contents of C0 and C10 with the logical AND operation, and the result is not equal to 0, then Y0=ON.
- When X2 and M30 are both equal to ON, or you compare the contents of the 32-bit register D10 (D11) and the 32-bit register D20 (D21) with the logical OR operation, and the result is not equal to 0, or you compare the contents of the 32-bit counter C235 and the 32-bit register D200 (D201) with the logical XOR operation, and the result is not equal to 0, then M60=ON.



| API | | | | |
|---|---|---|---|---|
| 224–230 | D | **LD※** | (S1) (S2) | Contact form compare LD* |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| LD※ | Continuous execution type | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DLD※ | Continuous execution type | - | - |

Flag signal: none

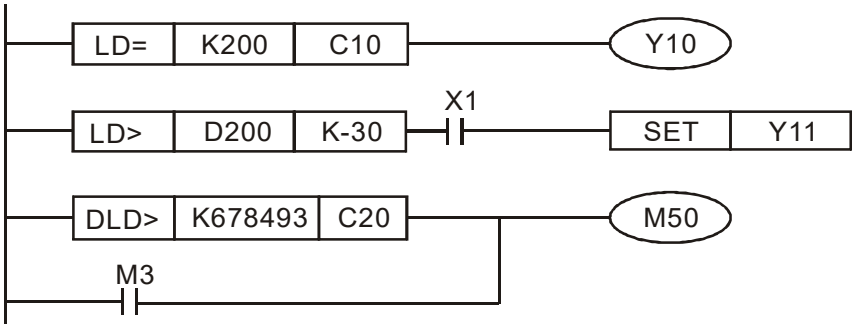
Explanation

- **$S_1$**: data source device 1. **$S_2$**: data source device 2.
- This command compares the contents of **$S_1$** and **$S_2$**. Taking API 224 (LD=) as an example, this command activates when the result of comparison is “equal”, and does not activate when the result is “unequal”.
- You can use the LD* directly to connect with the busbar.

| API No. | 16-bit commands | 32-bit commands | Conditions for activation | Conditions for inactivation |
|---|---|---|---|---|
| 224 | LD = | **D**LD = | $S_1 = S_2$ | $S_1 \neq S_2$ |
| 225 | LD < | **D**LD < | $S_1 < S_2$ | $S_1 \leq S_2$ |
| 226 | LD > | **D**LD > | $S_1 > S_2$ | $S_1 \geq S_2$ |
| 228 | LD < > | **D**LD < > | $S_1 \neq S_2$ | $S_1 = S_2$ |
| 229 | LD = > | **D**LD = > | $S_1 \leq S_2$ | $S_1 < S_2$ |
| 230 | LD = < | **D**LD = < | $S_1 \geq S_2$ | $S_1 > S_2$ |

Example

- When the content of C10 is equal to K200, then Y10=ON.
- When the content of D200 is greater than K-30, and X1=ON, then Y11=ON and remains in that state.



| API 232–238 | D | AND※ | | (S1) (S2) | Contact form compare AND* |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| AND※ | Continuous execution type | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DAND※ | Continuous execution type | - | - |

Flag signal: none

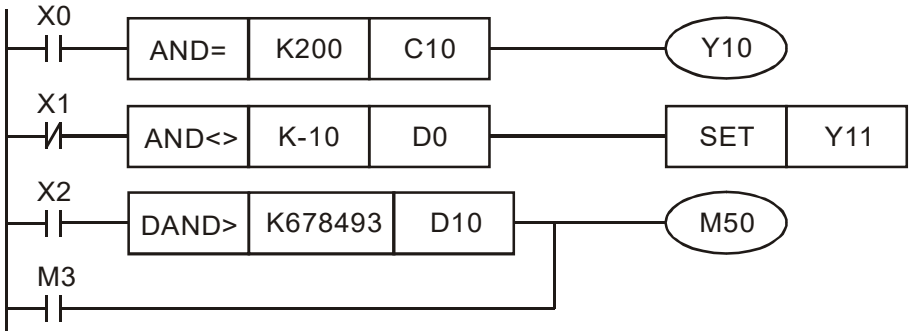
Explanation

- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. Taking API 232 (AND=) as an example, when the result of comparison is “equal”, this command activates; when the result of comparison is “unequal”, this command does not activate.
- The AND* command is a comparison command in series with a contact.

| API No. | 16-bit commands | 32-bit commands | Conditions for activation | Conditions for inactivation |
|---|---|---|---|---|
| 232 | AND = | **D**AND = | $S_1 = S_2$ | $S_1 \neq S_2$ |
| 233 | AND < | **D**AND < | $S_1 < S_2$ | $S_1 \leq S_2$ |
| 234 | AND > | **D**AND > | $S_1 > S_2$ | $S_1 \geq S_2$ |
| 236 | AND < > | **D**AND < > | $S_1 \neq S_2$ | $S_1 = S_2$ |
| 237 | AND = > | **D**AND = > | $S_1 \leq S_2$ | $S_1 < S_2$ |
| 238 | AND = < | **D**AND = < | $S_1 \geq S_2$ | $S_1 > S_2$ |

Example

- When X0=ON and the current value of C10 is also equal to K200, then Y10=ON.
- When X1=OFF and the content of register D0 is not equal to K-10, then Y11=ON and remains in that state.
- When X2=ON and the content of the 32-bit register D0 (D11) is less than 678,493, or M3=ON, then M50=ON.



| API | | | | |
|---|---|---|---|---|
| 240–246 | D | **OR※** | (S1) (S2) | Contact form compare OR* |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | * | * | * | * | * | * |
| S2 | | | | * | * | * | * | * | * | * | * |

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| OR※ | Continuous execution type | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| DOR※ | Continuous execution type | - | - |

Flag signal: none

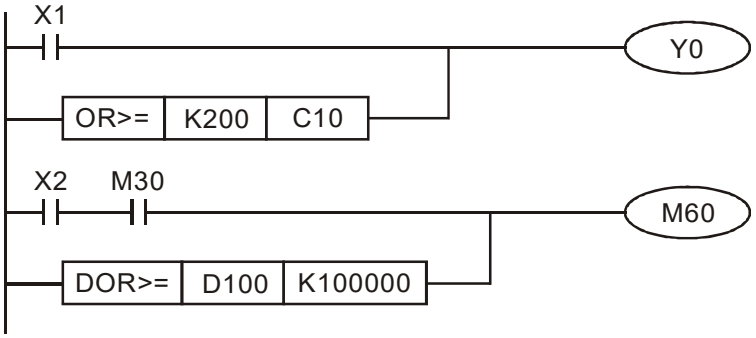
Explanation

- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. Taking API 240 (OR=) as an example, when the result of comparison is “equal”, this command activates; when the result of comparison is “unequal”, this command does not activate.
- The OR* command is a comparison command in parallel with a contact.

| API No. | 16-bit commands | 32-bit commands | Conditions for activation | Conditions for inactivation |
|---|---|---|---|---|
| 240 | OR = | **D**OR = | $S_1 = S_2$ | $S_1 \neq S_2$ |
| 241 | OR < | **D**OR < | $S_1 < S_2$ | $S_1 \leq S_2$ |
| 242 | OR > | **D**OR > | $S_1 > S_2$ | $S_1 \geq S_2$ |
| 244 | OR < > | **D**OR < > | $S_1 \neq S_2$ | $S_1 = S_2$ |
| 245 | OR = > | **D**OR = > | $S_1 \leq S_2$ | $S_1 < S_2$ |
| 246 | OR = < | **D**OR = < | $S_1 \geq S_2$ | $S_1 > S_2$ |

Example

- When X0=ON and the current value of C10 is also equal to K200, then Y10=ON.
- When X1=OFF and the content of register D0 is not equal to K-10, then Y11=ON and remains in that state.
- When X2=ON and the content of the 32-bit register D0 (D11) is less than 678,493, or M3=ON, then M50=ON.



| API 275–280 | FLD※ | (S1) (S2) | Floating point number contact form compare LD* |
|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | | | | | | * | * | * |
| S2 | | | | | | | | | * | * | * |

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| FLD※ | Continuous execution type | - | - |

Flag signal: none

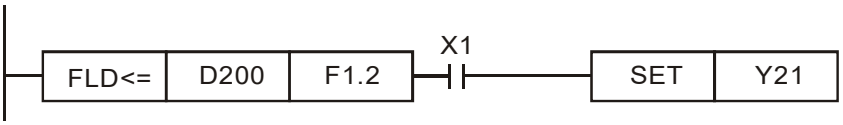
Explanation

- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. Taking “FLD=” as an example, if the result of comparison is “equal”, this command activates; but it does not activate when the result is “unequal”.
- The FLD* command can directly input floating point numbers (for instance: F1.2) to the $S_1$ and $S_2$ operands, or store the floating point numbers in register D for use in operations.
- You can use this command directly to connect with the busbar.

| API No. | 32-bit commands | Conditions for activation | Conditions for inactivation |
|---|---|---|---|
| 275 | FLD = | $S_1 = S_2$ | $S_1 \neq S_2$ |
| 276 | FLD < | $S_1 < S_2$ | $S_1 \leq S_2$ |
| 277 | FLD > | $S_1 > S_2$ | $S_1 \geq S_2$ |
| 278 | FLD < > | $S_1 \neq S_2$ | $S_1 = S_2$ |
| 279 | FLD = > | $S_1 \leq S_2$ | $S_1 < S_2$ |
| 280 | FLD = < | $S_1 \geq S_2$ | $S_1 > S_2$ |

Example

- When the floating point number in register D200 (D201) is less than or equal to F1.2, and X1 is activated, then contact Y21 activates and remains in that state.



| API 281–286 | | FAND※ | | (S1) (S2) | Floating point number contact form compare AND* |
|---|---|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | | | | | | * | * | * |
| S2 | | | | | | | | | * | * | * |

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| FAND※ | Continuous execution type | - | - |

Flag signal: none

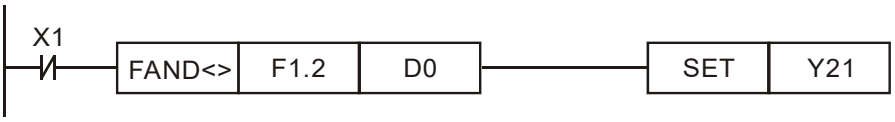
Explanation

- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. Taking “FAND=” as an example, if the result of comparison is “equal”, this command activates; but it does not activate when the result is “unequal”.
- The FAND* command can directly input floating point numbers (for instance: F1.2) to the $S_1$ and $S_2$ operands, or store floating point numbers in register D for use in operations.
- You can use this command directly to connect with the busbar.

| API No. | 32-bit commands | Conditions for activation | Conditions for inactivation |
|---|---|---|---|
| 281 | FAND = | $S_1 = S_2$ | $S_1 \neq S_2$ |
| 282 | FAND > | $S_1 < S_2$ | $S_1 \leq S_2$ |
| 283 | FAND < | $S_1 > S_2$ | $S_1 \geq S_2$ |
| 284 | FAND < > | $S_1 \neq S_2$ | $S_1 = S_2$ |
| 285 | FAND < = | $S_1 \leq S_2$ | $S_1 < S_2$ |
| 286 | FAND > = | $S_1 \geq S_2$ | $S_1 > S_2$ |

Example

- When X1=OFF, and the floating point number in register D100 (D101) is not equal to F1.2, then Y21=ON and remains in that state.



| API 287–292 | FOR※ | (S1) (S2) | Floating point number contact form compare OR* |
|---|---|---|---|

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | | | | | | * | * | * |
| S2 | | | | | | | | | * | * | * |

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

| 16-bit command | | | |
|---|---|---|---|
| - | - | - | - |

| 32-bit command (9 STEP) | | | |
|---|---|---|---|
| FOR※ | Continuous execution type | - | - |

Flag signal: none

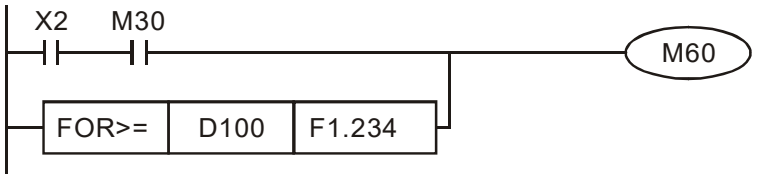
Explanation

- $S_1$: data source device 1. $S_2$: data source device 2.
- This command compares the contents of $S_1$ and $S_2$. Taking "FOR=" as an example, if the result of comparison is "equal", this command activates; but it does not activate when the result is "unequal".
- The FOR* command can directly input floating point numbers (for instance: F1.2) to the $S_1$ and $S_2$ operands, or store floating point numbers in register D for use in operations.
- You can use this command directly to connect with the busbar.

| API No. | 32-bit commands | Conditions for activation | Conditions for inactivation |
|---|---|---|---|
| 287 | FOR = | $S_1 = S_2$ | $S_1 \neq S_2$ |
| 288 | FOR < | $S_1 < S_2$ | $S_1 \leq S_2$ |
| 289 | FOR > | $S_1 > S_2$ | $S_1 \geq S_2$ |
| 290 | FOR < > | $S_1 \neq S_2$ | $S_1 = S_2$ |
| 291 | FOR = > | $S_1 \leq S_2$ | $S_1 < S_2$ |
| 292 | FOR = < | $S_1 \geq S_2$ | $S_1 > S_2$ |

Example

- When X2 and M30 are both equal to ON, or the floating point number in register D100 (D101) is greater than or equal to F1.234, then M60=ON.



## 17-6-5 Detailed explanation of drive special application commands

| API | | | | |
|---|---|---|---|---|
| 139 | RPR | P | (S1) (S2) | Read servo parameter |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | | | | | | * |
| S2 | | | | | | | | | | | * |

Notes on operand usage: none

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| RPR | Continuous execution type | RPRP | Pulse execution type |

| 32-bit command | | | |
|---|---|---|---|
| - | - | - | - |

Flag signal: none

Explanation

- **$S_1$**: Parameter address of data to be read. **$S_2$**: Register where data that is read is stored.

| API | | | | |
|---|---|---|---|---|
| 140 | WPR | P | (S1) (S2) | Write servo parameter |

| | bit device | | | Word device | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | Y | M | K | H | KnX | KnY | KnM | T | C | D |
| S1 | | | | * | * | | | | | | * |
| S2 | | | | * | * | | | | | | * |

Notes on operand usage: none

| 16-bit command (5 STEP) | | | |
|---|---|---|---|
| WPR | Continuous execution type | WPRP | Pulse execution type |

| 32-bit command | | | |
|---|---|---|---|
| - | - | - | - |

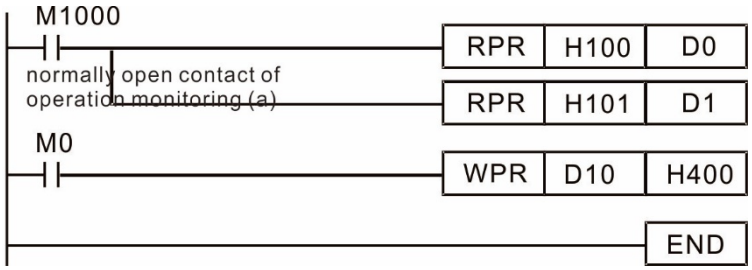
Flag signal: M1016 parameter read/write error, M1017 parameter written successfully.

Explanation

- **$S_1$**: Data to write to specified page. **$S_2$**: Parameter address of data to be written.

Example

- When the data in the MH300-L drive's parameter H01.00 is read and written to D0, data from H01.01 is read and written to D1.
- When M0=ON, the content of D10 is written to the MH300-L drive Pr.04.00 (first speed of multiple speed levels).
- When M1017=ON, the parameter has been written successfully.
- The MH300-L's WPR command does not support writing to the 20XX address, but the RPR command supports reading of 21XX, 22XX.




Recommendation Be cautious when using the WPR command. When writing parameters, most parameters are recorded when they are written, and these parameters may only be revised $10^9$ times: a memory write error may occur if parameters are written more than (MS)$10^6$ or (MH)$10^9$ times.

The number of times a parameter is written is based on whether the written value is modified. For instance, writing the same value 100 times at the same time counts as writing only once.

## 17-7 Error Display and Handling

| Code | ID* | Description | Recommended error resolution |
|---|---|---|---|
| PLod | 50 | Data writing memory error | Check whether the program has an error and download the program again. |
| PLSv | 51 | Data write memory error during program execution | Cycle the power and download the program again. |
| PLdA | 52 | Program transmission error | Try uploading again; if the error persists, send it to the manufacturer for service. |
| PLFn | 53 | Command error while downloading program | Check whether the program has an error and download the program again. |
| PLor | 54 | Program exceeds memory capacity or no program. | Cycle the power and download the program again. |
| PLFF | 55 | Command error during program execution | Check whether the program has an error and download the program again. |
| PLSn | 56 | Check code error | Check whether the program has an error and download the program again. |
| PLEd | 57 | Program has no END stop command. | Check whether the program has an error and download the program again |
| PLCr | 58 | MC command has been used continuously more than nine times. | Check whether the program has an error and download the program again. |
| PLdF | 59 | Download program error | Check whether the program has an error and download again. |
| PLSF | 60 | PLC scan time excessively long | Check whether the program code has a writing error and download again. |

*ID: Warning code

# 17-8 Explanation of Each PLC Mode Control (Speed)

Speed control:

Register table for speed mode:

Control special M

| Special M | Function Description | Attributes |
|---|---|---|
| M1025 | Drive frequency = set frequency (ON) / drive frequency = 0 (OFF) | RW |
| M1026 | Drive operating direction FWD (OFF) / REV (ON) | RW |
| M1040 | Hardware power (Servo On) | RW |
| M1042 | Quick Stop | RW |
| M1044 | Pause (Halt) | RW |
| M1052 | Lock frequency (lock, frequency locked at the current operating frequency) | RW |

Status special M

| Special M | Function Description | Attributes |
|---|---|---|
| M1015 | Frequency reached (when used with M1025) | RO |
| M1056 | Hardware already has power (Servo On Ready) | RO |
| M1058 | On Quick Stopping | RO |

Control special D

| Special D | Function Description | Attributes |
|---|---|---|
| D1060 | Operation mode setting (speed mode is 0) | RW |

Status special D

| Special D | Function Description | Attributes |
|---|---|---|
| D1037 | Drive output frequency (0.00–599.00 Hz) | RO |
| D1050 | Actual operation mode (speed mode is 0) | RO |

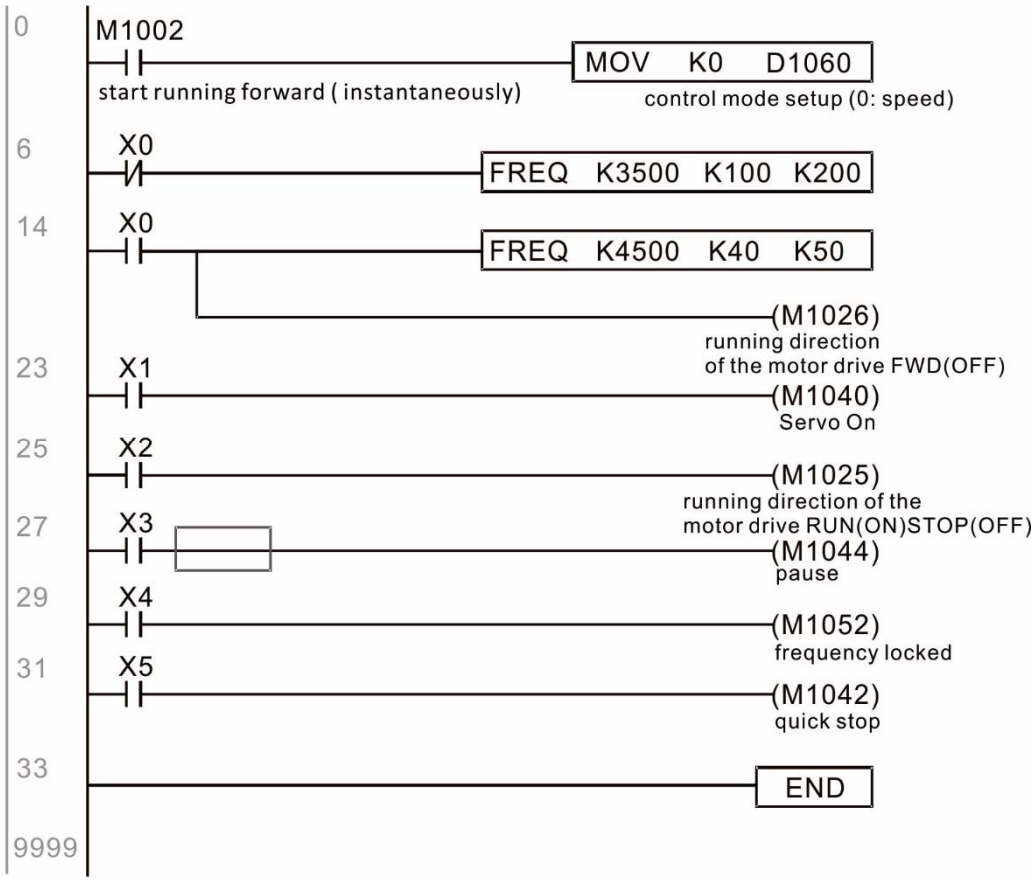
Speed mode control commands:

| **FREQ(P)** | S1 | S2 | S3 |
|---|---|---|---|
| | Target speed | The first acceleration time setting | The first deceleration time setting |

Example of speed mode control:

Before using speed control, if you use the FOC (magnetic field orientation) control method, you must first complete the setting of the electro-mechanical parameters.

1. Setting D1060 = 0 shifts the drive to speed mode (default).
2. Use the FREQ command to control frequency, acceleration time, and deceleration time.
3. Setting M1040 = 1, the drive is now excited, but the frequency is 0.
4. Setting M1025 = 1, the drive Frequency command now jumps to the frequency designated by FREQ, and acceleration and deceleration is controlled on the basis of the acceleration time and deceleration time specified by FREQ.
5. Use M1052 to lock the current operation frequency.
6. Use M1044 to temporarily pause the operation, and the deceleration method uses the deceleration settings.
7. Use M1042 to perform Quick Stop, and deceleration is as fast as possible without causing an error. There may still be a jump error if the load is too large.
8. Control user rights: M1040 (Servo On) > M1042 (Quick Stop) > M1044 (Halt) > M1052 (LOCK)

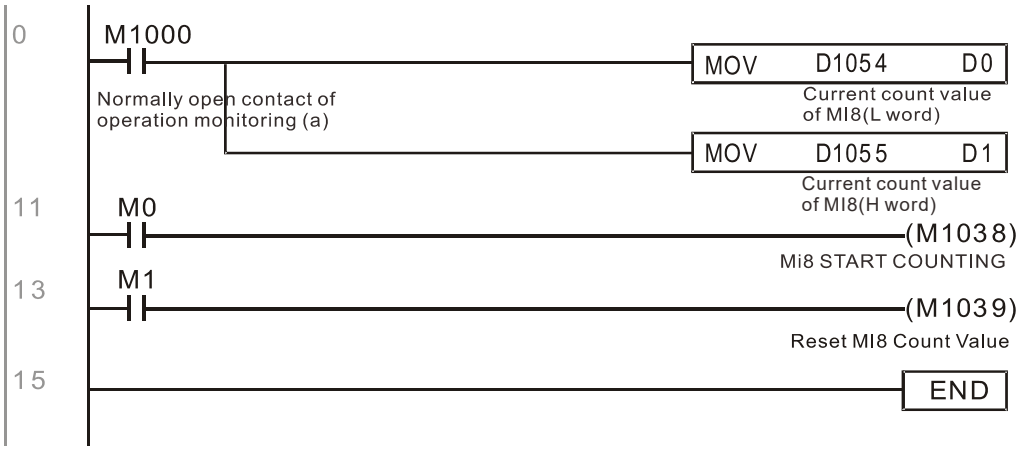


# 17-9 Count Function Using Pulse Input

## 17-9-1 High-speed count function

The MH300-L's MI7 supports one-way pulse counting, or you can use MI6+MI7 to support AB-phase two-way pulse counting, with a maximum speed of 33 k. The starting method is very simple, and only requires setting M1038 to begin counting. The 32 bit count value is stored in D1054 and D1055 in non-numerical form. M1039 resets the count value to 0.

Take MI7 one-way pulse input as an example:




※ When the PLC program defines MI7 for use as a high-speed counter, that is when M1038 or M1039 is written in PLC procedures, the other functions of MI7 are disabled.

## 17-9-2 Frequency calculation function

Apart from high-speed counting, the MH300-L's MI7 (one-way pulse counting) or MI6+MI7 (AB-phase two-way pulse counting) can also convert a received pulse to a frequency. The following figure shows that there is no conflict between frequency conversion and count calculations, which the MH300-L can perform simultaneously.

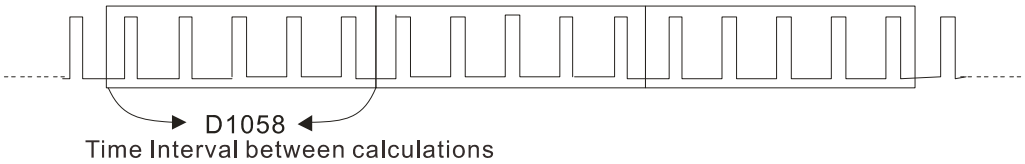
PLC speed calculation formula

D1057 Speed

D1058 Interval between calculations

D1059 Decimal places

Assume that there are five input pulses each second, (see figure below) we set D1058 = 1000 ms = 1.0 seconds as the calculation interval. This enables five pulses to be sent to the drive each second.




Assume that each five pulses correspond to 1 Hz, we set D1057 = 5.

Setting D1059 = 2 displays numbers to two decimal places, which is also 1.00 Hz. The numerical value displayed at D1056 is 100. For simplicity, the D1059 conversion formula can be expressed in the following formula:

D1056 = (Pulses per second / D1057) * (1000 / D1058) * (10^D1059)

# Chapter 18 Safe Torque Off Function

18-1 Basic Function Description

18-2 Safe Torque Off Terminal Function Description

18-3 Wiring Diagram

18-4 Failure Rate of the Drive Safety Function

18-5 Reset the Parameter Settings

18-6 Timing Diagram Description

18-7 Error Code and Troubleshooting Instructions

18-8 Test and Fault Confirmation

# 18-1 Basic Function Description

MH300-L series provides a Safe Torque Off (STO, Safe Torque Off) function. Through the dual-channel S1 and S2 signal input to turn off IGBT switching, thereby preventing the generation of motor torque in order to achieve safe stop. Please refer to Figure 1 for the circuit diagram of Safe Torque Off function.

MH300-L Safe Torque Off function meets the following international specifications:

ISO 13849-1: 2015 Category 3 PL d
IEC 61508 SIL2
EN 62061 SIL CL 2
EN 60204-1 Category 0

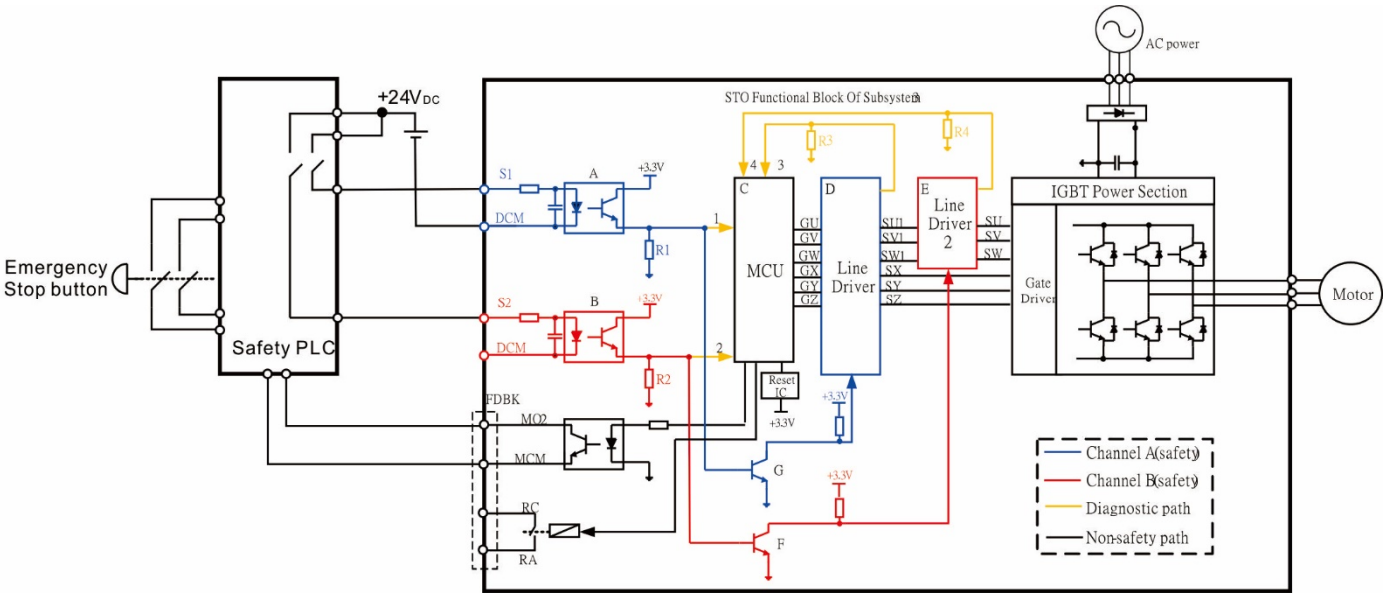



Figure 1: The circuit diagram of Safe Torque Off function

## 18-2 Safe Torque Off Terminal Function Description

As mentioned earlier STO (Safe torque off) related terminal functions are described in Table 1 below.

| Terminals | Terminal Function | Specifications |
|---|---|---|
| +24V | When the STO function is not used, the STO function can be disabled by shorting S1 and S2 with + 24 V | Output voltage range: +24 V ± 10 %<br>Output voltage capacity: 100 mA |
| S1 | Signal input of STO function channel 1 | **S1–DCM / S2–DCM**<br>Rated input voltage: +24 $V_{DC}$ ± 10 %; Max. input voltage: +30 $V_{DC}$ ± 10 %<br>Rated input current: 6.67 mA ± 10 %<br>**STO activation mode**<br>Input voltage level: 0 $V_{DC}$ < S1–DCM and S2–DCM < 5 $V_{DC}$<br>STO response time: ≤ 20 ms (time required for S1 / S2 operate till the drive stop outputting)<br>**STO cut-off mode**<br>Input voltage level: 11 $V_{DC}$ < S1–DCM and S2–DCM < 30 $V_{DC}$ |
| S2 | Signal input of STO function channel 2 | |
| DCM | Reference ground of S1 and S2 signal | |

Table 1: Terminal function description

Action logic and keypad display after S1 / S2 signal input are described in Table 2 below.

| Signal | Status | | | |
|---|---|---|---|---|
| S1–DCM | ON | ON | OFF | OFF |
| S2–DCM | ON | OFF | ON | OFF |
| Drive output | Ready to output | STL2 mode (Torque output off) | STL1 mode (Torque output off) | STO mode (Torque output off) |
| Error displayed on keypad | No error displayed | STL2 | STL1 | STO |

Table 2: Description of action logic and keypad display

- STO means channel 1 and 2 operate simultaneously and enter Safe Torque Off.
- STL1 means channel 1 operates.
- STL2 means channel 2 operates.
- STL3 means there is error detected in the internal circuit of channel 1 or channel 2.
- S1–DCM / S2–DCM ON: means S1–DCM / S2–DCM inputs a power supply > 11 $V_{DC}$.
- S1–DCM / S2–DCM OFF: means S1–DCM / S2–DCM inputs a power supply < 5 $V_{DC}$.

## 18-3 Wiring Diagram

18-3-1 Internal circuit diagram of safe control loop is shown in Figure2.

18-3-2 Terminals of the safe control loop + 24V-S1-S2 are short-circuited together with jumper wire at the factory, as shown in Figure 2.

18-3-3 The safe control loop wiring diagram is as follows:

1. Remove the jumper wire of +24V-S1-S2.
2. The wiring as shown in Figure 3 below. Normally, the switch ESTOP contact must be closed, thereby the drive can output without error displayed.
3. In STO mode, the switch ESTOP is turned on. The drive stops outputting and keypad displays STO.

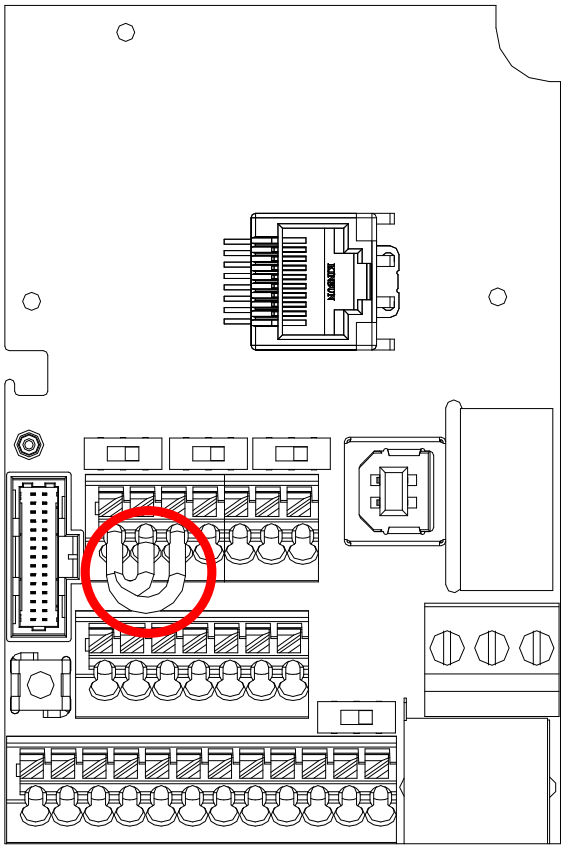


Figure 2

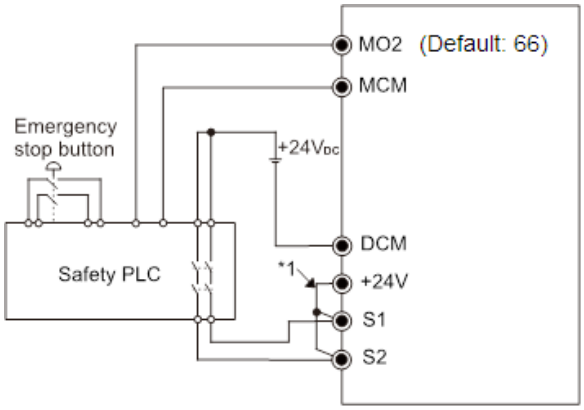



Figure 3

NOTE

*1 is factory jumper wire of +24V-S1-S2. To use the Safety function, please remove this jumper wire. Conversely, if the Safety function is disabled, then +24V-S1-S2 should be short-circuit with jumper wire.

## 18-4 Failure Rate of the Drive Safety Function

Please refer to Table 3 below for relevant safe parameters of safe loop:

| Item | Definition | Standard | Performance |
|---|---|---|---|
| SFF | Safe failure fraction | IEC61508 | S1–DCM = 88.35 %<br>S2–DCM = 88.2 % |
| HFT (Type A subsystem) | Hardware fault tolerance | IEC61508 | 1 |
| SIL | Safety integrity level | IEC61508 | SIL 2 |
| | | IEC62061 | SILCL 2 |
| PFH | Average frequency of dangerous failure [h-1] | IEC61508 | $1.36 \times 10^{-9}$ |
| $PFD_{av}$ | Probability of dangerous failure on demand | IEC61508 | $5.99 \times 10^{-6}$ |
| PTI | Proof test interval | IEC61508 | 1 year |
| Category | Category | ISO13849-1 | Category 3 |
| PL | Performance level | ISO13849-1 | d |
| $MTTF_d$ | Mean time to dangerous failure | ISO13849-1 | High |
| DC | Diagnostic coverage | ISO13849-1 | Low |

Table 3: Relevant safe parameters of safe loop

## 18-5 Reset the Parameter Settings

Pr. 06-44 can be used to set the reset method when an STO alarm occurs.

**06-44** STO Latch Selection

Factory setting: 0

Settings 0: STO Alarm latch
1: STO Alarm no latch

- Pr. 06-44 = 0 STO Alarm Latch: after the reason of STO Alarm is cleared, a Reset command is needed to clear STO Alarm.
- Pr. 06-44 = 1 STO Alarm no Latch: after the reason of STO Alarm is cleared, the STO Alarm will be cleared automatically.
- All of STL1–STL3 error are “Alarm latch” mode (in STL1–STL3 mode, the Pr. 06-44 function is not effective).

# 18-6 Timing Diagram Description

The following timing diagram shows the status of relevant signals under different conditions:

## 18-6-1 Normal operation status

As shown in Figure 4: When S1–DCM and S2–DCM is ON (STO function is not required), the drive will execute “Operating” or “Output Stop” according to RUN command.

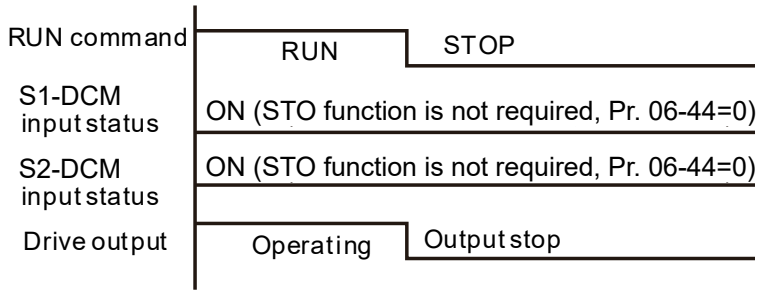



Figure **4**

### 18-6-2-1 STO, Pr. 06-44=0, Pr. 02-35=0 (Selection of external control operation after reset / power on, 0=not valid)

As shown in Figure 5: When both of S1–DCM and S2–DCM are OFF during operation (STO function is required), the drive will stop outputting when enter safe mode regardless of Run command is ON or OFF status.

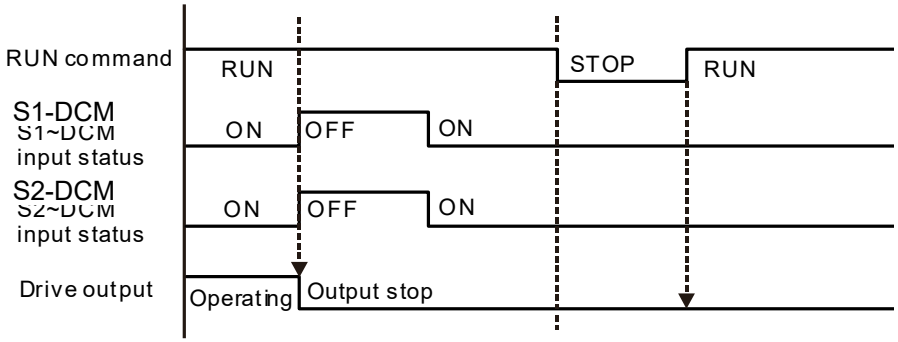



Figure **5**

### 18-6-2-2 STO, Pr. 06-44=0, Pr. 02-35=1 (Selection of external control operation after reset / power on, 1= the drive will execute RUN if command exists after reset)

As shown in Figure 6, the action is the same as in Figure 5. However, because Pr. 02-35=1, if RUN command still exists after reset, the drive will execute run command again immediately.

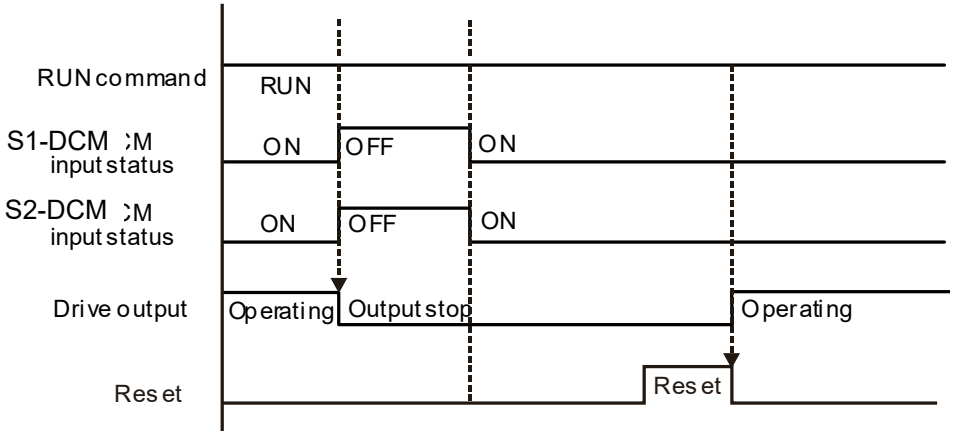



Figure 6

### 18-6-3 STO, Pr. 06-44=1

As shown in Figure 7: When both of S1–DCM and S2–DCM are OFF during operation (STO function is required), the drive will stop outputting. When the S1 / S2 status is restored (ON), the STO automatic alarm is automatically cleared. The drive can output when RUN command is released again.

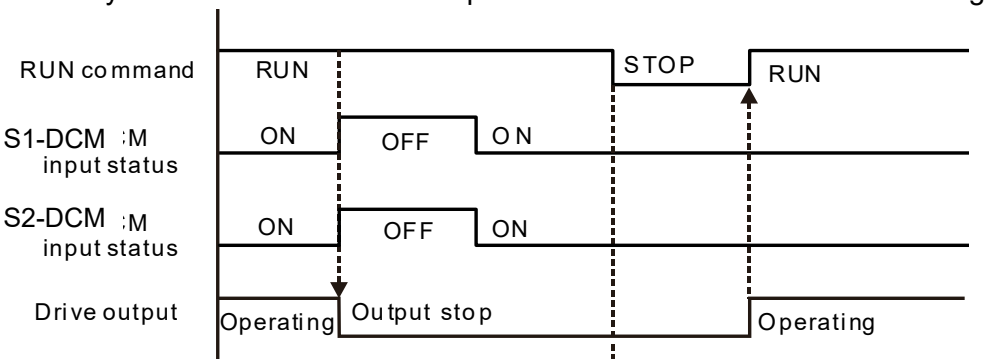



Figure 7

### 18-6-4 STL1, Pr. 06-44=0 or 1

As shown in Figure 8: When S1–DCM is OFF during operation (STO function is required) and S2–DCM is ON (STO function is not required), the drive will stop outputting and keypad will show STL1 error. However, STL1 error cannot be reset even if the S1 status is restored (ON) regardless of the parameter setting. Turn the power on after power off to reset, thereby the drive can restore to normal standby state.

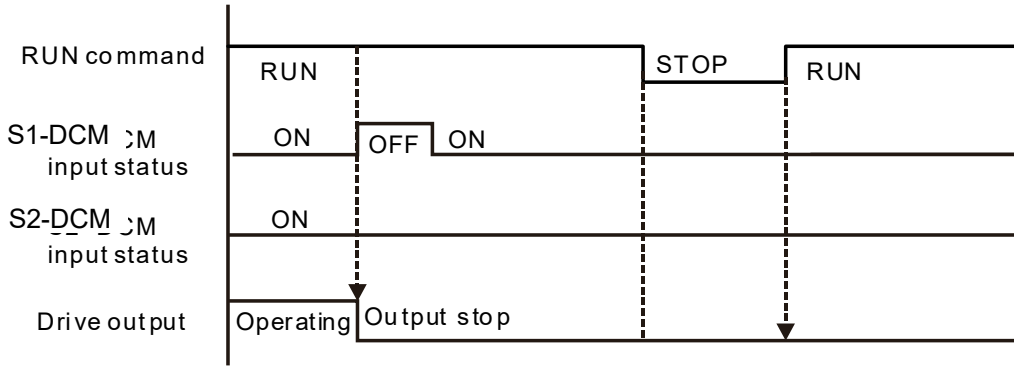



Figure 8

### 18-6-5 STL2, Pr. 06-44=0 or 1

As shown in Figure 9: When S1–DCM is ON during operation (STO function is not required) and S2–DCM is OFF (STO function is required), the drive will stop outputting and keypad will show STL2 error. However, STL2 error cannot be reset even if the S2 status is restored (ON) regardless of the parameter setting. Turn the power on after power off to reset, thereby the drive can restore to normal standby state.

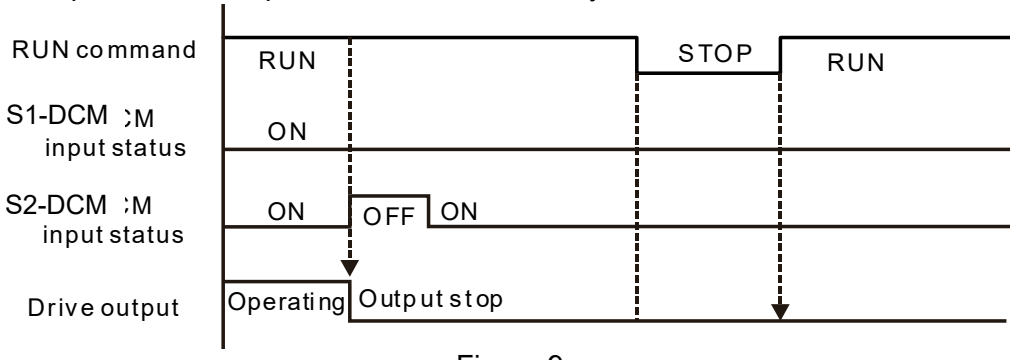



Figure 9

# 18-7 Error Code and Troubleshooting Instructions

## 18-7-1 Error Code Description

Refer to Pr.06-17–Pr.06-22 for fault record, wherein STO relevant error code is 72/76/77/78, the definition is as follows and Table 4:

| | |
|---|---|
| 06-17 | Fault Record 1 |
| 06-18 | Fault Record 2 |
| 06-19 | Fault Record 3 |
| 06-20 | Fault Record 4 |
| 06-21 | Fault Record 5 |
| 06-22 | Fault Record 6 |

Settings
72: Channel 1 (S1–DCM) safety loop error (STL1)
76: Safe torque off (STo)
77: Channel 2 (S2–DCM) safety loop error (STL2)
78: Internal loop error (STL3)

| Error code | Name | Description |
|---|---|---|
| 76 (STO) | Safe torque off | Safe torque off function active |
| 72 (STL1) | Channel 1 (S1–DCM) safety loop error | S1[This page intentionally left blank]DCM internal loop detected error |
| 77 (STL2) | Channel 2 (S2–DCM) safety loop error | S2[This page intentionally left blank]DCM internal loop detected error |
| 78 (STL3) | Internal loop error | S1[This page intentionally left blank]DCM and S2–DCM internal loop detected error |

Table 4: Error code description

### 18-7-2 Troubleshooting Instructions

Refer to the following instructions for troubleshooting when STO / STL1 / STL2 / STL3 shows on keypad. (Refer to Chapter 14 Error Codes)

| ID No. | KPMH-LC01 Display | Descriptions |
|---|---|---|
| 72 | | S1–DCM internal loop detected error<br>Corrective Actions<br>■ Check wiring of S1 terminal.<br>■ Reset emergency switch (ON: activated) and re-power<br>■ Check the input voltage to maintain at least 11 V.<br>■ Check the wiring of S1 and +24 V terminal.<br>■ After make sure all the wiring is correct, if STL1 fault still exists after re-power, please contact Delta. |
| 76 | | Safe torque off function active<br>Corrective Actions<br>■ Check wiring of S1 and S2 terminal.<br>■ Reset emergency switch (ON: activated) and re-power.<br>■ Check the input voltage to maintain at least 11 V.<br>■ Check the wiring of S1 / S2 and +24 V terminal.<br>■ After make sure all the wiring is correct, if STO fault still exists after re-power, please contact Delta. |
| 77 | | S2–DCM internal loop detected error.<br>Corrective Actions<br>■ Check wiring of S2 terminal.<br>■ Reset emergency switch (ON: activated) and re-power.<br>■ Check the input voltage to maintain at least 11 V.<br>■ Check the wiring of S2 and +24 V terminal.<br>■ After make sure all the wiring is correct, if STL2 fault still exists after re-power, please contact Delta. |
| 78 | | Internal loop detected error.<br>Corrective Actions<br>■ After make sure the wiring is correct, if STL3 fault still exists after re-power, please contact Delta. |

## 18-8 Test and Fault Confirmation

After wiring in accordance with Section 18-3 Wiring Diagram, please follow the steps below to check whether STO and related detection function are normal.

1. When the drive is powered on, make sure that S1–DCM and S2–DCM voltage falls between 11–30 $V_{DC}$, at this time, the drive should enter standby mode and waits for RUN command. There is no error displayed on keypad.
2. Press RUN command on the drive, use the emergency button or other methods to make S1–DCM and S2–DCM voltage falls between 0–5 $V_{DC}$ simultaneously after the output frequency is reached, at this time, the drive should enter torque stop mode STO and stop outputting voltage. Keypad displays STO error, and the response time of S1 and S2 signals to the drive stops outputting voltage should be ≤ 20 ms. Then restore S1–DCM and S2–DCM voltage to 11–30 $V_{DC}$, press RESET button on keypad and STO error will be cleared. The drive should enter standby mode and waits for RUN command.
3. Press RUN command on the drive, use the emergency button or other methods to make S1–DCM voltage fall between 0–5 $V_{DC}$, and S2–DCM voltage maintain between 11–30 $V_{DC}$ after the output frequency is reached, at this time, the drive should enter torque stop mode STL1 and stop outputting voltage. Keypad displays ST1 error, and the response time of S1 signals to the drive stops outputting voltage should be ≤ 20 ms. Then restore S1–DCM voltage to 11–30 $V_{DC}$, however press RESET button on keypad cannot clear STL1 error, the drive needs to be re-powered. Make sure that S1–DCM and S2–DCM voltage falls between 11–30 $V_{DC}$ and then re-power the drive, thus STL1 error will be cleared. The drive should enter standby mode and waits for RUN command.
4. Press RUN command on the drive, please use the emergency button or other methods to make S2–DCM voltage fall between 0–5 $V_{DC}$, and S1–DCM voltage maintain between 11–30 $V_{DC}$ after the output frequency is reached, at this time, the drive should enter torque stop mode STL2 and stop outputting voltage. Keypad displays ST2 error, and the response time of S2 signals to the drive stops outputting voltage should be ≤ 20 ms. Then restore S2–DCM voltage to 11–30 $V_{DC}$, however press RESET button on keypad cannot clear STL1 error, the drive needs to be re-powered. Make sure S1–DCM and S2–DCM voltage falls between 11–30 $V_{DC}$ and then re-power the drive, thus STL2 error will be cleared. The drive should enter standby mode and waits for RUN command.
5. If the above four steps can be conducted normally in sequence with no other error, then the safe torque off function loop is normal, as shown in Table 5 below. However, if there are situations differ from the above four steps or if STL3 occurs, the safe torque off function loop is abnormal. Please refer to 18-7 Error Code and Troubleshooting Instructions.

| Signal | Status | | | |
|---|---|---|---|---|
| S1–DCM | ON | ON | OFF | OFF |
| S2–DCM | ON | OFF | ON | OFF |
| Drive output | Ready to output | STL2 mode | STL1 mode | STO mode |
| Error displayed on keypad | No error displayed | STL2 | STL1 | STO |
| Response time | N.A | ≤ 20 ms | | |
| RESET mechanism | N.A | Re-power the drive | Re-power the drive | Can be RESET directly |

Table 5

- STO means channel 1 and 2 operate simultaneously and enter Safe Torque Off.
- STL1 means channel 1 operates.
- STL2 means channel 2 operates.
- STL3 means there is error detected in the internal circuit of channel 1 or channel 2.
- S1–DCM / S2–DCM ON: means S1–DCM / S2–DCM inputs a power supply > 11 $V_{DC}$.
- S1– DCM / S2–DCM OFF: means S1–DCM / S2–DCM inputs a power supply < 5 $V_{DC}$.

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# Appendix A. Revision History

Firmware Version: V1.02
Issued Edition: V01
Issued Date: May 25th, 2021
Revision History

| Change Description | Affected Chapter/Section |
|---|---|
| A table for the maximum shielded cable length for drive models with built-in EMC filters is added. | 7-6 EMC Filter |
| New section added. | 7-9 NEMA Kit |
| New section added. | 7-10 DIN-Rail Mounting |
| A description that hot swapping is not supported is added to the top of Chapter 8. | Chapter 8 Option Cards |
| Multi-function input (MI) setting value 62 (Mechanical brake error detection 2) added. | Chapter 11 (Parameter Group 2)<br>Chapter 12 (Parameter Group 2)<br>Chapter 15 |
| Roll-back solution added. | 1. Pr.02-39 & Pr.02-40: Elevator Timing Diagram revised<br>2. Pr.02-42: parameter name, default setting, setting range and descriptions revised<br>3. Pr.02-43 & Pr.02-44: parameters added |
| EPS function revised. | 1. Pr.02-83: descriptions added<br>2. Pr.06-81: descriptions added<br>3. Pr.06-89: UPS flowchart added |
| Error code 71 (Mechanical brake error 2: MBF2) added | 1. Pr.06-17 to Pr.06-22: fault records in both Chapter 11 and Chapter 12<br>2. Pr.06-23 to Pr.06-26: fault output options (bit table for fault code) in both Chapter 11 and Chapter 12<br>3. Chapter 14: Error code 71 added |

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