Preface

Thank you for choosing DELTA's high-performance VFD-E Series. The VFD-E Series is manufactured with high-quality components and materials and incorporate the latest microprocessor technology available.

This manual is to be used for the installation, parameter setting, troubleshooting, and daily maintenance of the AC motor drive. To guarantee safe operation of the equipment, read the following safety guidelines before connecting power to the AC motor drive. Keep this operating manual at hand and distribute to all users for reference.

To ensure the safety of operators and equipment, only qualified personnel familiar with AC motor drive are to do installation, start-up and maintenance. Always read this manual thoroughly before using VFD-E series AC Motor Drive, especially the WARNING, DANGER and CAUTION notes. Failure to comply may result in personal injury and equipment damage. If you have any questions, please contact your dealer.

PLEASE READ PRIOR TO INSTALLATION FOR SAFETY.

DANGER!

1. AC input power must be disconnected before any wiring to the AC motor drive is made.
2. A charge may still remain in the DC-link capacitors with hazardous voltages, even if the power has been turned off. To prevent personal injury, please ensure that power has turned off before opening the AC motor drive and wait ten minutes for the capacitors to discharge to safe voltage levels.
3. Never reassemble internal components or wiring.
4. The AC motor drive may be destroyed beyond repair if incorrect cables are connected to the input/output terminals. Never connect the AC motor drive output terminals U/T1, V/T2, and W/T3 directly to the AC mains circuit power supply.
5. Ground the VFD-E using the ground terminal. The grounding method must comply with the laws of the country where the AC motor drive is to be installed. Refer to the Basic Wiring Diagram.
6. VFD-E series is used only to control variable speed of 3-phase induction motors, NOT for 1-phase motors or other purpose.
7. VFD-E series shall NOT be used for life support equipment or any life safety situation.

WARNING!

1. DO NOT use Hi-pot test for internal components. The semi-conductor used in AC motor drive easily damage by high-pressure.
2. There are highly sensitive MOS components on the printed circuit boards. These components are especially sensitive to static electricity. To prevent damage to these components, do not touch these components or the circuit boards with metal objects or your bare hands.
3. Only qualified personnel are allowed to install, wire and maintain AC motor drive.

CAUTION!

1. Some parameters settings can cause the motor to run immediately after applying power.
2. DO NOT install the AC motor drive in a place subjected to high temperature, direct sunlight, high humidity, excessive vibration, corrosive gases or liquids, or airborne dust or metallic particles.
3. Only use AC motor drives within specification. Failure to comply may result in fire, explosion or electric shock.
4. To prevent personal injury, please keep children and unqualified people away from the equipment.
5. When the motor cable between AC motor drive and motor is too long, the layer insulation of the motor may be damaged. Please use a frequency inverter duty motor or add an AC output reactor to prevent damage to the motor. Refer to appendix B Reactor for details.
6. The rated voltage for AC motor drive must be ≤ 240V (≤ 480V for 460V models) and the mains supply current capacity must be ≤ 5000A RMS (≤10000A RMS for the ≥ 40hp (30kW) models).

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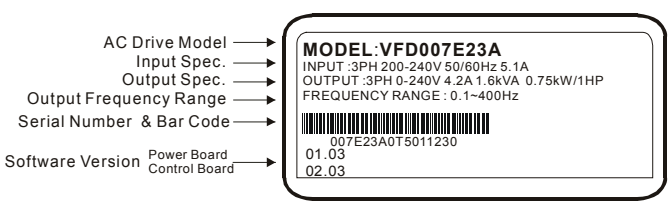
1.1 Receiving and Inspection

This VFD-E AC motor drive has gone through rigorous quality control tests at the factory before shipment. After receiving the AC motor drive, please check for the following:

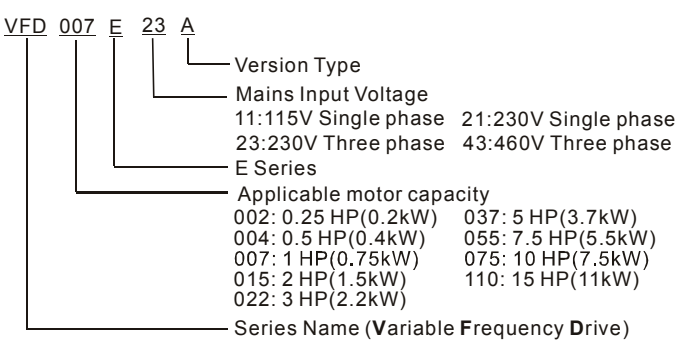
- Check to make sure that the package includes an AC motor drive, the User Manual/Quick Start and CD, dust covers and rubber bushings.
- Inspect the unit to assure it was not damaged during shipment.
- Make sure that the part number indicated on the nameplate corresponds with the part number of your order.

1.1.1 Nameplate Information

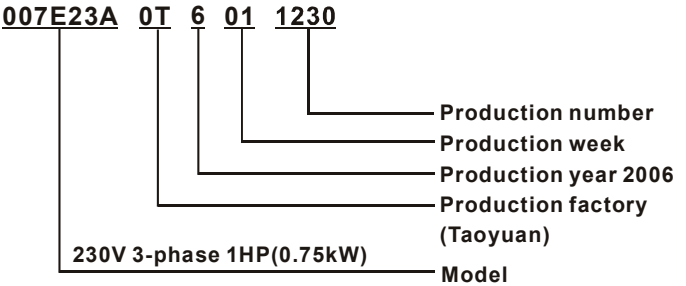
Example for 1HP/0.75kW 3-phase 230V AC motor drive



1.1.2 Model Explanation



1.1.3 Series Number Explanation



If the nameplate information does not correspond to your purchase order or if there are any problems, please contact your distributor.

1.1.4 Drive Frames

Frame	Power range	Models
A	0.25-2hp (0.2-1.5kW)	VFD002E11A/21A/23A, VFD004E11A/21A/23A/43A, VFD007E21A/23A/43A, VFD015E23A/43A
B	1-5hp (0.75-3.7kW)	VFD007E11A, VFD015E21A, VFD022E21A/23A/43A, VFD037E23A/43A
C	7.5-15hp (5.5-11kW)	VFD055E23A/43A, VFD075E23A/43A, VFD110E43A

Please refer to Chapter 2.3 for exact dimensions.

1.2 Appearances

(Refer to chapter 2.3 for exact dimensions)

0.25-2HP/0.2-1.5kW (Frame A)

1-5HP/0.75-3.7kW (Frame B)

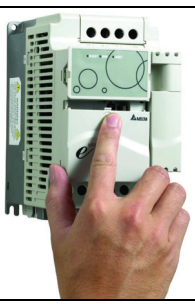
NOTE

Models of frame C (7.5-15HP/5.5-11kW) are under development.

1.3 Preparation for Installation and Wiring

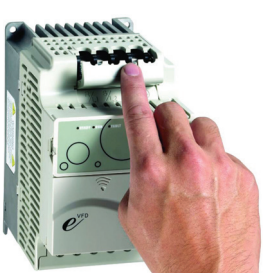
1.3.1 Remove Keypad

1.3.2 Remove Front Cover

Step 1	Step 2
	

1.3.3 Remove RST Terminal Cover

Frame B and Frame C



1.3.4 Remove UVW Terminal Cover

Frame B and Frame C

1.3.5 Remove Fan

1.4 Lifting

Please carry only fully assembled AC motor drives to prevent machine damage.

1.5 Storage

The AC motor drive should be kept in the shipping carton or crate before installation. In order to retain the warranty coverage, the AC motor drive should be stored properly when it is not to be used for an extended period of time. Storage conditions are:

Store in a clean and dry location free from direct sunlight or corrosive fumes.
Store within an ambient temperature range of -20 °C to +60 °C.
Store within a relative humidity range of 0% to 90% and non-condensing environment.
Store within an air pressure range of 86kPa to 106kPa.

CAUTION!

1. DO NOT store in an area with rapid changes in temperature. It may cause condensation and frost.
2. DO NOT place on the ground directly. It should be stored properly. Moreover, if the surrounding environment is humid, you should put exsiccator in the package.
3. If the AC motor drive is stored for more than 3 months, the temperature should not be higher than 30 °C. Storage longer than one year is not recommended, it could result in the degradation of the electrolytic capacitors.
4. When the AC motor drive is not used for longer time after installation on building sites or places with humidity and dust, it's best to move the AC motor drive to an environment as stated above.

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Chapter 2 Installation and Wiring

2.1 Ambient Conditions

Install the AC motor drive in an environment with the following conditions:

Operation	Air Temperature:	-10 ~ +50°C (14 ~ 122°F) -10 ~ +40°C (14 ~ 104°F) for side-by-side mounting
	Relative Humidity:	<90%, no condensation allowed
	Atmosphere pressure:	86 ~ 106 kPa
	Installation Site Altitude:	<1000m
	Vibration:	<20Hz: 9.80 m/s^2 (1G) max 20 ~ 50Hz: 5.88 m/s^2 (0.6G) max
Storage Transportation	Temperature:	-20°C ~ +60°C (-4°F ~ 140°F)
	Relative Humidity:	<90%, no condensation allowed
	Atmosphere pressure:	86 ~ 106 kPa
	Vibration:	<20Hz: 9.80 m/s^2 (1G) max 20 ~ 50Hz: 5.88 m/s^2 (0.6G) max
Pollution Degree	2: good for a factory type environment.	

CAUTION!

1. Operating, storing or transporting the AC motor drive outside these conditions may cause damage to the AC motor drive.
2. Failure to observe these precautions may void the warranty!

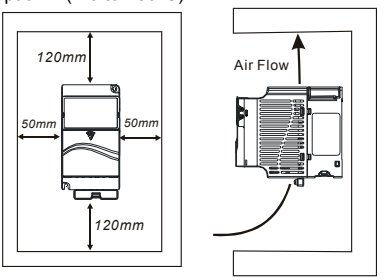
2.2 Installation

1. Mount the AC motor drive vertically on a flat vertical surface object by screws. Other directions are not allowed.
2. The AC motor drive will generate heat during operation. Allow sufficient space around the unit for heat dissipation.
3. The heat sink temperature may rise to 90°C when running. The material on which the AC motor drive is mounted must be noncombustible and be able to withstand this high temperature.
4. When AC motor drive is installed in a confined space (e.g. cabinet), the surrounding temperature must be within 10 ~ 40°C with good ventilation. DO NOT install the AC motor drive in a space with bad ventilation.

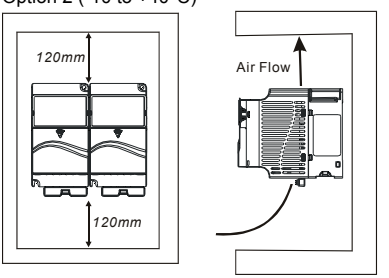
5. When installing multiple AC more drives in the same cabinet, they should be adjacent in a row with enough space. When installing one AC motor drive below another one, use a metal separation between the AC motor drives to prevent mutual heating. Refer to figure below for details.
6. Prevent fiber particles, scraps of paper, saw dust, metal particles, etc. from adhering to the heatsink.

Frame A Mounting Clearances

Option 1 (-10 to +50°C)

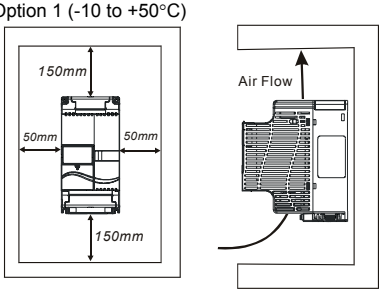


Option 2 (-10 to +40°C)

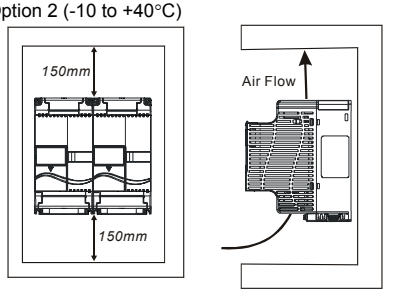


Frame B and C Mounting Clearances

Option 1 (-10 to +50°C)



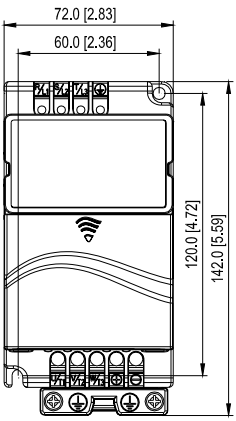
Option 2 (-10 to +40°C)

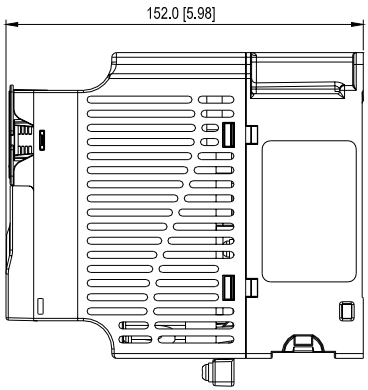


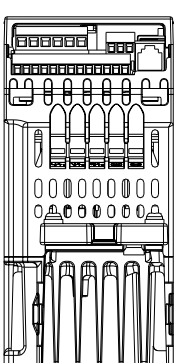
2.3 Dimensions

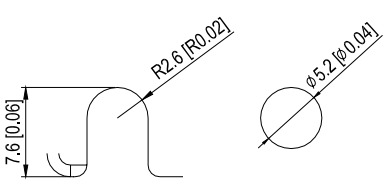
(Dimensions are in millimeter and [inch])

Frame A: VFD002E11A/21A/23A, VFD004E11A/21A/23A/43A VFD007E21A/23A/43A, VFD015E23A/43A

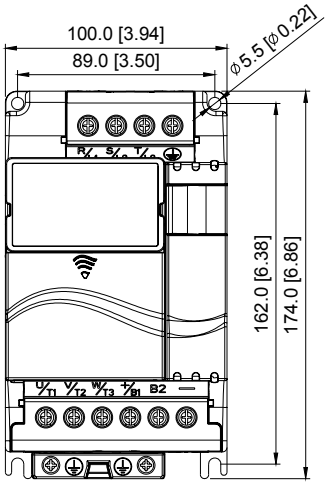


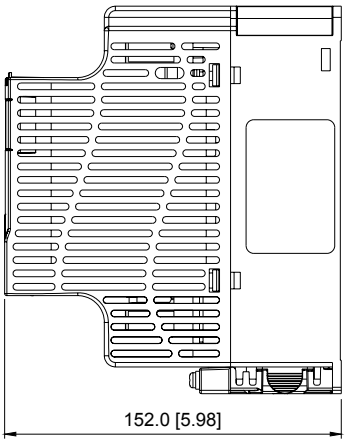


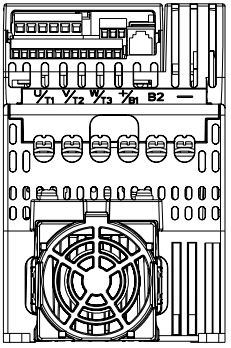


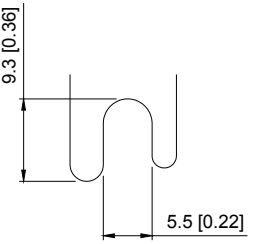


Frame B: VFD007E11A, VFD015E21A, VFD022E21A/23A/43A, VFD037E23A/43A



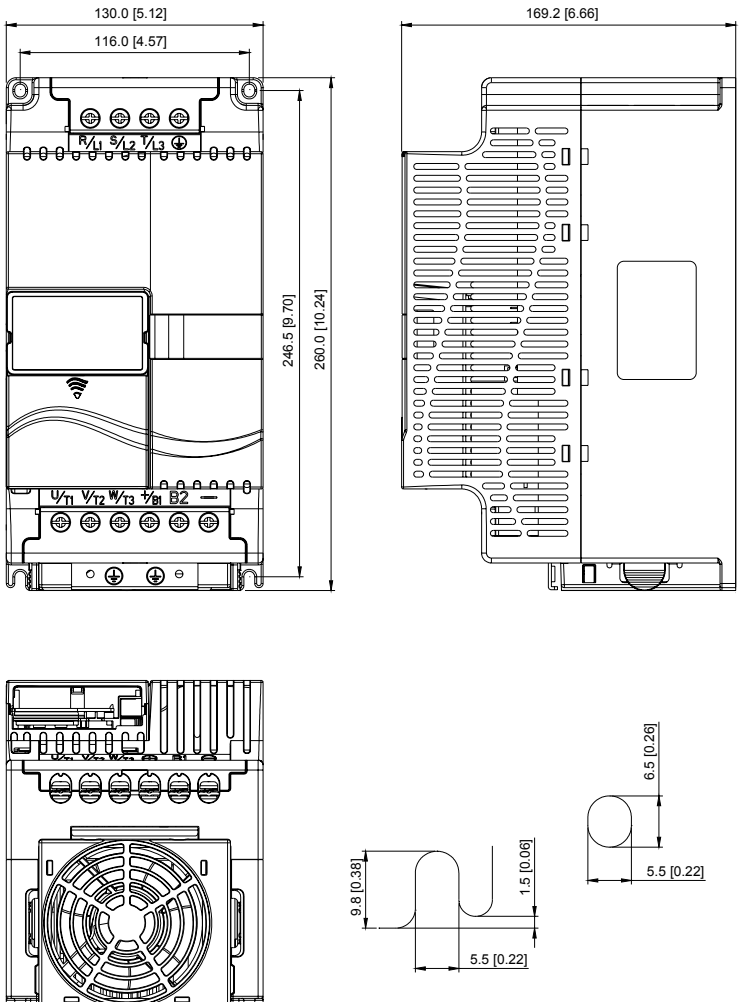






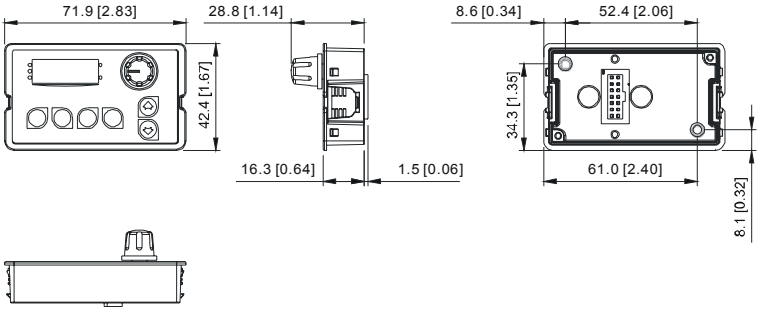
UNIT : mm(inch)

Frame C: VFD055E23A/43A, VFD075E23A/43A, VFD110E43A



Unit: mm [inch]

KPE-LE01



2.4 Wiring

After removing the front cover, check if the power and control terminals are clear. Be sure to observe the following precautions when wiring.

- General Wiring Information

Applicable Codes

All VFD-E series are Underwriters Laboratories, Inc. (UL) and Canadian Underwriters Laboratories (cUL) listed, and therefore comply with the requirements of the National Electrical Code (NEC) and the Canadian Electrical Code (CEC).

Installation intended to meet the UL and cUL requirements must follow the instructions provided in “Wiring Notes” as a minimum standard. Follow all local codes that exceed UL and cUL requirements. Refer to the technical data label affixed to the AC motor drive and the motor nameplate for electrical data.

The "Line Fuse Specification" in Appendix B, lists the recommended fuse part number for each E-Series part number. These fuses (or equivalent) must be used on all installations where compliance with U.L. standards is a required.

2.4.1 Basic Wiring

- Make sure that power is only applied to the R/L1, S/L2, T/L3 terminals. Failure to comply may result in damage to the equipment. The voltage and current should lie within the range as indicated on the nameplate.
- Check following items after finishing the wiring:
  1. Are all connections correct?
  2. No loose wires?
  3. No short-circuits between terminals or to ground?

A charge may still remain in the DC bus capacitors with hazardous voltages even if the power has been turned off. To prevent personal injury, please ensure that the power is turned off and wait ten minutes for the capacitors to discharge to safe voltage levels before opening the AC motor drive.

DANGER!

1. All the units must be grounded directly to a common ground terminal to prevent electric shock, fire and interference.
2. Only qualified personnel familiar with AC motor drives is allowed to perform installation, wiring and commissioning.
3. Make sure that the power is off before doing any wiring to prevent electric shocks.

Basic Wiring Diagrams

Users must connect wires according to the circuit diagrams on the following pages. Do not plug a modem or telephone line to the RS-485 communication port or permanent damage may result. Terminals 1 & 2 are the power supply for the optional copy keypad only and should not be used for RS-485 communication.

Figure 1 for models of VFD-E Series
VFD002E11A/21A/23A, VFD004E11A/21A/23A/43A, VFD007E21A/23A/43A, VFD015E23A/43A

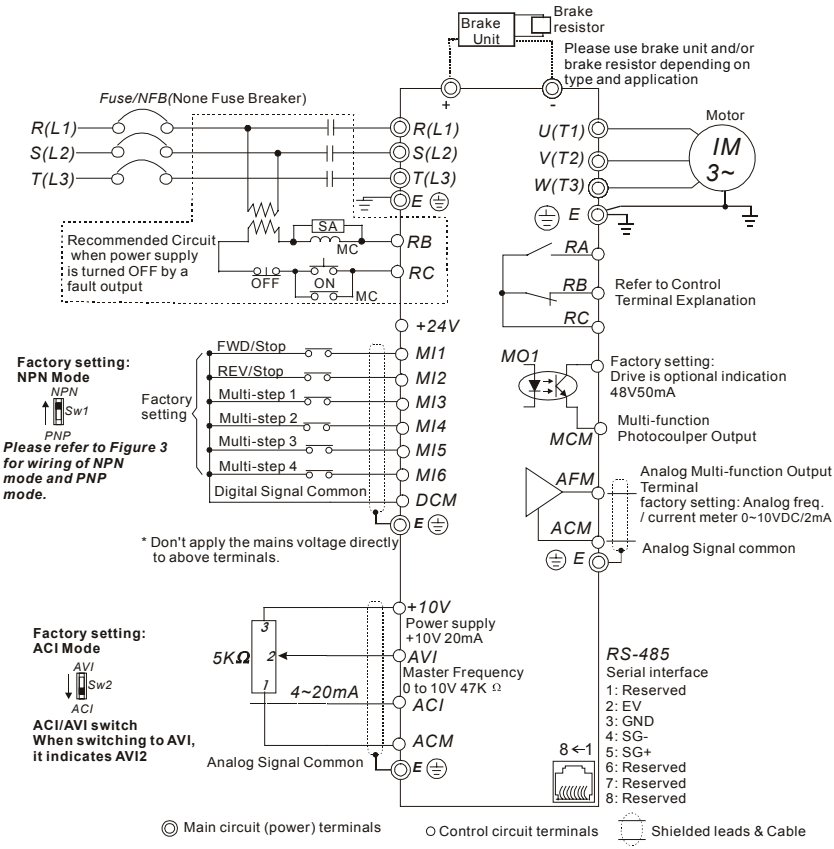


Figure 2 for models of VFD-E Series
VFD007E11A, VFD015E21A, VFD022E21A/23A/43A, VFD037E23A/43A, VFD055E23A/43A, VFD075E23A/43A, VFD110E43A

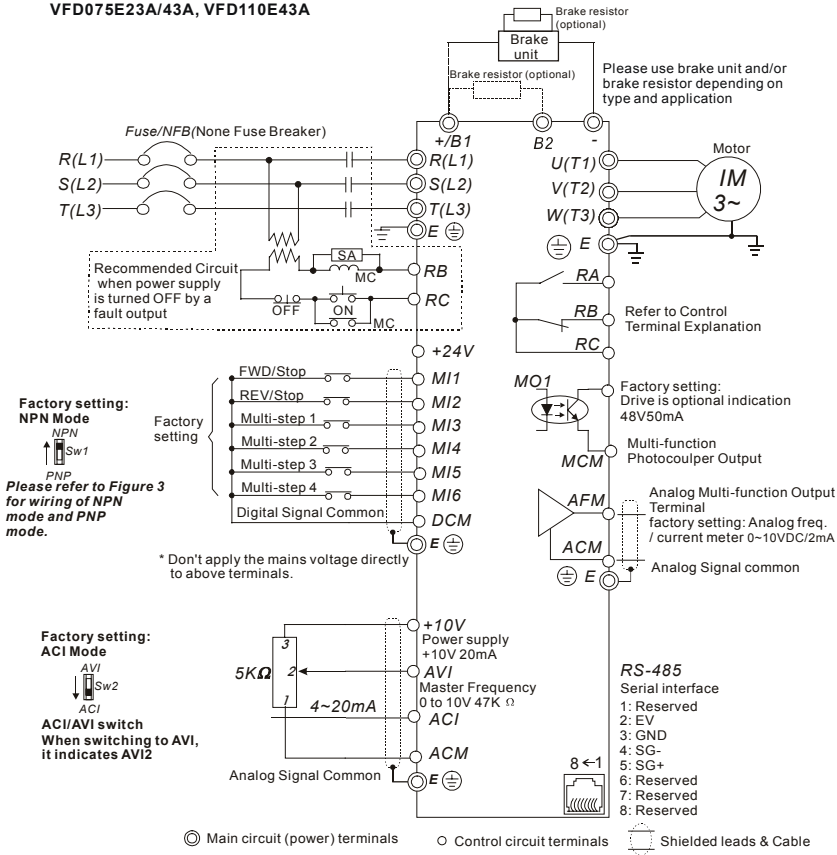
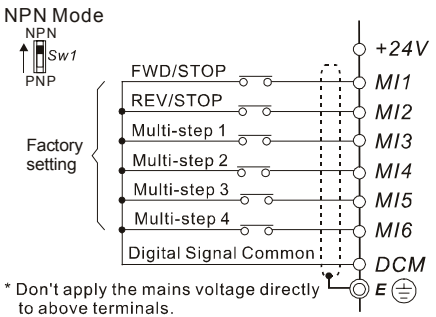
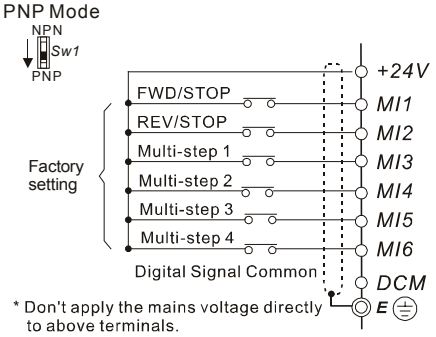
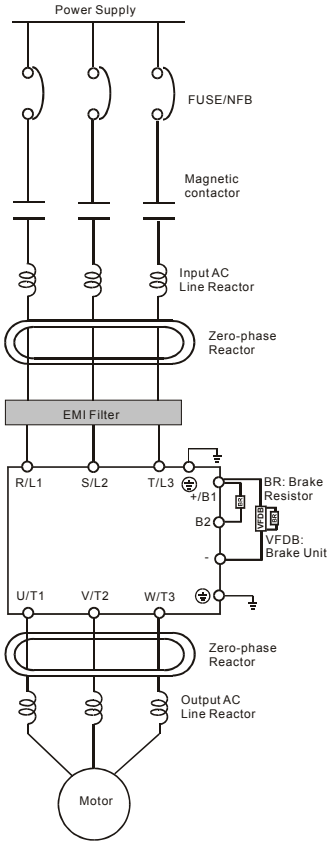


Figure 3 Wiring for NPN mode and PNP mode





2.4.2 External Wiring



Items	Explanations
Power supply	Please follow the specific power supply requirements shown in Appendix A.
Fuse/NFB (Optional)	There may be an inrush current during power up. Please check the chart of Appendix B and select the correct fuse with rated current. Use of an NFB is optional.
Magnetic contactor (Optional)	Please do not use a Magnetic contactor as the I/O switch of the AC motor drive, as it will reduce the operating life cycle of the AC drive.
Input AC Line Reactor (Optional)	Used to improve the input power factor, to reduce harmonics and provide protection from AC line disturbances (surges, switching spikes, short interruptions, etc.). AC line reactor should be installed when the power supply capacity is 500kVA or more and exceeds 6 times the inverter capacity, or the mains wiring distance $\leq$ 10m.
Zero-phase Reactor (Ferrite Core Common Choke) (Optional)	Zero phase reactors are used to reduce radio noise especially when audio equipment is installed near the inverter. Effective for noise reduction on both the input and output sides. Attenuation quality is good for a wide range from AM band to 10MHz. Appendix B specifies the zero phase reactor. (RF220X00A)
EMI filter (Optional)	To reduce electromagnetic interference, please refer to Appendix B for more details.
Brake resistor (Optional)	Used to reduce the deceleration time of the motor. Please refer to the chart in Appendix B for specific brake resistors.
Output AC Line Reactor (Optional)	Motor surge voltage amplitude depends on motor cable length. For applications with long motor cable (>20m), it is necessary to install a reactor at the inverter output side.

2.4.3 Main Terminals Connections

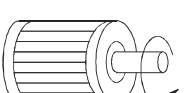
Terminal Symbol	Explanation of Terminal Function
R/L1, S/L2, T/L3	AC line input terminals (1-phase/3-phase)
U/T1, V/T2, W/T3	AC drive output terminals for connecting 3-phase induction motor
+/B1~ B2	Connections for Brake resistor (optional)
+/B1, -	Connections for External Brake unit (BUE series)
⏚	Earth connection, please comply with local regulations.

Mains power terminals (R/L1, S/L2, T/L3)

- Connect these terminals (R/L1, S/L2, T/L3) via a non-fuse breaker or earth leakage breaker to 3-phase AC power (some models to 1-phase AC power) for circuit protection. It is unnecessary to consider phase-sequence.
- It is recommended to add a magnetic contactor (MC) in the power input wiring to cut off power quickly and reduce malfunction when activating the protection function of AC motor drives. Both ends of the MC should have an R-C surge absorber.
- Do NOT run/stop AC motor drives by turning the power ON/OFF. Run/stop AC motor drives by RUN/STOP command via control terminals or keypad. If you still need to run/stop AC drives by turning power ON/OFF, it is recommended to do so only ONCE per hour.
- Do NOT connect 3-phase models to a 1-phase power source.

Control circuit terminals (U/T1, V/T2, W/T3)

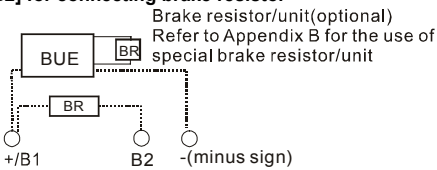
- When the AC drive output terminals U/T1, V/T2, and W/T3 are connected to the motor terminals U/T1, V/T2, and W/T3, respectively, the motor will rotate counterclockwise (as viewed on the shaft end of the motor) when a forward operation command is received. To permanently reverse the direction of motor rotation, switch over any of the two motor leads.



- DO NOT connect phase-compensation capacitors or surge absorbers at the output terminals of AC motor drives.

- With long motor cables, high capacitive switching current peaks can cause over-current, high leakage current or lower current readout accuracy. To prevent this, the motor cable should be less than 20m for 3.7kW models and below. And the cable should be less than 50m for 5.5kW models and above. For longer motor cables use an AC output reactor.
- Use well-insulated motor, suitable for inverter operation.

Terminals [+/B1, B2] for connecting brake resistor



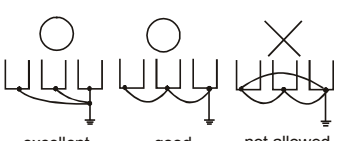
- Connect a brake resistor or brake unit in applications with frequent deceleration ramps, short deceleration time, too low braking torque or requiring increased braking torque.
- If the AC motor drive has a built-in brake chopper (frame B and frame C), connect the external brake resistor to the terminals [+/B1, B2].
- Models of frame A don't have a built-in brake chopper. Please connect an external optional brake unit (BUE-series) and brake resistor. Refer to BUE series user manual for details.
- Connect the terminals [+(P), -(N)] of the brake unit to the AC motor drive terminals [+/B1, -]. The length of wiring should be less than 5m with twisted cable.
- When not used, please leave the terminals [+/B1, -] open.

WARNING!

Short-circuiting [B2] or [-] to [+/B1] can damage the AC motor drive.

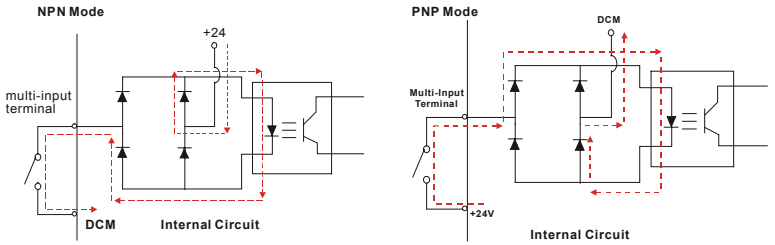
Grounding terminals (⏚)

- Make sure that the leads are connected correctly and the AC drive is properly grounded. (Ground resistance should not exceed 0.1Ω.)
- Use ground leads that comply with local regulations and keep them as short as possible.
- Multiple VFD-E units can be installed in one location. All the units should be grounded directly to a common ground terminal, as shown in the figure below. **Ensure there are no ground loops.**



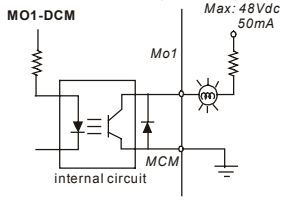
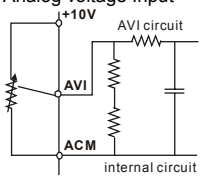
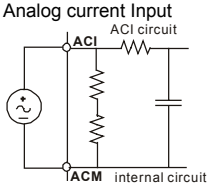
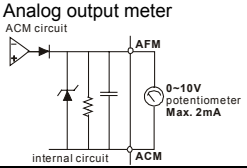
2.4.4 Control Terminals

Circuit diagram for digital inputs (NPN current 16mA.)



Terminal symbols and functions

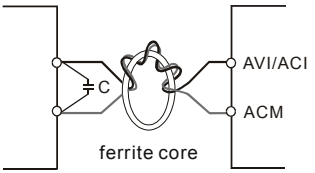
Terminal Symbol	Terminal Function	Factory Settings (NPN mode) ON: Connect to DCM
MI1	Forward-Stop command	ON: Run in MI1 direction OFF: Stop acc. to Stop Method
MI2	Reverse-Stop command	ON: Run in MI2 direction OFF: Stop acc. to Stop Method
MI3	Multi-function Input 3	Refer to Pr.04.05 to Pr.04.08 for programming the Multi-function Inputs. ON: the activation current is 16mA. OFF: leakage current tolerance is 10 μA.
MI4	Multi-function Input 4	
MI5	Multi-function Input 5	
MI6	Multi-function Input 6	
+24V	DC Voltage Source	+24VDC, 20mA used for PNP mode.
DCM	Digital Signal Common	Common for digital inputs and used for NPN mode.
RA	Multi-function Relay output (N.O.) a	Resistive Load: 5A(N.O.)/3A(N.C.) 240VAC 5A(N.O.)/3A(N.C.) 24VDC Inductive Load: 1.5A(N.O.)/0.5A(N.C.) 240VAC 1.5A(N.O.)/0.5A(N.C.) 24VDC Refer to Pr.03.00 for programming
RB	Multi-function Relay output (N.C.) b	
RC	Multi-function Relay common	

Terminal Symbol	Terminal Function	Factory Settings (NPN mode) ON: Connect to DCM
MO1	Multi-function Output 1 (Photocoupler)	Maximum 48VDC, 50mA Refer to Pr.03.01 for programming 
MCM	Multi-function output common	Common for Multi-function Outputs
+10V	Potentiometer power supply	+10VDC 20mA
AVI	Analog voltage Input 	Impedance: 47kΩ Resolution: 10 bits Range: 0 ~ 10VDC = 0 ~ Max. Output Frequency (Pr.01.00) Selection: Pr.02.00, Pr.02.09, Pr.10.00 Set-up: Pr.04.14 ~ Pr.04.17
ACI	Analog current Input 	Impedance: 250Ω Resolution: 10 bits Range: 4 ~ 20mA = 0 ~ Max. Output Frequency (Pr.01.00) Selection: Pr.02.00, Pr.02.09, Pr.10.00 Set-up: Pr.04.18 ~ Pr.04.21
AFM	Analog output meter 	0 to 10V, 2mA Impedance: 20kΩ Output current 2mA max Resolution: 8 bits Range: 0 ~ 10VDC Function: Pr.03.03 to Pr.03.04
ACM	Analog control signal (common)	Common for AVI, ACI, AFM

Control signal wiring size: 18 AWG (0.75 mm^2) with shielded wire.

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 (<20m) with proper grounding. If the noise is inductive, connecting the shield to terminal ACM can bring improvement.
- If the analog input signals are affected by noise from the AC motor drive, please connect a capacitor (0.1 μF and above) and ferrite core as indicated in the following diagrams:



wind each wires 3 times or more around the core

Digital inputs (MI1~MI6, DCM)

- When using contacts or switches to control the digital inputs, please use high quality components to avoid contact bounce.

Digital outputs (MO1, MCM)

- Make sure to connect the digital outputs to the right polarity, see wiring diagrams.
- When connecting a relay to the digital outputs, connect a surge absorber or fly-back diode across the coil and check the polarity.

General

- Keep control wiring as far as possible from the power wiring and in separate conduits to avoid interference. If necessary let them cross only at 90º angle.
- The AC motor drive control wiring should be properly installed and not touch any live power wiring or terminals.

NOTE

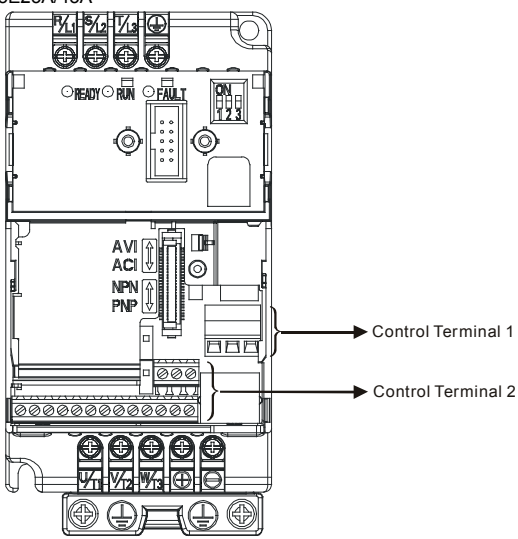
- If a filter is required for reducing EMI (Electro Magnetic Interference), install it as close as possible to AC drive. EMI can also be reduced by lowering the Carrier Frequency.
- When using a GFCI (Ground Fault Circuit Interrupter), select a current sensor with sensitivity of 200mA, and not less than 0.1-second detection time to avoid nuisance tripping.

DANGER!

Damaged insulation of wiring may cause personal injury or damage to circuits/equipment if it comes in contact with high voltage.

2.4.5 Main Circuit Terminals

Frame A: VFD002E11A/21A/23A, VFD004E11A/21A/23A/43A, VFD007E21A/23A/43A, VFD015E23A/43A



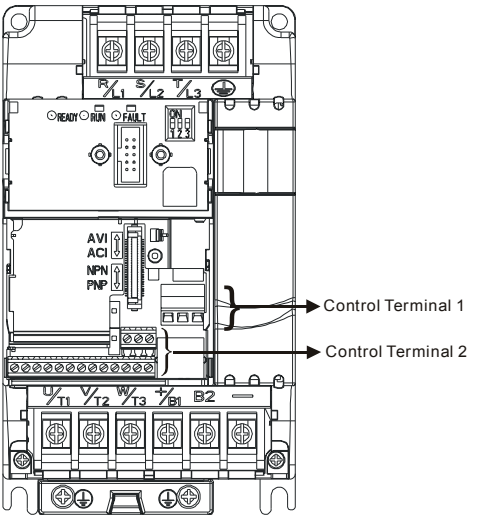
Control Terminal 1:
Torque: 5kgf-cm (4.4 lbf-in)
Wire Gauge: 12-24 AWG (3.3-0.2mm^2)

Control Terminal 2:
Torque: 2kgf-cm (2 lbf-in)
Wire Gauge: 16-24 AWG (1.3-0.2mm^2)

Power Terminal:
Torque: 14 kgf-cm (12 lbf-in)
Wire Gauge: 12-14 AWG (3.3-2.1mm^2)
Wire Type: Copper only, 75^{o}C

Frame B

VFD007E11A, VFD015E21A, VFD022E21A/23A/43A, VFD037E23A/43A



Control Terminal 1:

Torque: 5kgf-cm (4.4 lbf-in)

Wire Gauge: 12-24 AWG (3.3-0.2mm^2)

Control Terminal 2:

Torque: 2kgf-cm (2 lbf-in)

Wire Gauge: 16-24 AWG (1.3-0.2mm^2)

Power Terminal:

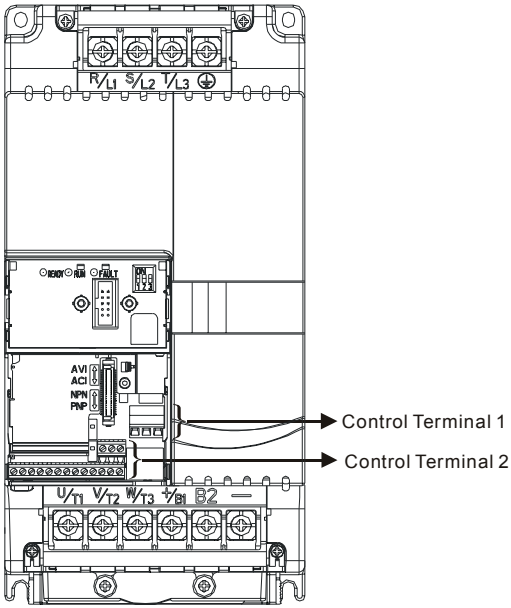
Torque: 18 kgf-cm (15.6 lbf-in)

Wire Gauge: 8-18 AWG (8.4-0.8mm^2)

Wire Type: Copper only, 75^{o}C

Frame C

VFD055E23A/43A, VFD075E23A/43A, VFD110E43A



Control Terminal 1:

Torque: 5kgf-cm (4.4 lbf-in)

Wire Gauge: 12-24 AWG (3.3-0.2mm^2)

Control Terminal 2:

Torque: 2kgf-cm (2 lbf-in)

Wire Gauge: 16-24 AWG (1.3-0.2mm^2)

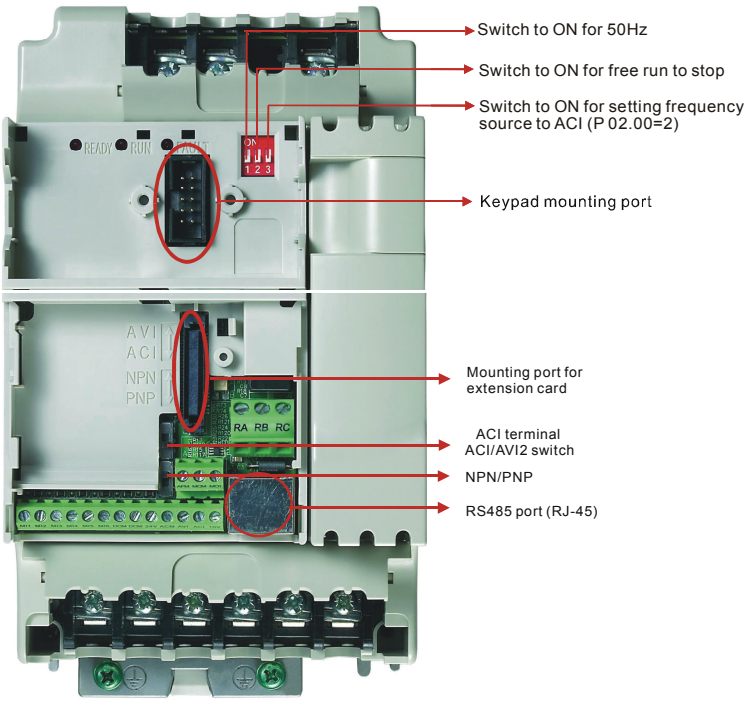
Power Terminal:

Torque: 30 kgf-cm (26 lbf-in)

Wire Gauge: 8-16 AWG (8.4-1.3mm^2)

Wire Type: Copper only, 75^{o}C

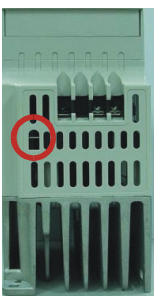
2.5 External Parts



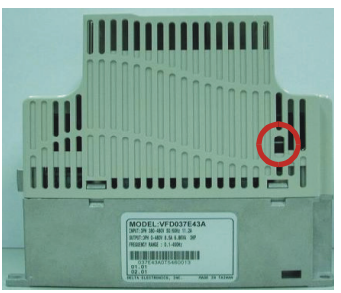
2.6 RFI Short Circuit

Main power isolated from earth:

If the AC motor drive is supplied from an isolated power (IT power), the RFI short circuit must be cut off. Then the RFI capacities (filter capacitors) will be disconnected from ground to prevent circuit damage (according to IEC 61800-3) and reduce earth leakage current. Refer to the following figures for the position of RFI short circuit.



Frame A
(on the top)



Frame B
(at the right side)

CAUTION!

1. After applying power to the AC motor drive, do not cut off the RFI short circuit. Therefore, please make sure that main power has been switched off before cutting the RFI short circuit.
2. The gap discharge may occur when the transient voltage is higher than 1,000V. Besides, electro-magnetic compatibility of the AC motor drives will be lower after cutting the RFI short circuit.
3. Do NOT cut the RFI short circuit when main power is connected to earth.
4. The RFI short circuit cannot be cut when high voltage tests are performed. The mains power and motor must be separated if high voltage test is performed and the leakage currents are too high.

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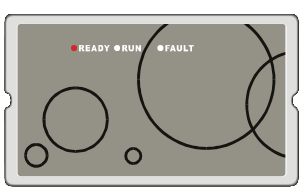
3.1 Preparations before Start-up

Carefully check the following items before proceeding.

- Make sure that the wiring is correct. In particular, check that the output terminals U/T1, V/T2, W/T3 are NOT connected to power and that the drive is well grounded.
- Verify that there are no short-circuits between terminals and from terminals to ground or mains power.
- Check for loose terminals, connectors or screws.
- Verify that no other equipment is connected to the AC motor.
- Make sure that all switches are OFF before applying power to ensure that the AC motor drive doesn't start running and there is no abnormal operation after applying power.
- Make sure that the front cover is well installed before applying power.
- Do NOT operate the AC motor drive with humid hands.
- Check following items after applying power: The display without digital keypad should be as following.



When power is applied, LED "READY" should light up as shown above.

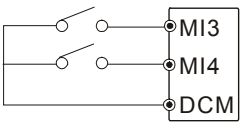
- The display with digital keypad should light up as follows (normal status with no error)

When power is ON, it will display "F 0.0"and LED "STOP" and "FWD" should light up.

- If the drive has built-in fan, it should run. The factory setting of Fan Control Pr.03.11=0 (Fan always on).

3.2 Operation Method

Refer to 4.2 How to operate the digital keypad and chapter 5 parameters for setting. Please choose a suitable method depending on application and operation rule. The operation is usually done as shown in the following table.

<table>
<tr><th>Operation Method</th><th>Frequency Source</th><th>Operation Command Source</th></tr>
<tr><td>Keypad</td><td>  </td><td> 
</td></tr>
<tr><td rowspan="2">Operate from external signal</td><td> 

Parameter setting:
04.05=10
04.06=11</td><td rowspan="2">External terminals input:
MI1-DCM
MI2-DCM</td></tr>
<tr><td>AVI, ACI</td></tr>
</table>

3.3 Trial Run

After finishing checking the items in “3.1 preparation before start-up”, you can perform a trial run. The factory setting of operation source is from external terminal (Pr.02.01=2).

1. After applying power, verify that LED “Ready” is on and both of LED RUN and FAULT is off.
2. Both MI1-DCM and MI2-DCM need to connect a switch.
3. Please connect a potentiometer among AVI, 10V and DCM or apply power 0-10Vdc to AVI-DCM.
4. Setting the potentiometer or 0-10Vdc power to less than 1V.
5. Setting MI1=On for forward running. And if you want to change to reverse running, you should set MI2=On. And if you want to decelerate to stop, please set MI1/MI2=Off.
6. Check following items:
   - ■ *Check if the motor direction of rotation is correct.*
   - ■ *Check if the motor runs steadily without abnormal noise and vibration.*
   - ■ *Check if acceleration and deceleration are smooth.*

If you want to perform a trial run by using digital keypad, please operate by the following steps.

- Connect digital keypad to AC motor drive correctly.
- After applying the power, verify that LED display shows F 0.0Hz.
- Set Pr.02.00=0 and Pr.02.01=0. (Refer to chapter 4 operation flow for detail)
  - Press  key to set frequency to around 5Hz.
  - Press  key for forward running. And if you want to change to reverse running, you should press  in  page. And if you want to decelerate to stop, please press  key.
  - Check following items:
    - *Check if the motor direction of rotation is correct.*
    - *Check if the motor runs steadily without abnormal noise and vibration.*
    - *Check if acceleration and deceleration are smooth.*

If the results of trial run are normal, please start formal run.

1. Please stop running immediately if any fault occurs and refer to troubleshooting for solving the problem.
2. Please do NOT touch output terminals U/T1, V/T2, W/T3 when power is still applied to R/L1, S/L2, T/L3 even when the AC motor drive has stopped. The DC-link capacitors may still be charged to hazardous voltage levels, even if the power has been turned off.
3. To avoid damage to components, do not touch them or the circuit boards with metal objects or your bare hands.

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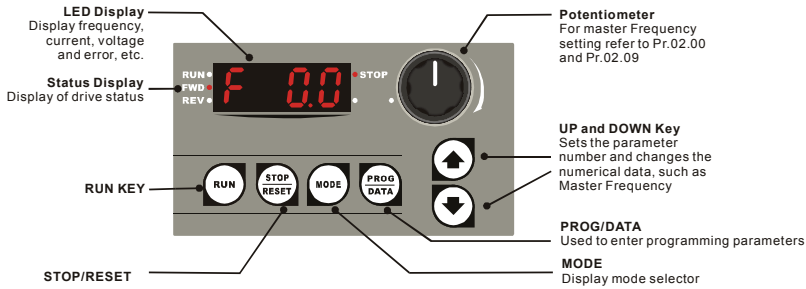
4.1 Description of the Digital Keypad



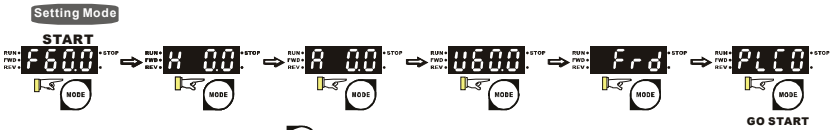
Display Message	Descriptions
	Displays the AC drive Master Frequency.
	Displays the actual output frequency at terminals U/T1, V/T2, and W/T3.
	User defined unit (where U = F x Pr.00.05)
	Displays the output current at terminals U/T1, V/T2, and W/T3.
	Displays the AC motor drive forward run status.
	Displays the AC motor drive reverse run status.
	The counter value (C).
	Displays the selected parameter.
	Displays the actual stored value of the selected parameter.
	External Fault.

Display Message	Descriptions
	Display “End” for approximately 1 second if input has been accepted by pressing PROG DATA key. After a parameter value has been set, the new value is automatically stored in memory. To modify an entry, use the ▲ and ▼ keys.
	Display “Err”, if the input is invalid.

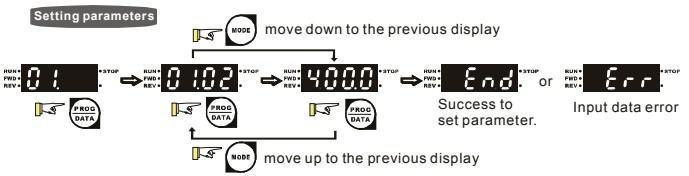
NOTE

When the setting exceeds 99.99 for those numbers with 2 decimals (i.e. unit is 0.01), it will only display 1 decimal due to 4-digital display.

4.2 How to Operate the Digital Keypad

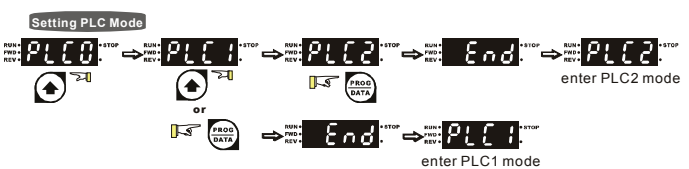


Note： In the selection mode, press PROG DATA to set the parameters.



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

Setting direction (When operation source is digital keypad)



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Chapter 5 Parameters

The VFD-E parameters are divided into 11 groups by property for easy setting. In most applications, the user can finish all parameter settings before start-up without the need for re-adjustment during operation.

The 11 groups are as follows:

Group 0: User Parameters
Group 1: Basic Parameters
Group 2: Operation Method Parameters
Group 3: Output Function Parameters
Group 4: Input Function Parameters
Group 5: Multi-Step Speed Parameters
Group 6: Protection Parameters
Group 7: Motor Parameters
Group 8: Special Parameters
Group 9: Communication Parameters
Group 10: PID Control Parameters
Group 11: Parameters for Extension Card

5.1 Summary of Parameter Settings

↗: The parameter can be set during operation.

Group 0 User Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
00.00	Identity Code of the AC motor drive	Read-only	##	
00.01	Rated Current Display of the AC motor drive	Read-only	#.#	
00.02	Parameter Reset	1: All parameters are read only 6: Clear PLC program 9: All parameters are reset to factory settings (50Hz, 220V/380V) 10: All parameters are reset to factory settings (60Hz, 220V/440V)	0	
↗00.03	Start-up Display Selection	0: Display the frequency command value (Fxxx) 1: Display the actual output frequency (Hxxx) 2: Display the content of user-defined unit (Uxxx) 3: Multifunction display, see Pr.00.04 4: FWD/REV command 5: PLCx (PLC selections: PLC0/PLC1/PLC2)	0	
↗00.04	Content of Multi-function Display	0: Display the content of user-defined unit (Uxxx) 1: Display the counter value (c) 2: Display PLC D1043 value (C) 3: Display DC-BUS voltage (u) 4: Display output voltage (E) 5: Display PID analog feedback signal value (b) (%) 6: Output power factor angle (n) 7: Display output power (P) 8: Display the estimated value of torque as it relates to current (t) 9: Display AVI (I) (%) 10: Display ACI / AVI2 (i) (%) 11: Display the temperature of IGBT (h) (°C)	0	
↗00.05	User-Defined Coefficient K	0. 1 to 160.0	1.0	
00.06	Power Board Software Version	Read-only	#.##	
00.07	Control Board Software Version	Read-only	#.##	
00.08	Password Input	0 to 9999	0	
00.09	Password Set	0 to 9999	0	
00.10	Control Method	0: V/f Control 1: Vector Control	0	

Group 1 Basic Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
01.00	Maximum Output Frequency (Fmax)	50.00 to 600.0 Hz	60.00	
01.01	Maximum Voltage Frequency (Fbase)	0.10 to 600.0 Hz	60.00	
01.02	Maximum Output Voltage (Vmax)	115V/230V series: 0.1V to 255.0V 460V series: 0.1V to 510.0V	220.0 440.0	
01.03	Mid-Point Frequency (Fmid)	0.10 to 600.0 Hz	1.50	
01.04	Mid-Point Voltage (Vmid)	115V/230V series: 0.1V to 255.0V 460V series: 0.1V to 510.0V	10.0 20.0	
01.05	Minimum Output Frequency (Fmin)	0.10 to 600.0 Hz	1.50	
01.06	Minimum Output Voltage (Vmin)	115V/230V series: 0.1V to 255.0V 460V series: 0.1V to 510.0V	10.0 20.0	
01.07	Output Frequency Upper Limit	0.1 to 120.0%	110.0	
01.08	Output Frequency Lower Limit	0.0 to100.0 %	0.0	
✓01.09	Accel Time 1	0.1 to 600.0 / 0.01 to 600.0 sec	10.0	
✓01.10	Decel Time 1	0.1 to 600.0 / 0.01 to 600.0 sec	10.0	
✓01.11	Accel Time 2	0.1 to 600.0 / 0.01 to 600.0 sec	10.0	
✓01.12	Decel Time 2	0.1 to 600.0 / 0.01 to 600.0 sec	10.0	
✓01.13	Jog Acceleration Time	0.1 to 600.0 / 0.01 to 600.0 sec	10.0	
✓01.14	Jog Deceleration Time	0.1 to 600.0 / 0.01 to 600.0 sec	10.0	
✓01.15	Jog Frequency	0.10 Hz to Fmax (Pr.01.00) Hz	6.00	
01.16	Auto acceleration / deceleration (refer to Accel/Decel time setting)	0: Linear Accel/Decel 1: Auto Accel, Linear Decel 2: Linear Accel, Auto Decel 3: Auto Accel/Decel (Set by load) 4: Auto Accel/Decel (set by Accel/Decel Time setting)	0	
01.17	Acceleration S-Curve	0.0 to 10.0 / 0.00 to 10.00 sec	0.0	
01.18	Deceleration S-Curve	0.0 to 10.0 / 0.00 to 10.00 sec	0.0	
01.19	Accel/Decel Time Unit	0: Unit: 0.1 sec 1: Unit: 0.01 sec	0	

Group 2 Operation Method Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
✓02.00	Source of First Master Frequency Command	0: Digital keypad UP/DOWN keys or Multi-function Inputs UP/DOWN. Last used frequency saved. 1: Digital keypad potentiometer 2: 0 to +10V from AVI 3: 4 to 20mA from ACI or 0 to +10V from AVI2 4: RS-485 serial communication (RJ-45).	2	
✓02.01	Source of First Operation Command	0: Digital keypad 1: External terminals. Keypad STOP/RESET enabled. 2: External terminals. Keypad STOP/RESET disabled. 3: RS-485 serial communication (RJ-45). Keypad STOP/RESET enabled. 4: RS-485 serial communication (RJ-45). Keypad STOP/RESET disabled.	2	
02.02	Stop Method	0: STOP: ramp to stop; E.F.: coast to stop 1: STOP: coast to stop; E.F.: coast to stop 2: STOP: ramp to stop; E.F.: ramp to stop 3: STOP: coast to stop; E.F.: ramp to stop	0	
02.03	PWM Carrier Frequency Selections	1 to 15kHz	8	
02.04	Motor Direction Control	0: Enable forward/reverse operation 1: Disable reverse operation 2: Disabled forward operation	0	
02.05	Line Start Lockout	0: Disable. Operation status is not changed even if operation command source Pr.02.01 is changed. 1: Enable. Operation status is not changed even if operation command source Pr.02.01 is changed. 2: Disable. Operation status will change if operation command source Pr.02.01 is changed. 3: Enable. Operation status will change if operation command source Pr.02.01 is changed.	1	
02.06	Loss of ACI Signal (4-20mA)	0: Decelerate to 0 Hz 1: Coast to stop and display “AErr” 2: Continue operation by last frequency command	0	
02.07	Up/Down Mode	0: by UP/DOWN Key 1: Based on accel/decel time 2: Constant speed 3: Pulse input unit	0	

Parameter	Explanation	Settings	Factory Setting	Customer
02.08	Accel/Decel Rate of Change of UP/DOWN Operation with Constant Speed	0.01~10.00 Hz	0.01	
✓02.09	Source of Second Frequency Command	0: Digital keypad UP/DOWN keys or Multi-function Inputs UP/DOWN. Last used frequency saved. 1: Digital keypad potentiometer 2: 0 to +10V from AVI 3: 4 to 20mA from ACI or 0 to +10V from AVI2 4: RS-485 serial communication (RJ-45).	0	
✓02.10	Combination of the First and Second Master Frequency Command	0: First Master Frequency Command 1: First Master Frequency Command+ Second Master Frequency Command 2: First Master Frequency Command - Second Master Frequency Command	0	
✓02.11	Keyboard Frequency Command	0.00 to 600.0Hz	60.00	
✓02.12	Communication Frequency Command	0.00 to 600.0Hz	60.00	
02.13	The Selections for Saving Keypad or Communication Frequency Command	0: Save Keypad & Communication Frequency 1: Save Keypad Frequency only 2: Save Communication Frequency only	0	
02.14	Frequency Command Selections at Stop (for Keypad and Communication)	0: by Current Freq Command 1: by Zero Freq Command 2: by Frequency Display at Stop	0	
02.15	Frequency Display at Stop	0.00 ~ 600.0Hz	60.00	
02.16	Display the Master Freq Command Source	Read Only	##	
02.17	Display the Operation Command Source	Read Only	##	

Group 3 Output Function Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
03.00	Multi-function Output Relay (RA1, RB1, RC1)	0: No function 1: AC drive operational 2: Master frequency attained 3: Zero speed	8	

Parameter	Explanation	Settings	Factory Setting	Customer
03.01	Multi-function Output Terminal MO1	4: Over torque detection 5: Base-Block (B.B.) indication 6: Low-voltage indication 7: Operation mode indication 8: Fault indication 9: Desired frequency attained 10: Terminal count value attained 11: Preliminary count value attained 12: Over Voltage Stall supervision 13: Over Current Stall supervision 14: Heat sink overheat warning 15: Over Voltage supervision 16: PID supervision 17: Forward command 18: Reverse command 19: Zero speed output signal 20: Warning(FbE,Cexx, AoL2, AUE, SAvE) 21: Brake control (Desired frequency attained)	1	
03.02	Desired Frequency Attained	0.00 to 600.0Hz	0.00	
✓03.03	Analog Output Signal	0: Analog frequency meter 1: Analog current meter	0	
✓03.04	Analog Output Gain	1 to 200%	100	
03.05	Terminal Count Value	0 to 9999	0	
03.06	Preliminary Count Value	0 to 9999	0	
03.07	EF Active When Preliminary Count Value Attained	0: Preliminary count value attained, no EF display 1: Preliminary count value attained, EF active	0	
03.08	Fan Control	0: Fan always ON 1: 1 minute after AC motor drive stops, fan will be OFF 2: Fan ON when AC motor drive runs, fan OFF when AC motor drive stops 3: Fan ON when preliminary heatsink temperature attained	0	
03.09	The Digital Output Used by PLC	Read only Bit0=1:RLY used by PLC Bit1=1:MO1 used by PLC Bit2=1:MO2/RA2 used by PLC Bit3=1:MO3/RA3 used by PLC Bit4=1:MO4/RA4 used by PLC Bit5=1:MO5/RA5 used by PLC Bit6=1:MO6/RA6 used by PLC Bit7=1:MO7/RA7 used by PLC	##	
03.10	The Analog Output Used by PLC	Read only Bit0=1:AFM used by PLC	##	

Parameter	Explanation	Settings	Factory Setting	Customer
03.11	Brake Release Frequency	0.00 to 20.00Hz	0.00	
03.12	Brake Engage Frequency	0.00 to 20.00Hz	0.00	
03.13	Display the Status of Multi-function Output Terminals	Read only Bit0: RLY Status Bit1: MO1 Status Bit2: MO2/RA2 Status Bit3: MO3/RA3 Status Bit4: MO4/RA4 Status Bit5: MO5/RA5 Status Bit6: MO6/RA6 Status Bit7: MO7/RA7 Status	##	

Group 4 Input Function Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
↗04.00	Keypad Potentiometer Bias	0.0 to 100.0 %	0.0	
↗04.01	Keypad Potentiometer Bias Polarity	0: Positive bias 1: Negative bias	00	
↗04.02	Keypad Potentiometer Gain	0.1 to 200.0 %	100.0	
04.03	Keypad Potentiometer Negative Bias, Reverse Motion Enable/Disable	0: No negative bias command 1: Negative bias: REV motion enabled	0	
04.04	2-wire/3-wire Operation Control Modes	0: 2-wire: FWD/STOP, REV/STOP 1: 2-wire: FWD/REV, RUN/STOP 2: 3-wire operation	0	
04.05	Multi-function Input Terminal (MI3)	0: No function 1: Multi-Step speed command 1 2: Multi-Step speed command 2	1	
04.06	Multi-function Input Terminal (MI4)	3: Multi-Step speed command 3 4: Multi-Step speed command 4 5: External reset	2	
04.07	Multi-function Input Terminal (MI5)	6: Accel/Decel inhibit 7: Accel/Decel time selection command 8: Jog Operation	3	
04.08	Multi-function Input Terminal (MI6)	9: External base block 10: Up: Increment master frequency 11: Down: Decrement master frequency 12: Counter Trigger Signal 13: Counter reset 14: E.F. External Fault Input	4	

Parameter	Explanation	Settings	Factory Setting	Customer
		15: PID function disabled 16: Output shutoff stop 17: Parameter lock enable 18: Operation command selection (external terminals) 19: Operation command selection(keypad) 20: Operation command selection(communication) 21: FWD/REV command 22: Source of second frequency command 23: Run/Stop PLC Program		
04.09	Multi-function Input Contact Selection	Bit0:MI1 Bit1:MI2 Bit2:MI3 Bit3:MI4 Bit4:MI5 Bit5:MI6 Bit6:MI7 Bit7:MI8 Bit8:MI9 Bit9:MI10 Bit10:MI11 Bit11:MI12 0:N.O., 1:N.C. P.S.:MI1 to MI3 will be invalid when it is 3-wire control.	0	
04.10	Digital Terminal Input Debouncing Time	1 to 20 (*2ms)	1	
04.11	Min AVI Voltage	0.0 to 10.0V	0.0	
04.12	Min AVI Frequency	0.0 to 100.0%	0.0	
04.13	Max AVI Voltage	0.0 to 10.0V	10.0	
04.14	Max AVI Frequency	0.0 to 100.0%	100.0	
04.15	Min ACI Voltage	0.0 to 20.0mA	4.0	
04.16	Min ACI Frequency	0.0 to 100.0%	0.0	
04.17	Min ACI Voltage	0.0 to 20.0mA	20.0	
04.18	Max ACI Frequency	0.0 to 100.0%	100.0	
04.19	ACI/AVI2 Selection	0: ACI 1: AVI2	0	
04.20	Min AVI2 Voltage	0.0 to 10.0V	0.0	
04.21	Min AVI2 Frequency	0.0 to 100.0%	0.0	
04.22	Max AVI2 Voltage	0.0 to 10.0V	10.0	
04.23	Max AVI2 Frequency	0.0 to 100.0%	100.0	

Parameter	Explanation	Settings	Factory Setting	Customer
04.24	The Digital Input Used by PLC	Read only. Bit0=1:MI1 used by PLC Bit1=1:MI2 used by PLC Bit2=1:MI3 used by PLC Bit3=1:MI4 used by PLC Bit4=1:MI5 used by PLC Bit5=1:MI6 used by PLC Bit6=1: MI7 used by PLC Bit7=1: MI8 used by PLC Bit8=1: MI9 used by PLC Bit9=1: MI10 used by PLC Bit10=1: MI11 used by PLC Bit11=1: MI12 used by PLC	##	
04.25	The Analog Input Used by PLC	Read only. Bit0=1:AVI used by PLC Bit1=1:ACI/AVI2 used by PLC	##	
04.26	Display the Status of Multi-function Input Terminal	Read only. Bit0: MI1 Status Bit1: MI2 Status Bit2: MI3 Status Bit3: MI4 Status Bit4: MI5 Status Bit5: MI6 Status Bit6: MI7 Status Bit7: MI8 Status Bit8: MI9 Status Bit9: MI10 Status Bit10: MI11 Status Bit11: MI12 Status	##	
04.27	Internal/External Multi-function Input Terminals Selection	0~4095	0	
04.28	Internal Terminal Status	0~4095	0	

Group 5 Multi-Step Speed and PLC Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
✓05.00	1st Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✓05.01	2nd Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✓05.02	3rd Step Speed Frequency	0.00 to 600.0 Hz	0.00	

Parameter	Explanation	Settings	Factory Setting	Customer
✗05.03	4th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.04	5th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.05	6th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.06	7th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.07	8th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.08	9th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.09	10th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.10	11th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.11	12th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.12	13th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.13	14th Step Speed Frequency	0.00 to 600.0 Hz	0.00	
✗05.14	15th Step Speed Frequency	0.00 to 600.0 Hz	0.00	

Group 6 Protection Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
06.00	Over-Voltage Stall Prevention	115/230V series: 330.0V to 410.0V 460V series: 660.0V to 820.0V 0.0: Disable over-voltage stall prevention	390.0V 780.0V	
06.01	Over-Current Stall Prevention during Accel	20 to 250%	170	
06.02	Over-Current Stall Prevention during Operation	20 to 250%	170	
06.03	Over-Torque Detection Mode (OL2)	0: Disabled 1: Enabled during constant speed operation. After the over-torque is detected, keep running until OL1 or OL occurs. 2: Enabled during constant speed operation. After the over-torque is detected, stop running. 3: Enabled during accel. After the over-torque is detected, keep running until OL1 or OL occurs. 4: Enabled during accel. After the over-torque is detected, stop running.	0	

Parameter	Explanation	Settings	Factory Setting	Customer
06.04	Over-Torque Detection Level	10 to 200%	150	
06.05	Over-Torque Detection Time	0.1 to 60.0 sec	0.1	
06.06	Electronic Thermal Overload Relay Selection	0: Special motor (forced external cooling) 1: Standard motor (self cooled by fan) 2: Disabled	2	
06.07	Electronic Thermal Characteristic	30 to 600 sec	60	
06.08	Present Fault Record	0: No fault 1: Over current (oc) 2: Over voltage (ov) 3: IGBT Overheat (oH1) 4: Power Board Overheat (oH2) 5: Overload (oL) 6: Overload1 (oL1) 7: Motor over load (oL2)	0	
06.09	Second Most Recent Fault Record	8: External fault (EF) 9: Current exceeds 2 times rated current during accel.(ocA) 10: Current exceeds 2 times rated current during decel.(ocd) 11: Current exceeds 2 times rated current during steady state operation (ocn) 12: Ground fault (GFF) 13: Reserved 14: Phase-Loss (PHL) 15: Reserved 16: Auto Acel/Decel failure (CFA)		
06.10	Third Most Recent Fault Record	17: SW/Password protection (codE) 18: Power Board CPU WRITE failure (cF1.0) 19: Power Board CPU READ failure (cF2.0) 20: CC, OC Hardware protection failure (HPF1)		
06.11	Fourth Most Recent Fault Record	21: OV Hardware protection failure (HPF2) 22: GFF Hardware protection failure (HPF3) 23: OC Hardware protection failure (HPF4)		
06.12	Fifth Most Recent Fault Record	24: U-phase error (cF3.0) 25: V-phase error (cF3.1) 26: W-phase error (cF3.2) 27: DCBUS error (cF3.3) 28: IGBT Overheat (cF3.4) 29: Power Board Overheat (cF3.5)		

Parameter	Explanation	Settings	Factory Setting	Customer
		30: Control Board CPU WRITE failure (cF1.1) 31: Control Board CPU WRITE failure (cF2.1) 32: ACI signal error (AErr) 33: Reserved 34: Motor PTC overheat protection (PtC1)		

Group 7 Motor Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
∕07.00	Motor Rated Current	30 %FLA to 120% FLA	100	
∕07.01	Motor No-Load Current	0%FLA to 99% FLA	40	
∕07.02	Torque Compensation	0.0 to 10.0	0.0	
∕07.03	Slip Compensation (Used without PG)	0.00 to 10.00	0.00	
07.04	Motor Parameters Auto Tuning	0: Disable 1: Auto tuning R1 2: Auto tuning R1 + no-load test	0	
07.05	Motor Line-to-line Resistance R1	0~65535 mΩ	0	
07.06	Motor Rated Slip	0.00 to 20.00 Hz	3.00	
07.07	Slip Compensation Limit	0 to 250%	200	
07.08	Torque Compensation Time Constant	0.01 ~10.00 Sec	0.10	
07.09	Slip Compensation Time Constant	0.05 ~10.00 sec	0.20	
07.10	Accumulative Motor Operation Time (Min.)	0 to 1439 Min.	0	
07.11	Accumulative Motor Operation Time (Day)	0 to 65535 Day	0	
07.12	Motor PTC Overheat Protection	0: Disable 1: Enable	0	
07.13	Input Debouncing Time of the PTC Protection	0~9999(*2ms)	100	
07.14	Motor PTC Overheat Protection Level	0.1~10.0V	2.4	
07.15	Motor PTC Overheat Warning Level	0.1~10.0V	1.2	
07.16	Motor PTC Overheat Reset Delta Level	0.1~5.0V	0.6	

Parameter	Explanation	Settings	Factory Setting	Customer
07.17	Treatment of the Motor PTC Overheat	0: Warn and RAMP to stop 1: Warn and COAST to stop 2: Warn and keep running	0	

Group 8 Special Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
08.00	DC Braking Current Level	0 to 100%	0	
08.01	DC Braking Time during Start-Up	0.0 to 60.0 sec	0.0	
08.02	DC Braking Time during Stopping	0.0 to 60.0 sec	0.0	
08.03	Start-Point for DC Braking	0.00 to 600.0Hz	0.00	
08.04	Momentary Power Loss Operation Selection	0: Operation stops after momentary power loss 1: Operation continues after momentary power loss, speed search starts with the Master Frequency reference value 2: Operation continues after momentary power loss, speed search starts with the minimum frequency	0	
08.05	Maximum Allowable Power Loss Time	0.1 to 5.0 sec	2.0	
08.06	Base-block Speed Search	0: Disable speed search 1: Speed search starts with last frequency command 2: Starts with minimum output frequency	1	
08.07	B.B. Time for Speed Search	0.1 to 5.0 sec	0.5	
08.08	Current Limit for Speed Search	30 to 200%	150	
08.09	Skip Frequency 1 Upper Limit	0.00 to 600.0 Hz	0.00	
08.10	Skip Frequency 1 Lower Limit	0.00 to 600.0 Hz	0.00	
08.11	Skip Frequency 2 Upper Limit	0.00 to 600.0 Hz	0.00	
08.12	Skip Frequency 2 Lower Limit	0.00 to 600.0 Hz	0.00	
08.13	Skip Frequency 3 Upper Limit	0.00 to 600.0 Hz	0.00	
08.14	Skip Frequency 3 Lower Limit	0.00 to 600.0 Hz	0.00	
08.15	Auto Restart After Fault	0 to 10 (0=disable)	0	
08.16	Auto Reset Time at Restart after Fault	0.1 to 6000 sec	60.0	

Parameter	Explanation	Settings	Factory Setting	Customer
08.17	Auto Energy Saving	0: Disable 1: Enable	0	
08.18	AVR Function	0: AVR function enable 1: AVR function disable 2: AVR function disable for decel. 3: AVR function disable for stop	0	
08.19	Software Braking Level	115V / 230V series: 370.0to 430.0V 460V series: 740.0 to 860.0V	380.0 760.0	
08.20	Compensation Coefficient for Motor Instability	0.0~5.0	0.0	

Group 9 Communication Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
09.00	Communication Address	1 to 254	1	
09.01	Transmission Speed	0: Baud rate 4800bps 1: Baud rate 9600bps 2: Baud rate 19200bps 3: Baud rate 38400bps	1	
09.02	Transmission Fault Treatment	0: Warn and keep operating 1: Warn and ramp to stop 2: Warn and coast to stop 3: No warning and keep operating	3	
09.03	Communication Protocol	0: 7,N,2 (Modbus, ASCII) 1: 7,E,1 (Modbus, ASCII) 2: 7,O,1 (Modbus, ASCII) 3: 8,N,2 (Modbus, RTU) 4: 8,E,1 (Modbus, RTU) 5: 8,O,1 (Modbus, RTU)	0	
09.04	Response Delay Time	0 ~ 200 msec	0	
09.05	Time-out Detection	0.1 ~ 120.0 seconds 0.0: Disable	0.0	
09.06	Reserved			
09.07	Reserved			

Group 10 PID Control Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
10.00	PID Set Point Selection	0: Disable PID operation 1: Keypad (based on Pr.02.00) 2: 0 to +10V from AVI 3: 4 to 20mA from ACI or 0 to +10V from AVI2 4: PID set point (Pr.10.11)	0	
10.01	Input Terminal for PID Feedback	0: **Positive** PID feedback from external terminal AVI (0 ~ +10VDC) 1: **Negative** PID feedback from external terminal AVI (0 ~ +10VDC) 2: **Positive** PID feedback from external terminal ACI (4 ~ 20mA)/ AVI2 (0 ~ +10VDC). 3: **Negative** PID feedback from external terminal ACI (4 ~ 20mA)/ AVI2 (0 ~ +10VDC).	0	
✓10.02	Proportional Gain (P)	0.0 to 10.0	1.0	
✓10.03	Integral Gain (I)	0.00 to 100.0 sec (0.00=disable)	1.00	
✓10.04	Derivative Control (D)	0.00 to 1.00 sec	0.00	
10.05	Upper Bound for Integral Control	0 to 100%	100	
10.06	Primary Delay Filter Time	0.0 to 2.5 sec	0.0	
10.07	PID Output Freq Limit	0 to 110%	100	
10.08	PID Feedback Signal Detection Time	0.0 to 3600 sec (0.0 disable)	60.0	
✓10.09	Treatment of the Erroneous PID Feedback Signals	0: Warn and RAMP to stop 1: Warn and COAST to stop 2: Warn and keep operation	0	
10.10	Gain Over the PID Detection Value	0.0 to 10.0	1.0	
✓10.11	Source of PID Set point	0.00 to 600.0Hz	0.00	
10.12	PID Offset Level	1.0 to 50.0%	10.0	
10.13	Detection Time of PID Offset	0.1 to 300.0 sec	5.0	
10.14	Sleep/Wake Up Detection Time	0.0 to 6550 sec	0.0	
10.15	Sleep Frequency	0.00 to 600.0 Hz	0.00	
10.16	Wakeup Frequency	0.00 to 600.0 Hz	0.00	

Parameter	Explanation	Settings	Factory Setting	Customer
10.17	Minimum PID Output Frequency Selection	0: By PID control 1: By minimum output frequency (Pr.01.05)	0	

Group 11 Parameters for Extension Card

Parameter	Explanation	Settings	Factory Setting	Customer
11.00	Multi-function Output Terminal MO2/RA2	0: No function 1: AC drive operational 2: Master frequency attained 3: Zero speed 4: Over torque detection 5: Base-Block (B.B.) indication 6: Low-voltage indication 7: Operation mode indication 8: Fault indication 9: Desired frequency attained 10: Terminal count value attained 11: Preliminary count value attained 12: Over Voltage Stall supervision 13: Over Current Stall supervision 14: Heat sink overheat warning 15: Over Voltage supervision 16: PID supervision 17: Forward command 18: Reverse command 19: Zero speed output signal 20: Warning(FbE,Cexx, AoL2, AUE, SAvE) 21: Brake control (Desired frequency attained)	0	
11.01	Multi-function Output Terminal MO3/RA3		0	
11.02	Multi-function Output Terminal MO4/RA4		0	
11.03	Multi-function Output Terminal MO5/RA5		0	
11.04	Multi-function Output Terminal MO6/RA6		0	
11.05	Multi-function Output Terminal MO7/RA7		0	
11.06	Multi-function Input Terminal (MI7)	0: No function 1: Multi-Step speed command 1 2: Multi-Step speed command 2 3: Multi-Step speed command 3 4: Multi-Step speed command 4 5: External reset 6: Accel/Decel inhibit 7: Accel/Decel time selection command 8: Jog Operation 9: External base block 10: Up: Increment master frequency 11: Down: Decrement master frequency	0	
11.07	Multi-function Input Terminal (MI8)		0	
11.08	Multi-function Input Terminal (MI9)		0	
11.09	Multi-function Input Terminal (MI10)		0	

Parameter	Explanation	Settings	Factory Setting	Customer
11.10	Multi-function Input Terminal (MI11)	12: Counter Trigger Signal 13: Counter reset 14: E.F. External Fault Input 15: PID function disabled 16: Output shutoff stop 17: Parameter lock enable	0	
11.11	Multi-function Input Terminal (MI12)	18: Operation command selection (external terminals) 19: Operation command selection (keypad) 20: Operation command selection (communication) 21: FWD/REV command 22: Source of second frequency command 23: Run/Stop PLC Program	0	

5.2 Parameter Settings for Applications

■ **Speed Search**

Applications	Purpose	Functions	Related Parameters
Windmill, winding machine, fan and all inertia loads	Restart free-running motor	Before the free-running motor is completely stopped, it can be restarted without detection of motor speed. The AC motor drive will auto search motor speed and will accelerate when its speed is the same as the motor speed.	08.04~08.08

■ **DC Braking before Running**

Applications	Purpose	Functions	Related Parameters
When e.g. windmills, fans and pumps rotate freely by wind or flow without applying power	Keep the free-running motor at standstill.	If the running direction of the free-running motor is not steady, please execute DC braking before start-up.	08.00 08.01

■ **Energy Saving**

Applications	Purpose	Functions	Related Parameters
Punching machines fans, pumps and precision machinery	Energy saving and less vibrations	Energy saving when the AC motor drive runs at constant speed, yet full power acceleration and deceleration For precision machinery it also helps to lower vibrations.	08.17

■ **Multi-step Operation**

Applications	Purpose	Functions	Related Parameters
Conveying machinery	Cyclic operation by multi-step speeds.	To control 15-step speeds and duration by simple contact signals.	04.05~04.08 05.00~05.14

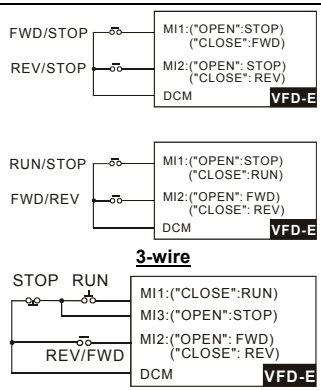
■ **Switching acceleration and deceleration times**

Applications	Purpose	Functions	Related Parameters
Auto turntable for conveying machinery	Switching acceleration and deceleration times by external signal	When an AC motor drive drives two or more motors, it can reach high-speed but still start and stop smoothly.	01.09~01.12 04.05~04.08

■ **Overheat Warning**

Applications	Purpose	Functions	Related Parameters
Air conditioner	Safety measure	When AC motor drive overheats, it uses a thermal sensor to have overheat warning.	03.00~03.01 04.05~04.08

■ **Two-wire/three-wire**

Applications	Purpose	Functions	Related Parameters
General application	To run, stop, forward and reverse by external terminals		02.00 02.09 04.04

■ **Operation Command**

Applications	Purpose	Functions	Related Parameters
General application	Selecting the source of control signal	Selection of AC motor drive control by external terminals, digital keypad or RS485.	02.01 04.05~04.08

■ **Frequency Hold**

Applications	Purpose	Functions	Related Parameters
General application	Acceleration/ deceleration pause	Hold output frequency during Acceleration/deceleration	04.05~04.08

■ **Auto Restart after Fault**

Applications	Purpose	Functions	Related Parameters
Air conditioners, remote pumps	For continuous and reliable operation without operator intervention	The AC motor drive can be restarted/reset automatically up to 10 times after a fault occurs.	08.15~08.16

■ **Emergency Stop by DC Braking**

Applications	Purpose	Functions	Related Parameters
High-speed rotors	Emergency stop without brake resistor	AC motor drive can use DC braking for emergency stop when quick stop is needed without brake resistor. When used often, take motor cooling into consideration.	08.00 08.02 08.03

■ **Over-torque Setting**

Applications	Purpose	Functions	Related Parameters
Pumps, fans and extruders	To protect machines and to have continuous/ reliable operation	The over-torque detection level can be set. Once OC stall, OV stall and over-torque occurs, the output frequency will be adjusted automatically. It is suitable for machines like fans and pumps that require continuous operation.	06.00~06.05

■ **Upper/Lower Limit Frequency**

Applications	Purpose	Functions	Related Parameters
Pump and fan	Control the motor speed within upper/lower limit	When user cannot provide upper/lower limit, gain or bias from external signal, it can be set individually in AC motor drive.	01.07 01.08

■ **Skip Frequency Setting**

Applications	Purpose	Functions	Related Parameters
Pumps and fans	To prevent machine vibrations	The AC motor drive cannot run at constant speed in the skip frequency range. Three skip frequency ranges can be set.	08.09~08.14

■ **Carrier Frequency Setting**

Applications	Purpose	Functions	Related Parameters
General application	Low noise	The carrier frequency can be increased when required to reduce motor noise.	02.03

■ **Keep Running when Frequency Command is Lost**

Applications	Purpose	Functions	Related Parameters
Air conditioners	For continuous operation	When the frequency command is lost by system malfunction, the AC motor drive can still run. Suitable for intelligent air conditioners.	02.06

■ **Output Signal during Running**

Applications	Purpose	Functions	Related Parameters
General application	Provide a signal for running status	Signal available to stop braking (brake release) when the AC motor drive is running. (This signal will disappear when the AC motor drive is free-running.)	03.00~03.01

■ **Output Signal in Zero Speed**

Applications	Purpose	Functions	Related Parameters
General application	Provide a signal for running status	When the output frequency is lower than the min. output frequency, a signal is given for external system or control wiring.	03.00~03.01

■ **Output Signal at Desired Frequency**

Applications	Purpose	Functions	Related Parameters
General application	Provide a signal for running status	When the output frequency is at the desired frequency (by frequency command), a signal is given for external system or control wiring (frequency attained).	03.00~03.01

■ **Output Signal for Base Block**

Applications	Purpose	Functions	Related Parameters
General application	Provide a signal for running status	When executing Base Block, a signal is given for external system or control wiring.	03.00~03.01

■ **Overheat Warning for Heat Sink**

Applications	Purpose	Functions	Related Parameters
General application	For safety	When heat sink is overheated, it will send a signal for external system or control wiring.	03.00~03.01

■ **Multi-function Analog Output**

Applications	Purpose	Functions	Related Parameters
General application	Display running status	The value of frequency, output current/voltage can be read by connecting a frequency meter or voltage/current meter.	03.06

5.3 Description of Parameter Settings

Group 0: User Parameters **✓This parameter can be set during operation.**

00.00 Identity Code of the AC motor drive

Settings Read Only Factory setting: ##

00.01 Rated Current Display of the AC motor drive

Settings Read Only Factory setting: #.#

📖 Pr. 00.00 displays the identity code of the AC motor drive. The capacity, rated current, rated voltage and the max. carrier frequency relate to the identity code. Users can use the following table to check how the rated current, rated voltage and max. carrier frequency of the AC motor drive correspond to the identity code.

📖 Pr.00.01 displays the rated current of the AC motor drive. By reading this parameter the user can check if the AC motor drive is correct.

00.02 Parameter Reset

Factory Setting: 0

Settings	1	All parameters are read-only
	6	Clear PLC program
	9	All parameters are reset to factory settings (50Hz, 115V/220V/380V)
	10	All parameters are reset to factory settings (60Hz, 115V/220V/440V)

📖 This parameter allows the user to reset all parameters to the factory settings except the fault records (Pr.06.08 ~ Pr.06.12).

50Hz: Pr.01.00 and Pr.01.01 are set to 50Hz and Pr.01.02 is set to 115V, 230V or 400V.

60Hz: Pr.01.00 and Pr.01.01 are set to 60Hz and Pr.01.02 is set to 115V, 230V or 460V.

📖 When Pr.00.02=1, all parameters are read-only. To write all parameters, set Pr.00.02=0.

00.03 ✓Start-up Display Selection

Factory Setting: 0

Settings	0	Display the frequency command value (Fxxx)	
	1	Display the actual output frequency (Hxxx)	
	2	Display the output current in A supplied to the motor (Axxx)	

3	Display the content of user-defined unit (Uxxx)	
4	FWD/REV command	
5	PLCx (PLC selections: PLC0/PLC1/PLC2)	

- This parameter determines the start-up display page after power is applied to the drive.
- For setting 5, PLC0: disable, PLC1: run PLC, PLC2: read/write PLC programs into AC motor drive.

00.04 Content of Multi-function Display

Factory Setting: 0

Settings	0	Display the content of user-defined unit (Uxxx)	
	1	Display the counter value which counts the number of pulses on TRG terminal	
	2	Display PLC D1043 value (C)	
	3	Display the actual DC BUS voltage in VDC of the AC motor drive	
	4	Display the output voltage in VAC of terminals U/T1, V/T2, W/T3 to the motor.	
	5	Display PID analog feedback signal value in %	
	6	Display the power factor angle in º of terminals U/T1, V/T2, W/T3 to the motor	
	7	Display the output power in kW of terminals U, V and W to the motor.	
	8	Display the estimated value of torque in Nm as it relates to current.	
	9	Display the signal of AVI analog input terminal in %. Range 0~10V corresponds to 0~100%.	
	10	Display the signal of ACI analog input terminal in % (Range 4~20mA corresponds to 0~100%) or display the signal of AVI2 analog input terminal in %. (Range 0~10V corresponds to 0~100%)	
	11	Display the temperature of IGBT (h) in ˚C	

00.05	✓User Defined Coefficient K	Unit: 0. 1
	Settings 0. 1 to d 160.0	Factory Setting: 1.0

The coefficient K determines the multiplying factor for the user-defined unit.

The display value is calculated as follows:

U (User-defined unit) = Actual output frequency * K (Pr.00.05)

Example:

A conveyor belt runs at 13.6m/s at motor speed 60Hz.

K = 13.6/60 = 0.22 (0.226667 rounded to 1 decimal), therefore Pr.00.05=0.2

With Frequency command 35Hz, display shows U and 35*0.2=7.0m/s.

(To increase accuracy, use K=2.2 or K=22.7 and disregard decimal point.)

00.06	Power Board Software Version
	Settings Read Only
	Display #.##

00.07	Control Board Software Version
	Settings Read Only
	Display #.##

00.08	Password Input	Unit: 1
	Settings 0 to 9999	Factory Setting: 0
	Display 0~2 (times of wrong password)	

The function of this parameter is to input the password that is set in Pr.00.09. Input the correct password here to enable changing parameters. You are limited to a maximum of 3 attempts. After 3 consecutive failed attempts, a blinking “codE” will show up to force the user to restart the AC motor drive in order to try again to input the correct password.

00.09	Password Set		Unit: 1
	Settings	0 to 9999	Factory Setting: 0
	Display	0	No password set or successful input in Pr. 00.08
		1	Password has been set

📖 To set a password to protect your parameter settings.

If the display shows 0, no password is set or password has been correctly entered in Pr.00.08.

All parameters can then be changed, including Pr.00.09.

The first time you can set a password directly. After successful setting of password the display will show 1.

Be sure to record the password for later use.

To cancel the parameter lock, set the parameter to 0 after inputting correct password into Pr. 00.08.

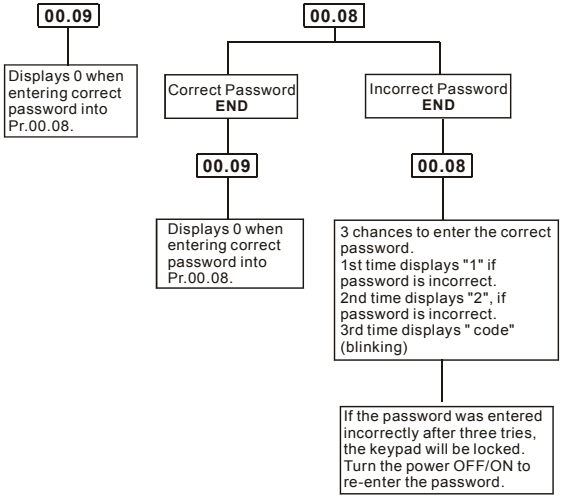
The password consists of min. 1 digits and max. 4 digits.

📖 How to make the password valid again after decoding by Pr.00.08:

Method 1: Re-input original password into Pr.00.09 (Or you can enter a new password if you want to use a changed or new one).

Method 2: After rebooting, password function will be recovered.

Password Decode Flow Chart



00.10	Control method	
		Factory Setting: 0
Settings	0	V/f control
	1	Vector Control

📖 This parameter determines the control method of the AC motor drive.

Group 1: Basic Parameters

01.00	Maximum Output Frequency (Fmax)	Unit: 0.01
Settings	50.00 to 600.0 Hz	Factory Setting: 60.00

This parameter determines the AC motor drive's Maximum Output Frequency. All the AC motor drive frequency command sources (analog inputs 0 to +10V and 4 to 20mA) are scaled to correspond to the output frequency range.

01.01	Maximum Voltage Frequency (Fbase)	Unit: 0.01
Settings	0.10 to 600.0Hz	Factory Setting: 60.00

This value should be set according to the rated frequency of the motor as indicated on the motor nameplate. Maximum Voltage Frequency determines the v/f curve ratio. For example, if the drive is rated for 460 VAC output and the Maximum Voltage Frequency is set to 60Hz, the drive will maintain a constant ratio of 7.66 V/Hz (460V/60Hz=7.66V/Hz). This parameter value must be equal to or greater than the Mid-Point Frequency (Pr.01.03).

01.02	Maximum Output Voltage (Vmax)		Unit: 0.1
Settings	115V/230V series	0.1 to 255.0V	Factory Setting: 220.0
	460V series	0.1 to 510.0V	Factory Setting: 440.0

This parameter determines the Maximum Output Voltage of the AC motor drive. The Maximum Output Voltage setting must be smaller than or equal to the rated voltage of the motor as indicated on the motor nameplate. This parameter value must be equal to or greater than the Mid-Point Voltage (Pr.01.04).

01.03	Mid-Point Frequency (Fmid)	Unit: 0.01
Settings	0.10 to 600.0Hz	Factory Setting: 1.50

This parameter sets the Mid-Point Frequency of the V/f curve. With this setting, the V/f ratio between Minimum Frequency and Mid-Point frequency can be determined. This parameter must be equal to or greater than Minimum Output Frequency (Pr.01.05) and equal to or less than Maximum Voltage Frequency (Pr.01.01).

01.04	Mid-Point Voltage (Vmid)		Unit: 0.1
Settings	115V/230V series	0.1 to 255.0V	Factory Setting: 10.0
	460V series	0.1 to 510.0V	Factory Setting: 20.0

This parameter sets the Mid-Point Voltage of any V/f curve. With this setting, the V/f ratio between Minimum Frequency and Mid-Point Frequency can be determined. This parameter must be equal to or greater than Minimum Output Voltage (Pr.01.06) and equal to or less than Maximum Output Voltage (Pr.01.02).

01.05	Minimum Output Frequency (Fmin)	Unit: 0.01
	Settings 0.10 to 600.0Hz	Factory Setting: 1.50

This parameter sets the Minimum Output Frequency of the AC motor drive. This parameter must be equal to or less than Mid-Point Frequency (Pr.01.03).

The settings of 01.03, 01.04, and 01.06 are invalid in Vector Control mode.

01.06	Minimum Output Voltage (Vmin)		Unit: 0.1
	Settings 115V/230V series	0.1 to 255.0V	Factory Setting: 10.0
	460V series	0.1 to 510.0V	Factory Setting: 20.0

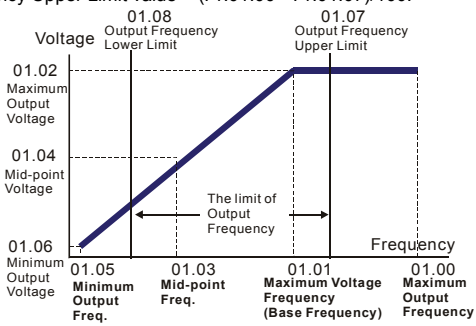
This parameter sets the Minimum Output Voltage of the AC motor drive. This parameter must be equal to or less than Mid-Point Voltage (Pr.01.04).

The settings of Pr.01.01 to Pr.01.06 have to meet the condition of Pr.01.02 ≥ Pr.01.04 ≥ Pr.01.06 and Pr.01.01 ≥ Pr.01.03 ≥ Pr.01.05.

01.07	Output Frequency Upper Limit	Unit: 0.1
	Settings 0.1 to 120.0%	Factory Setting: 110.0

This parameter must be equal to or greater than the Output Frequency Lower Limit (Pr.01.08). The Maximum Output Frequency (Pr.01.00) is regarded as 100%.

Output Frequency Upper Limit value = (Pr.01.00 * Pr.01.07)/100.



V/f Curve

01.08	Output Frequency Lower Limit	Unit: 0.1
	Settings 0.0 to 100.0%	Factory Setting: 0.0

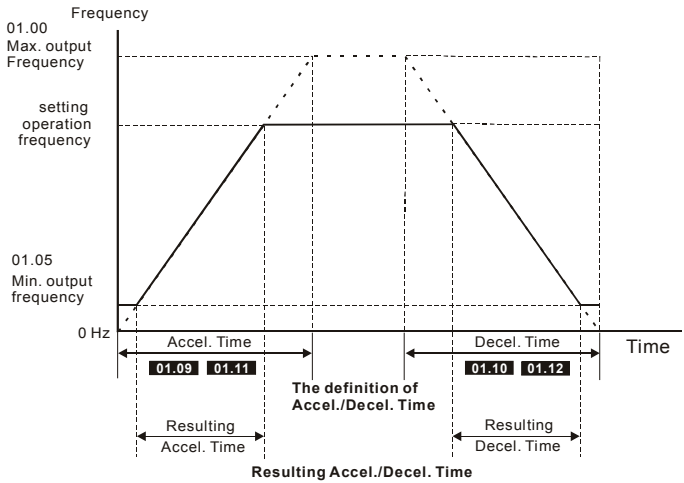
- The Upper/Lower Limits are to prevent operation errors and machine damage.
- If the Output Frequency Upper Limit is 50Hz and the Maximum Output Frequency is 60Hz, the Output Frequency will be limited to 50Hz.
- If the Output Frequency Lower Limit is 10Hz, and the Minimum Output Frequency (Pr.01.05) is set to 1.0Hz, then any Command Frequency between 1.0-10Hz will generate a 10Hz output from the drive.
- This parameter must be equal to or less than the Output Frequency Upper Limit (Pr.01.07).
- The Output Frequency Lower Limit value = (Pr.01.00 * Pr.01.08) /100.

01.09	↗Acceleration Time 1 (Taccel 1)	Unit: 0.1/0.01
01.10	↗Deceleration Time 1 (Tdecel 1)	Unit: 0.1/0.01
01.11	↗Acceleration Time 2 (Taccel 2)	Unit: 0.1/0.01
01.12	↗Deceleration Time 2 (Tdecel 2)	Unit: 0.1/0.01
	Settings 0.1 to 600.0 sec / 0.01 to 600.0 sec	Factory Setting: 10.0

01.19	Accel/Decel Time Unit	
		Factory Setting: 0
	Settings 0	Unit: 0.1 sec
	1	Unit: 0.01 sec

- The Acceleration Time is used to determine the time required for the AC motor drive to ramp from 0 Hz to Maximum Output Frequency (Pr.01.00). The rate is linear unless S-Curve is "Enabled"; see Pr.01.17.
- The Deceleration Time is used to determine the time required for the AC motor drive to decelerate from the Maximum Output Frequency (Pr.01.00) down to 0 Hz. The rate is linear unless S-Curve is "Enabled.", see Pr.01.18.
- The Acceleration/Deceleration Time 1, 2, 3, 4 are selected according to the Multi-function Input Terminals Settings. See Pr.04.05 to Pr.04.08 for more details.
- In the diagram shown below, the Acceleration/Deceleration Time of the AC motor drive is the time between 0 Hz to Maximum Output Frequency (Pr.01.00). Suppose the Maximum Output Frequency is 60 Hz, Minimum Output Frequency (Pr.01.05) is 1.0 Hz, and Acceleration/Deceleration Time is 10 seconds. The actual time for the AC motor drive to

accelerate from start-up to 60 Hz and to decelerate from 60Hz to 1.0Hz is in this case 9.83 seconds. ((60-1) * 10/60=9.83secs).

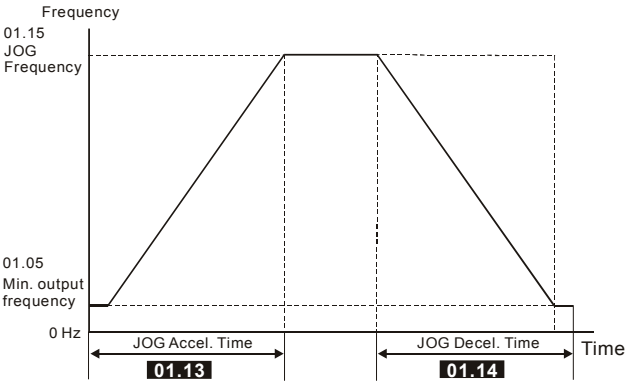


Resulting Accel./Decel. Time

01.13	↗Jog Acceleration Time		Unit: 0.1/0.01
	Settings	0.1 to 600.0/0.01 to 600.0 sec	Factory Setting: 10.0
01.14	↗Jog Deceleration Time		Unit: 0.1/0.01
	Settings	0.1 to 600.0/0.01 to 600.0 sec	Factory Setting: 10.0
01.15	↗Jog Frequency		Unit: 0.01
	Settings	0.10 to Fmax (Pr.01.00)Hz	Factory Setting: 6.00

🕮 Only external terminal JOG (MI3 to MI9)can be used. When the Jog command is “ON”, the AC motor drive will accelerate from Minimum Output Frequency (Pr.01.05) to Jog Frequency (Pr.01.15). When the Jog command is “OFF”, the AC motor drive will decelerate from Jog Frequency to zero. The used Accel/Decel time is set by the Jog Accel/Decel time (Pr.01.13, Pr.01.14).

🕮 Before using the JOG command, the drive must be stopped first. And during Jog operation, other operation commands are not accepted, except commands via the FORWARD, REVERSE and STOP keys on the digital keypad.



The definition of JOG Accel./Decel. Time

01.16 Auto-Acceleration / Deceleration

Factory Setting: 0

Settings	0	Linear acceleration / deceleration
	1	Auto acceleration, linear Deceleration.
	2	Linear acceleration, auto Deceleration.
	3	Auto acceleration / deceleration (set by load)
	4	Auto acceleration / deceleration (set by Accel/Decel Time setting)

- With Auto acceleration / deceleration it is possible to reduce vibration and shocks during starting/stopping the load.

  During Auto acceleration the torque is automatically measured and the drive will accelerate to the set frequency with the fastest acceleration time and the smoothest starting current.

  During Auto deceleration, regenerative energy is measured and the motor is smoothly stopped with the fastest deceleration time.

  But when this parameter is set to 04, the actual accel/decel time will be equal to or more than parameter Pr.01.09 ~Pr.01.12.
- Auto acceleration/deceleration makes the complicated processes of tuning unnecessary. It makes operation efficient and saves energy by acceleration without stall and deceleration without brake resistor.
- In applications with brake resistor or brake unit, Auto deceleration shall not be used.

01.17	Acceleration S-Curve	Unit: 0.1/0.01
01.18	Deceleration S-Curve	Unit: 0.1/0.01

Factory Setting: 0

Settings	0.0	S-curve disabled
	0.1 to 10.0/0.01 to 10.00	S-curve enabled (10.0/10.00 is the smoothest)

This parameter is used to ensure smooth acceleration and deceleration via S-curve.

The S-curve is disabled when set to 0.0 and enabled when set to 0.1 to 10.0/0.01 to 10.00.

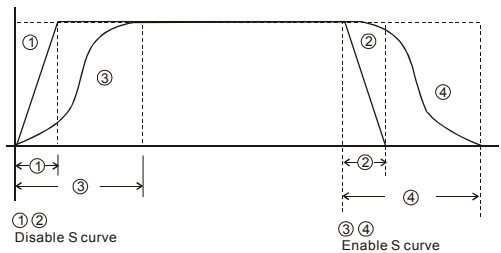
Setting 0.1/0.01 gives the quickest and setting 10.0/10.00 the longest and smoothest S-curve.

The AC motor drive will not follow the Accel/Decel Times in Pr.01.09 to Pr.01.12.

The diagram below shows that the original setting of the Accel/Decel Time is only for reference when the S-curve is enabled. The actual Accel/Decel Time depends on the selected S-curve (0.1 to 10.0).

The total Accel. Time=Pr.01.09 + Pr.01.17 or Pr.01.11 + Pr.01.17

The total Decel. Time=Pr.01.10 + Pr.01.18 or Pr.01.12 + Pr.01.18



Acceleration/deceleration Characteristics

Group 2: Operation Method Parameters

02.00 ✓ Source of First Master Frequency Command

Factory Setting: 2

02.09 ✓ Source of Second Master Frequency Command

Factory Setting: 0

Settings	0	Digital keypad UP/DOWN keys or Multi-function Inputs UP/DOWN. Last used frequency saved. (Digital keypad is optional)
	1	Potentiometer on digital keypad (Digital keypad is optional)
	2	AVI 0 ~ +10VDC
	3	ACI 4 ~ 20mA / AVI2 0 ~ +10VDC
	4	RS-485 serial communication (RJ-45).

- These parameters set the Master Frequency Command Source of the AC motor drive.
- The factory setting for master frequency command is 2. (digital keypad is optional.)
- Setting 3: use the ACI/AVI switch on the AC motor drive to select ACI or AVI2. When setting to AVI, AVI2 is indicated.
- When the AC motor drive is controlled by external terminal, please refer to Pr.02.05 for details.
- The first /second frequency/operation command is enabled/disabled by Multi Function Input Terminals. Please refer to Pr.04.05 ~ 04.08.

02.01 ✓ Source of First Operation Command

Factory Setting: 2

Settings	0	Digital keypad (Digital keypad is optional)
	1	External terminals. Keypad STOP/RESET enabled.
	2	External terminals. Keypad STOP/RESET disabled.
	3	RS-485 serial communication (RJ-45). Keypad STOP/RESET enabled.
	4	RS-485 serial communication (RJ-45). Keypad STOP/RESET disabled.

- The factory setting for source og first operation command is 2. (digital keypad is optional.)
- When the AC motor drive is controlled by external terminal, please refer to Pr.02.05/Pr.04.04 for details.

02.10	✓Combination of the First and Second Master Frequency Command

Factory Setting: 0

Settings	0	First Master Frequency Command Only
	1	First Master Frequency + Second Master Frequency
	2	First Master Frequency - Second Master Frequency

02.02	Stop Method

Factory Setting: 0

Settings	0	STOP: ramp to stop	E.F.: coast to stop
	1	STOP: coast to stop	E.F.: coast to stop
	2	STOP: ramp to stop	E.F.: ramp to stop
	3	STOP: coast to stop	E.F.: ramp to stop

🕮 The parameter determines how the motor is stopped when the AC motor drive receives a valid stop command or detects External Fault.

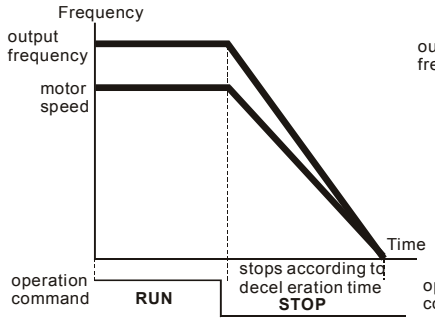
Ramp: the AC motor drive decelerates to Minimum Output Frequency (Pr.01.05) according to the deceleration time and then stops.

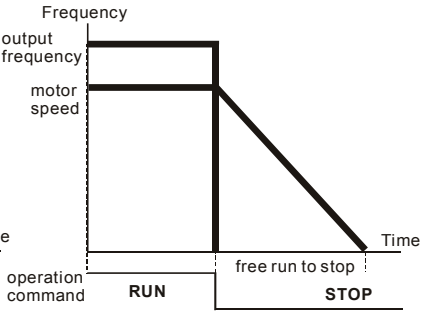
Coast: the AC motor drive stops the output instantly upon command, and the motor free runs until it comes to a complete standstill.

The motor stop method is usually determined by the characteristics of the motor load and how frequently it is stopped.

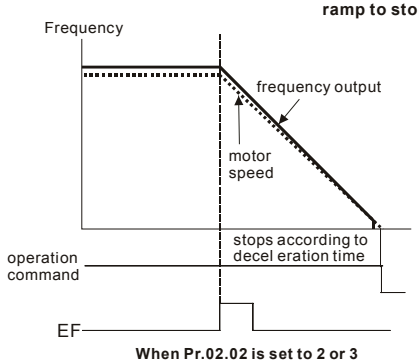
(1) It is recommended to use “ramp to stop” for safety of personnel or to prevent material from being wasted in applications where the motor has to stop after the drive is stopped. The deceleration time has to be set accordingly.

(2) If motor free running is allowed or the load inertia is large, it is recommended to select “coast to stop”. For example: blowers, punching machines, centrifuges and pumps.

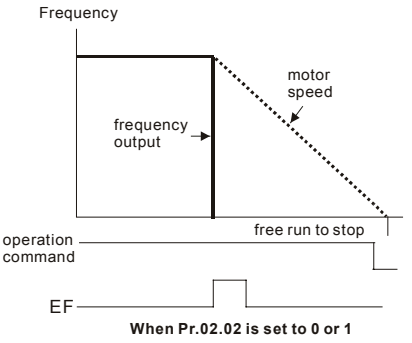




ramp to stop and free run to stop



When Pr.02.02 is set to 2 or 3



When Pr.02.02 is set to 0 or 1

02.03	PWM Carrier Frequency Selections	Unit: 1

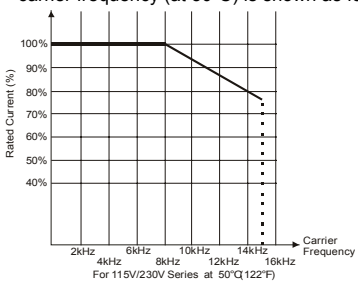
115V/230V/460V Series	
Power	0.25 to 15hp (0.2kW to 11kW)
Setting Range	1 to 15 kHz
Factory Setting	8 kHz

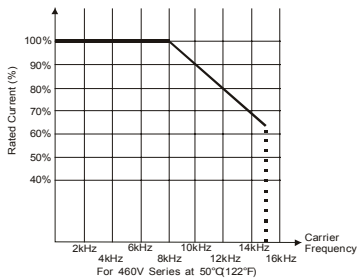
🕮 This parameter determines the PWM carrier frequency of the AC motor drive.

Carrier Frequency	Acoustic Noise	Electromagnetic Noise or leakage current	Heat Dissipation	Current Wave
1kHz	Significant	Minimal	Minimal	Minimal
8kHz	↕	↕	↕	↕
15kHz	Minimal	Significant	Significant	Significant

From the table, we see that the PWM carrier frequency has a significant influence on the electromagnetic noise, AC motor drive heat dissipation, and motor acoustic noise.

The PWM carrier frequency may derate the rated current. The higher carrier frequency will decrease rated current to prevent AC motor drive overheat and extend IGBT's life. Therefore, it is necessary to have this kind of protection method. The rated current for the AC motor drive with carrier frequency (8kHz and below) is 100%. The curve between the rated current and carrier frequency (at 50°C) is shown as follows.





02.04 Motor Direction Control

Factory Setting: 0

Settings	0	Forward/Reverse operation enabled
	1	Reverse operation disabled
	2	Forward operation disabled

This parameter is used to disable one direction of rotation of the AC motor drive direction of rotation. See Chapter 2 for definition of direction of rotation.

02.05 Line Start Lockout

Factory Setting: 1

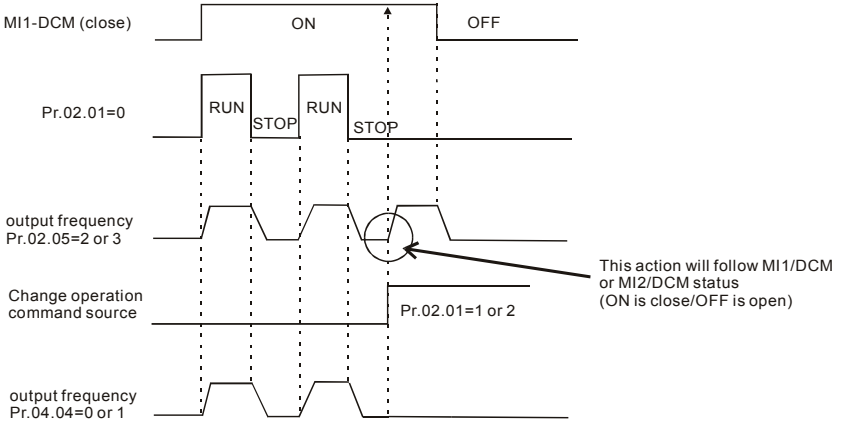
Settings	0	Disable. Operation status is not changed even if operation command source Pr.02.01 is changed.
	1	Enable. Operation status is not changed even if operation command source Pr.02.01 is changed.
	2	Disable. Operation status will change if operation command source Pr.02.01 is changed.
	3	Enable. Operation status will change if operation command source Pr.02.01 is changed.

This parameter determines the response of the drive upon power on and operation command source is changed.

Pr.02.05	Start lockout (Run when power is ON)	Operation status when operation command source is changed
0	Disable (AC motor drive will run)	Keep previous status
1	Enable (AC motor drive doesn't run)	Keep previous status
2	Disable (AC motor drive will run)	Change according to the new operation command source
3	Enable (AC motor drive doesn't run)	Change according to the new operation command source

🕮 When the operation command source is from external terminal and operation command is ON (FWD/REV-DCM=closed), the AC motor drive will operate according to Pr.02.05 after power is applied. **<For terminals FWD and REV only>**

1. When Pr.02.05 is set to 0 or 2, AC motor drive will run immediately.
2. When Pr.02.05 is set to 1 or 3, AC motor drive will remain stopped until operation command is received after previous operation command is cancelled.

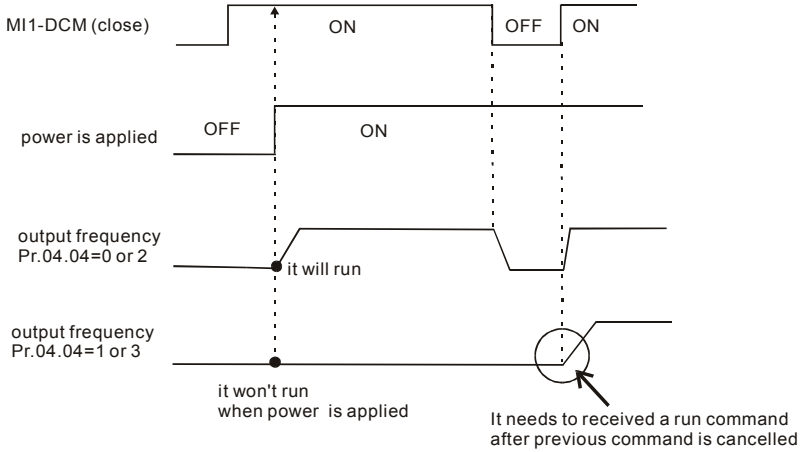


🕮 When the operation command source isn't from the external terminals, independently from whether the AC motor drive runs or stops, the AC motor drive will operate according to Pr.02.06 if the two conditions below are both met.

1. When operation command source is changed to external terminal (Pr.02.01=1 or 2)
2. The status of terminal and AC motor drive is different.

And the operation of the AC motor drive will be:

1. When setting 0 or 1, the status of AC motor drive is not changed by the terminal status.
2. When setting 2 or 3, the status of AC motor drive is changed by the terminal status.



The Line Start Lockout feature does not guarantee that the motor will never start under this condition. It is possible the motor may be set in motion by a malfunctioning switch.

02.06	Loss of ACI Signal (4-20mA)	
		Factory Setting: 0
Settings	0	Decelerate to 0Hz
	1	Coast to stop and display "AErr"
	2	Continue operation by the last frequency command

- This parameter determines the behavior when ACI is lost.
- When set to 1, it will display warning message "AErr" on the keypad in case of loss of ACI signal and execute the setting. When ACI signal is recovered, the warning message will stop blinking. Please press "RESET" key to clear it.

02.07	Up/Down Mode	
		Factory Setting: 0
Settings	0	By digital keypad up/down keys mode
	1	Based on Accel/Decel Time acc. to Pr.01.09 to 01.12
	2	Constant speed (acc. to Pr. 02.08)
	3	Pulse input unit (acc. to Pr. 02.08)

02.08	Accel/Decel Rate of Change of UP/DOWN Operation with Constant Speed	Unit: 0.01
Settings	0.01~10.00 Hz/ms	Factory Setting: 0.01

These parameters determine the increase/decrease of the master frequency when operated via the Multi-function Inputs when Pr.04.05~Pr.04.08 are set to 10 (Up command) or 11 (Down command).

02.11	✓Keyboard Frequency Command	Unit: 0.01
Settings	0.00 to 600.0Hz	Factory Setting: 60.00

This parameter can be used to set frequency command or read keypad frequency command.

02.12	✓Communication Frequency Command	Unit: 0.01
Settings	0.00 to 600.0Hz	Factory Setting: 60.00

This parameter can be used to set frequency command or read communication frequency command.

02.13	The Selections for Saving Keypad or Communication Frequency Command	
		Factory Setting: 0
Settings	0	Save Keypad & Communication Frequency
	1	Save Keypad Frequency only
	2	Save Communication Frequency only

This parameter is used to save keypad or RS-485 frequency command.

02.14	Frequency Command Selections at Stop (for Keypad and Communication)	
		Factory Setting: 0
Settings	0	By Current Freq Command
	1	By Zero Freq Command
	2	By Frequency Display at Stop

02.15	Frequency Display at Stop	Unit: 0.01
Settings	0.00 ~ 600.0Hz	Factory Setting: 60.00

These parameters are used to determinate the frequency at stop:

When setting Pr.02.14 to 0: the frequency at stop will be current frequency.

When setting Pr.02.14 to 1: the frequency at stop will be 0.

When setting Pr.02.14 to 2: the frequency at stop will be Pr.02.15.

02.16	Display the Master Freq Command Source	
Settings	Read Only	Factory setting: ##

🕮 You can read the master frequency command source by this parameter.

Display Value	Bit	Function
1	Bit0=1	Master Freq Command Source by First Freq Source (Pr.02.00).
2	Bit1=1	Master Freq Command Source by Second Freq Source (Pr.02.09).
4	Bit2=1	Master Freq Command Source by Multi-input function
8	Bit3=1	Master Freq Command Source by PLC Freq command

02.17 Display the Operation Command Source

Settings Read Only Factory setting: ##

🕮 You can read the operation source by this parameter.

Display Value	Bit	Function
1	Bit0=1	Operation Command Source by Digital Keypad
2	Bit1=1	Operation Command Source by RS485 communication
4	Bit2=1	Operation Command Source by External Terminal
8	Bit3=1	Operation Command Source by Multi-input function
16	Bit4=1	Operation Command Source by PLC Operation Command

Group 3: Output Function Parameters

03.00 Multi-function Output Relay (RA1, RB1, RC1)

Factory Setting: 8

03.01 Multi-function Output Terminal MO1

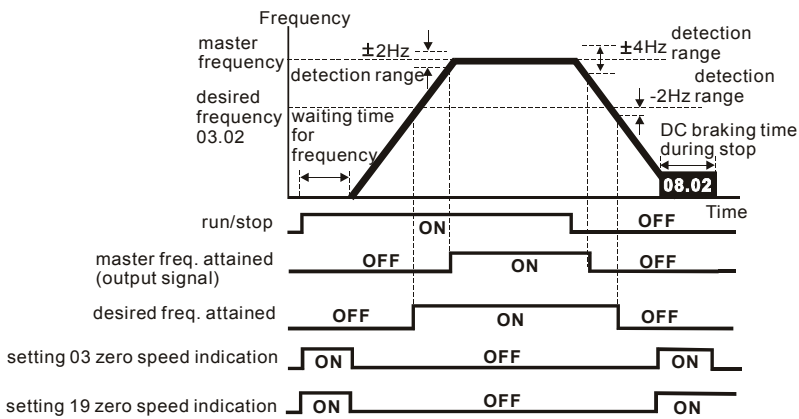
Factory Setting: 1

Settings	Function	Description
0	No Function	
1	AC Drive Operational	Active when the drive is ready or RUN command is “ON”.
2	Master Frequency Attained	Active when the AC motor drive reaches the output frequency setting.
3	Zero Speed	Active when Command Frequency is lower than the Minimum Output Frequency.
4	Over-Torque Detection	Active as long as over-torque is detected. (Refer to Pr.06.03 ~ Pr.06.05)
5	Baseblock (B.B.) Indication	Active when the output of the AC motor drive is shut off during baseblock. Base block can be forced by Multi-function input (setting 09).
6	Low-Voltage Indication	Active when low voltage(Lv) is detected.
7	Operation Mode Indication	Active when operation command is controlled by external terminal.
8	Fault Indication	Active when a fault occurs (oc, ov, oH, oL, oL1, EF, cF3, HPF, ocA, ocd, ocn, GFF).
9	Desired Frequency Attained	Active when the desired frequency (Pr.03.05) is attained.
10	Terminal Count Value Attained	Active when the counter reaches Terminal Count Value.
11	Preliminary Count Value Attained	Active when the counter reaches Preliminary Count Value.
12	Over Voltage Stall supervision	Active when the Over Voltage Stall function operating
13	Over Current Stall supervision	Active when the Over Current Stall function operating
14	Heat Sink Overheat Warning	When heatsink overheats, it will signal to prevent OH turn off the drive. When it is higher than 85°C (185°F), it will be ON.
15	Over Voltage supervision	Active when the DC-BUS voltage exceeds level

Settings	Function	Description
16	PID supervision	Active when the PID function is operating
17	Forward command	Active when the direction command is FWD
18	Reverse command	Active when the direction command is REV
19	Zero Speed Output Signal	Active unless there is an output frequency present at terminals U/T1, V/T2, and W/T3.
20	Communication Warning (FbE,Cexx, AoL2, AUE, SAvE)	Active when there is a Communication Warning
21	Brake Control (Desired Frequency Attained)	Active when output frequency ≥Pr.03.14. Deactivated when output frequency ≤Pr.03.15 after STOP command.

03.02	Desired Frequency Attained	Unit: 0.01
	Settings 0.00 to 600.0 Hz	Factory Setting: 0.00

If a multi-function output terminal is set to function as Desired Frequency Attained (Pr.03.00 to Pr.03.01=09), then the output will be activated when the programmed frequency is attained.



output timing chart of multiple function terminals when setting to frequency attained or zero speed indication

03.03	✓Analog Output Signal (AFM)	
		Factory Setting: 0
Settings	0	Analog Frequency Meter (0 to Maximum Output Frequency)
	1	Analog Current Meter (0 to 250% of rated AC motor drive current)

🕮 This parameter sets the function of the AFM output 0~+10VDC (ACM is common).

03.04	✓Analog Output Gain	Unit: 1
Settings	1 to 200%	Factory Setting: 100

🕮 This parameter sets the voltage range of the analog output signal AFM.

🕮 When Pr.03.03 is set to 0, the analog output voltage is directly proportional to the output frequency of the AC motor drive. With Pr.03.04 set to 100%, the Maximum Output Frequency (Pr.01.00) of the AC motor drive corresponds to +10VDC on the AFM output.

🕮 Similarly, if Pr.03.03 is set to 1, the analog output voltage is directly proportional to the output current of the AC drive. With Pr.03.04 set to 100%, then 2.5 times the rated current corresponds to +10VDC on the AFM output.

NOTE

Any type of voltmeter can be used. If the meter reads full scale at a voltage less than 10V, Pr. 03.04 should be set using the following formula:

Pr. 03.04 = ((meter full scale voltage)/10) x 100%

For Example: When using the meter with full scale of 5 volts, adjust Pr.03.04 to 50%. If Pr.03.03 is set to 0, then 5VDC will correspond to Maximum Output Frequency.

03.05	Terminal Count Value	Unit: 1
Settings	0 to 9999	Factory Setting: 0

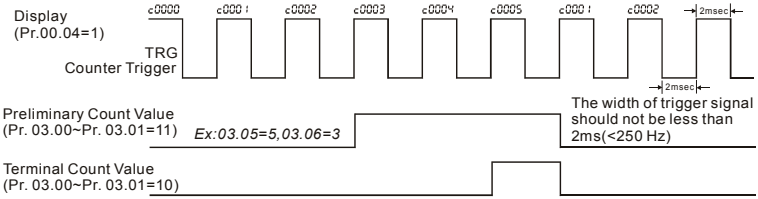
🕮 This parameter sets the count value of the internal counter. To increase the internal counter, one of Pr.04.05 to 04.08 should be set to 12. Upon completion of counting, the specified output terminal will be activated. (Pr.03.00 to Pr.03.01 set to 10).

🕮 When the display shows c555, the drive has counted 555 times. If display shows c555•, it means that real counter value is between 5,550 and 5,559.

03.06	Preliminary Count Value	Unit: 1
Settings	0 to 9999	Factory Setting: 0

When the counter value reaches this value, the corresponding multi-function output terminal will be activated, provided one of Pr.03.00 to Pr.03.01 set to 11 (Preliminary Count Value Setting). This multi-function output terminal will be deactivated upon completion of Terminal Count Value Attained.

The timing diagram:



03.07 EF Active when Preliminary Count Value Attained

Factory Setting: 0

Settings	0	Preliminary count value attained, no EF display
	1	Preliminary count value attained, EF active

If this parameter is set to 1 and the desired value of counter is attained, the AC drive will treat it as a fault. The drive will stop and show the “EF” message on the display.

03.08 Fan Control

Factory Setting: 0

Settings	0	Fan always ON
	1	1 minute after AC motor drive stops, fan will be OFF
	2	Fan ON when AC motor drive runs, fan OFF when AC motor drive stops
	3	Fan ON when preliminary heatsink temperature attained

This parameter determines the operation mode of the cooling fan.

03.09 The Digital Output Used by PLC

Settings Read Only Factory setting: ##

Bit0=1: RLY used by PLC

Bit1=1: MO1 used by PLC

Bit2=1: MO2/RA2 used by PLC

Bit3=1: MO3/RA3 used by PLC

Bit4=1: MO4/RA4 used by PLC

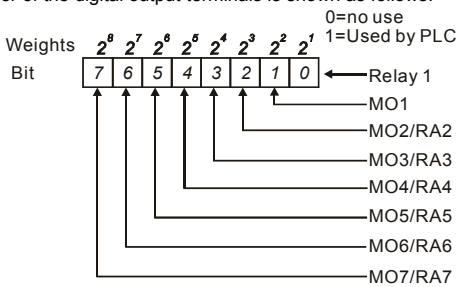
Bit5=1: MO5/RA5 used by PLC

Bit6=1: MO6/RA6 used by PLC

Bit7=1: MO7/RA7 used by PLC

🕮 The equivalent 8-bit is used to display the status (used or not used) of each digital output. The value that Pr.03.09 displays is the result after converting 8-bit binary into decimal value.

🕮 For standard AC motor drive, it only has 2-bit (bit0 and bit1). When extension card is installed, the number of the digital output terminals will increase according to the extension card. The maximum number of the digital output terminals is shown as follows.

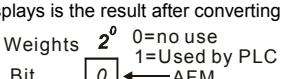


03.10 The Analog Output Used by PLC

Settings Read Only Factory setting: ##

Bit0=1: AFM used by PLC

🕮 The equivalent 1-bit is used to display the status (used or not used) of each analog output. The value that Pr.03.10 displays is the result after converting 1-bit binary into decimal value.



🕮 For Example:

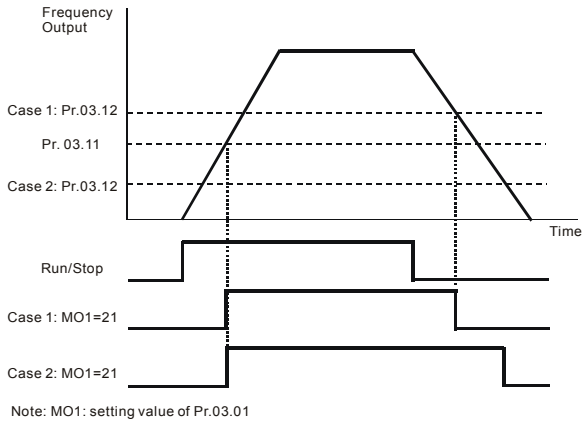
If Pr.03.10 displays 1, it means that AFM is used by PLC.

03.11	Brake Release Frequency	Unit: 0.01
	Settings 0.00 to 600.0Hz	Factory Setting: 0.00
03.12	Brake Engage Frequency	Unit: 0.01
	Settings 0.00 to 600.0Hz	Factory Setting: 0.00

📖 These two parameters are used to set control of mechanical brake via the output terminals (Relay or MO1) when Pr.03.00~03.01 is set to 21. Refer to the following example for details.

Example:

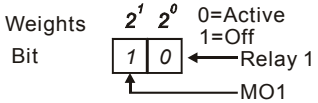
1. Case 1: Pr.03.12 ≥ Pr.03.11
2. Case 2: Pr.03.12 ≤ Pr.03.11



Note: MO1: setting value of Pr.03.01

03.13	Display the Status of Multi-function Output Terminals	
	Settings Read Only	Factory setting: ##
	Bit0: RLY Status	
	Bit1: MO1 Status	
	Bit2: MO2/RA2 Status	
	Bit3: MO3/RA3 Status	
	Bit4: MO4/RA4 Status	
	Bit5: MO5/RA5 Status	
	Bit6: MO6/RA6 Status	
	Bit7: MO7/RA7 Status	

📖 For standard AC motor drive (without extension card), the multi-function output terminals are falling-edge triggered and Pr.03.13 will display 3 (11) for no action.

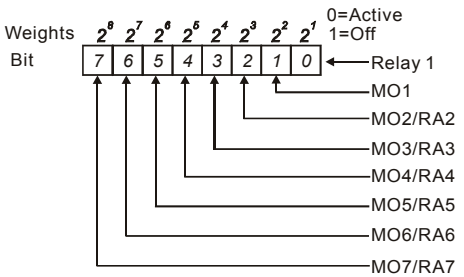


For Example:

If Pr.03.13 displays 2, it means Relay 1 is active.

The display value 2 =bit 1 X 2^1

When extension card is installed, the number of the multi-function output terminals will increase according to the extension card. The maximum number of the multi-function output terminals is shown as follows.

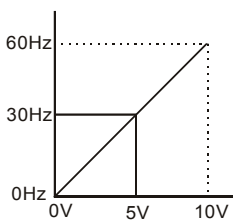


Group 4: Input Function Parameters

04.00	✓Keypad Potentiometer Bias	Unit: 0. 1
	Settings 0.0 to 100.0%	Factory Setting: 0.0
04.01	✓Keypad Potentiometer Bias Polarity	
		Factory Setting: 0
	Settings 0 Positive Bias	
	1 Negative Bias	
04.02	✓Keypad Potentiometer Gain	Unit: 0.1
	Settings 0.1 to 200.0%	Factory Setting: 100.0
04.03	Keypad Potentiometer Negative Bias, Reverse Motion Enable/Disable	
		Factory Setting: 0
	Settings 0 No Negative Bias Command	
	1 Negative Bias: REV Motion Enabled	

Example 1: Standard application

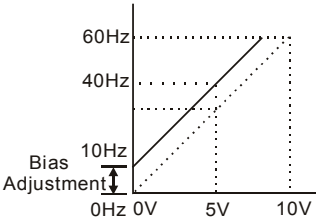
This is the most used setting. The user only needs to set Pr.02.00 to 01. The frequency command comes from keypad potentiometer on AVI.



Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =0%--Bias adjustment
Pr.04.01 =0--Positive bias
Pr.04.02 =100%--Input gain
Pr.04.03 =0--No negative bias command

Example 2: Use of bias

This example shows the influence of changing the bias. When the input is 0V the output frequency is 10 Hz. At mid-point a potentiometer will give 40 Hz. Once the Maximum Output Frequency is reached, any further increase of the potentiometer or signal will not increase the output frequency. (To use the full potentiometer range, please refer to Example 3.) The value of external input voltage/current 0-8.33V corresponds to the setting frequency 10-60Hz.



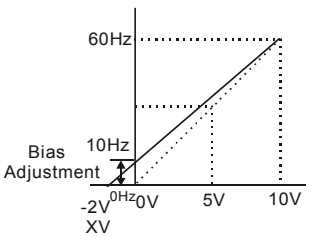
Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =16.7%--Bias adjustment
Pr.04.01 =0--Positive bias
Pr.04.02 =100%--Input gain
Pr.04.03 =0--No negative bias command

Gain:100%

Bias adjustment:((10Hz/60Hz)/(Gain/100%))*100%=16.7%

Example 3: Use of bias and gain for use of full range

This example also shows a popular method. The whole scale of the potentiometer can be used as desired. In addition to signals of 0 to 10V, the popular voltage signals also include signals of 0 to 5V, or any value under 10V. Regarding the setting, please refer to the following examples.



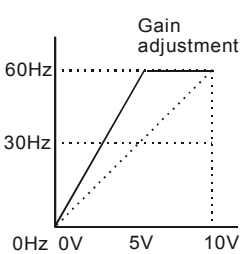
Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =20.0%--Bias adjustment
Pr.04.01 =0--Positive bias
Pr.04.02 =83.3%--Input gain
Pr.04.03 =0--No negative bias command

Gain:(10V/(10V+2V))*100%=83.3%

Bias adjustment:((10Hz/60Hz)/(Gain/100%))*100%=20.0%

Example 4: Use of 0-5V potentiometer range via gain adjustment

This example shows a potentiometer range of 0 to 5 Volts. Instead of adjusting gain as example below, you can set Pr. 01.00 to 120Hz to achieve the same results.

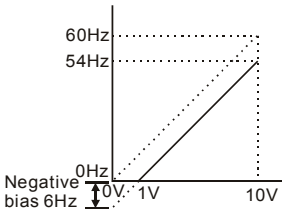


Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =0.0%--Bias adjustment
Pr.04.01 =0--Positive bias
Pr.04.02 =200%--Input gain
Pr.04.03 =0--No negative bias command

Gain:(10V/5V)*100%=200%

Example 5: Use of negative bias in noisy environment

In this example, a 1V negative bias is used. In noisy environments it is advantageous to use negative bias to provide a noise margin (1V in this example).



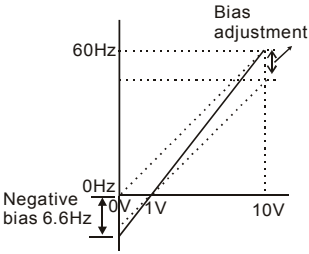
Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =10.0%--Bias adjustment
Pr.04.01 =1--Negative bias
Pr.04.02 =100%--Input gain
Pr.04.03 =0--No negative bias command

Gain:100%

Bias adjustment:((6Hz/60Hz)/(Gain/100%))*100%=10.0%

Example 6: Use of negative bias in noisy environment and gain adjustment to use full potentiometer range

In this example, a negative bias is used to provide a noise margin. Also a potentiometer frequency gain is used to allow the Maximum Output Frequency to be reached.



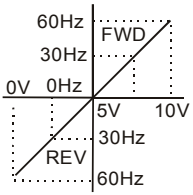
Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =10.0%--Bias adjustment
Pr.04.01 =1--Negative bias
Pr.04.02 =111%--Input gain
Pr.04.03 =0--No negative bias command

Gain:(10V/9V)*100%=111%

Bias adjustment:((6.6Hz/60Hz)/(Gain/100%))*100%=10.0%

Example 7: Use of 0-10V potentiometer signal to run motor in FWD and REV direction

In this example, the input is programmed to run a motor in both forward and reverse direction. The motor will be idle when the potentiometer position is at mid-point of its scale. Using the settings in this example disables the external FWD and REV controls.



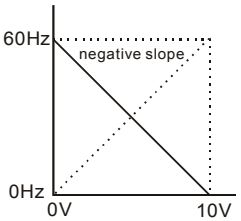
Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =50.0%--Bias adjustment
Pr.04.01 =1--Negative bias
Pr.04.02 =200%--Input gain
Pr.04.03 =1--Negative bias: REV motion enabled

Gain:(10V/5V)*100%=200%

Bias adjustment:((60Hz/60Hz)/(Gain/100%))*100%=200%

Example 8: Use negative slope

In this example, the use of negative slope is shown. Negative slopes are used in applications for control of pressure, temperature or flow. The sensor that is connected to the input generates a large signal (10V) at high pressure or flow. With negative slope settings, the AC motor drive will slow stop the motor. With these settings the AC motor drive will always run in only one direction (reverse). This can only be changed by exchanging 2 wires to the motor.



Pr.01.00=60Hz--Max. output Freq.
Potentiometer(**AVI)**
Pr.04.00 =100%--Bias adjustment
Pr.04.01 =0--Positive bias
Pr.04.02 =100%--Input gain
Pr.04.03 =1--Negative bias: REV motion enabled

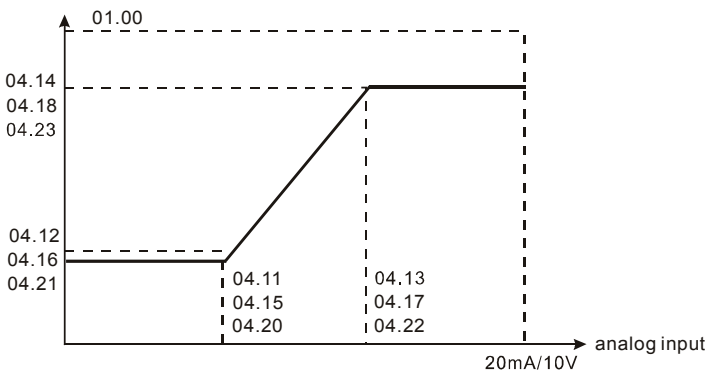
Gain:(10V/10V)*100%=100%

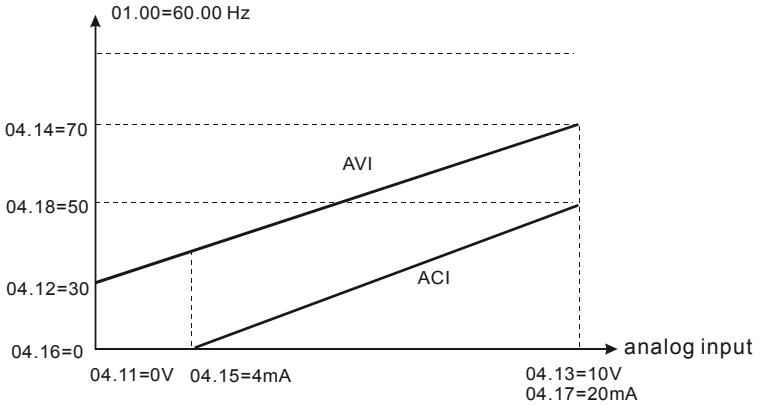
Bias adjustment:((60Hz/60Hz)/(Gain/100%))*100%=100%

04.11	Minimum AVI Voltage	Unit: 0.1
	Settings 0.0 to 10.0V	Factory Setting: 0.0
04.12	Minimum AVI Frequency (percentage of Pr.01.00)	Unit: 0.1
	Settings 0.0 to 100.0%	Factory Setting: 0.0
04.13	Maximum AVI Voltage	Unit: 0.1
	Settings 0.0 to 10.0V	Factory Setting: 10.0
04.14	Maximum AVI Frequency (percentage of Pr. 01.00)	Unit: 0.1
	Settings 0.0 to 100.0%	Factory Setting: 100.0
04.15	Minimum ACI Voltage	Unit: 0.1
	Settings 4.0 to 20.0mA	Factory Setting: 4.0
04.16	Minimum ACI Frequency (percentage of Pr. 01.00)	Unit: 0.1
	Settings 0.0 to 100.0%	Factory Setting: 0.0
04.17	Maximum ACI Voltage	Unit: 0.01
	Settings 4.0 to 20.0mA	Factory Setting: 0.00

04.18	Maximum ACI Frequency (percentage of Pr. 01.00)	Unit: 0.1
	Settings 0.0 to 100.0%	Factory Setting: 100.0
04.19	ACI Terminal Mode Selection	
		Factory Setting: 0
	Settings 0 ACI	
	1 AVI2	
04.20	Minimum AVI2 Voltage	Unit: 0.1
	Settings 0.0 to 10.0V	Factory Setting: 0.0
04.21	Minimum AVI2 Frequency (percentage of Pr.1-00)	Unit: 0.1
	Settings 0.0 to 100.0%	Factory Setting: 0.0
04.22	Maximum AVI2 Voltage	Unit: 0.1
	Settings 0.0 to 10.0V	Factory Setting: 10.0
04.23	Maximum AVI2 Frequency (percentage of Pr.1-00)	Unit: 0.1
	Settings 0.0 to 100.0%	Factory Setting: 100.0

- Please note the ACI/AVI switch on the AC motor drive. Switch to ACI for 4 to 20mA analog current signal (ACI) (Pr.04.19 should be set to 0) and AVI for analog voltage signal (AVI2) (Pr.04.19 should be set to 1).
- The above parameters are used to set the analog input reference values. The min and max frequencies are based on Pr.01.00 (during open-loop control) as shown in the following.



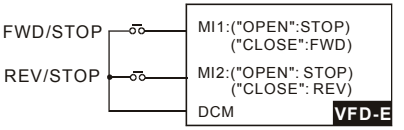
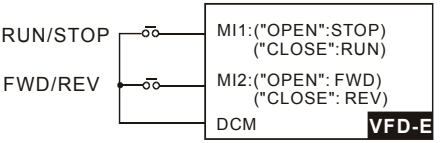
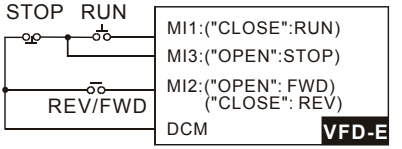


04.04	Multi-function Input Terminal (MI1, MI2) 2-wire/ 3-wire Operation Control Modes

Factory Setting: 0

Settings	0	2-wire: FWD/STOP, REV/STOP
	1	2-wire: FWD/REV, RUN/STOP
	2	3-wire Operation

There are three different types of control modes:

04.04		External Terminal
0	2-wire FWD /STOP REV / STOP	
1	2-wire FWD/ REV RUN / STOP	
2	3-wire	

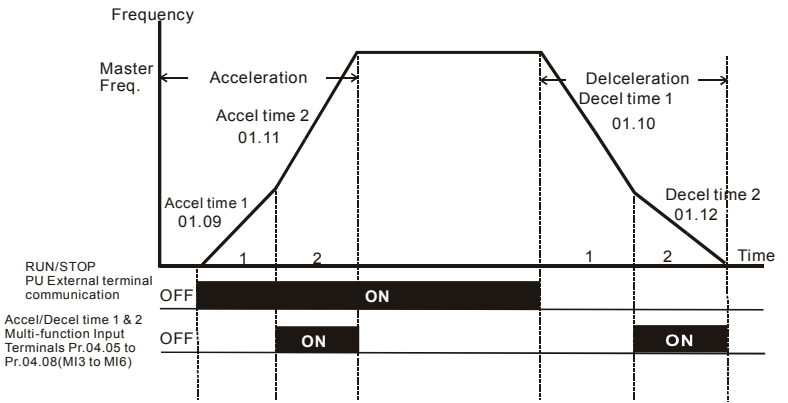
04.05	Multi-function Input Terminal (MI3)
	Factory Setting: 1
04.06	Multi-function Input Terminal (MI4)
	Factory Setting: 2
04.07	Multi-function Input Terminal (MI5)
	Factory Setting: 3
04.08	Multi-function Input Terminal (MI6)
	Factory Setting: 4

Settings	Function	Description
0	No Function	Any unused terminals should be programmed to 0 to insure they have no effect on operation.
1	Multi-Step Speed Command 1	These four inputs select the multi-speed defined by Pr.05.00 to Pr.05.14 as shown in the diagram at the end of this table. **NOTE: Pr.05.00 to Pr.05.14 can also be used to control output speed by programming the AC motor drive's internal PLC function. There are 17 step speed frequencies (including Master Frequency and Jog Frequency) to select for application.**
2	Multi-Step Speed Command 2	
3	Multi-Step Speed Command 3	
4	Multi-Step Speed Command 4	
5	External Reset	The External Reset has the same function as the Reset key on the Digital keypad. After faults such as O.H., O.C. and O.V. are cleared this input can be used to reset the drive.
6	Accel/Decel Inhibit	When the command is active, acceleration and deceleration is stopped and the AC motor drive maintains a constant speed.
7	Accel/Decel Time Selection Command	Used to select the one of 2 Accel/Decel Times (Pr.01.09 to Pr.01.12). See explanation at the end of this table.
8	Jog Operation Control	Parameter value 08 programs one of the Multi-function Input Terminals MI3 ~ MI6 (Pr.04.05~Pr.04.08) for Jog control. **NOTE: Programming for Jog operation by 08 can only be done while the motor is stopped. (Refer to parameter Pr.01.13~Pr.01.15)**

Settings	Function	Description
9	External Base Block (Refer to Pr. 08.06)	Parameter value 09 programs a Multi-function Input Terminals for external Base Block control. **NOTE: When a Base-Block signal is received, the AC motor drive will block all output and the motor will free run. When base block control is deactivated, the AC drive will start its speed search function and synchronize with the motor speed, and then accelerate to Master Frequency.**
10	UP: Increase Master Frequency	Increase/decrease the Master Frequency each time an input is received or continuously when the input stays active. When both inputs are active at the same time, the Master Frequency increase/decrease is halted. Please refer to Pr.02.07, 02.08. This function is also called “motor potentiometer”.
11	DOWN: Decrease Master Frequency	
12	Counter Trigger	Parameter value 12 programs one of the Multi-function Input Terminals MI3~MI6 (Pr.04.05~Pr.04.08) to increment the AC drive’s internal counter. When an input is received, the counter is incremented by 1.
13	Counter Reset	When active, the counter is reset and inhibited. To enable counting the input should be OFF. Refer to Pr.03.05 and 03.06.
14	External Fault	Parameter value 14 programs one of the Multi-function Input Terminals MI3~MI6 (Pr.04.05~Pr.04.08) to be External Fault (E.F.) inputs.
15	PID function disabled	When an input ON with this setting is ON, the PID function will be disabled.
16	Output Shutoff Stop	AC motor drive will stop output and the motor free run if one of these settings is enabled. If the status of terminal is changed, AC motor drive will restart from 0Hz.
17	Parameter lock enable	When this setting is enabled, all parameters will be locked and write parameters is disabled.
18	Operation Command Selection (Pr.02.01 setting/external terminals)	ON: Operation command via Ext. Terminals OFF: Operation command via Pr.02.01 setting Pr.02.01 is disabled if this parameter value 18 is set. See the explanation below this table.

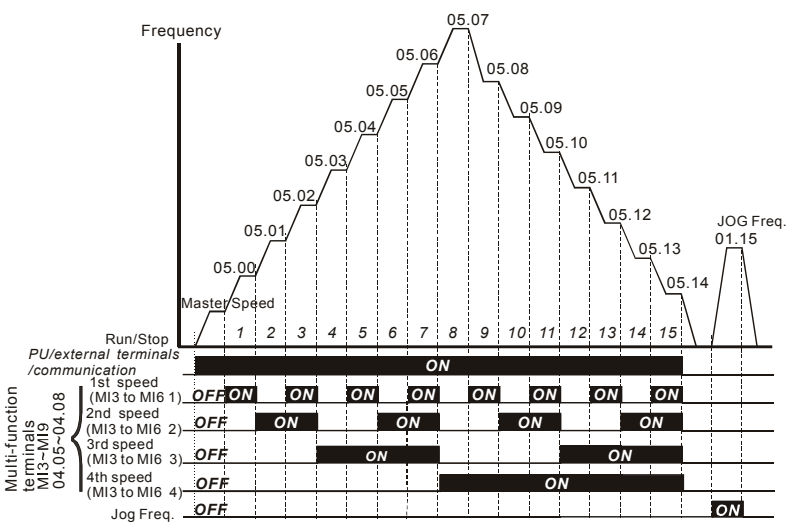
Settings	Function	Description
19	Operation Command Selection (Pr 02.01 setting/Digital Keypad)	ON: Operation command via Digital Keypad OFF: Operation command via Pr.02.01 setting Pr.02.01 is disabled if this parameter value 19 is set. See the explanation below this table.
20	Operation Command Selection (Pr 02.01 setting/ Communication)	ON: Operation command via Communication OFF: Operation command via Pr.02.01 setting Pr.02.01 is disabled if this parameter value 20 is set. See the explanation below this table.
21	Forward/Reverse	This function has top priority to set the direction for running (If "Pr.02.04=0")
22	Source of second frequency command enabled	Used to select the first/second frequency command source. Refer to Pr.02.00 and 02.09. ON: 2nd Frequency command source OFF: 1st Frequency command source
23	Run/Stop PLC Program	ON: Run PLC Program OFF: Stop PLC Program When operation command source is external terminal, the keypad cannot be used to change PLC status. And this function will be invalid when AC Motor drive is in PLC2 status.

Accel/Decel Time Selection



Accel/Decel Time and Multi-function Input Terminals

Multi-Step Speed

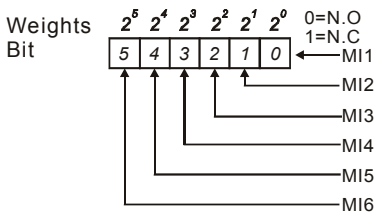


Multi-speed via External Terminals

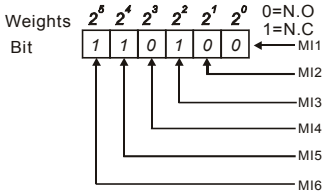
	MI6=4	MI5=3	MI4=2	MI3=1
Master frequency	OFF	OFF	OFF	OFF
1st speed	OFF	OFF	OFF	ON
2nd speed	OFF	OFF	ON	OFF
3rd speed	OFF	OFF	ON	ON
4th speed	OFF	ON	OFF	OFF
5th speed	OFF	ON	OFF	ON
6th speed	OFF	ON	ON	OFF
7th speed	OFF	ON	ON	ON
8th speed	ON	OFF	OFF	OFF
9th speed	ON	OFF	OFF	ON
10th speed	ON	OFF	ON	OFF
11th speed	ON	OFF	ON	ON
12th speed	ON	ON	OFF	OFF
13th speed	ON	ON	OFF	ON
14th speed	ON	ON	ON	OFF
15th speed	ON	ON	ON	ON

04.09	Multi-function Input Contact Selection	Unit: 1
	Settings 0 to 4095	Factory Setting: 0

- This parameter can be used to set the status of multi-function terminals (MI1~MI6 (N.O./N.C.) for standard AC motor drive).
- The MI1~MI3 setting will be invalid when the operation command source is external terminal (2/3wire).



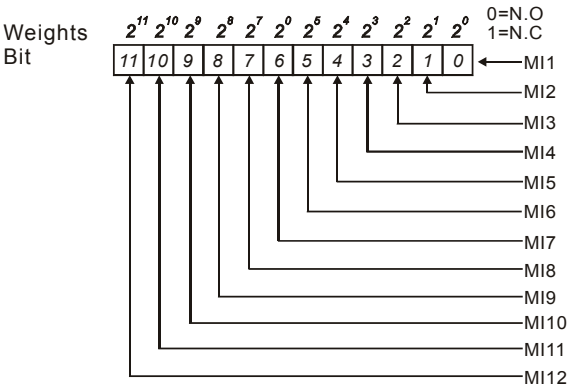
- The Setting method: It needs to convert binary number (6-bit) to decimal number for input.
- For example: if setting MI3, MI5, MI6 to be N.C. and MI1, MI2, MI4 to be N.O. The setting value Pr.04.09 should be bit5X2^5+bit4X2^4+bit2X2^2= 1X2^5+1X2^4+1X2^2= 32+16+4=52 as shown in the following.



The setting value
= bit5x2^5+bit4x2^4+bit2x2^2
= 1x2^5+1x2^4+1x2^2
=32+16+4 =52
Setting 04.09

NOTE:
2^{14}=16384 2^{13}=8192 2^{12}=4096 2^{11}=2048 2^{10}=1024
2^9=512 2^8=256 2^7=128 2^6=64 2^5=32
2^4=16 2^3=8 2^2=4 2^1=2 2^0=1

When extension card is installed, the number of the multi-function input terminals will increase according to the extension card. The maximum number of the multi-function input terminals is shown as follows.

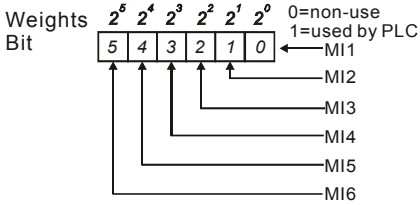


04.10	Digital Terminal Input Debouncing Time	Unit: 2
Settings	1 to 20	Factory Setting: 1

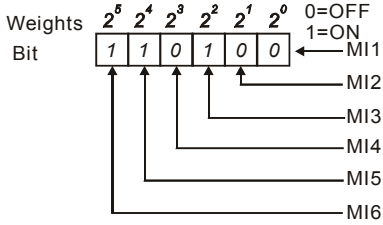
This parameter is to delay the signals on digital input terminals. 1 unit is 2 msec, 2 units are 4 msec, etc. The delay time is to debounce noisy signals that could cause the digital terminals to malfunction.

04.24	The Digital Input Used by PLC	
Settings	Read Only	Factory setting: ##
Display	Bit0=1: MI1 used by PLC	
	Bit1=1: MI2 used by PLC	
	Bit2=1: MI3 used by PLC	
	Bit3=1: MI4 used by PLC	
	Bit4=1: MI5 used by PLC	
	Bit5=1: MI6 used by PLC	
	Bit6=1: MI7 used by PLC	
	Bit7=1: MI8 used by PLC	
	Bit8=1: MI9 used by PLC	
	Bit9=1: MI10 used by PLC	
	Bit10=1: MI11 used by PLC	
	Bit11=1: MI12 used by PLC	

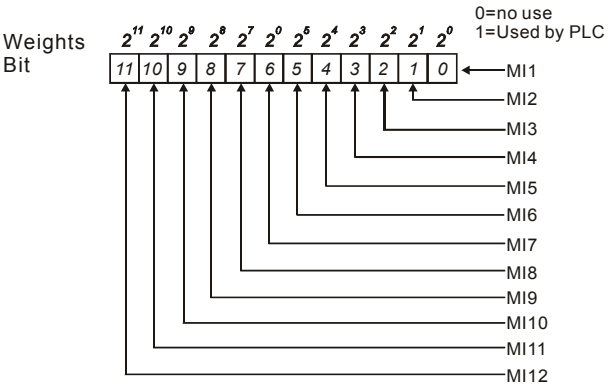
📖 For standard AC motor drive (without extension card), the equivalent 6-bit is used to display the status (used or not used) of each digital input. The value for Pr.04.24 to display is the result after converting 6-bit binary into decimal value.



📖 For example: when Pr.04.24 is set to 52 (decimal) = 110100 (binary) that indicates MI3, MI5 and MI6 are used by PLC.

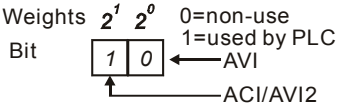


📖 When extension card is installed, the number of the digital input terminals will increase according to the extension card. The maximum number of the digital input terminals is shown as follows.



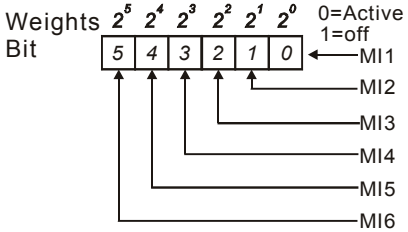
04.25	The Analog Input Used by PLC	
Settings	Read Only	Factory setting: ##
Display	Bit0=1: AVI used by PLC	
	Bit1=1: ACI/AVI2 used by PLC	

📖 The equivalent 2-bit is used to display the status(used or not used) of each analog input. The value for Pr.04.25 to display is the result after converting 2-bit binary into decimal value.



04.26	Display the Status of Multi-function Input Terminal	
Settings	Read Only	Factory setting: ##
Display	Bit0: MI1 Status	
	Bit1: MI2 Status	
	Bit2: MI3 Status	
	Bit3: MI4 Status	
	Bit4: MI5 Status	
	Bit5: MI6 Status	
	Bit6: MI7 Status	
	Bit7: MI8 Status	
	Bit8: MI9 Status	
	Bit9: MI10 Status	
	Bit10: MI11 Status	
	Bit11: MI12 Status	

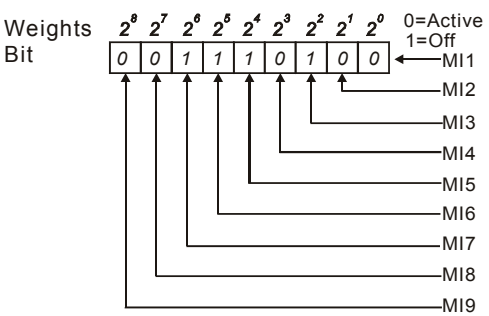
The multi-function input terminals are falling-edge triggered. For standard AC motor drive (without extension card), there are MI1 to MI6 and Pr.04.26 will display 63 (111111) for no action.



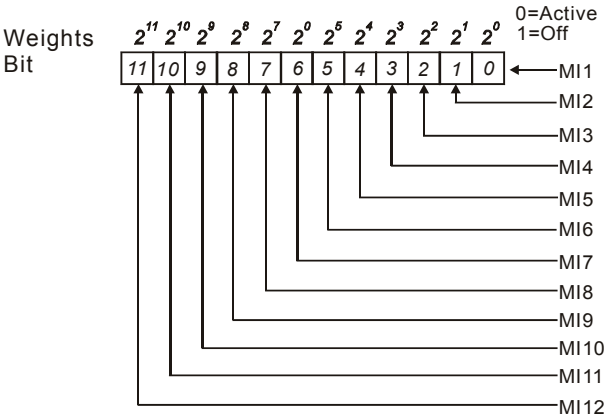
For Example:

If Pr.04.26 displays 52, it means MI1, MI2 and MI4 are active.

The display value 52= 32+16+4 =1 X 2^5+ 1X 2^4 + 1X 2^2 = bit 6 X 2^5+ bit 5 X 2^4 + bit 3 X 2^2

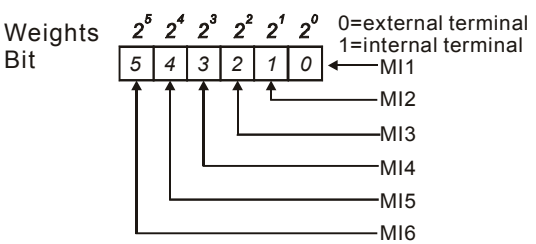


When extension card is installed, the number of the multi-function input terminals will increase according to the extension card. The maximum number of the multi-function input terminals is shown as follows.

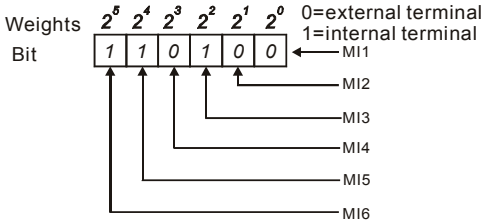


04.27	Internal/External Multi-function Input Terminals Selection	Unit: 1
	Settings 0 to 4095	Factory Setting: 0

- This parameter is used to select the terminals to be internal terminal or external terminal. You can activate internal terminals by Pr.04.28. A terminal cannot be both internal terminal and external terminal at the same time.
- For standard AC motor drive (without extension card), the multi-function input terminals are MI1 to MI6 as shown in the following.



- The Setting method is convert binary number to decimal number for input.
- For example: if setting MI3, MI5, MI6 to be internal terminals and MI1, MI2, MI4 to be external terminals. The setting value should be bit5X2^5+bit4X2^4+bit2X2^2= 1X2^5+1X2^4+1X2^2= 32+16+4=52 as shown in the following.

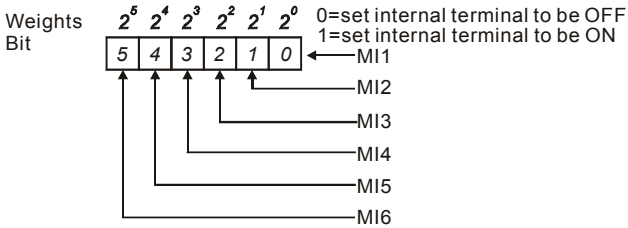


When extension card is installed, the number of the multi-function input terminals will increase according to the extension card. The maximum number of the multi-function input terminals is shown as follows.

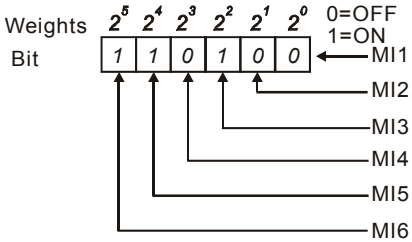
04.28	Internal Terminal Status	Unit: 1
Settings	0 to 4095	Factory Setting: 0

This parameter is used to set the internal terminal action via keypad, communication or PLC.

For standard AC motor drive (without extension card), the multi-function input terminals are MI1 to MI6 as shown in the following.



For example, if setting MI3, MI5 and MI6 to be ON, Pr.04.28 should be set to bit5X2^5+bit4X2^4+bit2X2^2= 1X2^5+1X2^4+1X2^2= 32+16+4=52 as shown in the following.



🕮 When extension card is installed, the number of the multi-function input terminals will increase according to the extension card. The maximum number of the multi-function input terminals is shown as follows.

Group 5: Multi-step speeds and PLC (Process Logic Control) parameters

05.00	✓1st Step Speed Frequency	Unit: 0.01
05.01	✓2nd Step Speed Frequency	Unit: 0.01
05.02	✓3rd Step Speed Frequency	Unit: 0.01
05.03	✓4th Step Speed Frequency	Unit: 0.01
05.04	✓5th Step Speed Frequency	Unit: 0.01
05.05	✓6th Step Speed Frequency	Unit: 0.01
05.06	✓7th Step Speed Frequency	Unit: 0.01
05.07	✓8th Step Speed Frequency	Unit: 0.01
05.08	✓9th Step Speed Frequency	Unit: 0.01
05.09	✓10th Step Speed Frequency	Unit: 0.01
05.10	✓11th Step Speed Frequency	Unit: 0.01
05.11	✓12th Step Speed Frequency	Unit: 0.01
05.12	✓13th Step Speed Frequency	Unit: 0.01
05.13	✓14th Step Speed Frequency	Unit: 0.01
05.14	✓15th Step Speed Frequency	Unit: 0.01
	Settings 0.00 to 600.0Hz	Factory Setting: 0.00

📖 The Multi-function Input Terminals (refer to Pr.04.05 to 04.08) are used to select one of the AC motor drive Multi-step speeds. The speeds (frequencies) are determined by Pr.05.00 to 05.14 as shown above.

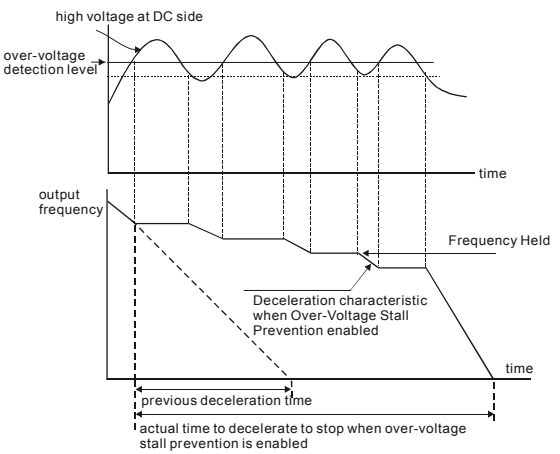
Group 6: Protection Parameters

06.00	Over-Voltage Stall Prevention		Unit: 0.1
	Settings 115V/230V series	330.0 to 410.0V	Factory Setting: 390.0
	460V series	660.0 to 820.0V	Factory Setting: 780.0
	0	Disable Over-voltage Stall Prevention (with brake unit or brake resistor)	

- During deceleration, the DC bus voltage may exceed its Maximum Allowable Value due to motor regeneration. When this function is enabled, the AC motor drive will not decelerate further and keep the output frequency constant until the voltage drops below the preset value again.
- Over-Voltage Stall Prevention must be disabled (Pr.06.00=0) when a brake unit or brake resistor is used.

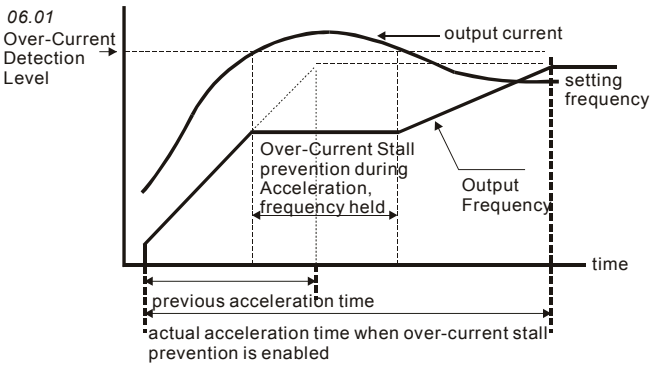
NOTE

With moderate inertia load, over-voltage stall prevention will not occur and the real deceleration time will be equal to the setting of deceleration time. The AC drive will automatically extend the deceleration time with high inertia loads. If the deceleration time is critical for the application, a brake resistor or brake unit should be used.



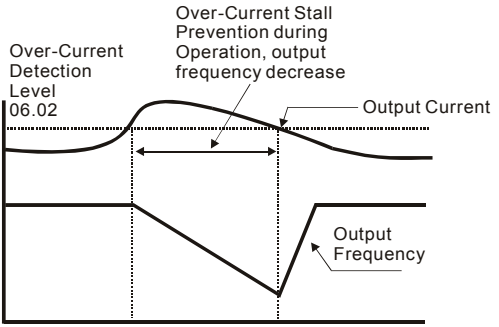
06.01	Over-Current Stall Prevention during Acceleration	Unit: 1
	Settings 20 to 250%	Factory Setting: 170

- A setting of 100% is equal to the Rated Output Current of the drive.
- During acceleration, the AC drive output current may increase abruptly and exceed the value specified by Pr.06.01 due to rapid acceleration or excessive load on the motor. When this function is enabled, the AC drive will stop accelerating and keep the output frequency constant until the current drops below the maximum value.



06.02	Over-current Stall Prevention during Operation	Unit: 1
	Settings 20 to 250%	Factory Setting: 170

- If the output current exceeds the setting specified in Pr.06.02 when the drive is operating, the drive will decrease its output frequency to prevent the motor stall. If the output current is lower than the setting specified in Pr.06.02, the drive will accelerate again to catch up with the set frequency command value.



over-current stall prevention during operation

06.03	Over-Torque Detection Mode (OL2)	
		Factory Setting: 0
Settings	0	Over-Torque detection disabled.
	1	Over-Torque detection enabled during constant speed operation. After over-torque is detected, keep running until OL1 or OL occurs.
	2	Over-Torque detection enabled during constant speed operation. After over-torque is detected, stop running.
	3	Over-Torque detection enabled during acceleration. After over-torque is detected, keep running until OL1 or OL occurs.
	4	Over-Torque detection enabled during acceleration. After over-torque is detected, stop running.

🕮 This parameter determines the operation mode of the drive after the over-torque (OL2) is detected via the following method: if the output current exceeds the over-torque detection level (Pr.06.04) longer than the setting of Pr.06.05 Over-Torque Detection Time, the warning message “OL2” is displayed. If a Multi-functional Output Terminal is set to over-torque detection (Pr.03.00~03.01=04), the output is on. Please refer to Pr.03.00~03.01 for details.

06.04	Over-Torque Detection Level (OL2)	Unit: 1
	Settings 10 to 200%	Factory Setting: 150

🕮 This setting is proportional to the Rated Output Current of the drive.

06.05	Over-Torque Detection Time (OL2)	Unit: 0.1
	Settings 0.1 to 60.0 sec	Factory Setting: 0.1

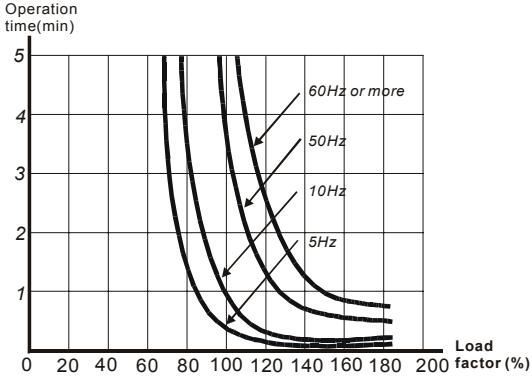
🕮 This parameter sets the time for how long over-torque must be detected before “OL2” is displayed.

06.06	Electronic Thermal Overload Relay Selection (OL1)	
		Factory Setting: 2
Settings	0	Operate with a Special Motor (forced external cooling)
	1	Operate with a Standard Motor (self-cooled by fan)
	2	Operation disabled

📖 This function is used to protect the motor from overloading or overheating.

06.07	Electronic Thermal Characteristic	Unit: 1
Settings	30 to 600 sec	Factory Setting: 60

📖 The parameter determines the time required for activating the I2t electronic thermal protection function. The graph below shows I2t curves for 150% output power for 1 minute.



06.08	Present Fault Record
06.09	Second Most Recent Fault Record
06.10	Third Most Recent Fault Record
06.11	Fourth Most Recent Fault Record
06.12	Fifth Most Recent Fault Record

Factory Setting: 0

Readings		
	0	No fault
	1	Over-current (oc)
	2	Over-voltage (ov)
	3	IGBT Overheat (oH1)
	4	Power Board Overheat (oH2)
	5	Overload(oL)
	6	Overload (oL1)

7	Motor Overload (oL2)
8	External Fault (EF)
9	Hardware protection failure (HPF)
10	Current exceeds 2 times rated current during accel.(ocA)
11	Current exceeds 2 times rated current during decel.(ocd)
12	Current exceeds 2 times rated current during steady state operation (ocn)
13	Reserved
14	Phase-loss (PHL)
15	Reserved
16	Auto accel/decel failure (CFA)
17	Software/password protection (codE)
18	Power Board CPU WRITE Failure (cF1.0)
19	Power Board CPU READ Failure (cF2.0)
20	CC, OC Hardware protection failure (HPF1)
21	OV Hardware protection failure (HPF2)
22	GFF Hardware protection failure (HPF3)
23	OC Hardware protection failure (HPF4)
24	U-phase error (cF3.0)
25	V-phase error (cF3.1)
26	W-phase error (cF3.2)
27	DCBUS error (cF3.3)
28	IGBT Overheat (cF3.4)
29	Power Board Overheat (cF3.5)
30	Control Board CPU WRITE failure (cF1.1)
31	Control Board CPU READ failure (cF2.1)
32	ACI signal error (AErr)
33	Reserved
34	Motor PTC overheat protection (PtC1)

📖 In Pr.06.08 to Pr.06.12 the five most recent faults that occurred, are stored. After removing the cause of the fault, use the reset command to reset the drive.

Group 7: Motor Parameters

07.00	✓Motor Rated Current	Unit: 1
	Settings 30% FLA to 120% FLA	Factory Setting: FLA

📖 Use the following formula to calculate the percentage value entered in this parameter:
(Motor Current / AC Drive Current) x 100%
with Motor Current=Motor rated current in A on type shield
AC Drive Current=Rated current of AC drive in A (see Pr.00.01)

📖 Pr.07.00 and Pr.07.01 must be set if the drive is programmed to operate in Vector Control mode (Pr.00.10 = 1). They also must be set if the "Electronic Thermal Overload Relay" (Pr.06.06) or "Slip Compensation"(Pr.07-03) functions are selected.

07.01	✓Motor No-load Current	Unit: 1
	Settings 0% FLA to 90% FLA	Factory Setting: 0.4*FLA

📖 The rated current of the AC drive is regarded as 100%. The setting of the Motor no-load current will affect the slip compensation.

📖 The setting value must be less than Pr.07.00 (Motor Rated Current).

07.02	✓Torque Compensation	Unit: 0.1
	Settings 0.0 to 10.0	Factory Setting: 0.0

📖 This parameter may be set so that the AC drive will increase its voltage output to obtain a higher torque. Only to be used for V/f control mode.

📖 Too high torque compensation can overheat the motor.

07.03	✓Slip Compensation (Used without PG)	Unit: 0.01
	Settings 0.00 to 10.00	Factory Setting: 0.00

📖 While driving an asynchronous motor, increasing the load on the AC motor drive will cause an increase in slip and decrease in speed. This parameter may be used to compensate the slip by increasing the output frequency. When the output current of the AC motor drive is bigger than the motor no-load current (Pr.07.01), the AC drive will adjust its output frequency according to this parameter.

07.04	Motor Parameters Auto Tuning	Unit: 1
		Factory Setting: 0
Settings	0 Disable	
	1 Auto Tuning R1 (motor doesn't run)	
	2 Auto Tuning R1 + No-load Test (with running motor)	

🕮 Start Auto Tuning by pressing RUN key after this parameter is set to 1 or 2.
When set to 1, it will only auto detect R1 value and Pr.07.01 must be input manually. When set to 2, the AC motor drive should be unloaded and the values of Pr.07.01 and Pr.07.05 will be set automatically.

🕮 The steps for AUTO-Tuning are:

1. Make sure that all the parameters are set to factory settings and the motor wiring is correct.
2. Make sure the motor has no-load before executing auto-tuning and the shaft is not connected to any belt or gear motor.
3. Fill in Pr.01.01, Pr.01.02, Pr.07.00, Pr.07.04 and Pr.07.06 with correct values.
4. After Pr.07.04 is set to 2, the AC motor drive will execute auto-tuning immediately after receiving a "RUN" command. (Note: The motor will run!). The total auto tune time will be 15 seconds + Pr.01.09 + Pr.01.10. Higher power drives need longer Accel/Decel time (factory setting is recommended). After executing Auto-tune, Pr.07.04 is set to 0.
5. After executing, please check if there are values filled in Pr.07.01 and Pr.07.05. If not, please press RUN key after setting Pr.07.04 again.
6. Then you can set Pr.00.10 to 1 and set other parameters according to your application requirement.

NOTE

1. In vector control mode it is not recommended to have motors run in parallel.
2. It is not recommended to use vector control mode if motor rated power exceeds the rated power of the AC motor drive.

07.05	Motor Line-to-line Resistance R1	Unit: 1
Settings	0 to 65535 mΩ	Factory Setting: 0

🕮 The motor auto tune procedure will set this parameter. The user may also set this parameter without using Pr.07.04.

07.06	Motor Rated Slip		Unit: 0.01
	Settings	0.00 to 20.00Hz	Factory Setting: 3.00

🕮 Refer to the rated rpm and the number of poles on the nameplate of the motor and use the following equation to calculate the rated slip.

Rated Slip (Hz) = F_{base} (Pr.01.01 base frequency) – (rated rpm x motor pole 120)

🕮 This parameter is valid only in vector mode.

07.07	Slip Compensation Limit		Unit: 1
	Settings	0 to 250%	Factory Setting: 200

🕮 This parameter sets the upper limit of the compensation frequency (the percentage of Pr.07.06).

Example: when Pr.07.06=5Hz and Pr.07.07=150%, the upper limit of the compensation frequency is 7.5Hz. Therefore, for a 50Hz motor, the max. output is 57.5Hz.

07.08	Torque Compensation Time Constant		Unit: 0.01
	Settings	0.01 ~10.00 sec	Factory Setting: 0.10
07.09	Slip Compensation Time Constant		Unit: 0.01
	Settings	0.05 ~10.00 sec	Factory Setting: 0.20

🕮 Setting Pr.07.08 and Pr.07.09 changes the response time for the compensations.

🕮 Too long time constants give slow response, too short values can give unstable operation.

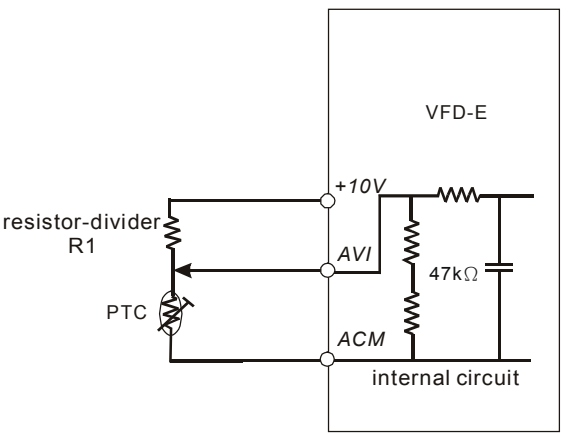
07.10	Accumulative Motor Operation Time (Min.)		Unit: 1
	Settings	0~1439	Factory Setting: 0
07.11	Accumulative Motor Operation Time (Day)		Unit: 1
	Settings	0 ~65535	Factory Setting: 0

🕮 Pr.07.10 and Pr.07.11 are used to record the motor operation time. They can be cleared by setting to 0 and time is less than 1 minute is not recorded.

07.12	Motor PTC Overheat Protection		Unit: 1
			Factory Setting: 0
	Settings	0 Disable	
		1 Enable	

07.14	Motor PTC Overheat Protection Level	Unit: 0.1
	Settings 0.1~10.0V	Factory Setting: 2.4

- When the motor is running at low frequency for a long time, the cooling function of the motor fan will be lower. To prevent overheating, it needs to have a Positive Temperature Coefficient thermoistor on the motor and connect its output signal to the drive's corresponding control terminals.
- When the source of first/second frequency command is set to AVI (02.00=2/02.09=2), it will disable the function of motor PTC overheat protection (i.e. Pr.07.12 cannot be set to 1).
- If temperature exceeds the setting level, motor will be coast to stop and PtC 1 is displayed. When the temperature decreases below the level of (Pr.07.15-Pr.07.16) and PtC 1 stops blinking, you can press RESET key to clear the fault.
- Pr.07.14 (overheat protection level) must exceed Pr.07.15 (overheat warning level).
- The PTC uses the AVI-input and is connected via resistor-divider as shown below.
  1. The voltage between +10V to ACM: lies within 10.4V~11.2V.
  2. The impedance for AVI is around 47kΩ.
  3. Recommended value for resistor-divider R1 is 1~20kΩ.
  4. Please contact your motor dealer for the curve of temperature and resistance value for PTC.



Refer to following calculation for protection level and warning level.

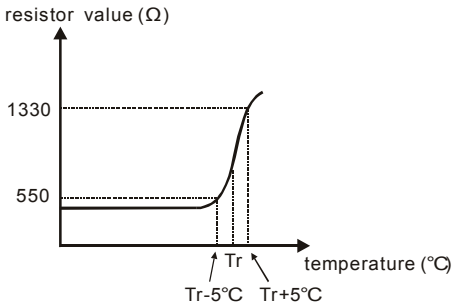
1. Protection level
   Pr.07.14= V_{+10} * (R_{PTC1}//47K) / [R1+(R_{PTC1}//47K)]
2. Warning level
   Pr.07.16= V_{+10} * (R_{PTC2}//47K) / [R1+(R_{PTC2}//47K)]
3. Definition:
   V+10: voltage between +10V-ACM, Range 10.4~11.2VDC
   RPTC1: motor PTC overheat protection level. Corresponding voltage level set in Pr.07.14, RPTC2: motor PTC overheat warning level. Corresponding voltage level set in Pr.07.15, 47kΩ: is AVI input impedance, R1: resistor-divider (recommended value: 1~20kΩ)

Take the standard PTC thermistor as example: if protection level is 1330Ω, the voltage between +10V-ACM is 10.5V and resistor-divider R1 is 4.4kΩ. Refer to following calculation for Pr.07.14 setting.

1330//47000=(1330*47000)/(1330+47000)=1293.4

10.5*1293.4/(4400+1293.4)=2.38(V) ≒2.4(V)

Therefore, Pr.07.14 should be set to 2.4.



07.15	Motor PTC Overheat Warning Level		Unit: 0.1
	Settings	0.1~10.0V	Factory Setting: 1.2
07.16	Motor PTC Overheat Reset Delta Level		Unit: 0.1
	Settings	0.1~5.0V	Factory Setting: 0.6
07.17	Treatment of the motor PTC Overheat		
			Factory Setting: 0
	Settings	0 Warn and RAMP to stop	
		1 Warn and COAST to stop	
		2 Warn and keep running	

🕮 If temperature exceeds the motor PTC overheat warning level (Pr.07.15), the drive will act according to Pr.07.17 and display PtC2. If the temperature decreases below the result (Pr.07.15 minus Pr.07.16), the warning display will disappear.

07.13	Input Debouncing Time of the PTC Protection	Unit: 2
	Settings 0~9999 (is 0-19998ms)	Factory Setting: 100

🕮 This parameter is to delay the signals on PTC analog input terminals. 1 unit is 2 msec, 2 units are 4 msec, etc.

Group 8: Special Parameters

08.00	DC Braking Current Level	Unit: 1
	Settings 0 to 100%	Factory Setting: 0

This parameter sets the level of DC Braking Current output to the motor during start-up and stopping. When setting DC Braking Current, the Rated Current (Pr.00.01) is regarded as 100%. It is recommended to start with a low DC Braking Current Level and then increase until proper holding torque has been achieved.

08.01	DC Braking Time during Start-up	Unit: 0.1
	Settings 0.0 to 60.0 sec	Factory Setting: 0.0

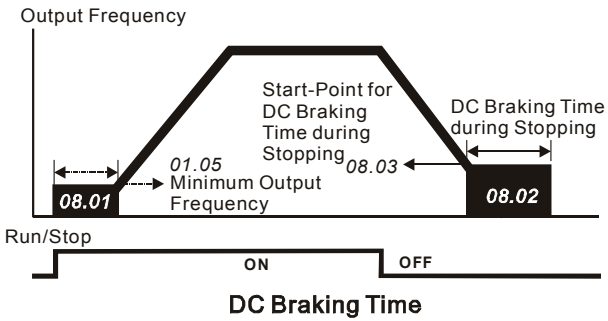
This parameter determines the duration of the DC Braking current after a RUN command. When the time has elapsed, the AC motor drive will start accelerating from the Minimum Frequency (Pr.01.05).

08.02	DC Braking Time during Stopping	Unit: 0.1
	Settings 0.0 to 60.0 sec	Factory Setting: 0.0

This parameter determines the duration of the DC Braking current during stopping. If stopping with DC Braking is desired, Pr.02.02 Stop Method must be set to 0 or 2 for Ramp to Stop.

08.03	Start-Point for DC Braking	Unit: 0.01
	Settings 0.00 to 600.0Hz	Factory Setting: 0.00

This parameter determines the frequency when DC Braking will begin during deceleration.



DC Braking Time

- DC Braking during Start-up is used for loads that may move before the AC drive starts, such as fans and pumps. Under such circumstances, DC Braking can be used to hold the load in position before setting it in motion.
- DC Braking during stopping is used to shorten the stopping time and also to hold a stopped load in position. For high inertia loads, a brake resistor for dynamic braking may also be needed for fast decelerations.

08.04	Momentary Power Loss Operation Selection	
		Factory Setting: 0
Settings	0	Operation stops (coast to stop) after momentary power loss.
	1	Operation continues after momentary power loss, speed search starts with the Master Frequency reference value.
	2	Operation continues after momentary power loss, speed search starts with the minimum frequency.

- This parameter determines the operation mode when the AC motor drive restarts from a momentary power loss.

08.05	Maximum Allowable Power Loss Time	Unit: 0.1
Settings	0.1 to 5.0 sec	Factory Setting: 2.0

- If the duration of a power loss is less than this parameter setting, the AC motor drive will resume operation. If it exceeds the Maximum Allowable Power Loss Time, the AC motor drive output is then turned off (coast stop).
- The selected operation after power loss in Pr.08.04 is only executed when the maximum allowable power loss time is ≤5 seconds and the AC motor drive displays “Lu”.
  But if the AC motor drive is powered off due to overload, even if the maximum allowable power loss time is ≤5 seconds, the operation mode as set in Pr.08.04 is not executed. In that case it starts up normally.

08.06	Base Block Speed Search	
		Factory Setting: 1
Settings	0	Disable
	1	Speed search starts with last frequency command
	2	Speed search starts with minimum output frequency (Pr.01.05)

- This parameter determines the AC motor drive restart method after External Base Block is enabled.

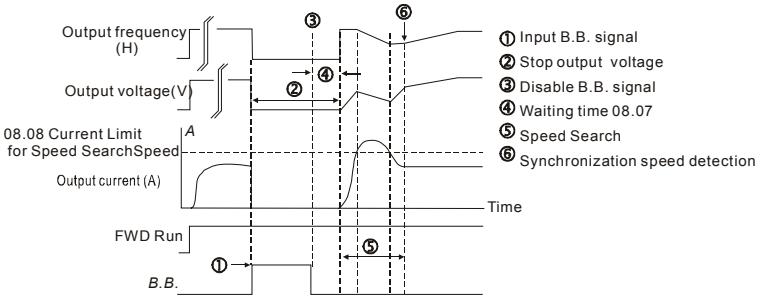


Fig 1:B.B. Speed Search with Last Output Frequency Downward Timing Chart
(Speed Search Current Attains Speed Search Level)

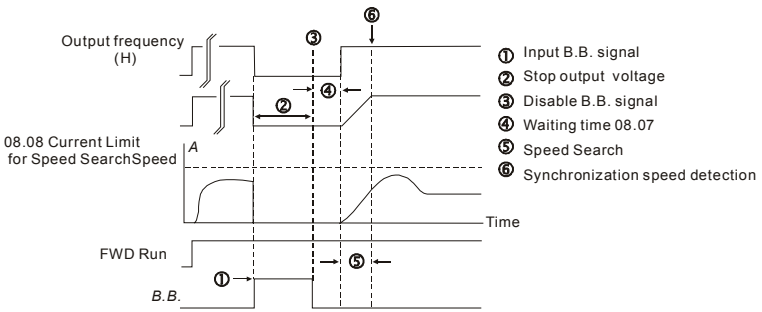


Fig 2: B.B. Speed Search with Last Output Frequency Downward Timing Chart
(Speed Search Current doesn't Attain Speed Search Level)

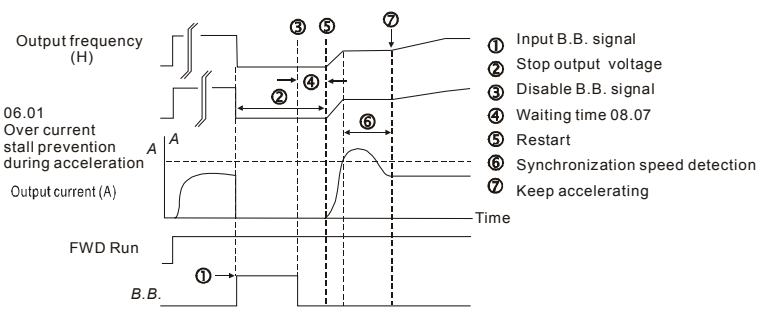


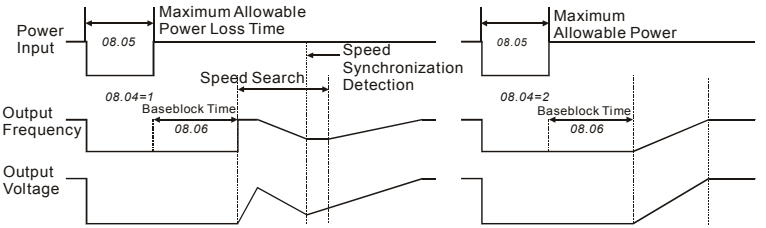
Fig3: B.B. Speed Search with Minimum Output Frequency Upward Timing Chart

08.07	Baseblock Time for Speed Search (BB)	Unit: 0.1
	Settings 0.1 to 5.0 sec	Factory Setting: 0.5

- When momentary power loss is detected, the AC motor drive will block its output and then wait for a specified period of time (determined by Pr.08.07, called Base-Block Time) before resuming operation. This parameter should be set at a value to ensure that any residual regeneration voltage from the motor on the output has disappeared before the drive is activated again.
- This parameter also determines the waiting time before resuming operation after External Baseblock and Auto Restart after Fault (Pr.08.15).
- When using a PG card with PG (encoder), speed search will begin at the actual PG (encoder) feedback speed.

08.08	Current Limit for Speed Search	Unit: 1
	Settings 30 to 200%	Factory Setting: 150

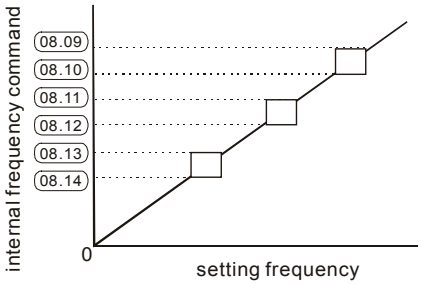
- Following a momentary power loss, the AC motor drive will start its speed search operation only if the output current is greater than the value set by Pr.08.08. When the output current is less than the value of Pr.08.08, the AC motor drive output frequency is at "speed synchronization point". The drive will start to accelerate or decelerate back to the operating frequency at which it was running prior to the power loss.



Momentary Power Loss Operation

08.09	Skip Frequency 1 Upper Limit	Unit: 0.01
08.10	Skip Frequency 1 Lower Limit	Unit: 0.01
08.11	Skip Frequency 2 Upper Limit	Unit: 0.01
08.12	Skip Frequency 2 Lower Limit	Unit: 0.01
08.13	Skip Frequency 3 Upper Limit	Unit: 0.01
08.14	Skip Frequency 3 Lower Limit	Unit: 0.01
	Settings 0.00 to 600.0Hz	Factory Setting: 0.00

- These parameters set the Skip Frequencies. It will cause the AC motor drive never to remain within these frequency ranges with continuous frequency output.
- These six parameters should be set as follows Pr.08.09 ≥ Pr.08.10 ≥ Pr.08.11 ≥ Pr.08.12 ≥ Pr.08.13 ≥ Pr.08.14.
- The frequency ranges may be overlapping.



08.15	Auto Restart After Fault	Unit: 1
Settings	0 to 10	Factory Setting: 0
	0 Disable	

- Only after an over-current OC or over-voltage OV fault occurs, the AC motor drive can be reset/restarted automatically up to 10 times.
- Setting this parameter to 0 will disable automatic reset/restart operation after any fault has occurred.

  When enabled, the AC motor drive will restart with speed search, which starts at the frequency before the fault. To set the waiting time before restart after a fault, please set Pr. 08.07 Base Block Time for Speed Search.

08.16	Auto Reset Time at Restart after Fault	Unit: 0.1
Settings	0.1 to 6000 sec	Factory Setting: 60.0

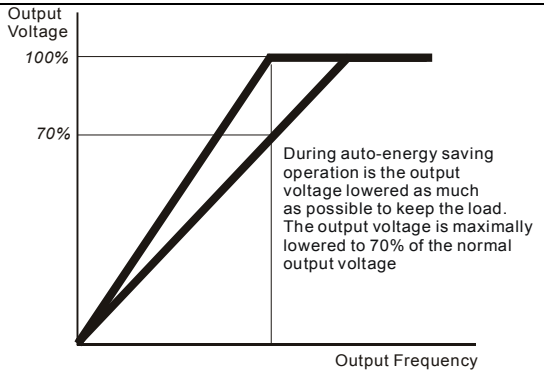
- This parameter should be used in conjunction with Pr.08.15.

  For example: If Pr.08.15 is set to 10 and Pr.08.16 is set to 600s (10 min), and if there is no fault for over 600 seconds from the restart for the previous fault, the auto reset times for restart after fault will be reset to 10.

08.17 Automatic Energy-saving

Factory Setting: 0

Settings	0	Energy-saving operation disabled
	1	Energy-saving operation enabled



08.18 Automatic Voltage Regulation (AVR)

Factory Setting: 0

Settings	0	AVR function enabled
	1	AVR function disabled
	2	AVR function disabled for deceleration
	3	AVR function disabled for stop

- The rated voltage of the motor is usually 230V/200VAC 50Hz/60Hz and the input voltage of the AC motor drive may vary between 180V to 264 VAC 50Hz/60Hz. Therefore, when the AC motor drive is used without AVR function, the output voltage will be the same as the input voltage. When the motor runs at voltages exceeding the rated voltage with 12% - 20%, its lifetime will be shorter and it can be damaged due to higher temperature, failing insulation and unstable torque output.
- AVR function automatically regulates the AC motor drive output voltage to the Maximum Output Voltage (Pr.01.02). For instance, if Pr.01.02 is set at 200 VAC and the input voltage is at 200V to 264VAC, then the Maximum Output Voltage will automatically be reduced to a maximum of 200VAC.
- When the motor ramps to stop, the deceleration time is longer. When setting this parameter to 2 with auto acceleration/deceleration, the deceleration will be quicker.

08.19	Software Braking Level (the Action Level of the Brake resistor)		Unit: 1
	Settings	115/230V series: 370.0 to 430.0V	Factory Setting: 380.0
		460V series: 740.0 to 860.0V	Factory Setting: 760.0

- This parameter sets the DC-bus voltage at which the brake chopper is activated.
- This parameter will be invalid for Frame A models without brake chopper for which BUE brake unit must be used.

08.20	Compensation Coefficient for Motor Instability		Unit: 0.1
	Settings	0.0~5.0	Factory Setting: 0.0

- The drift current will occur in a specific zone of the motor and it will make motor instable. By using this parameter, it will improve this situation greatly.
- The drift current zone of the high-power motors is usually in the low frequency area.
- It is recommended to set to more than 2.0.

Group 9: Communication Parameters

There is a built-in RS-485 serial interface, marked RJ-45 near to the control terminals. The pins are defined below:

RS-485
Serial interface

1: Reserved	2: EV	3: GND
4: SG-	5: SG+	6: Reserved
7: Reserved	8: Reserved	

Each VFD-E AC motor drive has a pre-assigned communication address specified by Pr.09.00. The RS485 master then controls each AC motor drive according to its communication address.

09.00	Communication Address	
	Settings 1 to 254	Factory Setting: 1

🕮 If the AC motor drive is controlled by RS-485 serial communication, the communication address for this drive must be set via this parameter. And the communication address for each AC motor drive must be different and unique.

09.01	Transmission Speed	
		Factory Setting: 1
Settings	0	Baud rate 4800 bps (bits / second)
	1	Baud rate 9600 bps
	2	Baud rate 19200 bps
	3	Baud rate 38400 bps

🕮 This parameter is used to set the transmission speed between the RS485 master (PLC, PC, etc.) and AC motor drive.

09.02	Transmission Fault Treatment	
		Factory Setting: 3
Settings	0	Warn and keep operating
	1	Warn and RAMP to stop
	2	Warn and COAST to stop
	3	No warning and keep operating

🕮 This parameter is set to how to react if transmission errors occur.

🕮 See list of error messages below (see section 3.6.)

09.03	Communication Protocol

Factory Setting: 0

Settings	0	Modbus ASCII mode, protocol <7,N,2>
	1	Modbus ASCII mode, protocol <7,E,1>
	2	Modbus ASCII mode, protocol <7,O,1>
	3	Modbus RTU mode, protocol <8,N,2>
	4	Modbus RTU mode, protocol <8,E,1>
	5	Modbus RTU mode, protocol <8,O,1>

🕮 1. Control by PC or PLC

★A VFD-E can be set up to communicate in Modbus networks using one of the following modes: ASCII (American Standard Code for Information Interchange) or RTU (Remote Terminal Unit). Users can select the desired mode along with the serial port communication protocol in Pr.09.03.

★Code Description:

ASCII mode:

Each 8-bit data is the combination of two ASCII characters. For example, a 1-byte data: 64 Hex, shown as '64' in ASCII, consists of '6' (36Hex) and '4' (34Hex).

Character	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'
ASCII code	30H	31H	32H	33H	34H	35H	36H	37H

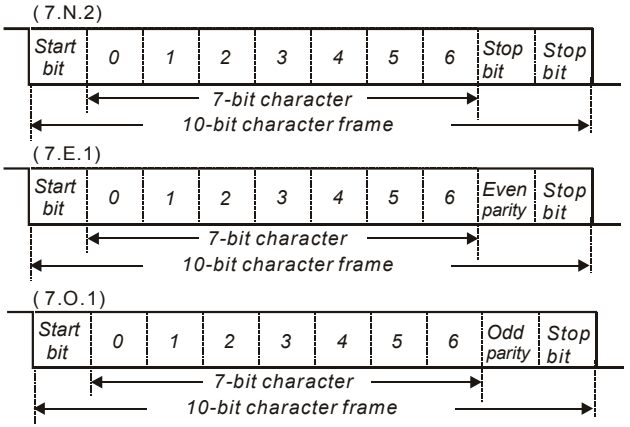
Character	'8'	'9'	'A'	'B'	'C'	'D'	'E'	'F'
ASCII code	38H	39H	41H	42H	43H	44H	45H	46H

RTU mode:

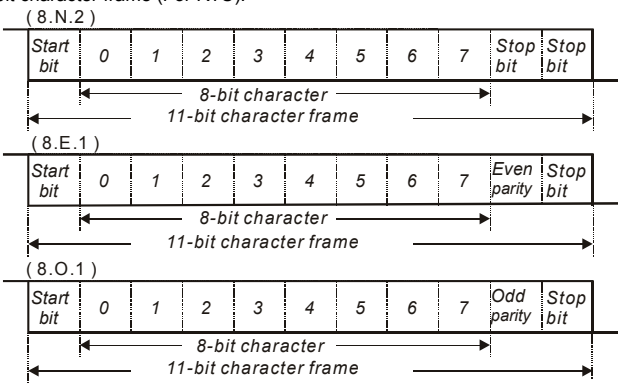
Each 8-bit data is the combination of two 4-bit hexadecimal characters. For example, 64 Hex.

🕮 2. Data Format

10-bit character frame (For ASCII):



11-bit character frame (For RTU):



3. Communication Protocol

3.1 Communication Data Frame:

ASCII mode:

STX	Start character ':' (3AH)
Address Hi	Communication address:
Address Lo	8-bit address consists of 2 ASCII codes
Function Hi	Command code:
Function Lo	8-bit command consists of 2 ASCII codes
DATA (n-1) to DATA 0	Contents of data: Nx8-bit data consist of 2n ASCII codes n<=20, maximum of 40 ASCII codes
LRC CHK Hi	LRC check sum:
LRC CHK Lo	8-bit check sum consists of 2 ASCII codes
END Hi	End characters:
END Lo	END1= CR (0DH), END0= LF(0AH)

RTU mode:

START	A silent interval of more than 10 ms
Address	Communication address: 8-bit address
Function	Command code: 8-bit command
DATA (n-1) to DATA 0	Contents of data: n×8-bit data, n<=40 (20 x 16-bit data)
CRC CHK Low	CRC check sum: 16-bit check sum consists of 2 8-bit characters
CRC CHK High	
END	A silent interval of more than 10 ms

3.2 Address (Communication Address)

Valid communication addresses are in the range of 0 to 254. A communication address equal to 0, means broadcast to all AC drives (AMD). In this case, the AMD will not reply any message to the master device.

00H: broadcast to all AC drives

01H: AC drive of address 01

0FH: AC drive of address 15

10H: AC drive of address 16

:

FEH: AC drive of address 254

For example, communication to AMD with address 16 decimal (10H):

ASCII mode: Address='1','0' => '1'=31H, '0'=30H

RTU mode: Address=10H

3.3 Function (Function code) and DATA (data characters)

The format of data characters depends on the function code.

03H: read data from register

06H: write single register

08H: loop detection

10H: write multiple registers

The available function codes and examples for VFD-E are described as follows:

(1) 03H: multi read, read data from registers.

Example: reading continuous 2 data from register address 2102H, AMD address is 01H.

ASCII mode:

Command message:

STX	':'
Address	'0'
	'1'
Function	'0'
	'3'
Starting data address	'2'
	'1'
	'0'
	'2'
Number of data (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 data (Count by byte)	'0'
	'4'
Content of starting address 2102H	'1'
	'7'
	'7'
	'0'
Content of address 2103H	'0'
	'0'
	'0'
	'0'
LRC Check	'7'
	'1'
END	CR
	LF

RTU mode:

Command message:

Address	01H
Function	03H
Starting data address	21H
	02H
Number of data (count by word)	00H
	02H
CRC CHK Low	6FH
CRC CHK High	F7H

Response message:

Address	01H
Function	03H
Number of data (count by byte)	04H
Content of address 2102H	17H
	70H
Content of address 2103H	00H
	00H
CRC CHK Low	FEH
CRC CHK High	5CH

(2) 06H: single write, write single data to register.

Example: writing data 6000(1770H) to register 0100H. AMD address is 01H.

ASCII mode:

Command message:

STX	':'
Address	'0'
	'1'
Function	'0'
	'6'
Data address	'0'
	'1'
	'0'
	'0'
Data content	'1'
	'7'
	'7'
	'0'

Response message:

STX	':'
Address	'0'
	'1'
Function	'0'
	'6'
Data address	'0'
	'1'
	'0'
	'0'
Data content	'1'
	'7'
	'7'
	'0'

Command message:

LRC Check	'7'
	'1'
END	CR
	LF

Response message:

LRC Check	'7'
	'1'
END	CR
	LF

RTU mode:

Command message:

Address	01H
Function	06H
Data address	01H
	00H
Data content	17H
	70H
CRC CHK Low	86H
CRC CHK High	22H

Response message:

Address	01H
Function	06H
Data address	01H
	00H
Data content	17H
	70H
CRC CHK Low	86H
CRC CHK High	22H

(3) 10H: write multiple registers (write multiple data to registers)

Example: Set the multi-step speed,

Pr.05.00=50.00 (1388H), Pr.05.01=40.00 (0FA0H). AC drive address is 01H.

ASCII Mode:

Command message:

STX	':'
Address 1	'0'
Address 0	'1'
Function 1	'1'
Function 0	'0'
Starting data address	'0'
	'5'
	'0'
	'0'
Number of data (count by word)	'0'
	'0'
	'0'
	'2'
Number of data (count by byte)	'0'
	'4'
The first data content	'1'
	'3'
	'8'
	'8'
The second data content	'0'
	'F'
	'A'
	'0'
LRC Check	'9'
	'A'
END	CR
	LF

Response message:

STX	':'
Address 1	'0'
Address 0	'1'
Function 1	'1'
Function 0	'0'
Starting data address	'0'
	'5'
	'0'
	'0'
Number of data (count by word)	'0'
	'0'
	'0'
	'2'
LRC Check	'E'
	'8'
END	CR
	LF

RTU mode:

Command message:

Address	01H
Function	10H
Starting data address	05H
	00H
Number of data (count by word)	00H'
	02H
Number of data (count by byte)	04
The first data content	13H
	88H
The second data content	0FH
	A0H
CRC Check Low	'9'
CRC Check High	'A'

Response message:

Address	01H
Function	10H
Starting data address	05H
	00H
Number of data (count by word)	00H
	02H
CRC Check Low	41H
CRC Check High	04H

3.4 Check sum

ASCII mode:

LRC (Longitudinal Redundancy Check) is calculated by summing up, module 256, 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.

For example, reading 1 word from address 0401H of the AC drive with address 01H.

STX	':'
Address 1	'0'
Address 0	'1'
Function 1	'0'
Function 0	'3'
Starting data address	'0'
	'4'
	'0'
	'1'
Number of data	'0'
	'0'
	'0'
	'1'
LRC Check 1	'F'
LRC Check 0	'6'
END 1	CR
END 0	LF

01H+03H+04H+01H+00H+01H=0AH, the 2's-complement negation of 0AH is **F6**H.

RTU mode:

Address	01H
Function	03H
Starting data address	21H
	02H
Number of data (count by word)	00H
	02H
CRC CHK Low	6FH
CRC CHK High	F7H

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 with MSB zero filling, then repeat step 3. If the LSB of CRC register is 1, shift the CRC register one bit to the right with MSB zero filling, Exclusive OR the CRC register with the polynomial value A001H, then repeat step 3.

Step 5: Repeat step 3 and 4 until eight shifts have been performed. When this is done, a complete 8-bit byte will have been processed.

Step 6: Repeat step 2 to 5 for the next 8-bit byte of the command message. Continue doing this until all bytes have been 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, i.e. the lower order byte will be 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;
}
```

3.5 Address list

The contents of available addresses are shown as below:

Content	Address	Function	
AC drive Parameters	GGnnH	GG means parameter group, nn means parameter number, for example, the address of Pr 04.01 is 0401H. Refer to chapter 5 for the function of each parameter. When reading parameter by command code 03H, only one parameter can be read at one time.	
Command Write only	2000H	Bit 0-1	00B: No function 01B: Stop 10B: Run 11B: Jog + Run
		Bit 2-3	Reserved
		Bit 4-5	00B: No function 01B: FWD 10B: REV 11B: Change direction
		Bit 6-7	00B: Comm. forced 1st accel/decel 01B: Comm. forced 2nd accel/decel
		Bit 8-15	Reserved
	2001H	Frequency command	
	2002H	Bit 0	1: EF (external fault) on
		Bit 1	1: Reset
		Bit 2-15	Reserved
Status monitor Read only	2100H	Error code:	
		0: No error occurred	
		1: Over-current (oc)	
		2: Over-voltage (ov)	
		3: IGBT Overheat (oH1)	
		4: Power Board Overheat (oH2)	
		5: Overload (oL)	
		6: Overload1 (oL1)	
		7: Overload2 (oL2)	
		8: External fault (EF)	
		9: Current exceeds 2 times rated current during accel (ocA)	
		10: Current exceeds 2 times rated current during decel (ocd) Current exceeds 2 times rated current during decel (ocd)	
		11: Current exceeds 2 times rated current during steady state operation (ocn)	
		12: Ground Fault (GFF)	

Content	Address	Function	
Status monitor Read only	2100H	13: Low voltage (Lv)	
		14: PHL (Phase-Loss)	
		15: Base Block	
		16: Auto accel/decel failure (cFA)	
		17: Software protection enabled (codE)	
		18: Power Board CPU WRITE failure (CF1.0)	
		19: Power Board CPU READ failure (CF2.0)	
		20: CC, OC Hardware protection failure (HPF1)	
		21: OV Hardware protection failure (HPF2)	
		22: GFF Hardware protection failure (HPF3)	
		23: OC Hardware protection failure (HPF4)	
		24: U-phase error (cF3.0)	
		25: V-phase error (cF3.1)	
		26: W-phase error (cF3.2)	
		27: DCBUS error (cF3.3)	
		28: IGBT Overheat (cF3.4)	
		29: Power Board Overheat (cF3.5)	
		30: Control Board CPU WRITE failure (cF1.1)	
		31: Control Board CPU WRITE failure (cF2.1)	
		32: ACI signal error (AErr)	
		33: Reserved	
		34: Motor PTC overheat protection (PtC1)	
	2101H	Status of AC drive	
		Bit 0-1	00B: RUN LED is off, STOP LED is on (The AC motor Drive stops)
			01B: RUN LED blinks, STOP LED is on (When AC motor drive decelerates to stop)
			10B: RUN LED is on, STOP LED blinks (When AC motor drive is standby)
			11B: RUN LED is on, STOP LED is off (When AC motor drive runs)
		Bit 2	1: JOG command
		Bit 3-4	00B: FWD LED is on, REV LED is off (When AC motor drive runs forward)
			01B: FWD LED is on, REV LED blinks (When AC motor drive runs from reverse to forward)
			10B: FWD LED blinks, REV LED is on (When AC motor drive runs from forward to reverse)
			11B: FWD LED is off, REV LED is on (When AC motor drive runs reverse)
		Bit 5-7	Reserved
		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 11-15	Reserved
	2102H	Frequency command (F)	
	2103H	Output frequency (H)	
	2104H	Output current (AXXX.X)	
	2105H	Reserved	
	2106H	Reserved	
	2107H	Reserved	

Content	Address	Function
	2108H	DC-BUS Voltage (UXXX.X)
	2109H	Output voltage (EXXX.X)
	210AH	Display temperature of IGBT (°C)

3.6 Exception response:

The AC motor drive is expected to return a normal response after receiving command messages from the master device. The following depicts the conditions when no normal response is replied to the master device.

The AC motor drive does not receive the messages due to a communication error; thus, the AC motor drive has no response. The master device will eventually process a timeout condition.

The AC motor drive receives the messages without a communication error, but cannot handle them. An exception response will be returned to the master device and an error message “CExx” will be displayed on the keypad of AC motor drive. The xx of “CExx” is a decimal code equal to the exception code that is described below.

In the exception response, the most significant bit of the original command code is set to 1, and an exception code which explains the condition that caused the exception is returned.

Example of an exception response of command code 06H and exception code 02H:

ASCII mode:

STX	‘:’
Address Low	‘0’
Address High	‘1’
Function Low	‘8’
Function High	‘6’
Exception code	‘0’
	‘2’
LRC CHK Low	‘7’
LRC CHK High	‘7’
END 1	CR
END 0	LF

RTU mode:

Address	01H
Function	86H
Exception code	02H
CRC CHK Low	C3H
CRC CHK High	A1H

The explanation of exception codes:

Exception code	Explanation
01	Illegal function code: The function code received in the command message is not available for the AC motor drive.
02	Illegal data address: The data address received in the command message is not available for the AC motor drive.
03	Illegal data value: The data value received in the command message is not available for the AC drive.
04	Slave device failure: The AC motor drive is unable to perform the requested action.
10	Communication time-out: If Pr.09.05 is not equal to 0.0, Pr.09.02=0~2, and there is no communication on the bus during the Time Out detection period (set by Pr.09.05), “cE10” will be shown on the keypad.

3.7 Communication program of PC:

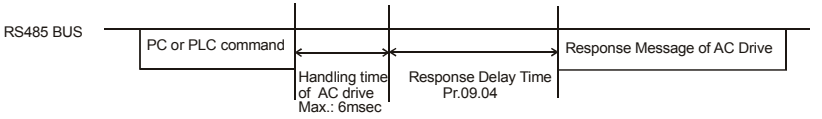
The following is a simple example of how to write a communication program for Modbus ASCII mode on a PC in C language.

```
#include<stdio.h>
#include<dos.h>
#include<conio.h>
#include<process.h>
#define PORT 0x03F8  /* the address of COM1 */
/* the address offset value relative to COM1 */
#define THR  0x0000
#define RDR  0x0000
#define BRDL  0x0000
#define IER  0x0001
#define BRDH 0x0001
#define LCR  0x0003
#define MCR  0x0004
#define LSR  0x0005
#define MSR  0x0006
unsigned char rdat[60];
/* read 2 data from address 2102H of AC drive with address 1 */
unsigned char tdat[60]={':','0','1','0','3','2','1','0','2', '0','0','0','2','D','7','\r','\n'};
void main(){
int i;
outportb(PORT+MCR,0x08);          /* interrupt enable */
```

```
outportb(PORT+IER,0x01);          /* interrupt as data in */
outportb(PORT+LCR,(inportb(PORT+LCR) | 0x80));
/* the BRDL/BRDH can be access as LCR.b7==1 */
outportb(PORT+BRDL,12);           /* set baudrate=9600, 12=115200/9600*/
outportb(PORT+BRDH,0x00);
outportb(PORT+LCR,0x06);          /* set protocol, <7,N,2>=06H, <7,E,1>=1AH,
<7,O,1>=0AH, <8,N,2>=07H, <8,E,1>=1BH, <8,O,1>=0BH   */
for(i=0;i<=16;i++){
while(!(inportb(PORT+LSR) & 0x20)); /* wait until THR empty */
outportb(PORT+THR,tdat[i]);      /* send data to THR */   }
i=0;
while(!kbhit()){
if(inportb(PORT+LSR) & 0x01){ /* b0==1, read data ready */
rdat[i++]=inportb(PORT+RDR); /* read data form RDR */
}   }   }
```

09.04	Response Delay Time	Unit: 2
	Settings 0 ~ 200 (400msec)	Factory Setting: 0

🕮 This parameter is the response delay time after AC drive receives communication command as shown in the following. 1 unit = 2 msec.



09.05	Time-out Detection	Unit: 0.1
	Settings 0.0 to 120.0 sec 0.0 Disable	Factory Setting: 0.0

🕮 If Pr.09.05 is not equal to 0.0, Pr.09.02=0~2, and there is no communication on the bus during the Time Out detection period (set by Pr.09.05), “cE10” will be shown on the keypad.

09.06	Reserved
09.07	Reserved

Group 10: PID Control

10.00	PID Set Point Selection	
		Factory Setting: 0
Settings	0	Disable
	1	Digital keypad UP/DOWN keys
	2	AVI 0 ~ +10VDC
	3	ACI 4 ~ 20mA / AVI2 0 ~ +10VDC
	4	PID set point (Pr.10.11)

10.01	Input Terminal for PID Feedback	
		Factory Setting: 0
Settings	0	**Positive** PID feedback from external terminal AVI (0 ~ +10VDC).
	1	**Negative** PID feedback from external terminal AVI (0 ~ +10VDC).
	2	**Positive** PID feedback from external terminal ACI (4 ~ 20mA)/ AVI2 (0 ~ +10VDC).
	3	**Negative** PID feedback from external terminal ACI (4 ~ 20mA)/ AVI2 (0 ~ +10VDC).

- Note that the measured variable (feedback) controls the output frequency (Hz). Select input terminal accordingly. Make sure this parameter setting does not conflict with the setting for Pr.10.00 (Master Frequency).
- When Pr.10.00 is set to 2 or 3, the set point (Master Frequency) for PID control is obtained from the AVI or ACI/AVI2 external terminal (0 to +10V or 4-20mA) or from multi-step speed. When Pr.10.00 is set to 1, the set point is obtained from the keypad.
- Negative feedback means: +target value – feedback
  Positive feedback means: -target value + feedback.

10.02	↗Proportional Gain (P)	Unit: 0. 1
Settings	0.0 to 10.0	Factory Setting: 1.0

- This parameter specifies proportional control and associated gain (P). If the other two gains (I and D) are set to zero, proportional control is the only one effective. With 10% deviation (error) and P=1, the output will be P x10% x Master Frequency.

NOTE

The parameter can be set during operation for easy tuning.

10.03	✓Integral Gain (I)	Unit: 0.01
	Settings 0.00 to 100.0 sec	Factory Setting: 1.00
	0.00 Disable	

🕮 This parameter specifies integral control (continual sum of the deviation) and associated gain (I). When the integral gain is set to 1 and the deviation is fixed, the output is equal to the input (deviation) once the integral time setting is attained.

The parameter can be set during operation for easy tuning.

10.04	✓Derivative Control (D)	Unit: 0.01
	Settings 0.00 to 1.00 sec	Factory Setting: 0.00

🕮 This parameter specifies derivative control (rate of change of the input) and associated gain (D). With this parameter set to 1, the PID output is equal to differential time x (present deviation – previous deviation). It increases the response speed but it may cause over-compensation.

The parameter can be set during operation for easy tuning.

10.05	Upper Bound for Integral Control	Unit: 1
	Settings 0 to 100 %	Factory Setting: 100

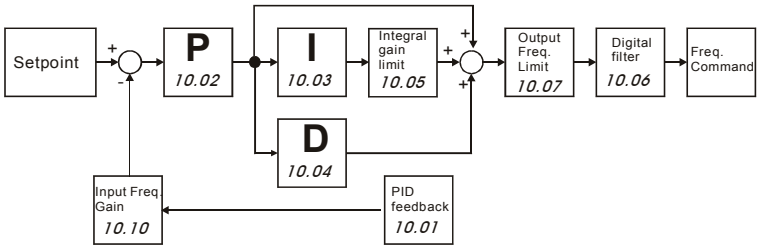
🕮 This parameter defines an upper bound or limit for the integral gain (I) and therefore limits the Master Frequency.

🕮 The formula is: Integral upper bound = Maximum Output Frequency (Pr.01.00) x (Pr.10.05). This parameter can limit the Maximum Output Frequency.

10.06	Primary Delay Filter Time	Unit: 0.1
	Settings 0.0 to 2.5 sec	Factory Setting: 0.0

🕮 To avoid amplification of measurement noise in the controller output, a derivative digital filter is inserted. This filter helps to dampen oscillations.

The complete PID diagram is in the following:



10.07	PID Output Frequency Limit	Unit: 1
	Settings 0 to 110 %	Factory Setting: 100

📖 This parameter defines the percentage of output frequency limit during the PID control. The formula is Output Frequency Limit = Maximum Output Frequency (Pr.01.00) X Pr.10.07 %. This parameter will limit the Maximum Output Frequency. An overall limit for the output frequency can be set in Pr.01.07.

10.08	PID Feedback Signal Detection Time	Unit: 0.1
	Settings 0.0 to d 3600 sec	Factory Setting: 60.0

📖 This parameter defines the time during which the PID feedback must be abnormal before a warning (see Pr.10.09) is given. It also can be modified according to the system feedback signal time.

📖 If this parameter is set to 0.0, the system would not detect any abnormality signal.

10.09	Treatment of the Erroneous Feedback Signals (for PID and PG feedback error)	
		Factory Setting: 0
	Settings 0 Warning and RAMP to stop	
	1 Warning and COAST to stop	
	2 Warning and keep operating	

📖 AC motor drive action when the feedback signals (analog PID feedback or PG (encoder) feedback) are abnormal according to Pr.10.16.

10.10	Gain Over the PID Detection Value	Unit: 0.1
	Settings 0.0 to 10.0	Factory Setting: 1.0

📖 This is the gain adjustment over the feedback detection value. Refer to PID control block diagram in Pr.10.06 for detail.

10.11	✓Source of PID Set point		Unit: 0.01
	Settings	0.00 to 600.0Hz	Factory Setting: 0.00

📖 This parameter is used in conjunction with Pr.10.00 set 4 to input a set point in Hz.

10.12	PID Offset Level		Unit: 0.1
	Settings	1.0 to 50.0%	Factory Setting: 10.0
10.13	Detection Time of PID Offset		Unit: 0.1
	Settings	0.1 to 300.0 sec	Factory Setting: 5.0

📖 This parameter is used to set detection of the offset between set point and feedback.

📖 When the offset is higher than the setting of Pr.10.12 for a time exceeding the setting of Pr.10.13, the AC motor drive will output a signal when Pr.03.00 ~ Pr.03.01 is set to 16.

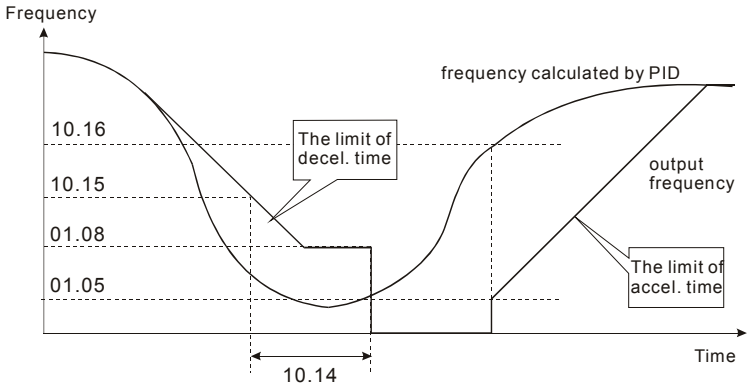
10.14	Sleep/Wake Up Detection Time		Unit: 0.1
	Settings	0.0 to 6550 sec	Factory Setting: 0.0
10.15	Sleep Frequency		Unit: 0.01
	Settings	0.00 to 600.0 Hz	Factory Setting: 0.00
10.16	Wakeup Frequency		Unit: 0.01
	Settings	0.00 to 600.0 Hz	Factory Setting: 0.00

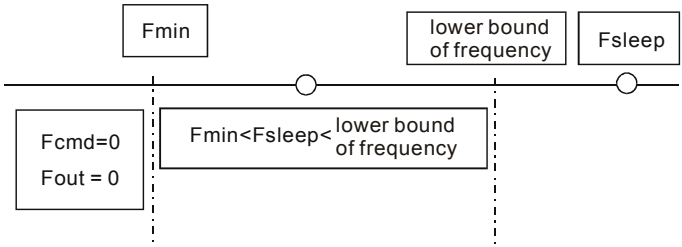
📖 When the actual output frequency $\leq$ Pr.10.15 and the time exceeds the setting of Pr.10.14, the AC motor drive will be in sleep mode.

📖 When the actual frequency command > Pr.10.16 and the time exceeds the setting of Pr.10.14, the AC motor drive will restart.

📖 When the AC motor drive is in sleep mode, frequency command is still calculated by PID. When frequency reaches wake up frequency, AC motor drive will accelerate from Pr.01.05 minimum frequency following the V/f curve.

📖 The wake up frequency must be higher than sleep frequency.





- When output frequency ≤ sleep frequency and time > detection time, it will go in sleep mode.
- When min. output frequency ≦ PID frequency ≦ lower bound of frequency and sleep function is enabled (output frequency ≤ sleep frequency and time > detection time), frequency will be 0 (in sleep mode). If sleep function is disabled, frequency command = lower bound frequency.
- When PID frequency < min. output frequency and sleep function is enabled (output frequency ≤ sleep frequency and time > detection time), output frequency =0 (in sleep mode).
  If output frequency ≤ sleep frequency but time < detection time, frequency command = lower frequency. If sleep function is disabled, output frequency =0.

10.17	Minimum PID Output Frequency Selection

Factory Setting: 0

Settings	0	By PID control
	1	By Minimum output frequency (Pr.01.05)

- This is the source selection of minimum output frequency when control is by PID.

Group 11: Parameters for Extension Card

Make sure that the extension card is installed on the AC motor drive correctly before using group 11 parameters. See Appendix B for details.

11.00	Multi-function Output Terminal MO2/RA2
11.01	Multi-function Output Terminal MO3/RA3
11.02	Multi-function Output Terminal MO4/RA4
11.03	Multi-function Output Terminal MO5/RA5
11.04	Multi-function Output Terminal MO6/RA6
11.05	Multi-function Output Terminal MO7/RA7
	Settings 0 to 21 Factory Setting: 0

Settings	Function	Description
0	No Function	
1	AC Drive Operational	Active when the drive is ready or RUN command is "ON".
2	Master Frequency Attained	Active when the AC motor drive reaches the output frequency setting.
3	Zero Speed	Active when Command Frequency is lower than the Minimum Output Frequency.
4	Over-Torque Detection	Active as long as over-torque is detected. (Refer to Pr.06.03 ~ Pr.06.05)
5	Baseblock (B.B.) Indication	Active when the output of the AC motor drive is shut off during baseblock. Base block can be forced by Multi-function input (setting 09).
6	Low-Voltage Indication	Active when low voltage (Lv) is detected.
7	Operation Mode Indication	Active when operation command is controlled by external terminal.
8	Fault Indication	Active when a fault occurs (oc, ov, oH, oL, oL1, EF, cF3, HPF, ocA, ocd, ocn, GFF).
9	Desired Frequency Attained	Active when the desired frequency (Pr.03.05) is attained.
10	Terminal Count Value Attained	Active when the counter reaches Terminal Count Value.
11	Preliminary Count Value Attained	Active when the counter reaches Preliminary Count Value.

Settings	Function	Description
12	Over Voltage Stall supervision	Active when the Over Voltage Stall function operating
13	Over Current Stall supervision	Active when the Over Current Stall function operating
14	Heat Sink Overheat Warning	When heatsink overheats, it will signal to prevent OH turn off the drive. When it is higher than 85°C (185°F), it will be ON.
15	Over Voltage supervision	Active when the DC-BUS voltage exceeds level
16	PID supervision	Active when the PID function is operating
17	Forward command	Active when the direction command is FWD
18	Reverse command	Active when the direction command is REV
19	Zero Speed Output Signal	Active unless there is an output frequency present at terminals U/T1, V/T2, and W/T3.
20	Communication Warning (FbE,Cexx, AoL2, AUE, SAvE)	Active when there is a Communication Warning
21	Brake Control (Desired Frequency Attained)	Active when output frequency ≥Pr.03.14. Deactivated when output frequency ≤Pr.03.15 after STOP command.

11.06	Multi-function Input Terminal (MI7)
11.07	Multi-function Input Terminal (MI8)
11.08	Multi-function Input Terminal (MI9)
11.09	Multi-function Input Terminal (MI10)
11.10	Multi-function Input Terminal (MI11)
11.11	Multi-function Input Terminal (MI12)

Settings 0 to 23 Factory Setting: 0

Settings	Function	Description
0	No Function	Any unused terminals should be programmed to 0 to insure they have no effect on operation.
1	Multi-Step Speed Command 1	These four inputs select the multi-speed defined by Pr.05.00 to Pr.05.14 as shown in the diagram at the end of the table in Pr.04.08.
2	Multi-Step Speed Command 2	

Settings	Function	Description
3	Multi-Step Speed Command 3	**NOTE: Pr.05.00 to Pr.05.14 can also be used to control output speed by programming the AC motor drive's internal PLC function. There are 17 step speed frequencies (including Master Frequency and Jog Frequency) to select for application.**
4	Multi-Step Speed Command 4	
5	External Reset	The External Reset has the same function as the Reset key on the Digital keypad. After faults such as O.H., O.C. and O.V. are cleared this input can be used to reset the drive.
6	Accel/Decel Inhibit	When the command is active, acceleration and deceleration is stopped and the AC motor drive maintains a constant speed.
7	Accel/Decel Time Selection Command	Used to select the one of 2 Accel/Decel Times (Pr.01.09 to Pr.01.12). See explanation at the end of this table.
8	Jog Operation Control	Parameter value 08 programs one of the Multi-function Input Terminals MI7 ~ MI12 (Pr.11.06~Pr.11.11) for Jog control. **NOTE: Programming for Jog operation by 08 can only be done while the motor is stopped. (Refer to parameter Pr.01.13~Pr.01.15)**
9	External Base Block (Refer to Pr.08.06)	Parameter value 09 programs a Multi-function Input Terminals for external Base Block control. **NOTE: When a Base-Block signal is received, the AC motor drive will block all output and the motor will free run. When base block control is deactivated, the AC drive will start its speed search function and synchronize with the motor speed, and then accelerate to Master Frequency.**
10	UP: Increase Master Frequency	Increase/decrease the Master Frequency each time an input is received or continuously when the input stays active. When both inputs are active at the same time, the Master Frequency increase/decrease is halted. Please refer to Pr.02.07, 02.08. This function is also called "motor potentiometer".
11	DOWN: Decrease Master Frequency	
12	Counter Trigger	Parameter value 12 programs one of the Multi-function Input Terminals MI7 ~ MI12 (Pr.11.06~Pr.11.11) to increment the AC drive's internal counter. When an input is received, the counter is incremented by 1.

Settings	Function	Description
13	Counter Reset	When active, the counter is reset and inhibited. To enable counting the input should be OFF. Refer to Pr.03.05 and 03.06.
14	External Fault	Parameter value 14 programs one of the Multi-function Input Terminals MI7 ~ MI12 (Pr.11.06~Pr.11.11) to be External Fault (E.F.) inputs.
15	PID function disabled	When an input ON with this setting is ON, the PID function will be disabled.
16	Output Shutoff Stop	AC motor drive will stop output and the motor free run if one of these settings is enabled. If the status of terminal is changed, AC motor drive will restart from 0Hz.
17	Parameter lock enable	When this setting is enabled, all parameters will be locked and write parameters is disabled.
18	Operation Command Selection (Pr.02.01 setting/external terminals)	ON: Operation command via Ext. Terminals OFF: Operation command via Pr.02.01 setting Pr.02.01 is disabled if this parameter value 18 is set. See the explanation below this table.
19	Operation Command Selection (Pr 02.01 setting/Digital Keypad)	ON: Operation command via Digital Keypad OFF: Operation command via Pr.02.01 setting Pr.02.01 is disabled if this parameter value 19 is set. See the explanation below this table.
20	Operation Command Selection (Pr 02.01 setting/ Communication)	ON: Operation command via Communication OFF: Operation command via Pr.02.01 setting Pr.02.01 is disabled if this parameter value 20 is set. See the explanation below this table.
21	Forward/Reverse	This function has top priority to set the direction for running (If “Pr.02.04=0”)
22	Source of second frequency command enabled	Used to select the first/second frequency command source. Refer to Pr.02.00 and 02.09. ON: 2nd Frequency command source OFF: 1st Frequency command source

Settings	Function	Description
23	Run/Stop PLC Program	ON: Run PLC Program OFF: Stop PLC Program When operation command source is external terminal, the keypad cannot be used to change PLC status. And this function will be invalid when AC Motor drive is in PLC2 status.

Chapter 6 Fault Code Information

The AC motor drive has a comprehensive fault diagnostic system that includes several different alarms and fault messages. Once a fault is detected, the corresponding protective functions will be activated. The following faults are displayed as shown on the AC motor drive digital keypad display. The five most recent faults can be read from the digital keypad or communication.

Wait 5 seconds after a fault has been cleared before performing reset via keypad of input terminal.

6.1 Common Problems and Solutions

Fault Name	Fault Descriptions	Corrective Actions
oc	**Over current** Abnormal increase in current.	1. Check if motor power corresponds with the AC motor drive output power. 2. Check the wiring connections to U/T1, V/T2, W/T3 for possible short circuits. 3. Check the wiring connections between the AC motor drive and motor for possible short circuits, also to ground. 4. Check for loose contacts between AC motor drive and motor. 5. Increase the Acceleration Time. 6. Check for possible excessive loading conditions at the motor. 7. If there are still any abnormal conditions when operating the AC motor drive after a short-circuit is removed and the other points above are checked, it should be sent back to manufacturer.
ou	**Over voltage** The DC bus voltage has exceeded its maximum allowable value.	1. Check if the input voltage falls within the rated AC motor drive input voltage range. 2. Check for possible voltage transients. 3. DC-bus over-voltage may also be caused by motor regeneration. Either increase the Decel. Time or add an optional brake resistor (and brake unit). 4. Check whether the required braking power is within the specified limits.

Fault Name	Fault Descriptions	Corrective Actions
oH1 oH2	**Overheating** Heat sink temperature too high	1. Ensure that the ambient temperature falls within the specified temperature range. 2. Make sure that the ventilation holes are not obstructed. 3. Remove any foreign objects from the heatsinks and check for possible dirty heat sink fins. 4. Check the fan and clean it. 5. Provide enough spacing for adequate ventilation.
Lu	**Low voltage** The AC motor drive detects that the DC bus voltage has fallen below its minimum value.	1. Check whether the input voltage falls within the AC motor drive rated input voltage range. 2. Check whether the motor has sudden load. 3. Check for correct wiring of input power to R-S-T (for 3-phase models) without phase loss.
oL	**Overload** The AC motor drive detects excessive drive output current. **NOTE: The AC motor drive can withstand up to 150% of the rated current for a maximum of 60 seconds.**	1. Check whether the motor is overloaded. 2. Reduce torque compensation setting in Pr.07.02. 3. Take the next higher power AC motor drive model.
oL1	**Overload 1** Internal electronic overload trip	1. Check for possible motor overload. 2. Check electronic thermal overload setting. 3. Use a higher power motor. 4. Reduce the current level so that the drive output current does not exceed the value set by the Motor Rated Current Pr.07.00.
oL2	**Overload 2** Motor overload.	1. Reduce the motor load. 2. Adjust the over-torque detection setting to an appropriate setting (Pr.06.03 to Pr.06.05).
HPF1	**GFF hardware error**	Return to the factory.
HPF2	**CC (current clamp)**	
HPF3	**OC hardware error**	
HPF4	**OV hardware error**	
bb	**External Base Block.** (Refer to Pr. 08.07)	1. When the external input terminal (B.B) is active, the AC motor drive output will be turned off. 2. Deactivate the external input terminal (B.B) to operate the AC motor drive again.

Fault Name	Fault Descriptions	Corrective Actions
ocA	**Over-current during acceleration**	1. Short-circuit at motor output: Check for possible poor insulation at the output lines. 2. Torque boost too high: Decrease the torque compensation setting in Pr.07.02. 3. Acceleration Time too short: Increase the Acceleration Time. 4. AC motor drive output power is too small: Replace the AC motor drive with the next higher power model.
ocd	**Over-current during deceleration**	1. Short-circuit at motor output: Check for possible poor insulation at the output line. 2. Deceleration Time too short: Increase the Deceleration Time. 3. AC motor drive output power is too small: Replace the AC motor drive with the next higher power model.
ocn	**Over-current during steady state operation**	1. Short-circuit at motor output: Check for possible poor insulation at the output line. 2. Sudden increase in motor loading: Check for possible motor stall. 3. AC motor drive output power is too small: Replace the AC motor drive with the next higher power model.
EF	**External Fault**	1. When multi-function input terminals (MI3-MI9) are set to external fault, the AC motor drive stops output U, V and W. 2. Give RESET command after fault has been cleared.
cF 1.0	**Internal EEPROM can not be programmed.**	Return to the factory.
cF 1.1	**Internal EEPROM can not be programmed.**	Return to the factory.
cF2.0	**Internal EEPROM can not be read.**	1. Press RESET key to set all parameters to factory setting. 2. Return to the factory.
cF2.1	**Internal EEPROM can not be read.**	1. Press RESET key to set all parameters to factory setting. 2. Return to the factory.
cF3.0	**U-phase error**	Return to the factory.
cF3.1	**V-phase error**	
cF3.2	**W-phase error**	
cF3.3	**OV or LV**	
cF3.4 cF3.5	**Current sensor error**	

Fault Name	Fault Descriptions	Corrective Actions
GFF	**Ground fault**	When (one of) the output terminal(s) is grounded, short circuit current is more than 50% of AC motor drive rated current, the AC motor drive power module may be damaged. **NOTE: The short circuit protection is provided for AC motor drive protection, not for protection of the user.** 1. Check whether the IGBT power module is damaged. 2. Check for possible poor insulation at the output line.
cFA	**Auto accel/decel failure**	1. Check if the motor is suitable for operation by AC motor drive. 2. Check if the regenerative energy is too large. 3. Load may have changed suddenly.
cE--	**Communication Error**	1. Check the RS485 connection between the AC motor drive and RS485 master for loose wires and wiring to correct pins. 2. Check if the communication protocol, address, transmission speed, etc. are properly set. 3. Use the correct checksum calculation. 4. Please refer to group 9 in the chapter 5 for detail information.
codE	**Software protection failure**	Return to the factory.
AErr	**Analog signal error**	Check the wiring of ACI
FbE	**PID feedback signal error**	1. Check parameter settings (Pr.10.01) and AVI/ACI wiring. 2. Check for possible fault between system response time and the PID feedback signal detection time (Pr.10.08)
PHL	**Phase Loss**	Check Power Source Input if all 3 input phases are connected without loose contacts.
AUE	**Auto Tuning Error**	1. Check cabling between drive and motor 2. Retry again

6.2 Reset

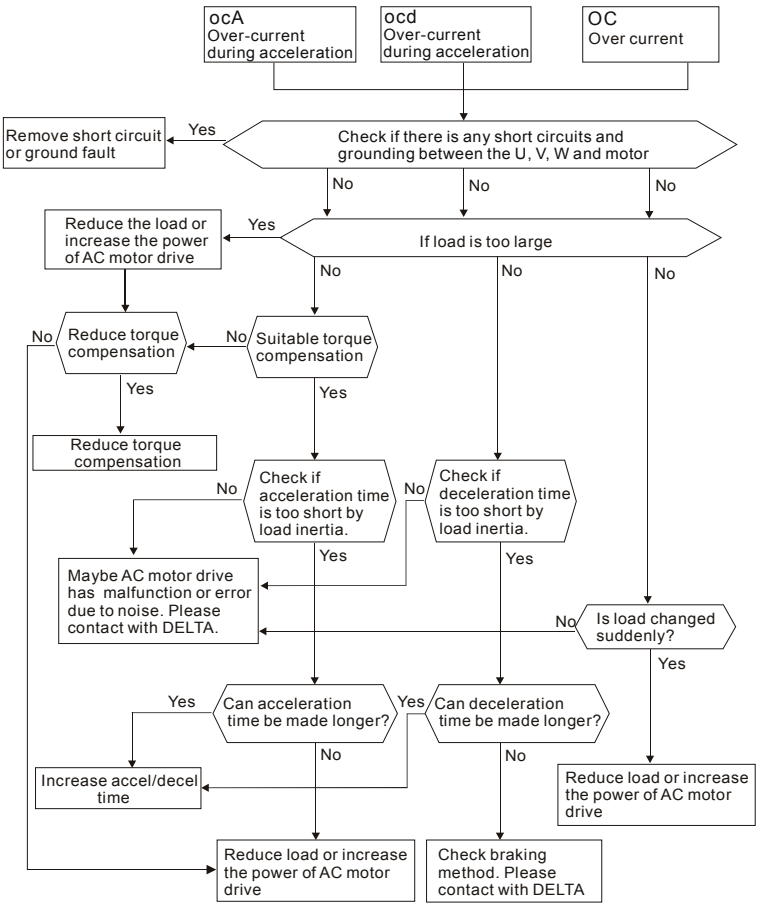
There are three methods to reset the AC motor drive after solving the fault:

1. Press STOP RESET key on keypad.
2. Set external terminal to “RESET” (set one of Pr.04.05~Pr.04.08 to 05) and then set to be ON.
3. Send “RESET” command by communication.

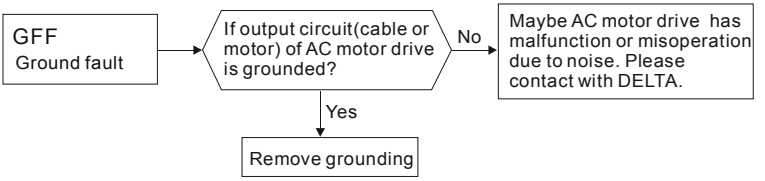
NOTE

Make sure that RUN command or signal is OFF before executing RESET to prevent damage or personal injury due to immediate operation.

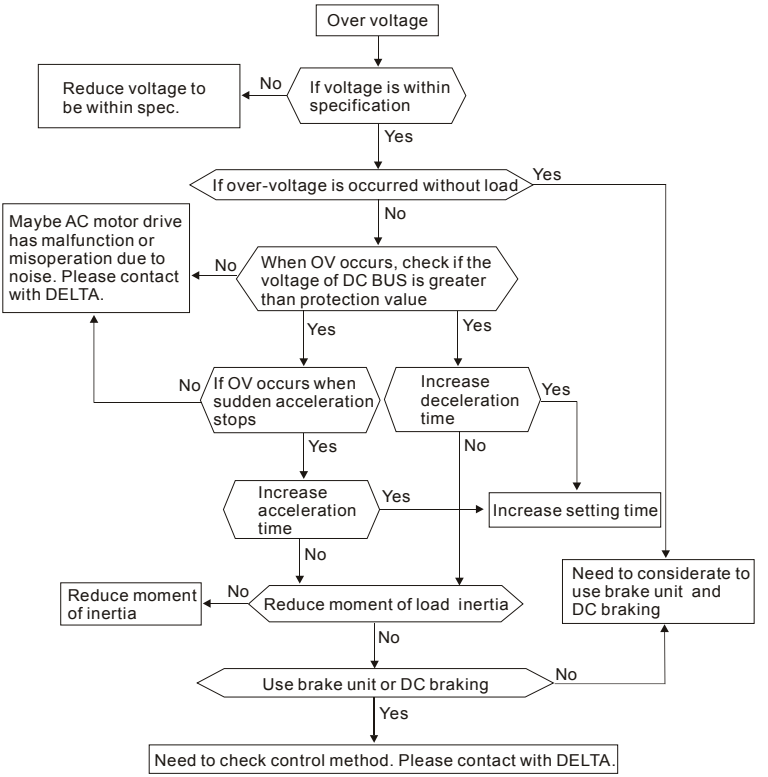
7.1 Over Current (OC)



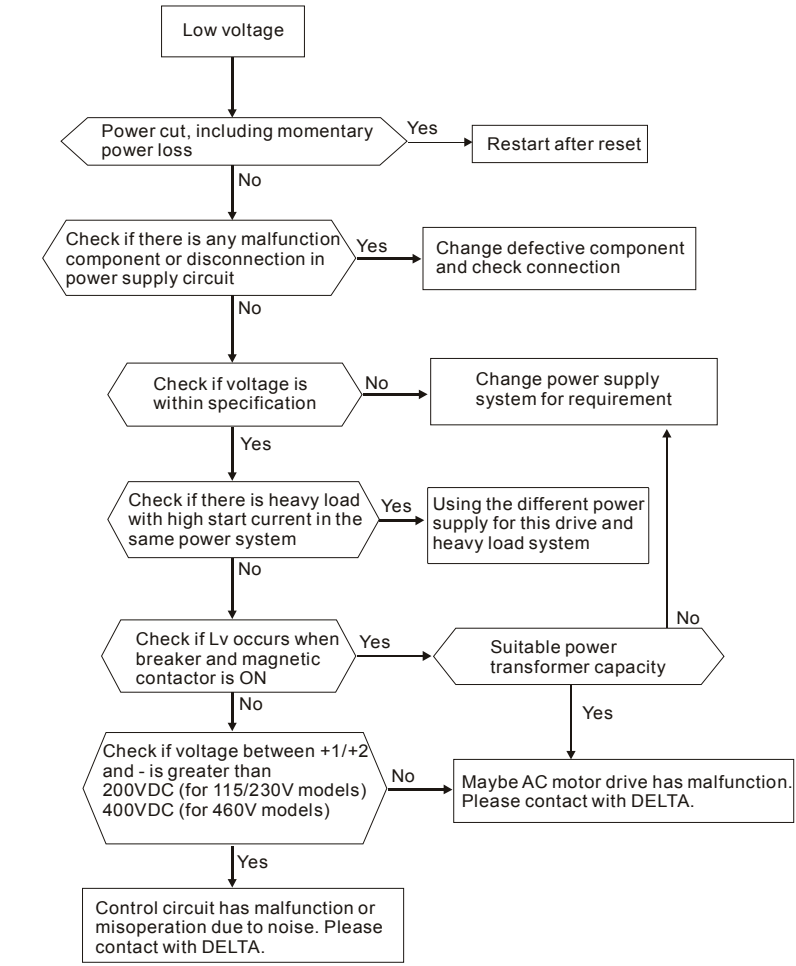
7.2 Ground Fault



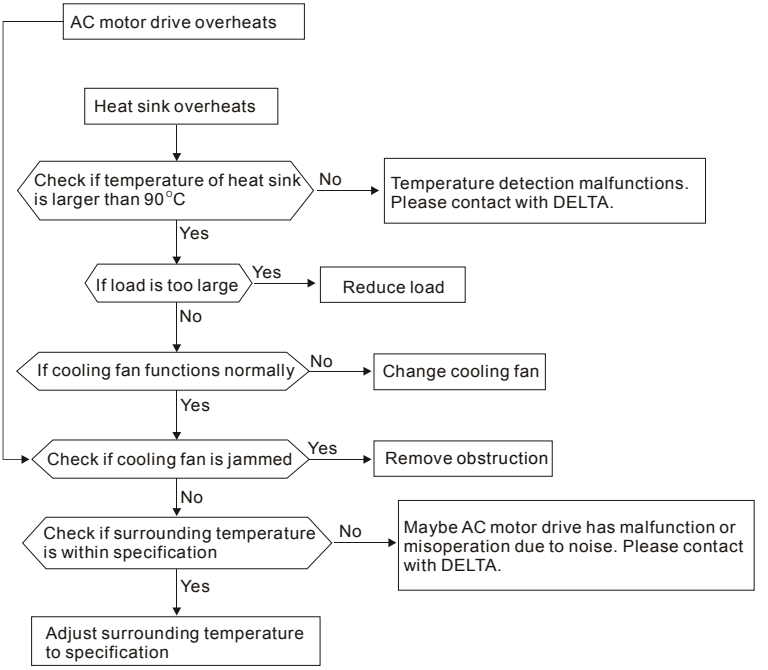
7.3 Over Voltage (OV)



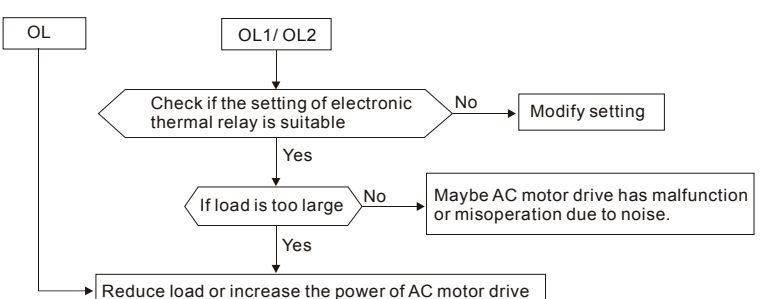
7.4 Low Voltage (Lv)



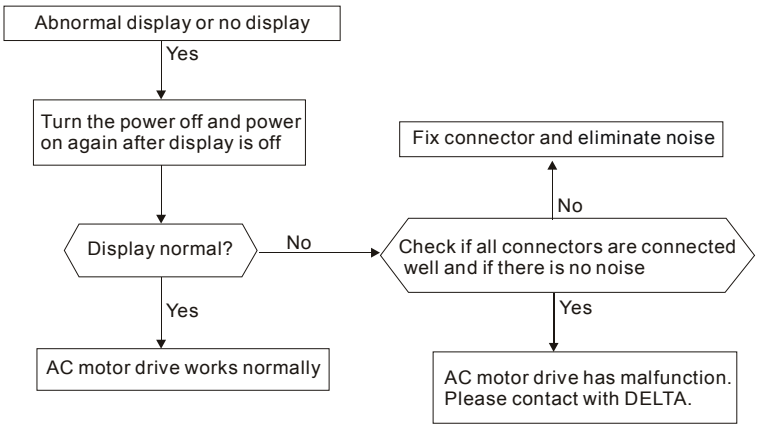
7.5 Over Heat (OH)



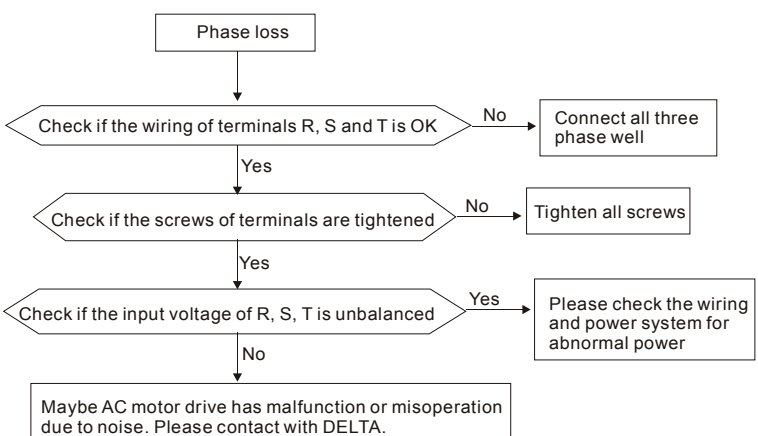
7.6 Overload



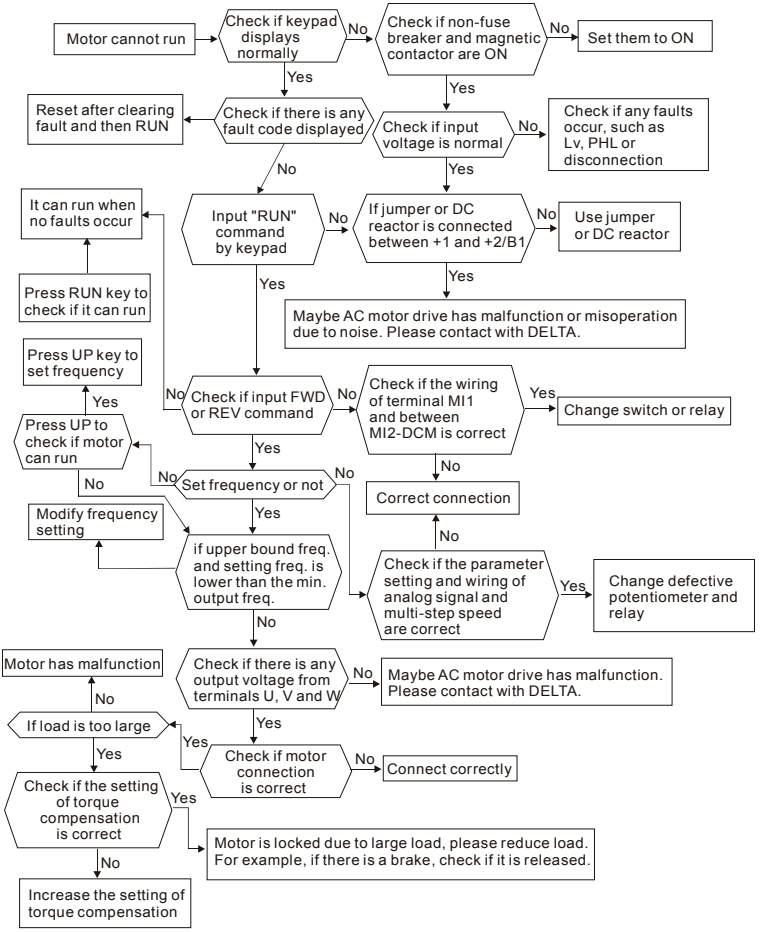
7.7 Keypad Display is Abnormal



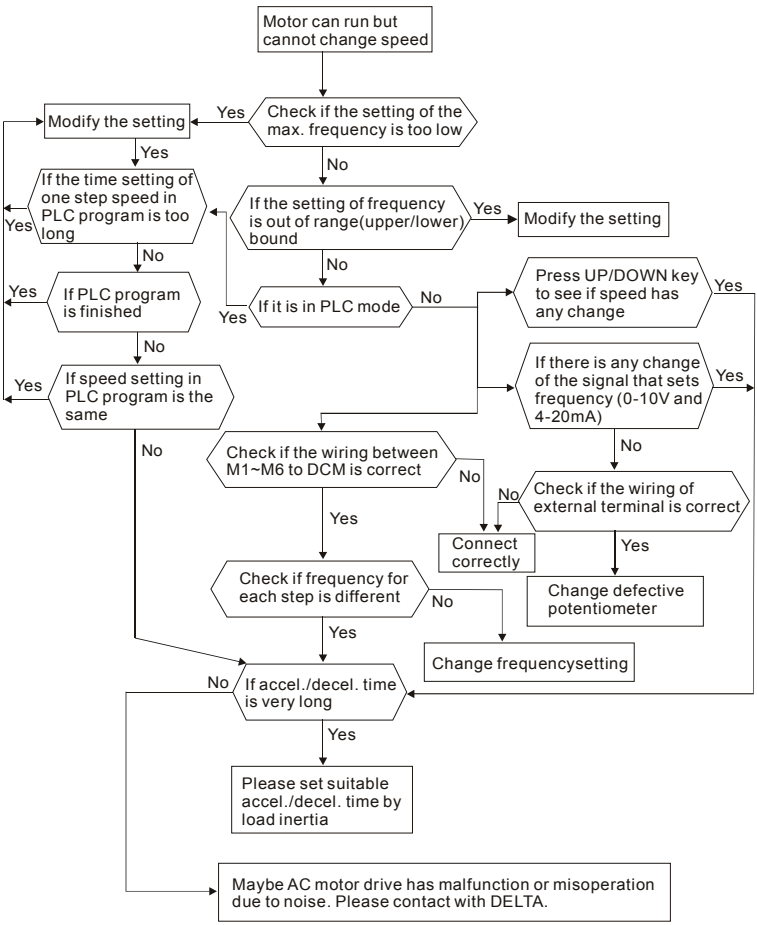
7.8 Phase Loss (PHL)



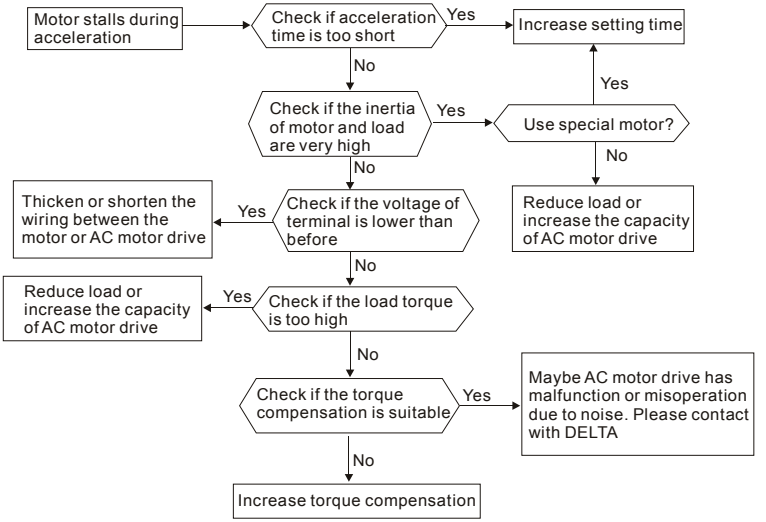
7.9 Motor cannot Run



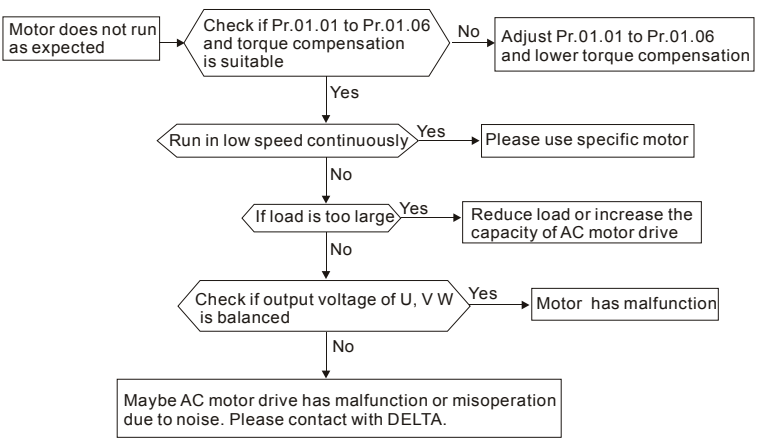
7.10 Motor Speed cannot be Changed



7.11 Motor Stalls during Acceleration



7.12 The Motor does not Run as Expected



7.13 Electromagnetic/Induction Noise

Many sources of noise surround AC motor drives and penetrate it by radiation or conduction. It may cause malfunctioning of the control circuits and even damage the AC motor drive. Of course, there are solutions to increase the noise tolerance of an AC motor drive. But this has its limits. Therefore, solving it from the outside as follows will be the best.

1. Add surge killers on the relays and contacts to suppress switching surges.
2. Shorten the wiring length of the control circuit or serial communication and keep them separated from the power circuit wiring.
3. Comply with the wiring regulations by using shielded wires and isolation amplifiers for long wires.
4. The grounding terminal should comply with the local regulations and be grounded independently, i.e. not to have common ground with electric welding machines and other power equipment.
5. Connect a noise filter at the mains input terminal of the AC motor drive to filter noise from the power circuit. VFD-E can have a built-in filter as option.

In short, solutions for electromagnetic noise exist of “no product”(disconnect disturbing equipment), “no spread”(limit emission for disturbing equipment) and “no receive”(enhance immunity).

7.14 Environmental Condition

Since an AC motor drive is an electronic device, you should comply with the environmental conditions as stated in the appendix A. Here are some remedial measures if necessary.

1. To prevent vibration, the use of anti-vibration dampers is the last choice. Vibrations must be within the specification. Vibration causes mechanical stress and it should not occur frequently, continuously or repeatedly to prevent damage to the AC motor drive.
2. Store the AC motor drive in a clean and dry location, free from corrosive fumes/dust to prevent corrosion and poor contacts. Poor insulation in a humid location can cause short-circuits. If necessary, install the AC motor drive in a dust-proof and painted enclosure and in particular situations, use a completely sealed enclosure.
3. The ambient temperature should be within the specification. Too high or too low temperature will affect the lifetime and reliability. For semiconductor components, damage will occur once any specification is out of range. Therefore, it is necessary to periodically check air quality and the cooling fan and provide extra cooling of necessary. In addition, the microcomputer may not work in extremely low temperatures, making cabinet heating necessary.

4. Store within a relative humidity range of 0% to 90% and non-condensing environment. Use an air conditioner and/or exsiccator.

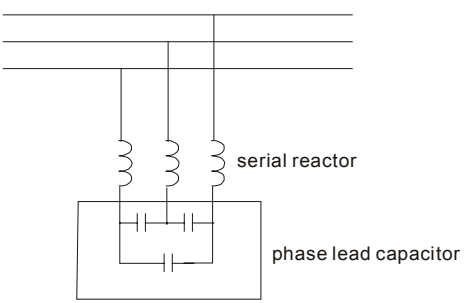
7.15 Affecting Other Machines

An AC motor drive may affect the operation of other machines due to many reasons. Some solutions are:

■ High Harmonics at Power Side

High harmonics at power side during running can be improved by:

1. Separate the power system: use a transformer for AC motor drive.
2. Use a reactor or rectifier at the power input terminal of the AC motor drive or decrease high harmonic by multiple circuit.
3. If phase lead capacitors are used (never on the AC motor drive output!!), use serial reactors to prevent damage to the capacitors damage from high harmonics.



■ Motor Temperature Rises

When the motor is a standard induction motor with fan, the cooling will be bad at low speeds, causing the motor to overheat. Besides, high harmonics at the output increases copper and core losses. The following measures should be used depending on load and operation range.

1. Use a motor with independent ventilation (forced external cooling) or increase the motor rated power.
2. Use a special inverter duty motor.
3. Do NOT run at low speeds for long times.

Chapter 8 Maintenance and Inspections

Modern AC motor drives are based on solid-state electronics technology. Preventive maintenance is required to keep the AC motor drive in its optimal condition, and to ensure a long life. It is recommended to have a qualified technician perform a check-up of the AC motor drive regularly.

Daily Inspection:

Basic check-up items to detect if there were any abnormalities during operation are:

1. Whether the motors are operating as expected.
2. Whether the installation environment is abnormal.
3. Whether the cooling system is operating as expected.
4. Whether any irregular vibration or sound occurred during operation.
5. Whether the motors are overheating during operation.
6. Always check the input voltage of the AC drive with a Voltmeter.

Periodic Inspection:

Before the check-up, always turn off the AC input power and remove the cover. Wait at least 10 minutes after all display lamps have gone out, and then confirm that the capacitors have fully discharged by measuring the voltage between ⊕ ~ ⊖. It should be less than 25VDC.

DANGER!

1. Disconnect AC power before processing!
2. Only qualified personnel shall install, wire and maintain AC motor drives. Please take off any metal objects, such as watches and rings, before operation. And only insulated tools are allowed.
3. Never reassemble internal components or wiring.
4. Prevent electric shocks.

Periodical Maintenance

■ **Ambient environment**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check the ambient temperature, humidity, vibration and see if there are any dust, gas, oil or water drops	Visual inspection and measurement with equipment with standard specification	○		
Check if there are any dangerous objects in the environment	Visual inspection	○		

■ **Voltage**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check if the voltage of main circuit and control circuit is correct	Measure with multimeter with standard specification	○		

■ **Keypad**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Is the display clear for reading?	Visual inspection	○		
Any missing characters?	Visual inspection	○		

■ **Mechanical parts**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual and aural inspection		○	
If there are any loose screws	Tighten the screws		○	

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If any part is deformed or damaged	Visual inspection		O	
If there is any color change by overheating	Visual inspection		O	
If there is any dust or dirt	Visual inspection		O	

■ **Main circuit**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose or missing screws	Tighten or replace the screw		O	
If machine or insulator is deformed, cracked, damaged or with changed color change due to overheating or ageing	Visual inspection **NOTE: Please ignore the color change of copper plate**		O	
If there is any dust or dirt	Visual inspection		O	

■ **Terminals and wiring of main circuit**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If the wiring shows change of color change or deformation due to overheat	Visual inspection		O	
If the insulation of wiring is damaged or the color has changed	Visual inspection		O	
If there is any damage	Visual inspection		O	

■ **DC capacity of main circuit**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any leakage of liquid, change of color, cracks or deformation	Visual inspection	○		
Measure static capacity when required	Static capacity ≥ initial value X 0.85		○	

■ **Resistor of main circuit**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any peculiar smell or insulator cracks due to overheating	Visual inspection, smell		○	
If there is any disconnection	Visual inspection or measure with multimeter after removing wiring between +1/+2 ~ - Resistor value should be within ± 10%		○	

■ **Transformer and reactor of main circuit**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal vibration or peculiar smell	Visual, aural inspection and smell		○	

■ **Magnetic contactor and relay of main circuit**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws	Visual and aural inspection. Tighten screw if necessary.	○		
If the contact works correctly	Visual inspection	○		

■ **Printed circuit board and connector of main circuit**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws and connectors	Tighten the screws and press the connectors firmly in place.		O	
If there is any peculiar smell and color change	Visual inspection and smell		O	
If there is any crack, damage, deformation or corrosion	Visual inspection		O	
If there is any leaked liquid or deformation in capacitors	Visual inspection		O	

■ **Cooling fan of cooling system**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual, aural inspection and turn the fan with hand (turn off the power before operation) to see if it rotates smoothly			O
If there is any loose screw	Tighten the screw			O
If there is any change of color due to overheating	Change fan			O

■ **Ventilation channel of cooling system**

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any obstruction in the heat sink, air intake or air outlet	Visual inspection	O		

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Appendix A Specifications

Voltage Class		115V Class		
Model Number VFD-XXXE		002	004	007
Max. Applicable Motor Output (kW)		0.2	0.4	0.75
Max. Applicable Motor Output (hp)		0.25	0.5	1.0
Output Rating	Rated Output Capacity (kVA)	0.6	1.0	1.6
	Rated Output Current (A)	1.6	2.5	4.2
	Maximum Output Voltage (V)	3-Phase Proportional to Twice the Input Voltage		
	Output Frequency (Hz)	0.1~400 Hz		
	Carrier Frequency (kHz)	1-15		
Input Rating	Rated Input Current (A)	Single-phase		
		6	9	18
	Rated Voltage/Frequency	Single phase, 100-120V, 50/60Hz		
	Voltage Tolerance	± 10%(90~132 V)		
	Frequency Tolerance	± 5%(47~63 Hz)		
Cooling Method		Natural Cooling		Fan Cooling
Weight (kg)		1.2	1.2	1.2

Voltage Class		230V Class							
Model Number VFD-XXXE		002	004	007	015	022	037	055	075
Max. Applicable Motor Output (kW)		0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5
Max. Applicable Motor Output (hp)		0.25	0.5	1.0	2.0	3.0	5.0	7.5	10
Output Rating	Rated Output Capacity (kVA)	0.6	1.0	1.6	2.9	4.2	6.5	9.5	12.5
	Rated Output Current (A)	1.6	2.5	4.2	7.5	11.0	17	25	33
	Maximum Output Voltage (V)	3-Phase Proportional to Input Voltage							
	Output Frequency (Hz)	0.1~400 Hz							
	Carrier Frequency (kHz)	1-15							
Input Rating	Rated Input Current (A)	Single/3-phase					3-phase		
		4.9/1.9	6.5/2.7	9.5/5.1	15.7/9	24/15	20.6	26	34
	Rated Voltage/Frequency	Single/3-phase 200-240 V, 50/60Hz					3-phase 200-240V, 50/60Hz		
	Voltage Tolerance	± 10%(180~264 V)							
	Frequency Tolerance	± 5%(47~63 Hz)							
Cooling Method		Natural Cooling			Fan Cooling				
Weight (kg)		1.1	1.1	1.1	1.9	1.9	1.9	3.5	3.5

Voltage Class		460V Class							
Model Number VFD-XXXE		004	007	015	022	037	055	075	110
Max. Applicable Motor Output (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11
Max. Applicable Motor Output (hp)		0.5	1.0	2.0	3.0	5.0	7.5	10	15
Output Rating	Rated Output Capacity (kVA)	1.2	2.0	3.3	4.4	6.8	9.9	13.7	18.3
	Rated Output Current (A)	1.5	2.5	4.2	5.5	8.2	13	18	24
	Maximum Output Voltage (V)	3-Phase Proportional to Input Voltage							
	Output Frequency (Hz)	0.1~400 Hz							
	Carrier Frequency (kHz)	1-15							
Input Rating	Rated Input Current (A)	3-phase							
		1.9	3.2	4.3	7.1	11.2	14	19	26
	Rated Voltage/Frequency	3-phase, 380-480V, 50/60Hz							
	Voltage Tolerance	± 10%(342~528V)							
	Frequency Tolerance	± 5%(47~63Hz)							
Cooling Method		Natural Cooling		Fan Cooling					
Weight (kg)		1.2	1.2	1.2	1.9	1.9	4.2	4.2	4.2

General Specifications			
Control Characteristics	Control System		SPWM(Sinusoidal Pulse Width Modulation) control (V/f or sensorless vector control)
	Frequency Setting Resolution		0.01Hz
	Output Frequency Resolution		0.01Hz
	Torque Characteristics		Including the auto-torque/auto-slip compensation; starting torque can be 150% at 5.0Hz
	Overload Endurance		150% of rated current for 1 minute
	Skip Frequency		Three zones, setting range 0.1-400Hz
	Accel/Decel Time		0.1 to 600 seconds (2 Independent settings for Accel/Decel time)
	Stall Prevention Level		Setting 20 to 250% of rated current
	DC Braking		Operation frequency 0.1-600.0Hz, output 0-100% rated current Start time 0-60 seconds, stop time 0-60 seconds
	Regenerated Braking Torque		Approx. 20% (up to 125% possible with optional brake resistor or externally mounted brake unit, 1-15hp (0.75-11kW) models have brake chopper built-in)
	V/f Pattern		Adjustable V/f pattern
Operating Characteristics	Frequency Setting	Keypad	Setting by ▲ ▼
		External Signal	Potentiometer-5kΩ/0.5W, 0 to +10VDC, 4 to 20mA, RS-485 interface; Multi-function Inputs 3 to 9 (15 steps, Jog, up/down)
	Operation Setting Signal	Keypad	Set by RUNand STOP
		External Signal	2 wires/3 wires (Fwd, Rev, EF), JOG operation, RS-485 serial interface (MODBUS), programmable logic controller
	Multi-function Input Signal		Multi-step selection 0 to 15, Jog, accel/decel inhibit, 2 accel/decel switches, counter, , external Base Block (NC, NO), auxiliary motor control is invalid, ACI/AVI/AUI selections, driver reset, UP/DOWN key settings, NPN/PNP input selection

General Specifications		
	Multi-function Output Indication	AC drive operating, frequency attained, non-zero frequency, Base Block, fault indication, local/remote indication, auxiliary motor output, driver is ready, overheat alarm, emergency stop and status selections of input terminals (NC/NO)
	Analog Output Signal	Output frequency/current
Alarm Output Contact		Contact will be On when drive malfunctions (1 Form C/change-over contact and 1 open collector output) for standard type)
Operation Functions		Built-in PLC, AVR, accel/decel S-Curve, over-voltage/over-current stall prevention, 5 fault records, reverse inhibition, momentary power loss restart, DC braking, auto torque/slip compensation, auto tuning, adjustable carrier frequency, output frequency limits, parameter lock/reset, vector control, PID control, fan & pump control, external counter, MODBUS communication, abnormal reset, abnormal re-start, power-saving, sleep/revival function, digital frequency output, fan control, sleep/wake frequency, master/auxiliary frequency, 1st/2nd frequency source selections, 1st/2nd frequency source combination, NPN/PNP selection
Protection Functions		Over voltage, over current, under voltage, under current, external fault, overload, ground fault, overheating, electronic thermal, IGBT short circuit, PTC
Display Keypad		6-key, 7-segment LED with 4-digit, 5 status LEDs, master frequency, output frequency, output current, custom units, parameter values for setup and lock, faults, RUN, STOP, RESET, FWD/REV, JOG, PLC
Enviromental Conditions	Enclosure Rating	IP20
	Pollution Degree	2
	Installation Location	Altitude 1,000 m or lower, keep from corrosive gasses, liquid and dust
	Ambient Temperature	-10°C to 50°C (40°C for side-by-side mounting) Non-Condensing and not frozen
	Storage/ Transportation Temperature	-20 °C to 60 °C
	Ambient Humidity	Below 90% RH (non-condensing)
	Vibration	9.80665m/s^2 (1G) less than 20Hz, 5.88m/s2 (0.6G) at 20 to 50Hz
Approvals		

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Appendix B Accessories

B.1 All Brake Resistors & Brake Units Used in AC Motor Drives

Note: Please only use DELTA resistors and recommended values. Other resistors and values will void Delta's warranty. Please contact your nearest Delta representative for use of special resistors. The brake unit should be at least 10 cm away from AC motor drive to avoid possible interference. Refer to the "Brake unit Module User Manual" for further details.

Voltage	Applicable Motor		Full Load Torque Nm	Resistor value spec for each AC Motor Drive	Brake Unit Model BUE No. of Units Used	Brake Resistors Model and No. of Units Used		Braking Torque 10%ED	Min. Equivalent Resistor Value for each AC Motor Drive
	hp	kW							
115V	1/4	0.2	0.110	80W 200Ω	BUE20015	BR080W200	1	400	120Ω
	1/2	0.4	0.216	80W 200Ω	BUE20015	BR080W200	1	220	120Ω
	1	0.75	0.427	80W 200Ω	BUE20015	BR080W200	1	125	120Ω
230V Series	1/4	0.2	0.110	80W 200Ω	BUE20015	BR080W200	1	400	120Ω
	1/2	0.4	0.216	80W 200Ω	BUE20015	BR080W200	1	220	120Ω
	1	0.75	0.427	80W 200Ω	BUE20015	BR080W200	1	125	120Ω
	2	1.5	0.849	300W 100Ω		BR300W100	1	125	82Ω
	3	2.2	1.262	300W 100Ω		BR300W100	1	125	82Ω
	5	3.7	2.080	400W 40Ω		BR400W040	1	125	33Ω
	7.5	5.5	3.111	500W 30Ω		BR500W030	1	125	30Ω
	10	7.5	4.148	1000W 20Ω		BR1K0W020	1	125	20Ω
460V Series	1/2	0.4	0.216	80W 750Ω	BUE40015	BR080W750	1	230	470Ω
	1	0.75	0.427	80W 750Ω	BUE40015	BR080W750	1	125	470Ω
	2	1.5	0.849	300W 400Ω	BUE40015	BR300W400	1	125	470Ω
	3	2.2	1.262	300W 250Ω		BR300W250	1	125	160Ω
	5	3.7	2.080	400W 150Ω		BR400W150	1	125	130Ω
	7.5	5.5	3.111	500W 100Ω		BR500W100	1	125	91Ω
	10	7.5	4.148	1000W 75Ω		BR1K0W075	1	125	62Ω
	15	11	6.186	1000W 50Ω		BR1K0W050	1	125	39Ω

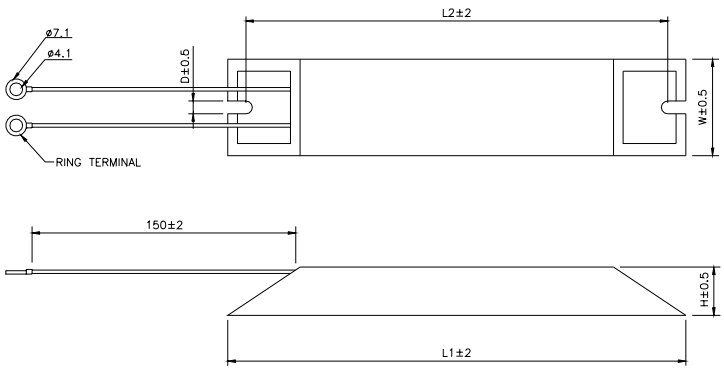
NOTE

1. Please select the brake unit and/or brake resistor according to the table.
2. If damage to the drive or other equipment is due to the fact that the brake resistors and the braking modules in use are not provided by Delta, the warranty will be void.
3. Take into consideration the safety of the environment when installing the brake resistors.
4. If the minimum resistance value is to be utilized, consult local dealers for the calculation of the power in Watt.
5. Please select thermal relay trip contact to prevent resistor over load. Use the contact to switch power off to the AC motor drive!
6. When using more than 2 brake units, equivalent resistor value of parallel brake unit can't be less than the value in the column "Minimum Equivalent Resistor Value for Each AC Drive" (the right-most column in the table).
7. Please read the wiring information in the user manual of the brake unit thoroughly prior to installation and operation.

B.1.1 Dimensions and Weights for Brake resistors

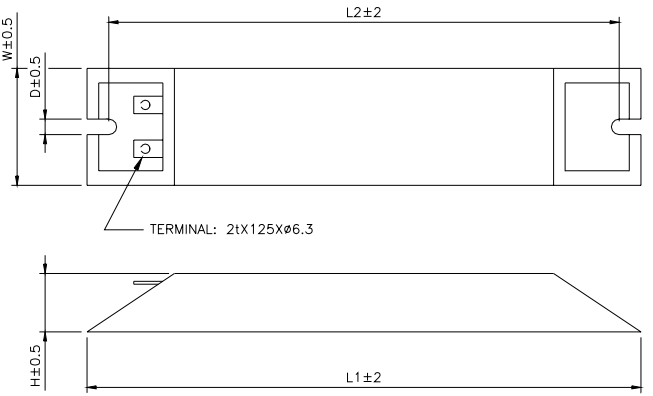
(Dimensions are in millimeter)

Order P/N: BR080W200, BR080W750, BR300W100, BR300W250, BR300W400, BR400W150, BR400W040



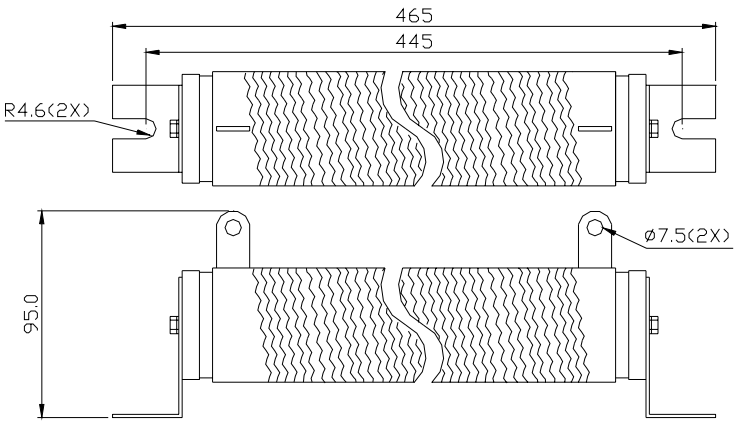
Model no.	L1	L2	H	D	W	Max. Weight (g)
BR080W200	140	125	20	5.3	60	160
BR080W750						
BR300W100	215	200	30	5.3	60	750
BR300W250						
BR300W400						
BR400W150	265	250	30	5.3	60	930
BR400W040						

Order P/N: BR500W030, BR500W100, BR1KW020, BR1KW075



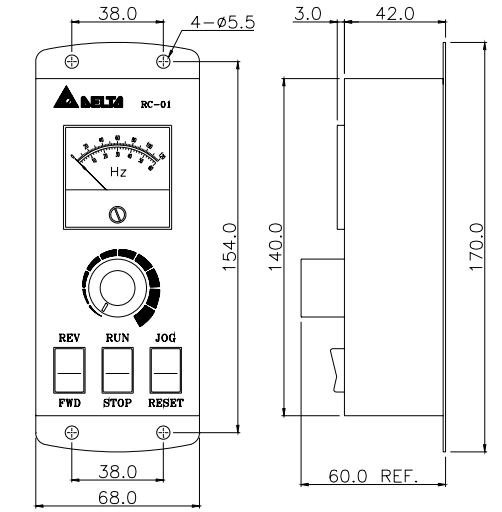
Model no.	L1	L2	H	D	W	Max. Weight (g)
BR500W030	335	320	30	5.3	60	1100
BR500W100						
BR1KW020	400	385	50	5.3	100	2800
BR1KW075						

Order P/N: BR1K0W050



B.2 Remote Controller RC-01

Dimensions are in millimeter



VFD-E Programming:

Pr.02.00 set to 2

Pr.02.01 set to 1 (external controls)

Pr.02.05 set to 1 (setting Run/Stop and Fwd/Rev controls)

Pr.04.07 (MI5) set to 5 (External reset)

Pr.04.08 (MI6) set to 8 (JOG operation)

B.3 AC Reactor

B.3.1 AC Input Reactor Recommended Value

230V, 50/60Hz, 1-Phase

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)
				3~5% impedance
0.2	1/4	4	6	6.5
0.4	1/2	5	7.5	3
0.75	1	8	12	1.5
1.5	2	12	18	1.25
2.2	3	18	27	0.8

460V, 50/60Hz, 3-Phase

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
0.4	1/2	2	3	20	32
0.75	1	4	6	9	12
1.5	2	4	6	6.5	9
2.2	3	8	12	5	7.5
3.7	5	8	12	3	5
5.5	7.5	12	18	2.5	4.2
7.5	10	18	27	1.5	2.5
11	15	25	37.5	1.2	2
15	20	35	52.5	0.8	1.2

B.3.2 AC Output Reactor Recommended Value

115V/230V, 50/60Hz, 3-Phase

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
0.2	1/4	4	4	9	12
0.4	1/2	6	6	6.5	9
0.75	1	8	12	3	5
1.5	2	8	12	1.5	3

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
2.2	3	12	18	1.25	2.5
3.7	5	18	27	0.8	1.5
5.5	7.5	25	37.5	0.5	1.2
7.5	10	35	52.5	0.4	0.8

460V, 50/60Hz, 3-Phase

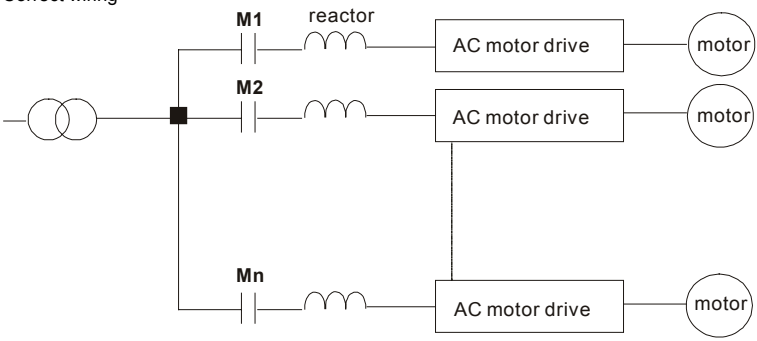
kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
0.4	1/2	2	3	20	32
0.75	1	4	6	9	12
1.5	2	4	6	6.5	9
2.2	3	8	12	5	7.5
3.7	5	12	18	2.5	4.2
5.5	7.5	18	27	1.5	2.5
7.5	10	18	27	1.5	2.5
11	15	25	37.5	1.2	2

B.3.3 Applications for AC Reactor

Connected in input circuit

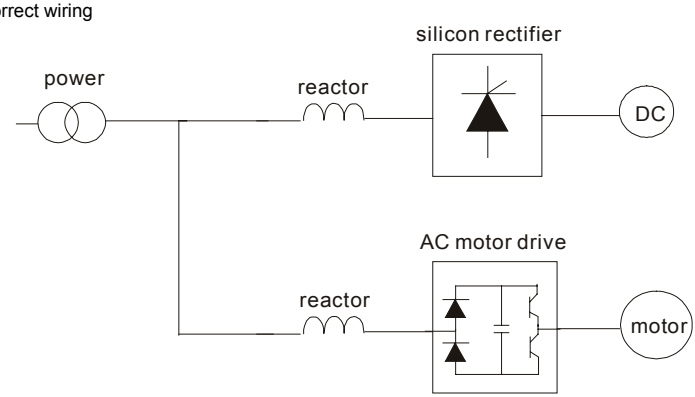
Application 1	Question
When more than one AC motor drive is connected to the same mains power, and one of them is ON during operation.	When applying power to one of the AC motor drive, the charge current of the capacitors may cause voltage dip. The AC motor drive may be damaged when over current occurs during operation.

Correct wiring



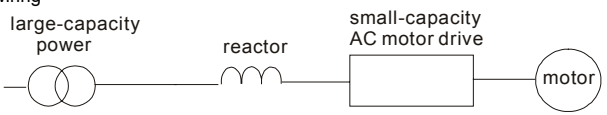
Application 2	Question
Silicon rectifier and AC motor drive are connected to the same power.	Switching spikes will be generated when the silicon rectifier switches on/off. These spikes may damage the mains circuit.

Correct wiring



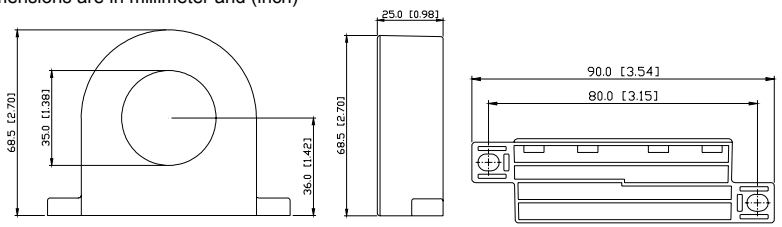
Application 3	Question
Used to improve the input power factor, to reduce harmonics and provide protection from AC line disturbances (surges, switching spikes, short interruptions, etc.). The AC line reactor should be installed when the power supply capacity is 500kVA or more and exceeds 6 times the inverter capacity, or the mains wiring distance $\leq$ 10m.	When the mains power capacity is too large, line impedance will be small and the charge current will be too high. This may damage AC motor drive due to higher rectifier temperature.

Correct wiring



B.4 Zero Phase Reactor (RF220X00A)

Dimensions are in millimeter and (inch)



	Motor		Qty.	Recommended Wire Size (mm^2)	Wiring Method
	HP	kW			
115V/230V Series	1/4	0.2	1	0.5 - 5.5	Diagram A
	1/2	0.4			
	1	0.75			
	2	1.5			
	3	2.2		3.5 - 5.5	
	5	3.7		5.5	
	7.5	5.5	4	8	Diagram B
	10	7.5			
460V Series	1/4	0.2	1	0.5 - 5.5	Diagram A
	1/2	0.4			
	1	0.75			
	2	1.5			
	3	2.2			
	5	3.7			
	7.5	5.5		3.5 - 5.5	
	10	7.5		5.5	
	15	11	4	8 - 14	Diagram B

Diagram A
Please wind each wire 4 times around the core. The reactor must be put at inverter output as close as possible.

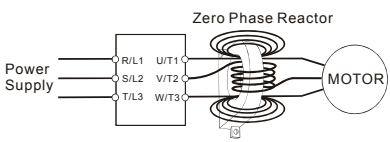
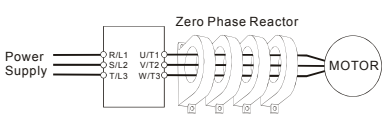


Diagram B
Please put all wires through 4 cores in series without winding.



B.5 Non-fuse Circuit Breaker Chart

Per UL 508C, paragraph 45.8.4, part a:

1. For 1-phase drives, the current rating of the breaker shall be 4 times maximum input current rating.
2. For 3-phase drives, the current rating of the breaker shall be 4 times maximum output current rating.

(Refer to Appendix A for rated input/output current)

1-phase		3-phase	
Model	**Recommended non-fuse breaker (A)**	**Model**	**Recommended non-fuse breaker (A)**
VFD002E11A	15	VFD002E23A	5
VFD002E21A	10	VFD004E23A	5
VFD004E11A	20	VFD004E43A	5
VFD004E21A	15	VFD007E23A	10
VFD007E11A	30	VFD007E43A	5
VFD007E21A	20	VFD015E23A	20
VFD015E21A	30	VFD015E43A	10
VFD022E21A	50	VFD022E23A	30
		VFD022E43A	15
		VFD037E23A	40
		VFD037E43A	20
		VFD055E23A	50
		VFD055E43A	30
		VFD075E23A	60
		VFD075E43A	40
		VFD110E43A	50

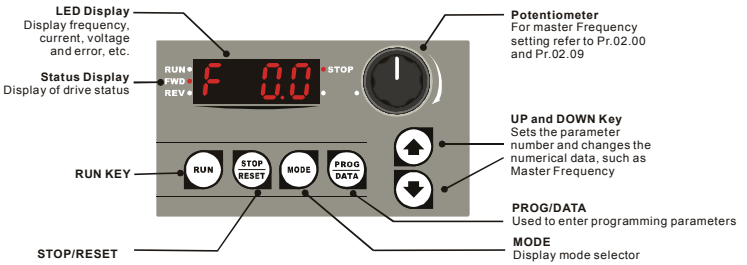
B.6 Fuse Specification Chart

Smaller fuses than those shown in the table are permitted.

Model	I (A) Input	I (A) Output	Line Fuse	
			I (A)	Bussmann P/N
VFD002E11A	6	1.6	15	JJN-15
VFD002E21A	4.9	1.6	10	JJN-10
VFD002E23A	1.9	1.6	5	JJN-6
VFD004E11A	9	2.5	20	JJN-20
VFD004E21A	6.5	2.5	15	JJN-15
VFD004E23A	2.7	2.5	5	JJN-6
VFD004E43A	1.9	1.5	5	JJS-6
VFD007E11A	18	4.2	30	JJN-30
VFD007E21A	9.7	4.2	20	JJN-20
VFD007E23A	5.1	4.2	10	JJN-10
VFD007E43A	3.2	2.5	5	JJS-6
VFD015E21A	15.7	7.5	30	JJN-30
VFD015E23A	9	7.5	20	JJN-20
VFD015E43A	4.3	4.2	10	JJS-10
VFD022E21A	24	11	50	JJN-50
VFD022E23A	15	11	30	JJN-30
VFD022E43A	7.1	5.5	15	JJS-15
VFD037E23A	20.6	17	40	JJN-40
VFD037E43A	11.2	8.2	20	JJS-20
VFD055E23A	26	25	50	JJN-50
VFD055E43A	14	13	30	JJS-30
VFD075E23A	34	33	60	JJN-60
VFD075E43A	19	18	40	JJS-40
VFD110E43A	26	24	50	JJS-50

B.7 KPE-LE01

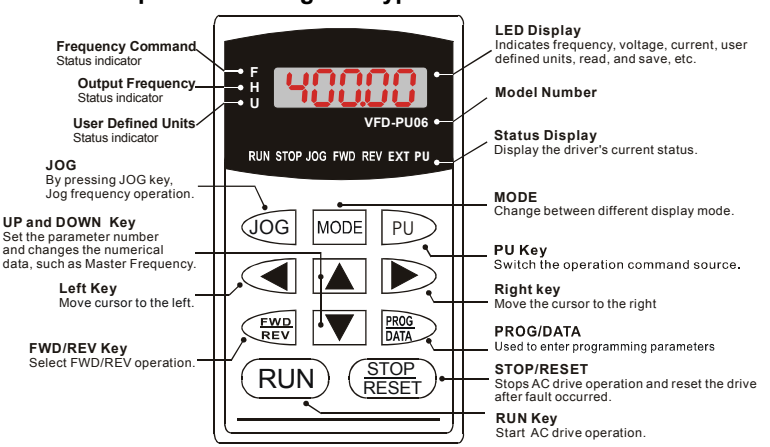
B.7.1 Description of the Digital keypad KPE-LE01



Refer to Chapter 4 for details.

B.8 PU06

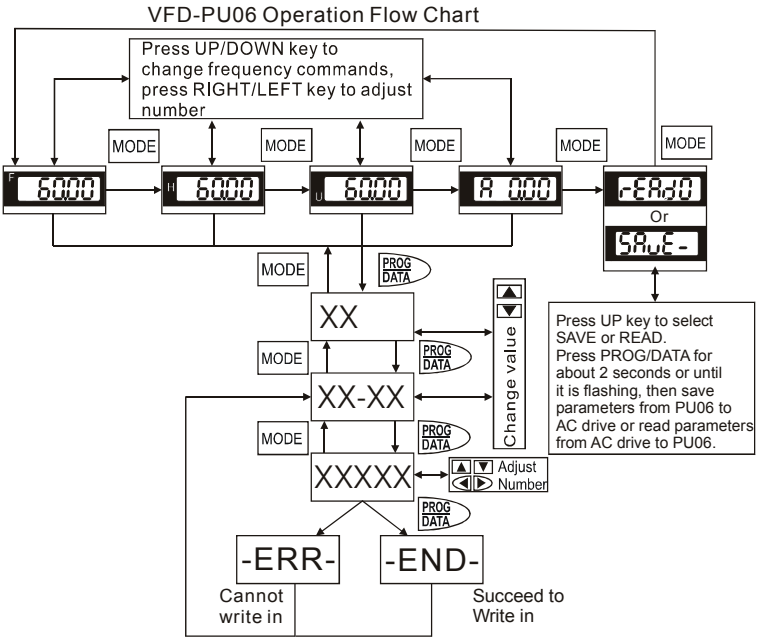
B.8.1 Description of the Digital keypad VFD-PU06



B.8.2 Explanation of Display Message

Display Message	Descriptions
	The AC motor drive Master Frequency Command.
	The Actual Operation Frequency present at terminals U, V, and W.
	The custom unit (u)
	The output current present at terminals U, V, and W.
	Press ▲ to change the mode to READ. Press PROG/DATA for about 2 sec or until it's flashing, read the parameters of AC drive to the digital keypad PU06. It can read 4 groups of parameters to PU06. (read 0 – read 3)
	Press ▲ to change the mode to SAVE. Press PROG/DATA for about 2 sec or until it's flashing, then write the parameters from the digital keypad PU06 to AC drive. If it has saved, it will show the type of AC motor drive.
	The specified parameter setting.
	The actual value stored in the specified parameter.
	External Fault
	"End" displays for approximately 1 second if the entered input data have been accepted. After a parameter value has been set, the new value is automatically stored in memory. To modify an entry, use the ▲ or ▼ keys.
	"Err" displays if the input is invalid.
	Communication Error. Please check the AC motor drive user manual (Chapter 5, Group 9 Communication Parameter) for more details.

B.8.3 Operation Flow Chart

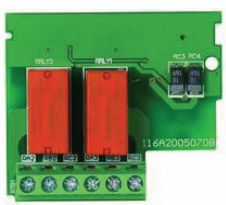


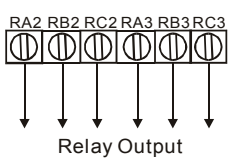
B.9 Extension Card

Installation method

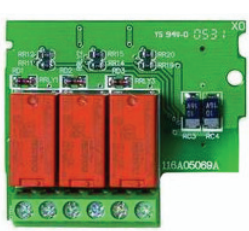
B.9.1 Relay Card

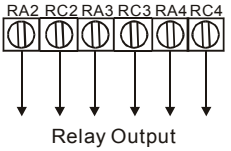
EME-R2CA





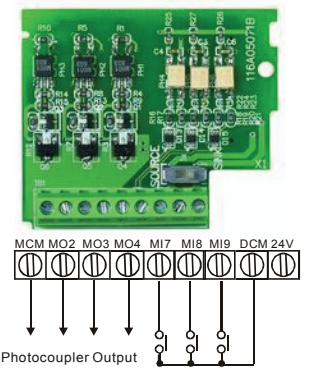
EME-R3AA





B.9.2 I/O Card

EME-D33A

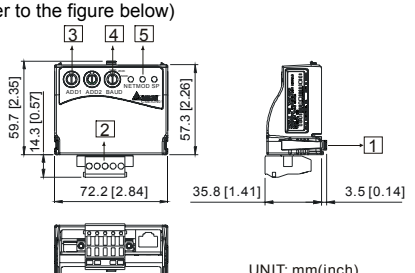


B.10 Fieldbus Modules

B.10.1 DeviceNet Communication Module (CME-DN01)

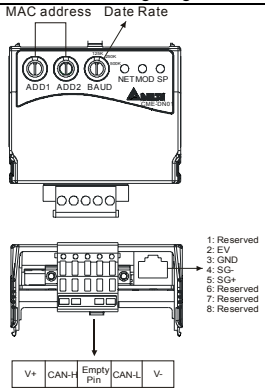
B.10.1.1 Panel Appearance and Dimensions

1. For RS-485 connection to VFD-E 2. Communication port for connecting DeviceNet network 3. Address selector 4. Baud rate selector 5. Three LED status indicators for monitor. (Refer to the figure below)

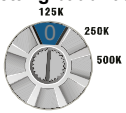


B.10.1.2 Wiring and Setting

Refer to following diagram for details.



Setting baud rate



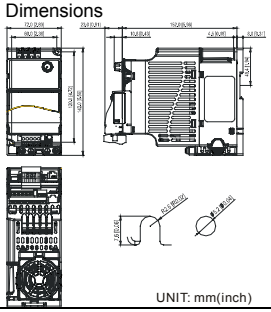
Switch Value	Baud Rate
0	125K
1	250K
2	500K
Other	AUTO

Setting MAC addresses: use decimal system.

B.10.1.3 Mounting Method

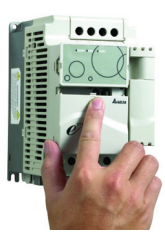
Step1 and step2 show how to mount this communication module onto VFD-E. The dimension on the left hand side is for your reference.

Dimensions



STEP 1

STEP 2



B.10.1.4 Power Supply

No external power is needed. Power is supplied via RS-485 port that is connected to VFD-E. An 8 pins RJ-45 cable, which is packed together with this communication module, is used to connect the RS-485 port between VFD-E and this communication

module for power. This communication module will perform the function once it is connected. Refer to the following paragraph for LED indications.

B.10.1.5 LEDs Display

1. **SP:** Green LED means in normal condition, Red LED means abnormal condition.
2. **Module:** Green blinking LED means no I/O data transmission, Green steady LED means I/O data transmission OK.

   Red LED blinking or steady LED means module communication is abnormal.
3. **Network:** Green LED means DeviceNet communication is normal, Red LED means abnormal

Refer to user manual for detail information-- *Chapter 5 Troubleshooting*.

B.10.2 LonWorks Communication Module (CME-LW01)

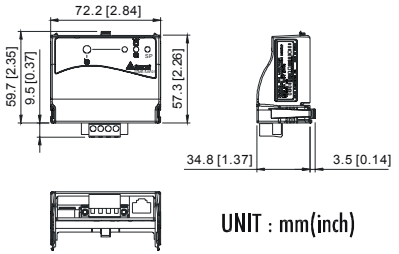
B.10.2.1 Introduction

Device CME-LW01 is used for communication interface between Modbus and LonTalk. CME-LW01 needs be configured via LonWorks network tool first, so that it can perform the function on LonWorks network. No need to set CME-LW01 address.

This manual provides instructions for the installation and setup for CME-LW01 that is used to communicate with Delta VFD-E (firmware version of VFD-E should conform with CME-LW01 according to the table below) via LonWorks Network. Refer to Chapter 4 in user manual for nvoDriveID.

Delta AC Drive		CME-LW01
Series	Firmware Version	nvoDrive ID
VFD-E	Version 2.02 or higher	6

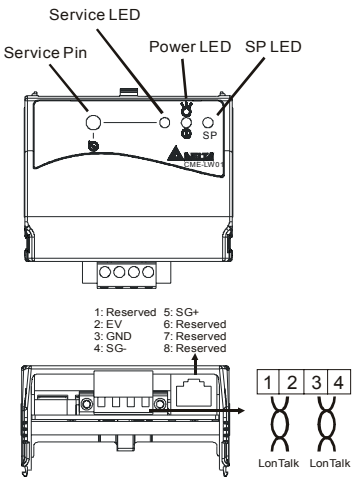
B.10.2.2 Dimensions



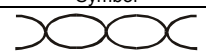
B.10.2.3 Specification

Power supply:	16-30VDC, 750mW
Communication:	Modbus in ASCII format, protocol: 9600, 7, N, 2
LonTalk:	free topology with FTT-10A 78 Kbps.
LonTalk terminal:	9 terminals, wire gauge: 28-12 AWG, wire strip length: 7-8mm
RS-485 port:	8 pins with RJ-45

B.10.2.4 Wiring



■ *Terminal definition for LonTalk system*

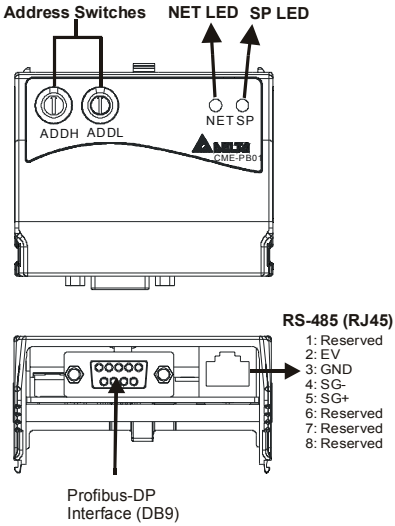
Terminal	Symbol	Function
1		These are twisted pair cables to connect to LonTalk system. Terminals 1 and 2 should be used as one group, and the same for terminals 3 and 4.
2		
3		
4		

B.10.2.5 LED Indications

There are three LEDs in front panel of CME-LW01. If the communication is normal, power LED, SP LED should be green (red LED means abnormal communication) and service LED should be OFF. If LEDs display do not match, refer to user manual for details.

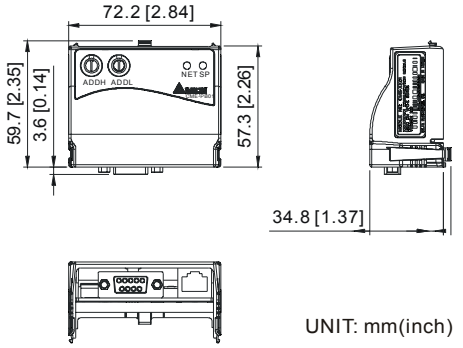
B.10.3 Profibus Communication Module (CME-PB01)

B.10.3.1 Panel Appearance



1. SP LED: Indicating the connection status between VFD-E and CME-PB01.
2. NET LED: Indicating the connection status between CME-PB01 and PROFIBUS-DP.
3. Address Switches: Setting the address of CME-PB01 on PROFIBUS- DP network.
4. RS-485 Interface (RJ45): Connecting to VFD-E, and supply power to CME-PB01.
5. PROFIBUS-DP Interface (DB9): 9-PIN connector that connects to PROFIBUS-DP network.
6. Extended Socket: 4-PIN socket that connects to PROFIBUS-DP network.

B.10.3.1 Dimensions



UNIT: mm(inch)

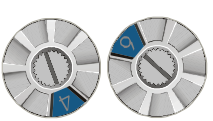
B.10.3.2 Parameters setting in VFD-E

	VFD-E
Baud Rate 9600	Pr.09.01=1
RTU 8, N, 2	Pr.09.03=3
Freq. Source	Pr.02.00=4
Command Source	Pr.02.01=3

B.10.3.3 Power Supply

The power of CME-PB01 is supplied from VFD-E. Please connect VFD-E to CME-PB01 by using 8 pins RJ-45 cable, which is packed together with CME-PB01. After connection is completed, CME-PB01 is powered whenever power is applied to VFD-E.

B.10.3.4 PROFIBUS Address



CME-PB01 has two rotary switches for the user to select the PROFIBUS address. The set value via 2 address switches, ADDH and ADDL, is in HEX format. ADDH sets the upper 4 bits, and ADDL sets the lower 4 bits of the PROFIBUS address.

Address	Meaning
1..0x7D	Valid PROFIBUS address
0 or 0x7E..0xFE	Invalid PROFIBUS address

Appendix C How to Select the Right AC Motor Drive

The choice of the right AC motor drive for the application is very important and has great influence on its lifetime and the performance. If the capacity of AC motor drive is too large, it cannot offer complete protection to the motor and it may be damaged. If the capacity of AC motor drive is too small, it cannot offer the required performance and the AC motor drive may be damaged due to overloading.

But by simply selecting the AC motor drive of the same capacity as the motor, user application requirements cannot always be fully met. Therefore, a designer should consider all the conditions, including load type, load speed, load characteristic, operation method, rated output, rated speed, power and the change of load capacity. The following table lists the factors you need to consider, depending on your requirements.

Item		Related Specification			
		Speed and torque characteristics	Time ratings	Overload capacity	Starting torque
Load type	Friction load and weight load Liquid (viscous) load Inertia load Load with power transmission	●			●
Load speed and torque characteristics	Constant torque Constant output Decreasing torque Decreasing output	●	●		
Load characteristics	Constant load Shock load Repetitive load High starting torque Low starting torque	●	●	●	●
Continuous operation, Short-time operation Long-time operation at medium/low speeds			●	●	
Maximum output current (instantaneous) Constant output current (continuous)		●		●	
Maximum frequency, Base frequency		●			
Power supply transformer capacity or percentage impedance Voltage fluctuations and unbalance Number of phases, single phase protection Frequency				●	●
Mechanical friction, losses in wiring				●	●
Duty cycle modification			●		

C.1 Capacity Formulas

1. When one AC motor drive operates one motor

The starting capacity should be less than 1.5x rated capacity of AC motor drive

The starting capacity is

$$\frac{k \times N}{973 \times \eta \times \cos\varphi}\left(T_L + \frac{GD^2}{375} \times \frac{N}{t_A}\right) \leq 1.5 \times the\_capacity\_of\_AC\_motor\_drive(kVA)$$

2. When one AC motor drive operates more than one motor

2.1 The starting capacity should be less than the rated capacity of the AC motor drive

■ *Acceleration time ≦60 seconds*

The starting capacity is

$$\frac{k \times N}{\eta \times \cos\varphi}\left[n_T + n_S(k_{S-1})\right] = P_{C1}\left[1 + \frac{n_L}{n_T}(k_{S-1})\right] \leq 1.5 \times the\_capacity\_of\_AC\_motor\_drive(kVA)$$

■ *Acceleration time ≧60 seconds*

The starting capacity is

$$\frac{k \times N}{\eta \times \cos\varphi}\left[n_T + n_S(k_{S-1})\right] = P_{C1}\left[1 + \frac{n_L}{n_T}(k_{S-1})\right] \leq the\_capacity\_of\_AC\_motor\_drive(kVA)$$

2.2 The current should be less than the rated current of the AC motor drive(A)

■ *Acceleration time ≦60 seconds*

$$n_T + I_M\left[1 + \frac{n_S}{n_T}(k_S - 1)\right] \leq 1.5 \times the\_rated\_current\_of\_AC\_motor\_drive(A)$$

■ *Acceleration time ≧60 seconds*

$$n_T + I_M\left[1 + \frac{n_S}{n_T}(k_S - 1)\right] \leq the\_rated\_current\_of\_AC\_motor\_drive(A)$$

2.3 When it is running continuously

■ The *requirement* of load capacity should be less than the capacity of the AC motor drive(kVA)

The requirement of load capacity is

$$\frac{k \times P_M}{\eta \times \cos\varphi} \leq the\_capacity\_of\_AC\_motor\_drive(kVA)$$

■ *The motor capacity should be less than the capacity of AC motor drive*

$$k \times \sqrt{3} \times V_M \times I_M \times 10^{-3} \leq the\_capacity\_of\_AC\_motor\_drive(kVA)$$

■ *The current should be less than the rated current of AC motor drive(A)*

$$k \times I_M \leq the\_rated\_current\_of\_AC\_motor\_drive(A)$$

Symbol explanation

P_M	: Motor shaft output for load (kW)
η	: Motor efficiency (normally, approx. 0.85)
$\cos\varphi$	: Motor power factor (normally, approx. 0.75)
V_M	: Motor rated voltage (V)
I_M	: Motor rated current (A), for commercial power
k	: Correction factor calculated from current distortion factor (1.05-1.1, depending on PWM method)
P_{C1}	: Continuous motor capacity (kVA)
k_S	: Starting current/rated current of motor
n_T	: Number of motors in parallel
n_S	: Number of simultaneously started motors
GD^2	: Total inertia (GD^2) calculated back to motor shaft (kg m^2)
T_L	: Load torque
t_A	: Motor acceleration time
N	: Motor speed

C.2 General Precautions

Selection Note

A. When the AC Motor Drive is connected directly to a large-capacity power transformer (600kVA or above) or when phase lead capacitors are switched, excess peak currents may occur in the power input circuit and the rectifier section might be damaged. To avoid this, use an AC input reactor (optional) before AC Motor Drive mains input to reduce the current and improve the input power efficiency.

B. When a special motor is used or more than one motor is driven in parallel with a single AC Motor Drive, select the AC Motor Drive current ≥1.25x(Sum of the motor rated currents).

C. The starting and accel./decel. characteristics of a motor are limited by the rated current and the overload protection of the AC Motor Drive. Compared to running the motor D.O.L. (Direct On-Line), a lower starting torque output with AC Motor Drive can be expected. If higher starting torque is required (such as for elevators, mixers, tooling machines, etc.) use an AC Motor Drive of higher capacity or increase the capacities for both the motor and the AC Motor Drive.

D. When an error occurs on the drive, a protective circuit will be activated and the AC Motor Drive output is turned off and the motor will coast to stop. For an emergency stop, an external mechanical brake is needed to quickly stop the motor.

Parameter Settings Note

A. The AC Motor Drive can be driven at an output frequency up to 400Hz (less for some models). Setting errors may create a dangerous situation. For safety, the use of the upper limit frequency function is strongly recommended.

B. High DC braking operating voltages and long operation time (at low frequencies) may cause overheating of the motor. In that case, forced external motor cooling is recommended.

C. Motor accel./decel. time is determined by motor rated torque, load torque, and load inertia.

D. If the stall prevention function is activated, the accel./decel. time is automatically extended to a length that the AC Motor Drive can handle. If the motor needs to decelerate within a certain time with high load inertia that can't be handled by the AC Motor Drive in the required time, either use an external brake resistor and/or brake unit, depending on the model, (to shorten deceleration time only) or increase the capacity for both the motor and the AC Motor Drive.

C.3 How to Choose a Suitable Motor

Standard motor

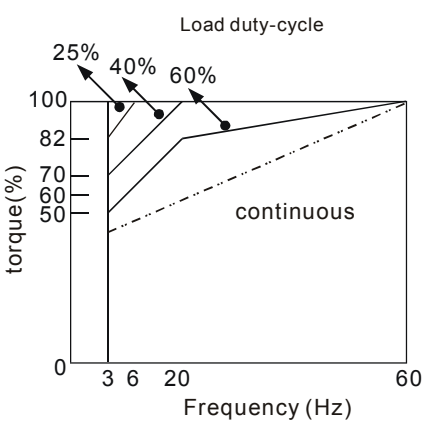
When using the AC Motor Drive to control a standard 3-phase induction motor, take the following precautions:

A. The motor losses are greater than for an inverter duty motor.

B. Avoid running the motor at low speed for a long time. Under this condition, the motor temperature may rise above the motor rating due to limited airflow produced by the motor's fan. Consider external forced motor cooling.

C. When the standard motor operates at low speed for long time, the output load must be decreased.

D. The load tolerance of a standard motor is as follows:



E. If 100% continuous torque is required at low speed, it may be necessary to use a special inverter duty motor.

F. Motor dynamic balance and rotor endurance should be considered if the operating speed exceeds the rated speed (60Hz) of a standard motor.

G. Motor torque characteristics vary when an AC Motor Drive instead of commercial power supply drives the motor. Check the load torque characteristics of the machine to be connected.

H. Because of the high carrier frequency PWM control of the VFD series, pay attention to the following motor vibration problems:

- *Resonant mechanical vibration: anti-vibration (damping) rubbers should be used to mount equipment that runs at varying speed.*
- *Motor imbalance: special care is required for operation at 50 or 60 Hz and higher frequency.*
- *To avoid resonances, use the Skip frequencies.*

I. The motor fan will be very noisy when the motor speed exceeds 50 or 60Hz.

Special motors:

A. Pole-changing (Dahlander) motor:

The rated current is different from that of a standard motor. Please check before operation and select the capacity of the AC motor drive carefully. When changing the pole number the motor needs to be stopped first. If over current occurs during operation or regenerative voltage is too high, please let the motor free run to stop (coast).

B. Submersible motor:

The rated current is higher than that of a standard motor. Please check before operation and choose the capacity of the AC motor drive carefully. With long motor cable between AC motor drive and motor, available motor torque is reduced.

C. Explosion-proof (Ex) motor:

Needs to be installed in a safe place and the wiring should comply with the (Ex) requirements. Delta AC Motor Drives are not suitable for (Ex) areas with special precautions.

D. Gear reduction motor:

The lubricating method of reduction gearbox and speed range for continuous operation will be different and depending on brand. The lubricating function for operating long time at low speed and for high-speed operation needs to be considered carefully.

E. Synchronous motor:

The rated current and starting current are higher than for standard motors. Please check before operation and choose the capacity of the AC motor drive carefully. When the AC motor drive operates more than one motor, please pay attention to starting and changing the motor.

Power Transmission Mechanism

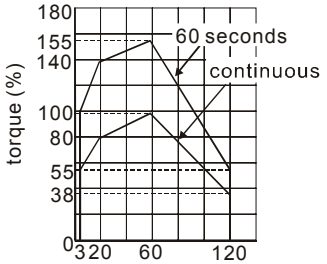
Pay attention to reduced lubrication when operating gear reduction motors, gearboxes, belts and chains, etc. over longer periods at low speeds. At high speeds of 50/60Hz and above, lifetime reducing noises and vibrations may occur.

Motor torque

The torque characteristics of a motor operated by an AC motor drive and commercial mains power are different.

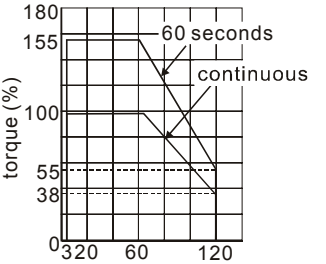
Below you'll find the torque-speed characteristics of a standard motor (4-pole, 15kW):

AC motor drive

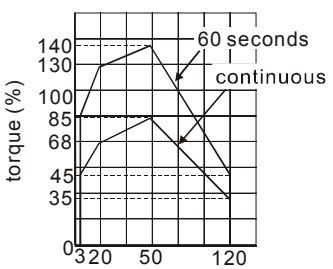


Base freq.: 60Hz
V/F for 220V/60Hz

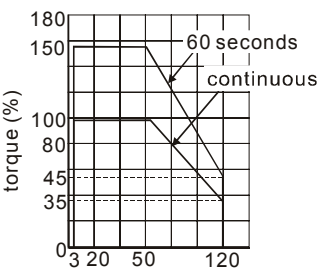
Motor



Base freq.: 60Hz
V/F for 220V/60Hz



Base freq.: 50Hz
V/F for 220V/50Hz



Base freq.: 50Hz
V/F for 220V/50Hz

Appendix D How to Use PLC Function

D.1 The Steps for PLC Execution

Please operate PLC function by the following five steps.

1. Switch the mode to PLC2 for program download/upload:
   A. Go to “PLC0” page by pressing the MODE key
   B. Change to “PLC2” by pressing the “UP” key and then press the “ENTER” key after confirmation
   C. If succeeded, “END” is displayed and back to “PLC2” after one or two seconds.

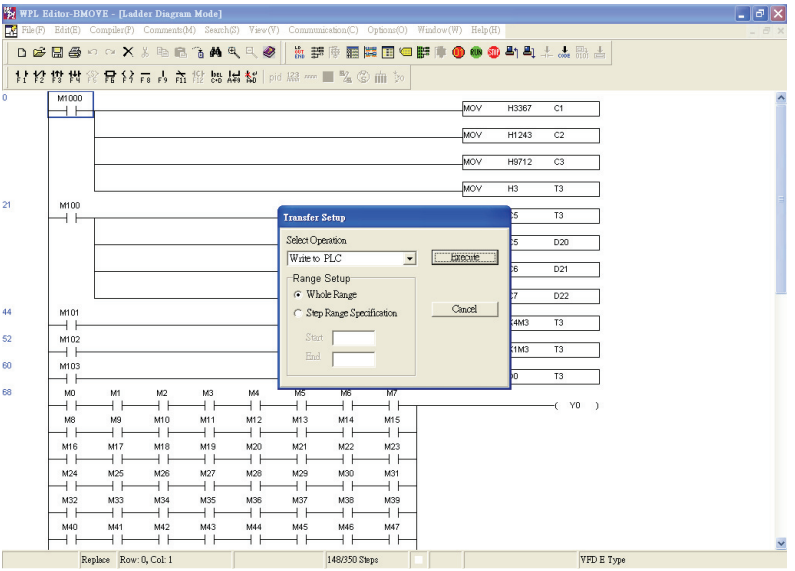
NOTE

You don’t need to care about the PLC warning, such as PLod, PLSv and PldA, before downloading a program to VFD-E.

Disable | Run PLC | Read/write PLC program into AC drives

2. Connection: Please connect RJ-45 of AC motor drive to computer via a RS485-to-RS232 converter.

3. Download PLC program to AC drive: Refer to D.2 to D.7 for writing program and download the editor (WPLSoft V2.09) at DELTA website http://www.delta.com.tw/product/em/plc/plc_software.asp.



4. Run the program. The PLC status will always be PLC2, even if the AC motor drive is switched off.

   There are three ways to operate PLC:

   A. In “PLC1” page: execute PLC program.

   B. In “PLC2” page: execute/stop PLC program by using WPL software.

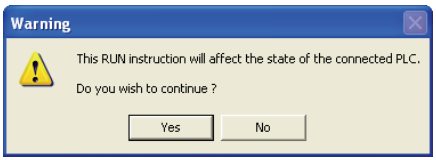
   C. After setting multi-function input terminals (MI3 to MI9) to 23 (RUN/STOP PLC), it will display “PLC1” for executing PLC when the terminal is ON. It will display “PLC0” to stop PLC program when terminals are OFF.

NOTE

When external terminals are set to 23 and the terminal is ON, it cannot use keypad to change PLC mode. Moreover, when it is PLC2, you cannot execute PLC program by external terminals.

NOTE

When power on after power off, the PLC status will be in “PLC1”.



5. When you are in “PLC2”, please remember to change to “PLC1” when finished to prevent anyone modifying PLC program.

NOTE

When output/input terminals (MI1~MI9, Relay1~Relay 4, MO1~MO4) are used in PLC program, they cannot be used in other places. For example, When Y0 in PLC program is activated, the corresponding output terminals Relay(RA/RB/RC) will be used. At this moment, parameter 03.00 setting will be invalid. Because the terminal has been used by PLC.

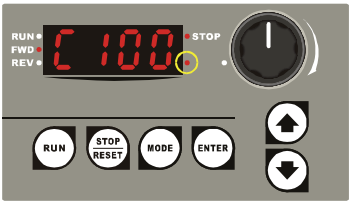
NOTE

The PLC corresponding input points for MI1 to MI6 are X0 to X5. When extension card are added, the extension input points will be numbered from X06 and output points will start from Y2.

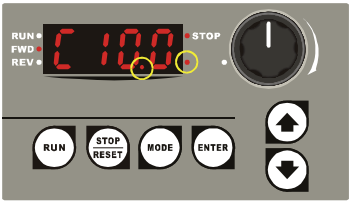
D.2 The Limit of PLC

1. The protocol of PLC is 7,E,1
2. Make sure that the AC drive is stop and stop PLC before program upload/download.
3. The priority of commands WPR and FREQ is FREQ > WPR.
4. When setting P 00.04 to 2, the display will be the value in PLC register D1043.
5. 0 ~ 999 display:

6. 1000 ~ 9999 display: It will only display the first 3 digits. The LED at the bottom-right corner will light to indicate 10 times of the display value. For example, the actual value for the following figure is 100X10=1000.



7. 10000~65535 display: It will only display the first 3 digits. The LED at the bottom-right corner and the single decimal point between the middle and the right-most numbers will light to indicate 100 times of the display value. For example, the actual value for the following figure is 100X100=10000.



D.3 Edition Explanation of Ladder Diagram

Ladder diagram is a diagram language that applied on the automatic control and it is also a diagram that made up of the symbols of electric control circuit. PLC procedures are finished after ladder diagram editor edits the ladder diagram. It is easy to understand the control flow that indicated with diagram and also accept by technical staff of electric control circuit. Many basic symbols and motions of ladder diagram are the same as mechanical and electrical equipments of traditional automatic power panel, such as button, switch, relay, timer, counter and etc.

The kinds and amounts of PLC internal equipment will be different with brands. Although internal equipment has the name of traditional electric control circuit, such as relay, coil and contact. It doesn't have the real components in it. In PLC, it just has a basic unit of internal memory. If this bit is 1, it means the coil is ON and if this bit is 0, it means the coil is OFF. You should read the corresponding value of that bit when using contact (Normally Open, NO or contact a). Otherwise, you should read the opposite sate of corresponding value of that bit when using contact (Normally Close, NC or contact b). Many relays will need many bits, such as 8-bits makes up a byte. 2 bytes can make up a word. 2 words makes up double word. When using many relays to do calculation,

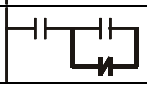
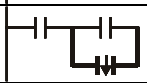
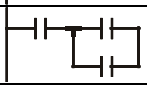
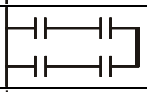
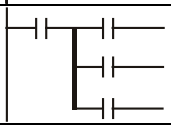
such as add/subtraction or shift, you could use byte, word or double word. Furthermore, the two equipments, timer and counter, in PLC not only have coil but also value of counting time and times. In conclusion, each internal storage unit occupies fixed storage unit. When using these equipments, the corresponding content will be read by bit, byte or word.

Basic introduction of the inner equipment of PLC:

Input relay	Input relay is the basic storage unit of internal memory that corresponds to external input point (it is the terminal that used to connect to external input switch and receive external input signal). Input signal from external will decide it to display 0 or 1. You couldn't change the state of input relay by program design or forced ON/OFF via WPLSoft. The contacts (contact a, b) can be used unlimitedly. If there is no input signal, the corresponding input relay could be empty and can't be used with other functions. ☞ Equipment indication method: X0, X1,…X7, X10, X11,…. The symbol of equipment is X and the number uses octal.
Output relay	Output relay is the basic storage unit of internal memory that corresponds to external output point (it is used to connect to external load). It can be driven by input relay contact, the contact of other internal equipment and itself contact. It uses a normally open contact to connect to external load and other contacts can be used unlimitedly as input contacts. It doesn't have the corresponding output relay, if need, it can be used as internal relay. ☞ Equipment indication: Y0, Y1,…Y7, Y10, Y11,…. . The symbol of equipment is Y and the number uses octal.
Internal relay	The internal relay doesn't connect directly to outside. It is an auxiliary relay in PLC. Its function is the same as the auxiliary relay in electric control circuit. Each auxiliary relay has the corresponding basic unit. It can be driven by the contact of input relay, output relay or other internal equipment. Its contacts can be used unlimitedly. Internal auxiliary relay can't output directly, it should output with output point. ☞ Equipment indication: M0, M1,…, M4, M5. The symbol of equipment is M and the number uses decimal number system.
Timer	Timer is used to control time. There are coil, contact and timer storage. When coil is ON, its contact will act (contact a is close, contact b is open) when attaining desired time. The time value of timer is set by settings and each timer has its regular period. User sets the timer value and each timer has its timing period. Once the coil is OFF, the contact won't act (contact a is open and contact b is close) and the timer will be set to zero. ☞ Equipment indication: T0, T1,…,T255. The symbol of equipment is T and the number uses decimal system. The different number range corresponds with the different timing period.
Counter	Counter is used to count. It needs to set counter before using counter (i.e. the pulse of counter). There are coil, contacts and storage unit of counter in counter. When coil is from OFF to ON, that means input a pulse in counter and the counter should add 1. There are 16-bit, 32-bit and high-speed counter for user to use. ☞ Equipment indication: C0, C1,…,C255. The symbol of equipment is C and the number uses decimal.
Data register	PLC needs to handle data and operation when controlling each order, timer value and counter value. The data register is used to store data or parameters. It stores

	16-bit binary number, i.e. a word, in each register. It uses two continuous number of data register to store double words. ☞ Equipment indication: D0, D1,…,D9,999. The symbol of equipment is D and the number uses decimal.

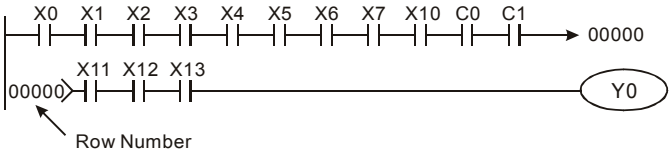
The structure and explanation of ladder diagram:

Ladder Diagram Structure	Explanation	Command	Equipment
	Normally open, contact a	LD	X, Y, M, T, C
	Normally closed, contact b	LDI	X, Y, M, T, C
	Serial normally open	AND	X, Y, M, T, C
	Parallel normally open	OR	X, Y, M, T, C
	Parallel normally closed	ORI	X, Y, M, T, C
	Rising-edge trigger switch	LDP	X, Y, M, T, C
	Falling-edge trigger switch	LDF	X, Y, M, T, C
	Rising-edge trigger in serial	ANDP	X, Y, M, T, C
	Falling-edge trigger in serial	ANDF	X, Y, M, T, C
	Rising-edge trigger in parallel	ORP	X, Y, M, T, C
	Falling-edge trigger in parallel	ORF	X, Y, M, T, C
	Block in serial	ANB	none
	Block in parallel	ORB	none
	Multiple output	MPS MRD MPP	none

Ladder Diagram Structure	Explanation	Command	Equipment
	Output command of coil drive	OUT	Y, M, S
	Basic command, Application command	Application command	Please refer to basic command and application command
	Inverse logic	INV	none

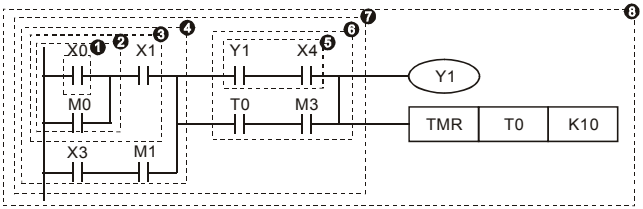
D.4 The Edition of PLC Ladder Diagram

The program edited method is from left power line to right power line. (the right power line will be omitted during the edited of WPLSoft.) After editing a row, go to editing the next row. The maximum contacts in a row are 11 contacts. If you need more than 11 contacts, you could have the new row and start with continuous line to continue more input devices. The continuous number will be produced automatically and the same input point can be used repeatedly. The drawing is shown as follows.



The operation of ladder diagram is to scan from left upper corner to right lower corner. The output handling, including the operation frame of coil and application command, at the most right side in ladder diagram.

Take the following diagram for example; we analyze the process step by step. The number at the right corner is the explanation order.



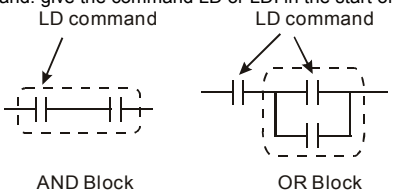
The explanation of command order:

1	LD	X0
2	OR	M0
3	AND	X1
4	LD	X3

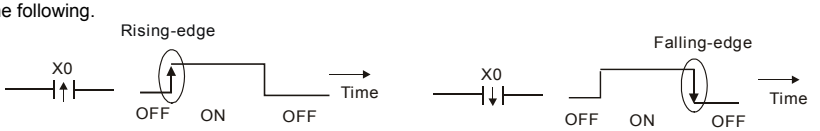
	AND	M1
	ORB	
5	LD	Y1
	AND	X4
6	LD	T0
	AND	M3
	ORB	
7	ANB	
8	OUT	Y1
	TMR	T0 K10

The detail explanation of basic structure of ladder diagram

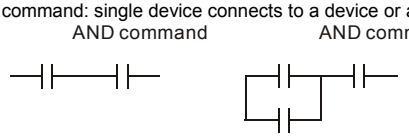
1. LD (LDI) command: give the command LD or LDI in the start of a block.



The structures of command LDP and LDF are similar to the command LD. The difference is that command LDP and LDF will act in the rising-edge or falling-edge when contact is ON as shown in the following.

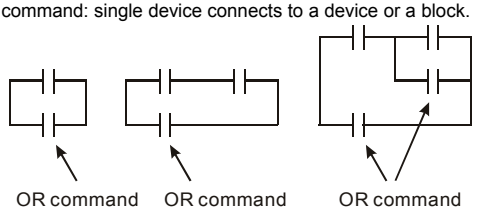


2. AND (ANI) command: single device connects to a device or a block in series.



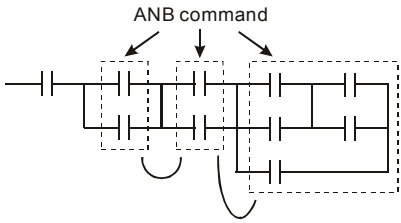
The structures of ANDP and ANDF are the same but the action is in rising-edge or falling-edge.

3. OR (ORI) command: single device connects to a device or a block.

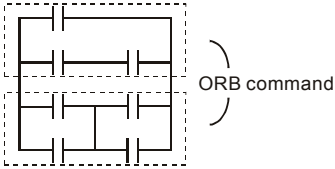


The structures of ORP and ORF are the same but the action is in rising-edge or falling-edge.

4. ANB command: a block connects to a device or a block in series.



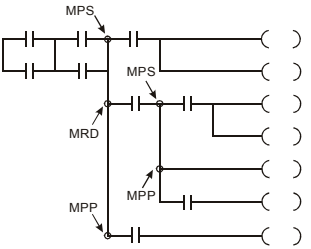
5. ORB command: a block connects to a device or a block in parallel.



If there are several blocks when operate ANB or ORB, they should be combined to blocks or network from up to down or from left to right.

6. MPS, MRD, MPP commands: Divergent memory of multi-output. It can produce many various outputs.
7. The command MPS is the start of divergent point. The divergent point means the connection place between horizontal line and vertical line. We should determine to have contact memory command or not according to the contacts status in the same vertical line. Basically, each contact could have memory command but in some places of ladder diagram conversion will be omitted due to the PLC operation convenience and capacity limit. MPS command can be used for 8 continuous times and you can recognize this command by the symbol "┬".
8. MRD command is used to read memory of divergent point. Because the logical status is the same in the same horizontal line, it needs to read the status of original contact to keep on analyzing other ladder diagram. You can recognize the command MRD by the symbol "├".
9. MPP command is used to read the start status of the top level and pop it out from stack. Because it is the last item of the horizontal line, it means the status of this horizontal line is ending.

You can recognize this command by the symbol "└". Basically, that is all right to use the above method to analyze but sometimes compiler will omit the same outputs as shown at the right.



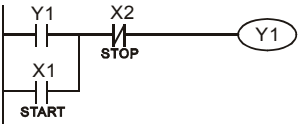
D.5 The Example for Designing Basic Program

- Start, Stop and Latching

  In the same occasions, it needs transient close button and transient open button to be start and stop switch. Therefore, if you want to keep the action, you should design latching circuit. There are several latching circuits in the following:

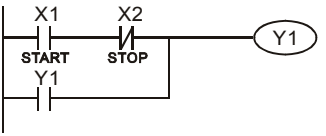
Example 1: the latching circuit for priority of stop

When start normally open contact X1=On, stop normally contact X2＝Off, and Y1=On are set at the same time, if X2=On, the coil Y1 will stop acting. Therefore, it calls priority of stop.



Example 2: the latching circuit for priority of start

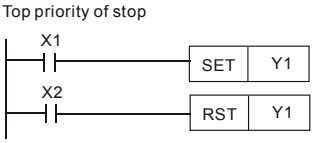
When start normally open contact X1=On, stop normally contact X2＝Off and Y1=On (coil Y1 will be active and latching) are valid at the same time, if X2=On, coil Y1 will be active due to latched contact. Therefore, it calls priority of start.



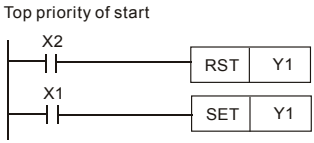
Example 3: the latching circuit of SET and RST commands

The figure at the right side is latching circuit that made up of RST and SET command.

It is top priority of stop when RST command is set behind SET command. When executing PLC from up to down, The coil Y1 is ON and coil Y1 will be OFF when

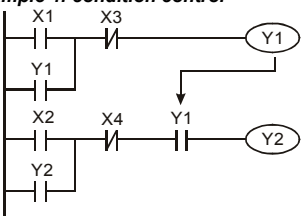


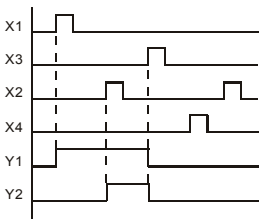
X1 and X2 act at the same time, therefore it calls priority of stop.
It is top priority of start when SET command is set after RST command. When X1 and X2 act at the same time, Y1 is ON so it calls top priority of start.



- The common control circuit

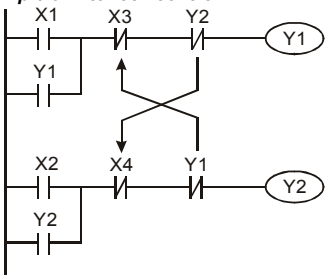
Example 4: condition control

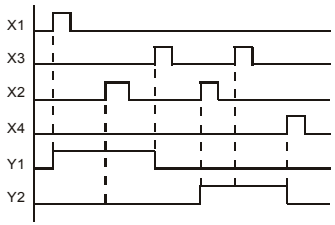




X1 and X3 can start/stop Y1 separately, X2 and X4 can start/stop Y2 separately and they are all self latched circuit. Y1 is an element for Y2 to do AND function due to the normally open contact connects to Y2 in series. Therefore, Y1 is the input of Y2 and Y2 is also the input of Y1.

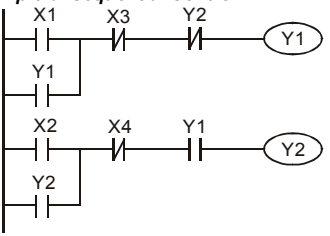
Example 5: Interlock control





The figure above is the circuit of interlock control. Y1 and Y2 will act according to the start contact X1 and X2. Y1 and Y2 will act not at the same time, once one of them acts and the other won't act. (This is called interlock.) Even if X1 and X2 are valid at the same time, Y1 and Y2 won't act at the same time due to up-to-down scan of ladder diagram. For this ladder diagram, Y1 has higher priority than Y2.

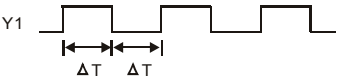
Example 6: Sequential Control



If add normally close contact Y2 into Y1 circuit to be an input for Y1 to do AND function. (as shown in the left side) Y1 is an input of Y2 and Y2 can stop Y1 after acting. In this way, Y1 and Y2 can execute in sequential.

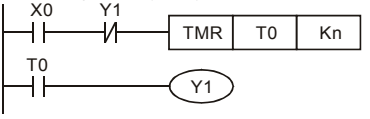
Example 7: Oscillating Circuit

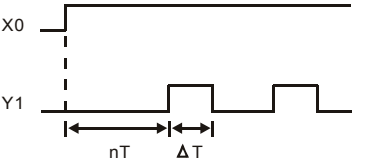
The period of oscillating circuit is ΔT+ΔT



The figure above is a very simple ladder step diagram. When starting to scan Y1 normally close contact, Y1 normally close contact is close due to the coil Y1 is OFF. Then it will scan Y1 and the coil Y1 will be ON and output 1. In the next scan period to scan normally close contact Y1, Y1 normally close contact will be open due to Y1 is ON. Finally, coil Y1 will be OFF. The result of repeated scan, coil Y will output the vibrating pulse with cycle time ΔT(On)+ΔT(Off).

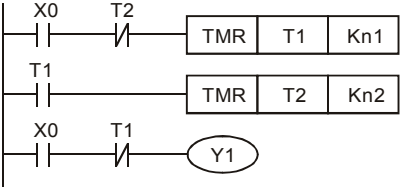
The vibrating circuitry of cycle time ΔT(On)+ΔT(Off):

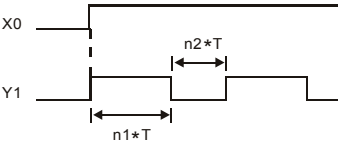




The figure above uses timer T0 to control coil Y1 to be ON. After Y1 is ON, timer T0 will be closed at the next scan period and output Y1. The oscillating circuit will be shown as above. (n is the setting of timer and it is decimal number. T is the base of timer. (clock period))

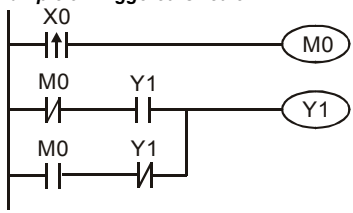
Example 8: Blinking Circuit

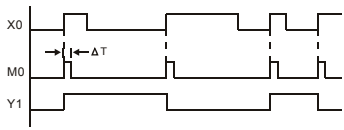




The figure above is common used oscillating circuit for indication light blinks or buzzer alarms. It uses two timers to control On/OFF time of Y1 coil. If figure, n1 and n2 are timer setting of T1 and T2. T is the base of timer (clock period)

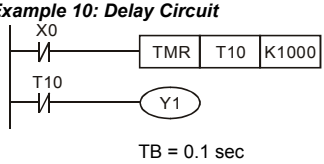
Example 9: Triggered Circuit

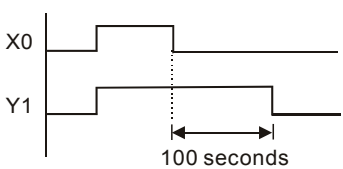




In figure above, the rising-edge differential command of X0 will make coil M0 to have a single pulse of △T (a scan time). Y1 will be ON during this scan time. In the next scan time, coil M0 will be OFF, normally close M0 and normally close Y1 are all closed. However, coil Y1 will keep on being ON and it will make coil Y1 to be OFF once a rising-edge comes after input X0 and coil M0 is ON for a scan time. The timing chart is as shown above. This circuit usually executes alternate two actions with an input. From above timing: when input X0 is a square wave of a period T, output coil Y1 is square wave of a period 2T.

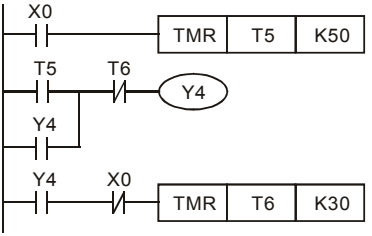
Example 10: Delay Circuit

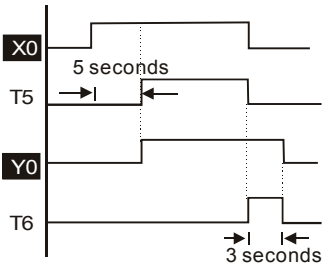




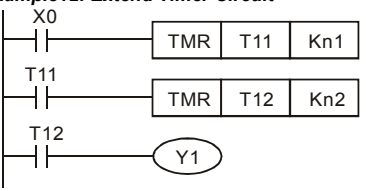
When input X0 is ON, output coil Y1 will be ON at the same time due to the corresponding normally close contact OFF makes timer T10 to be OFF. Output coil Y1 will be OFF after delaying 100 seconds (K1000*0.1 seconds =100 seconds) once input X0 is OFF and T10 is ON. Please refer to timing chart above.

Example 11: Output delay circuit, in the following example, the circuit is made up of two timers. No matter input X0 is ON or OFF, output Y4 will be delay.

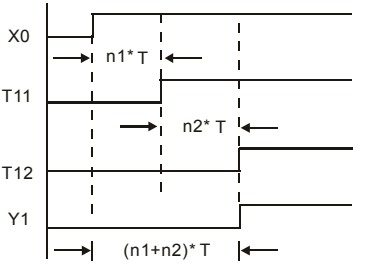




Example12: Extend Timer Circuit



In this circuit, the total delay time from input X0 is close and output Y1 is ON= (n1+n2)* T. where T is clock period.



D.6 PLC Devices

D.6.1 Summary of DVP-PLC Device Number

Items	Specifications	Remarks
Control Method	Stored program, cyclic scan system	
I/O Processing Method	Batch processing (when END instruction is executed)	I/O refresh instruction is available
Execution Speed	Basic commands (minimum 0.24 us)	Application commands (10 ~ hundreds us)
Program Language	Instruction, Ladder Logic, SFC	Including the Step commands
Program Capacity	350 STEPS	SRAM + Battery

Items					Specifications		Remarks
Commands					45 commands		28 basic commands 17 application commands
Input/Output Contact					Input (X): 6, output (Y): 2		
Relay bit mode	X	External Input Relay			X0~X17, 16 points, octal number system	Total is 32 points	Correspond to external input point
	Y	External Output Relay			Y0~Y17, 16 points, octal number system		Correspond to external output point
	M	Auxiliary	For general		M0~M159, 160 points	Total is 192 points	Contacts can switch to On/Off in program
			For special		M1000~M1031, 32 points		
	T	Timer	100ms timer		T0~T15, 16 points	Total is 16 points	When the timer indicated by TMR command attains the setting, the T contact with the same number will be On.
	C	Counter	16-bit count up for general		C0~C7, 8 points	Total is 8 points	When the counter indicated by CNT command attains the setting, the C contact with the same number will be On.
			32-bit count up/down high-speed counter	1-phase input	C235, 1 point (need to use with PG card)	Total is 1 point	
				1-phase 2 inputs			
				2-phase 2 inputs			
Register WORD data	T	Present value of timer			T0~T15, 16 points		When timer attains, the contact of timer will be On.
	C	Present value of counter			C0~C8, 8-bit counter, 8 points C235, 32-bit counter, 1 point		When timer attains, the contact of timer will be On.
	D	Data register	For general		D0~D29, 30 points	Total is 75 points	It can be memory area for storing data.
			For special		D1000~D1044, 45 points		
Constant	K	Decimal			K-32,768 ~ K32,767 (16-bit operation)		
	H	Hexadecimal			H0000 ~ HFFFF (16-bit operation)		
Communication port (for read/write program)					RS485 (slave)		
Analog input/output					Built-in 2 analog inputs and 1 analog output		
Function extension module (optional)					Digital input/output card (A/D, D/A card)		

D.6.2 Device Reference Table

Device	X													
ID	0	1	2	3	4	5	6	7	10	11	12	13	14	15
Terminals of AC Drives	MI1	MI2	MI3	MI4	MI5	MI6	--	--	--	--	--	--	--	--
Relay Card-2C (EME-DR2CA)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Relay Card-3A (EME-R3AA)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3IN/3OUT Card (EME-D33A)	--	--	--	--	--	--	MI7	MI8	MI9	--	--	--	--	--

Device	Y													
ID	0	1	2	3	4	5	6	7	10	11	12	13	14	15
Terminals of AC Drives	RY	MO1	--	--	--	--	--	--	--	--	--	--	--	--
Relay Card-2C (EME-DR2CA)	--	--	RY2	RY3	--	--	--	--	--	--	--	--	--	--
Relay Card-3A (EME-R3AA)	--	--	RY2	RY3	RY4	--	--	--	--	--	--	--	--	--
3IN/3OUT Card (EME-D33A)	--	--	MO2	MO3	MO4	--	--	--	--	--	--	--	--	--

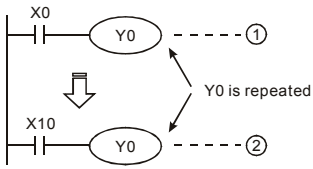
D.6.3 Devices Functions

■ The Function of Input/output Contacts

The function of input contact X: input contact X reads input signal and enter PLC by connecting with input equipment. It is unlimited usage times for A contact or B contact of each input contact X in program. The On/Off of input contact X can be changed with the On/Off of input equipment but can't be changed by using peripheral equipment (WPLSoft).

■ The Function of Output Contact Y

The mission of output contact Y is to drive the load that connects to output contact Y by sending On/Off signal. There are two kinds of output contact: one is relay and the other is transistor. It is unlimited usage times for A or B contact of each output contact Y in program. But there is number for output coil Y and it is recommended to use one time in program. Otherwise, the output result will be decided by the circuit of last output Y with PLC program scan method.



The output of Y0 will be decided by circuit ②, i.e. decided by On/Off of X10.

D.6.4 Value, constant [K] / [H]

Constant	K	Decimal	K-32,768 ~ K32,767 (16-bit operation) K-2,147,483,648 ~ K2,147,483,647 (32-bit operation)
	H	Hexadecimal	H0 ~ HFFFF (16-bit operation) H0 ~ HFFFFFFFF (32-bit operation)

There are five value types for DVP-PLC to use by the different control destination. The following is the explanation of value types.

1. Binary Number (BIN)

It uses binary system for the PLC internal operation or storage. The relative information of binary system is in the following.

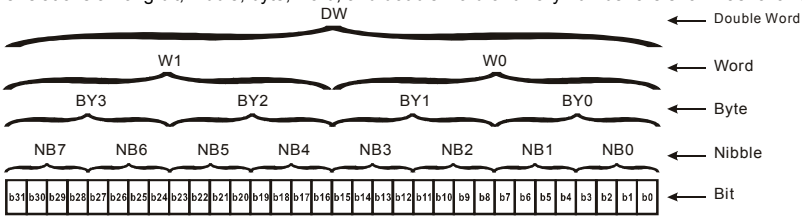
Bit : Bit is the basic unit of binary system, the status are 1 or 0.

Nibble : It is made up of continuous 4 bits, such as b3~b0. It can be used to represent number 0~9 of decimal or 0~F of hexadecimal.

Byte : It is made up of continuous 2 nibbles, i.e. 8 bits, b7~b0. It can used to represent 00~FF of hexadecimal system.

Word : It is made up of continuous 2 bytes, i.e. 16 bits, b15~b0. It can used to represent 0000~FFFF of hexadecimal system.

The relations among bit, nibble, byte, word, and double word of binary number are shown as follows.



2. Octal Number (OCT)

The numbers of external input and output terminal of DVP-PLC use octal number.

Example:

External input: X0~X7, X10~X17…(device number)

External output: Y0~Y7, Y10~Y17…(device number)

3. Decimal Number (DEC)

The suitable time for decimal number to use in DVP-PLC system.

- To be the setting value of timer T or counter C, such as TMR C0 K50. (K constant)
- To be the device number of M, T, C and D. For example: M10, T30. (device number)
- To be operand in application command, such as MOV K123 D0. (K constant)

4. BCD (Binary Code Decimal, BCD)

It shows a decimal number by a unit number or four bits so continuous 16 bits can use to represent the four numbers of decimal number. BCD code is usually used to read the input value of DIP switch or output value to 7-segment display to be display.

5. Hexadecimal Number (HEX)

The suitable time for hexadecimal number to use in DVP-PLC system.

- To be operand in application command. For example: MOV H1A2B D0. (constant H)

Constant K:

In PLC, it is usually have K before constant to mean decimal number. For example, K100 means 100 in decimal number.

> Exception:
>
> The value that is made up of K and bit equipment X, Y, M, S will be bit, byte, word or double word. For example, K2Y10, K4M100. K1 means a 4-bit data and K2~K4 can be 8, 12 and 16-bit data separately.

Constant H:

In PLC, it is usually have H before constant to mean hexadecimal number. For example, H100 means 100 in hexadecimal number.

D.6.5 The Function of Auxiliary Relay

There are output coil and A, B contacts in auxiliary relay M and output relay Y. It is unlimited usage times in program. User can control loop by using auxiliary relay, but can't drive external load directly. There are two types divided by its characteristics.

1. Auxiliary relay for general : It will reset to Off when power loss during running. Its state will be Off when power on after power loss.
2. Auxiliary relay for special : Each special auxiliary relay has its special function. Please don't use undefined auxiliary relay.

D.6.6 The Function of Timer

The unit of timer is 1ms, 10ms and 100ms. The count method is count up. The output coil will be On when the present value of timer equals to the settings. The setting is K in decimal number. Data register D can be also used as settings.

The real setting time of timer = unit of timer * settings

D.6.7 The Features and Functions of Counter

Features:

Item	16 bits counters	32 bits counters	
Type	General	General	High speed
Count direction	Count up	Count up/down	
Settings	0~32,767	-2,147,483,648~+2,147,483,647	
Designate for constant	Constant K or data register D	Constant K or data register D (2 for designated)	
Present value change	Counter will stop when attaining settings	Counter will keep on counting when attaining settings	
Output contact	When count attains settings, contact will be On and latched.	When count up attains settings, contact will be On and latched. When count down attains settings, contact will reset to Off.	
Reset action	The present value will reset to 0 when RST command is executed and contact will reset to Off.		
Present register	16 bits	32 bits	
Contact action	After scanning, act together.	After scanning, act together.	Act immediately when count attains. It has no relation with scan period.

Functions:

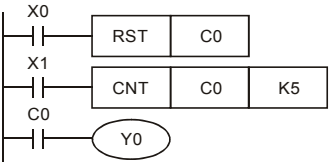
When pulse input signal of counter is from Off to On, the present value of counter equals to settings and output coil is On. Settings are decimal system and data register D can also be used as settings.

16-bit counters C0~C7:

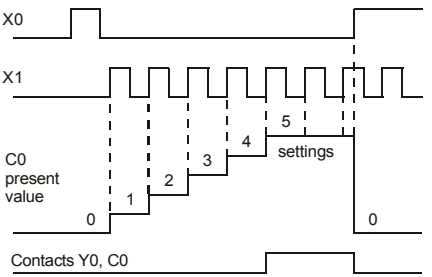
1. Setting range of 16-bit counter is K0~K32,767. (K0 is the same as K1. output contact will be On immediately at the first count.
2. General counter will be clear when PLC is power loss. If counter is latched, it will remember the value before power loss and keep on counting when power on after power loss.
3. If using MOV command, WPLSoft to send a value, which is large than setting to C0, register, at the next time that X1 is from Off to On, C0 counter contact will be On and present value will be set to the same as settings.
4. The setting of counter can use constant K or register D (not includes special data register D1000~D1999) to be indirect setting.
5. If using constant K to be setting, it can only be positive number but if setting is data register D, it can be positive/negative number. The next number that counter counts up from 32,767 is -32,768.

Example:

```
LD    X0
RST   C0
LD    X1
CNT   C0  K5
LD    C0
OUT   Y0
```



1. When X0=On, RST command is executed, C0 reset to 0 and output contact reset to Off.
2. When X1 is from Off to On, counter will count up (add 1).
3. When counter C0 attains settings K5, C0 contact is On and C0 = setting =K5. C0 won't accept X1 trigger signal and C0 remains K5.



32-bit high-speed addition/subtraction counter C235:

1. Setting range of 32-bit high-speed addition/subtraction counter is : K2,147,483,648~K2,147,483,647.
2. The settings can be positive / negative numbers by using constant K or data register D (special data register D1000~D1044 is not included). If using data register D, the setting will occupy two continuous data register.

The total band width of high-speed counter that VFD-E supports is up to 30kHz and 500kHz for pulse input.

D.6.8 Register Types

There are two types of register which sorts by characters in the following:

1. General register : The data in register will be cleared to 0 when PLC switches from RUN to STOP or power is off.
2. Special register : Each special register has the special definition and purpose. It is used to save system status, error messages, monitor state.

D.6.9 Special Auxiliary Relays

Special M	Function	Read(R)/ Write(W)
M1000	Normally open contact (a contact). This contact is On when running and it is On when the status is set to RUN.	R
M1001	Normally Off contact (b contact). This contact is Off in running and it is Off when the status is set to RUN.	R
M1002	On only for 1 scan after RUN. Initial pulse is contact a. It will get positive pulse in the RUN moment. Pulse width=scan period.	R
M1003	Off only for 1 scan after RUN. Initial pulse is contact a. It will get negative pulse in the RUN moment. Pulse width=scan period.	R
M1004	Reserved	--
M1005	Fault indication of the AC motor drives	R
M1006	Output frequency is 0	R
M1007	The operation direction of AC motor drives	R
M1008	Reserved	--
M1009	Reserved	--
M1010	Reserved	--
M1011	10ms clock pulse, 5ms On/5ms Off	R
M1012	100ms clock pulse, 50ms On / 50ms Off	R
M1013	1s clock pulse, 0.5s On / 0.5s Off	R
M1014	1min clock pulse, 30s On / 30s Off	R
M1015	Frequency attained	R
M1016	Parameter read/write error	R
M1017	Succeed to write parameter	R
M1018	Enable high-speed counter function (When M1028=On)	R
M1019	Reserved	R
M1020	Zero flag	R
M1021	Borrow flag	R
M1022	Carry flag	R
M1023	Divisor is 0	R
M1024	Reserved	--

Special M	Function	Read(R)/ Write(W)
M1025	RUN(ON) / STOP(OFF) the AC motor drive	R/W
M1026	The operation direction of the AC motor drive (FWD: OFF, REV: ON)	R/W
M1027	Reserved	--
M1028	Enable(ON)/disable(OFF) high-speed counter function	R/W
M1029	Clear the value of high-speed counter	R/W
M1030	Decide to count up(OFF)/count down(ON)	R/W
M1031	Reserved	--

D.6.10 Special Registers

Special D	Function	Read(R)/ Write(W)
D1000-D1009	Reserved	--
D1010	Present scan time (Unit: 0.1ms)	R
D1011	Minimum scan time (Unit: 0.1ms)	R
D1012	Maximum scan time (Unit: 0.1ms)	R
D1013-D1019	0~32,767(unit: 0.1ms) addition type of High-speed connection timer	R
D1020	Output frequency	R
D1021	Output current	R
D1022	The ID of the extension card: 02 USB Card 03 12-Bit A/D (2CH) 12-Bit D/A (2CH) 04 Relay Card-2C 05 Relay Card-3A 06 3IN/3OUT Card 07 PG Card	R
D1023-D1024	Reserved	--
D1025	The present value of the high-speed counter (low byte)	R
D1026	The present value of the high-speed counter (high byte)	R
D1027	Frequency command of the PID control	R
D1028	The value of AVI (analog voltage input) 0-10V corresponds to 0-1023	R

Special D	Function	Read(R)/ Write(W)
D1029	The value of ACI (analog current input) 4-20mA corresponds to 0-1023 or the value of AVI2 (analog voltage input) 0-10V corresponds to 0-1023	R
D1030	The value of V.R digital keypad 0-10V corresponds to 0-1023	R
D1031-D1035	Reserved	--
D1036	PLC error code	R
D1037-D1039	Reserved	--
D1040	Analog output value	R/W
D1041-D1042	Reserved	--
D1043	User defined (when Pr.00.04 is set to 2, the register data will be displayed as C xxx)	R/W
D1044	High-speed counter mode	R/W

D.6.11 Communication Addresses for Devices (only for PLC2 mode)

Device	Address	Device	Address	Device	Address
X0	0400H	Y0	0500H	T0~T15	0600H~060FH
X1	0401H	Y1	0501H	M0~M159	0800H~089FH
X2	0402H	Y2	0502H	M1000~M1031	0BE8H~0C07H
X3	0403H	Y3	0503H	C0~C7	0E00H~0E07H
X4	0404H	Y4	0504H	D0~D63	1000H~101DH
X5	0405H	Y5	0505H	D1000~D1044	13E8H~1414H
X6	0406H	Y6	0506H	--	--
X7	0407H	Y7	0507H	--	--
X10	0408H	Y10	0508H	--	--
X11	0409H	Y11	0509H	--	--
X12	040AH	Y12	050AH	--	--
X13	040BH	Y13	050BH	--	--
X14	040CH	Y14	050CH	--	--
X15	040DH	Y15	050DH	--	--
X16	040EH	Y16	050EH	--	--
X17	040FH	Y17	050FH	--	--

D.6.12 Function Code (only for PLC2 mode)

Function Code	Description	Supported Devices
01	Read coil status	Y, M, T, C
02	Read input status	X, Y, M, T, C
03	Read one data	T, C, D
05	Force changing one coil status	Y, M, T, C
06	Write in one data	T, C, D
0F	Force changing multiple coil status	Y, M, T, C
10	Write in multiple data	T, C, D

D.7 Commands

D.7.1 Basic Commands

Commands	Function	Operands
LD	Load contact A	X, Y, M, T, C
LDI	Load contact B	X, Y, M, T, C
AND	Series connection with A contact	X, Y, M, T, C
ANI	Series connection with B contact	X, Y, M, T, C
OR	Parallel connection with A contact	X, Y, M, T, C
ORI	Parallel connection with B contact	X, Y, M, T, C
ANB	Series connects the circuit block	None
ORB	Parallel connects the circuit block	None
MPS	Save the operation result	None
MRD	Read the operation result (the pointer not moving)	None
MPP	Read the result	None
INV	Inverter the result	None

D.7.2 Output Commands

Commands	Function	Operands
OUT	Drive coil	Y, M
SET	Action latched (ON)	Y, M
RST	Clear the contacts or the registers	Y, M, T, C, D

D.7.3 Timer and Counters

Commands	Function	Operands
TMR	16-bit timer	T-K or T-D
CNT	16-bit counter	C-K or C-D

D.7.4 Main Control Commands

Commands	Function	Operands
MC	Connect the common series connection contacts	N0~N7
MCR	Disconnect the common series connection contacts	N0~N7

D.7.5 Rising-edge/falling-edge Detection Commands of Contact

Commands	Function	Operands
LDP	Rising-edge detection operation starts	X, Y, M, T, C
LDF	Falling-edge detection operation starts	X, Y, M, T, C
ANDP	Rising-edge detection series connection	X, Y, M, T, C
ANDF	Falling-edge detection series connection	X, Y, M, T, C
ORP	Rising-edge detection parallel connection	X, Y, M, T, C
ORF	Falling-edge detection parallel connection	X, Y, M, T, C

D.7.6 Rising-edge/falling-edge Output Commands

Commands	Function	Operands
PLS	Rising-edge output	Y, M
PLF	Falling-edge output	Y, M

D.7.7 End Command

Command	Function	Operands
END	Program end	none

D.7.8 Description of the Application Commands

Classification	Mnemonic Codes 16 bits	P Command	Function
Transmission Comparison	CMP	✓	Compare
	ZCP	✓	Zone compare
	MOV	✓	Data Move
	BMOV	✓	Block move
Four Fundamental Operations of Arithmetic	ADD	✓	Perform the addition of BIN data
	SUB	✓	Perform the subtraction of BIN data
	MUL	✓	Perform the multiplication of BIN data
	DIV	✓	Perform the division of BIN data
	INC	✓	Perform the addition of 1
	DEC	✓	Perform the subtraction of 1
Rotation and Displacement	ROR	✓	Rotate to the right
	ROL	✓	Rotate to the left
Special	DHSCS	X	High speed counter enable
	FPID	✓	Control PID parameters of inverter
	FREQ	✓	Control frequency of inverter
	RPR	✓	Read the parameter
	WPR	✓	Write the parameter

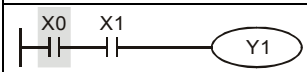
D.7.9 Explanation for the Commands

Mnemonic	**Function**						
LD	Load A contact						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The LD command is used on the A contact that has its start from the left BUS or the A contact that is the start of a contact circuit. Function of the command is to save present contents, and at the same time, save the acquired contact status into the accumulative register.

Program Example:

Ladder diagram	Command code		Operation
	**LD**	**X0**	Load contact A of X0
	AND	X1	Connect to contact A of X1 in series
	OUT	Y1	Drive Y1 coil

Mnemonic	**Function**						
LDI	Load B contact						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The LDI command is used on the B contact that has its start from the left BUS or the B contact that is the start of a contact circuit. Function of the command is to save present contents, and at the same time, save the acquired contact status into the accumulative register.

Program Example:

Ladder diagram: Command code: Operation:

LDI	**X0**	Load contact B of X0
AND	X1	Connect to contact A of X1 in series
OUT	Y1	Drive Y1 coil

Mnemonic	**Function**						
AND	Series connection- A contact						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The AND command is used in the series connection of A contact. The function of the command is to readout the status of present specific series connection contacts first, and then to perform the "AND" calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:

Command code:		Operation:
LDI	X1	Load contact B of X1
AND	**X0**	Connect to contact A of X0 in series
OUT	Y1	Drive Y1 coil

Mnemonic	**Function**						
ANI	Series connection- B contact						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The ANI command is used in the series connection of B contact. The function of the command is to readout the status of present specific series connection contacts first, and then to perform the "AND" calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:

Command code:		Operation:
LD	X1	Load contact A of X1
ANI	**X0**	Connect to contact B of X0 in series
OUT	Y1	Drive Y1 coil

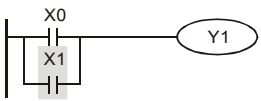
Mnemonic	**Function**						
OR	Parallel connection- A contact						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The OR command is used in the parallel connection of A contact. The function of the command is to readout the status of present specific series connection contacts, and then to perform the "OR" calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
OR	**X1**	Connect to contact A of X1 in parallel
OUT	Y1	Drive Y1 coil

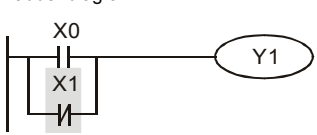
Mnemonic	**Function**						
ORI	Parallel connection- B contact						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The ORI command is used in the parallel connection of B contact. The function of the command is to readout the status of present specific series connection contacts, and then to perform the "OR" calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X1	Load contact A of X0
ORI	**X1**	Connect to contact B of X1 in parallel
OUT	Y1	Drive Y1 coil

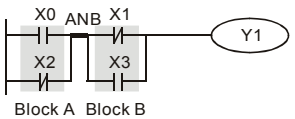
Mnemonic	**Function**
ANB	Series connection (Multiple Circuits)
Operand	None

Explanations:

To perform the “ANB” calculation between the previous reserved logic results and contents of the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
ORI	X2	Connect to contact B of X2 in parallel
LDI	X1	Load contact B of X1
OR	X3	Connect to contact A of X3 in parallel
ANB		Connect circuit block in series
OUT	Y1	Drive Y1 coil

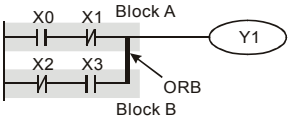
Mnemonic	**Function**
ORB	Parallel connection (Multiple circuits)
Operand	None

Explanations:

To perform the “OR” calculation between the previous reserved logic results and contents of the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
ANI	X1	Connect to contact B of X1 in series
LDI	X2	Load contact B of X2
AND	X3	Connect to contact A of X3 in series
ORB		Connect circuit block in parallel
OUT	Y1	Drive Y1 coil

Mnemonic	**Function**
MPS	Store the current result of the internal PLC operations
Operand	None

Explanations:

To save contents of the accumulative register into the operation result. (the result operation pointer pulses 1)

Mnemonic	**Function**
MRD	Reads the current result of the internal PLC operations
Operand	None

Explanations:

Reading content of the operation result to the accumulative register. (the pointer of operation result doesn't move)

Mnemonic	**Function**
INV	Inverting Operation
Operand	None

Explanations:

Inverting the operation result and use the new data as an operation result.

Program Example:

Ladder diagram:

Command code:		Operation:
LD	X0	Load A contact of X0
INV		Inverting the operation result
OUT	Y1	Drive Y1 coil

Mnemonic	**Function**						
OUT	Output coil						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	--	✓	✓	✓	--	--	--

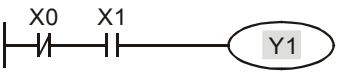
Explanations:

Output the logic calculation result before the OUT command to specific device.

Motion of coil contact

Operation result	Coil	OUT command	
		Contact	
		A contact (normally open)	B contact (normally closed)
FALSE	OFF	Non-continuity	Continuity
TRUE	ON	Continuity	Non-continuity

Program Example:
Ladder diagram:



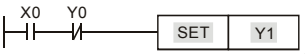
Command code:		Operation:
LDI	X0	Load contact B of X0
AND	X1	Connect to contact A of X1 in series
OUT	**Y1**	Drive Y1 coil

Mnemonic	Function						
SET	Latch (ON)						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	--	✓	✓	✓	--	--	--

Explanations:

When the SET command is driven, its specific device is set to be “ON,” which will keep “ON” whether the SET command is still driven. You can use the RST command to set the device to “OFF”.

Program Example:
Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
ANI	Y0	Connect to contact B of Y0 in series
SET	**Y1**	Y1 latch (ON)

Mnemonic	Function						
RST	Clear the contacts or the registers						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	--	✓	✓	✓	✓	✓	✓

Explanations:

When the RST command is driven, motion of its specific device is as follows:

Device	Status
S, Y, M	Coil and contact will be set to “OFF”.
T, C	Present values of the timer or counter will be set to 0, and the coil and contact will be set to “OFF.”
D, E, F	The content value will be set to 0.

Program Example:

Ladder diagram:

Command code:		Operation:
LD	X0	Load contact A of X0
RST	**Y5**	Clear contact Y5

Mnemonic	Function	
TMR	16-bit timer	
Operand	T-K	T0~T15, K0~K32,767
	T-D	T0~T15, D0~D29

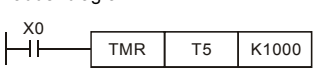
Explanations:

When TMR command is executed, the specific coil of timer is ON and timer will start to count. When the setting value of timer is attained (counting value >= setting value), the contact will be as following:

NO(Normally Open) contact	Open collector
NC(Normally Closed) contact	Close collector

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0 T5 timer
TMR	**T5 K1000**	Setting is K1000

Remarks: Please refer to the specification for the operand T usage.

Mnemonic	Function	
CNT	16-bit counter	
Operand	C-K	C0~C7, K0~K32,767
	C-D	C0~C7, D0~D29

Explanations:

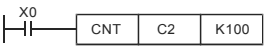
1. When the CNT command is executed from OFF→ON, which means that the counter coil is driven, and 1 should thus be added to the counter's value; when the counter achieved specific set value (value of counter = the setting value), motion of the contact is as follows:

NO(Normally Open) contact	Continuity
NC(Normally Closed) contact	Non-continuity

2. If there is counting pulse input after counting is attained, the contacts and the counting values will be unchanged. To re-count or to conduct the CLEAR motion, please use the RST command.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0 C2 counter
CNT	**C2 K100**	Setting is K100

Mnemonic	Function
MC / MCR	Master control Start/Reset
Operand	N0~N7

Explanations:

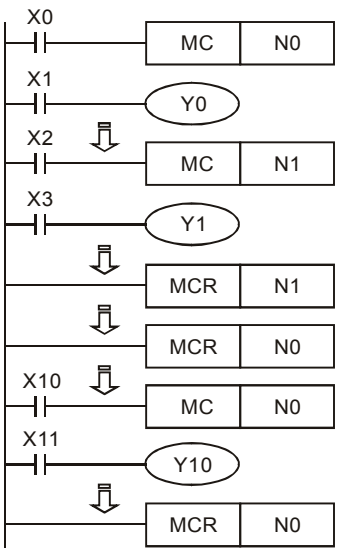
1. MC is the main-control start command. When the MC command is executed, the execution of commands between MC and MCR will not be interrupted. When MC command is OFF, the motion of the commands that between MC and MCR is described as follows:

Timer	The counting value is set back to zero, the coil and the contact are both turned OFF
Accumulative timer	The coil is OFF, and the timer value and the contact stay at their present condition
Subroutine timer	The counting value is back to zero. Both coil and contact are turned OFF.
Counter	The coil is OFF, and the counting value and the contact stay at their present condition

Coils driven up by the OUT command	All turned OFF
Devices driven up by the SET and RST commands	Stay at present condition
Application commands	All of them are not acted , but the nest loop FOR-NEXT command will still be executed for times defined by users even though the MC-MCR commands is OFF.

2. MCR is the main-control ending command that is placed at the end of the main-control program and there should not be any contact commands prior to the MCR command.
3. Commands of the MC-MCR main-control program supports the nest program structure, with 8 layers as its greatest. Please use the commands in order from N0~ N7, and refer to the following:

Program Example:
Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
MC	**N0**	Enable N0 common series connection contact
LD	X1	Load A contact of X1
OUT	Y0	Drive Y0 coil
:		
LD	X2	Load A contact of X2
MC	**N1**	Enable N1 common series connection contact
LD	X3	Load A contact of X3
OUT	Y1	Drive Y1 coil
:		
MCR	**N1**	Disable N1 common series connection contact
:		
MCR	**N0**	Disable N0 common series connection contact
:		
LD	X10	Load A contact of X10
MC	**N0**	Enable N0 common series connection contact
LD	X11	Load A contact of X11
OUT	Y10	Drive Y10 coil
:		
MCR	**N0**	Disable N0 common series connection contact

Mnemonic	Function						
LDP	Rising-edge detection operation						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

Usage of the LDP command is the same as the LD command, but the motion is different. It is used to reserve present contents and at the same time, saving the detection status of the acquired contact rising-edge into the accumulative register.

Program Example:

Ladder diagram:

Command code:		Operation:
LDP	**X0**	Start X0 rising-edge detection
AND	X1	Series connection A contact of X1
OUT	Y1	Drive Y1 coil

Mnemonic	Function						
LDF	Falling-edge detection operation						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

Usage of the LDF command is the same as the LD command, but the motion is different. It is used to reserve present contents and at the same time, saving the detection status of the acquired contact falling-edge into the accumulative register.

Program Example:

Ladder diagram:

Command code:		Operation:
LDF	**X0**	Start X0 falling-edge detection
AND	X1	Series connection A contact of X1
OUT	Y1	Drive Y1 coil

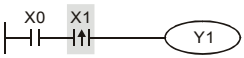
Mnemonic	Function						
ANDP	Rising-edge series connection						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

ANDP command is used in the series connection of the contacts' rising-edge detection.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
ANDP	**X1**	X1 rising-edge detection in series connection
OUT	Y1	Drive Y1 coil

Mnemonic	Function						
ANDF	Falling-edge series connection						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

ANDF command is used in the series connection of the contacts' falling-edge detection.

Program Example:

Ladder diagram:

Command code:		Operation:
LD	**X0**	Load A contact of X0
ANDF	**X1**	X1 falling-edge detection in series connection
OUT	Y1	Drive Y1 coil

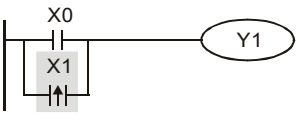
Mnemonic	Function						
ORP	Rising-edge parallel connection						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The ORP commands are used in the parallel connection of the contact's rising-edge detection.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
ORP	**X1**	X1 rising-edge detection in parallel connection
OUT	Y1	Drive Y1 coil

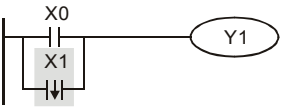
Mnemonic	**Function**						
ORF	Falling-edge parallel connection						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	✓	✓	✓	✓	✓	✓	--

Explanations:

The ORP commands are used in the parallel connection of the contact's falling-edge detection.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
ORF	**X1**	X1 falling-edge detection in parallel connection
OUT	Y1	Drive Y1 coil

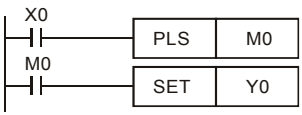
Mnemonic	**Function**						
PLS	Rising-edge output						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	--	✓	✓	--	--	--	--

Explanations:

When X0=OFF→ON (rising-edge trigger), PLS command will be executed and M0 will send the pulse of one time which the length is a scan time.

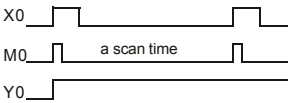
Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
PLS	**M0**	M0 rising-edge output
LD	M0	Load the contact A of M0
SET	Y0	Y0 latched (ON)

Timing Diagram:



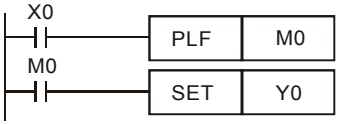
Mnemonic	**Function**						
PLF	Falling-edge output						
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29	X0~X17
	--	✓	✓	--	--	--	--

Explanations:

When X0= ON→OFF (falling-edge trigger), PLF command will be executed and M0 will send the pulse of one time which the length is the time for scan one time.

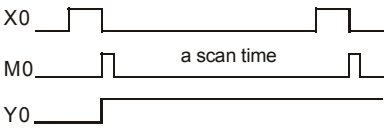
Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
PLF	**M0**	M0 falling-edge output
LD	M0	Load the contact A of M0
SET	Y0	Y0 latched (ON)

Timing Diagram:



Mnemonic	Function
END	Program End
Operand	None

Explanations:

It needs to add the END command at the end of ladder diagram program or command program. PLC will scan from address o to END command, after executing it will return to address 0 to scan again.

API	Mnemonic		Operands	Function
10	CMP	P	S_1, S_2, D	Compare

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	
S_1				*	*	*	*	*	*	*	*	CMP, CMPP: 7 steps DCMP, DCMPP: 13 steps
S_2				*	*	*	*	*	*	*	*	
D		*	*									

Operands:

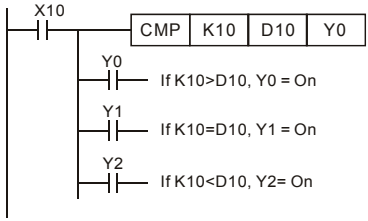
S_1: First comparison value S_2: Second comparison value D: Comparison result

Explanations:

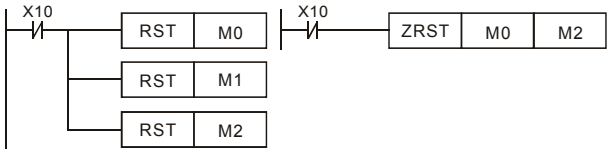
1. Operand D occupies 3 continuous devices.
2. Refer to each model specification for usage range.
3. The contents of the comparison source **S_1** and **S_2** are compared and **D** denotes the compare result.
4. Two comparison values are compared algebraically and this function compares the two values that are considered binary values. If b15=1 in 16-bit command, the comparison will regard the value as the negative of the binary value.

Program Example:

1. If **D** is set to Y0, then Y0, Y1, Y2 will work as the program example as below.
2. When X10=On, CMP command is driven and one of Y0, Y1, Y2 is On. When X10=Off, CMP command is not driven and Y0, Y1, Y2 remain in the previous status.
3. The comparison result of $\geqq$, $\leqq$, $\neq$ commands can be got by the parallel connection of Y0~Y2.



4. Please use RST or ZRST command to reset the comparison result.



API	Mnemonic		Operands	Function
11	ZCP	P	S_1, S_2, S, D	Zone Compare

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	ZCP, ZCPP: 9 steps DZCP, DZCPP: 17 steps
S_1				*	*	*	*	*	*	*	*	
S_2				*	*	*	*	*	*	*	*	
S				*	*	*	*	*	*	*	*	
D		*	*									

Operands:

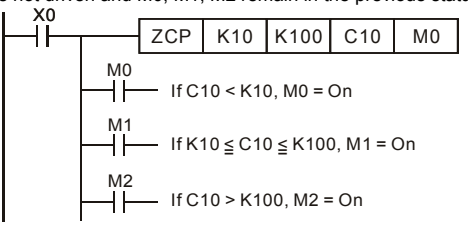
S1: First comparison value (Minimum) S2: Second comparison value (Maximum) S: Comparison value D: Comparison result

Explanations:

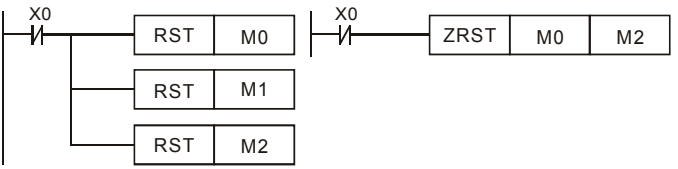
1. Operand S_1 should be less than Operand S_2.
2. Operand D occupies 3 continuous devices.
3. Refer to each model specification for usage range.
4. S is compared with its limits S1 and S2 and D denotes the compare result.
5. When S1 > S2, set S1 as the limit to compare.
6. Two comparison values are compared algebraically and this function compares the two values that are considered binary values. If b15=1 in 16-bit command, the comparison will regard the value as the negative of the binary value.

Program Example:

1. If **D** is set to M0, then M0, M1, M2 will work as the program example as below.
2. When X0=On, ZCP command is driven and one of M0, M1, M2 is On. When X0=Off, ZCP command is not driven and M0, M1, M2 remain in the previous status.



3. Please use RST or ZRST command to reset the comparison result.



API	Mnemonic		Operands	Function
12	MOV	P	S, D	Move

OP \ Type	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	
S				*	*	*	*	*	*	*	*	MOV, MOVP: 5 steps DMOV, DMOVP: 9 steps
D							*	*	*	*	*	

Operands:

S: Data source D: Data destination

Explanations:

1. Refer to specification for usage range.
2. When the MOV command is driven, the data of **S** is moved to **D** without any change. If the MOV command is not driven, the content of **D** remain unchanged.

Program Example:

MOV command is used in 16-bit command to move data.

1. When X0=Off, the content of D10 remain unchanged. If X0=On, the data of K10 is moved to D10 data register.
2. When X1=Off, the content of D10 remain unchanged. If X1=On, the data of T0 is moved to D10 data register.

API	Mnemonic		Operands	Function
15	BMOV	P	S, D, n	Block Move

Type OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	BMOV, BMOVP: 7 steps
S						*	*	*	*	*	*	
D							*	*	*	*	*	
n				*	*				*	*	*	

Operands:

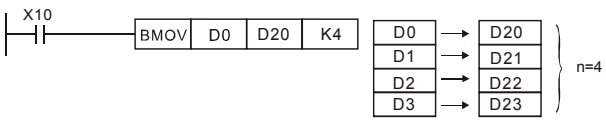
S: Source D: Destination n: Number of data to move

Explanations:

1. The usage range of operand n=1~ 512
2. Refer to specification for usage range.
3. This command is used to move an assigned block of multiple data to a new destination. Move the contents of the **n** register, with this **n** register obtained from counting the registers within the **S** -assigned numbers, to the **n** register within the **D** -assigned number. If the **n** -assigned points exceed the usage range of this device, only those that are within the enabled range will be moved.

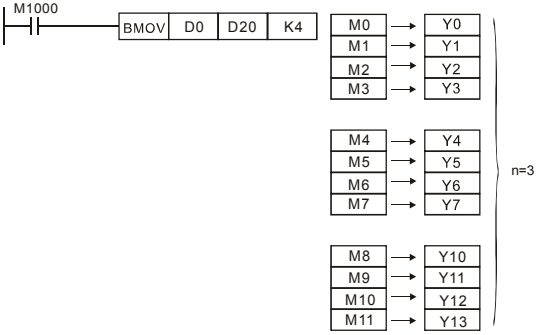
Program Example 1:

When X10=On, move the contents of the four registers D0~D3 to their corresponding registers D20~D23.



Program Example 2:

If move the specified bit device, KnX, KnY, KnM, the digit numbers of S and D should be the same and this also means the number of n should be the same.



Program Example 3:

The BMOV command has built the automatic movement as the program example below to prevent overwriting errors from occurring when the specified numbers of S and D coincide.

When S > D, the BMOV command is processed in the order as ①→②→③

API	Mnemonic		Operands	Function
20	ADD	**P**	S_1, S_2, D	Addition

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	
S_1				*	*	*	*	*	*	*	*	ADD, ADDP: 7 steps DADD, DADDP: 13 steps
S_2				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

Operands:

S1: Augend S2: Addend D: Addition result

Explanations:

1. Refer to specification for usage range.
2. **S_1** + **S_2** = **D**. Performs the addition on BIN data **S_1** and the BIN data **S_2**, and stores the addition result into the device **D**.
3. The most significant bit are the symbolic bit 0 and 1. 0 indicates positive and 1 indicates negative. All calculation are algebraically processed, i.e. 3 + (-9) = -6.
4. Flag changes of binary addition

   16-bit command:

   A. If the operation result is "0", then the Zero flag, M1020 is set to ON.

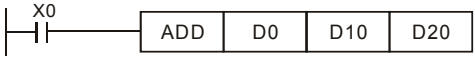
   B. If the operation result exceeds -32,768, the borrow flag, M1021 is set to ON.

   C. If the operation result exceeds 32,767, the carry flag, M1022 is set to ON.

Program Example 1:

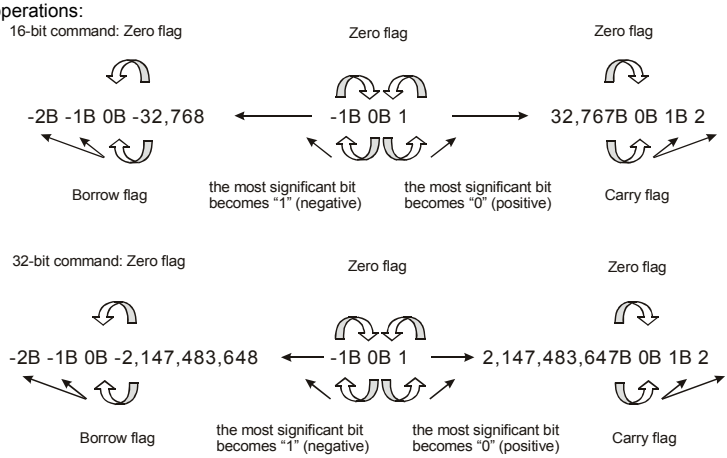
16-bit command:

When X0 is ON, the data contained within the augend D0 and addend D10 is combined and the total is stored in the result device D20.



Remarks:

Flag operations:



API	Mnemonic		Operands	Function
21	SUB	**P**	S_1, S_2, D	Subtraction

OP \ Type	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	
S_1				*	*	*	*	*	*	*	*	SUB, SUBP: 7 steps DSUB, DSUBP: 13 steps
S_2				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

Operands:

S_1: Minuend S_2: Subtrahend D: Subtraction result

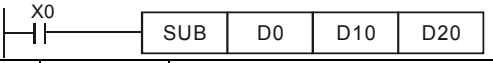
Explanations:

1. **S_1** − **S_2** = **D**. Performs the subtraction of BIN data **S_1** and the BIN data **S_2**, and stores the subtraction result into the device **D**.
2. The most significant bits are the symbolic bit 0 and 1. 0 indicates positive and 1 indicates negative. All calculations are algebraically processed.
3. Flag changes of binary subtraction
   16-bit command:
   A. If the operation result is “0”, then the Zero flag, M1020 is set to ON.
   B. If the operation result exceeds –32,768, the borrow flag, M1021 is set to ON.
   C. If the operation result exceeds 32,767, the carry flag, M1022 is set to ON.

Program Example:

16-bit command:

When X0 is ON, the data contained within the subtrahend D10 is subtracted from the data contained within the minuend D0 and the result of this calculation is stored in the result device D20.



API	Mnemonic		Operands	Function
22	MUL	P	S_1, S_2, D	Multiplication

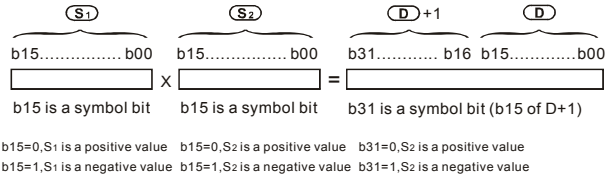
OP \ Type	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	
S_1				*	*	*	*	*	*	*	*	MUL, DMULP: 7 steps
S_2				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

Operands:

S_1: Multiplicand S_2: Multiplier D: Multiplication result

Explanations:

1. In 16-bit command, operand D occupies 2 continuous devices.
2. S1 × S2 = D. Performs the Multiplication of BIN data S1 and the BIN data S2, and stores the multiplication result into the device D. Please pay careful attention to the polarity display of the operation result of S1, S2 and D in the 16-bit command.
   16-bit command:

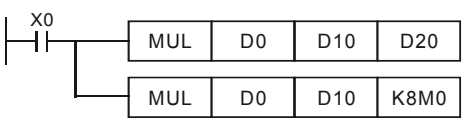


When D is bit device, it can specify K1~K4 and produce a 16-bit result. Then, the flag M1067, M1068 will be On and D1067 record error code "0E19".

Program Example:

16-bit command:

A 16-bit data source, D10 is multiplied by another 16-bit data source, D20. The upper 16-bit data is stored in D21 and the lower one is stored in D20. The polarity of the result is indicated by the OFF/ON of the most significant bit. OFF indicates the value of positive 0 and ON indicates the value of negative 1.



(D0) × (D10) = (D21, D20)

API		Mnemonic		Operands	Function
23		DIV	P	S_1, S_2, D	Division

OP \ Type	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	DIV, DIVP: 7 steps
S_1				*	*	*	*	*	*	*	*	
S_2				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

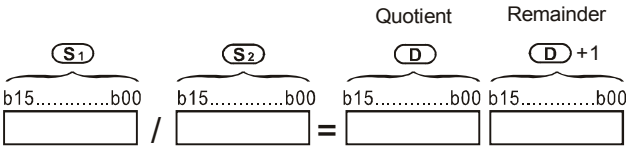
Operands:

S_1: dividend S_2: divisor D: Quotient and Remainder

Explanations:

1. In 16-bit command, operand D occupies 2 continuous devices.
2. **S_1** ÷ **S_2** = **D**. Performs the division of BIN data **S_1** and the BIN data **S_2**, and stores the result into the device **D**. Please pay careful attention to the polarity display of the operation result of **S_1**, **S_2** and **D** in the 16-bit command.

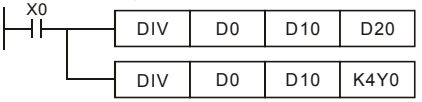
   16-bit command:



When **D** is bit device, it can specify K1~K4 to produce a 16-bit result and occupies 2 continuous groups. In regards to the operation result, the quotient and remainder are stored. For ES model, the operation result will turn out quotient only without remainder.

Program Example:

When X0 is ON, the primary source D0 (divisor) is divided by the second source D10 (dividend). The quotient is specified to be stored in D20 and the remainder is specified to be stored in D21. The polarity of the result is indicated by the OFF/ON of the most significant bit. OFF indicates the value of positive and ON indicates the value of negative.



API	Mnemonic		Operands	Function
24	INC	P	D	Increment

OP \ Type	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	
D							*	*	*	*	*	INC, INCP: 3 steps

Operands:

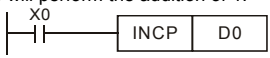
D: Destination

Explanations:

1. If the command is not the pulse execution command, "1" is added to the value of destination device **D** on every execution of the command whenever INC command is scanned for each cycle. This command is usually pulse execution (INCP).
2. In 16-bit command, when +32,767 is reached, "1" is added and it will write a value of –32,768 to the destination device. In 32-bit command, when +2,147,483,647 is reached, "1" is added and it will write a value of -2,147,483,648 to the destination device.
3. Flag M1020~M1022 won't be influenced by the operation result of this command.

Program Example:

When X0 is ON, the content of D0 will perform the addition of 1.



API	Mnemonic		Operands	Function
25	DEC	P	D	Decrement

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	DEC, DECP: 3 steps
D							*	*	*	*	*	

Operands:

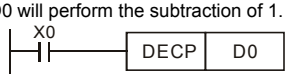
D: Destination

Explanations:

1. If operand D use with device F, it is only available in 16-bit command.
2. In 16-bit command, when –32,768 is reached, "1" is subtracted and it will write a value of +32,767 to the destination device. In 32-bit command, when -2,147,483,648 is reached, "1" is subtracted and it will write a value of +2,147,483,647 to the destination device.
3. Flag M1020~M1022 won't be influenced by the operation result of this command.

Program Example:

When X0 is ON, the content of D0 will perform the subtraction of 1.



API	Mnemonic		Operands	Function
30	ROR	P	D, n	Rotate to the Right

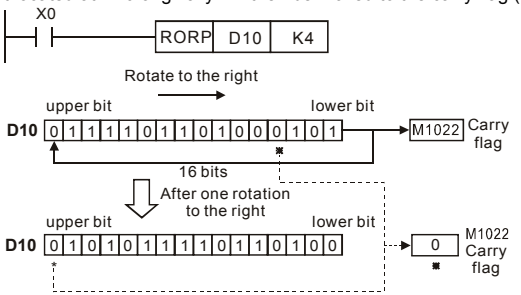
OP \ Type	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	
D							*	*	*	*	*	ROR, RORP: 5 steps
n				*	*							

Explanations:

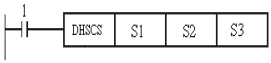
1. If operand D is specified as KnY, KnM, only K4 (16-bit) is valid.
2. Essential condition: 1≤n≤16 (16-bit).
3. **D**: Rotation device (destination device) **n**: Bit places of one time rotation.
4. The bit pattern of device **D** is rotated **n** bit places to the right on every operation of the command.
5. M1022 (Carry flag).

Program Example:

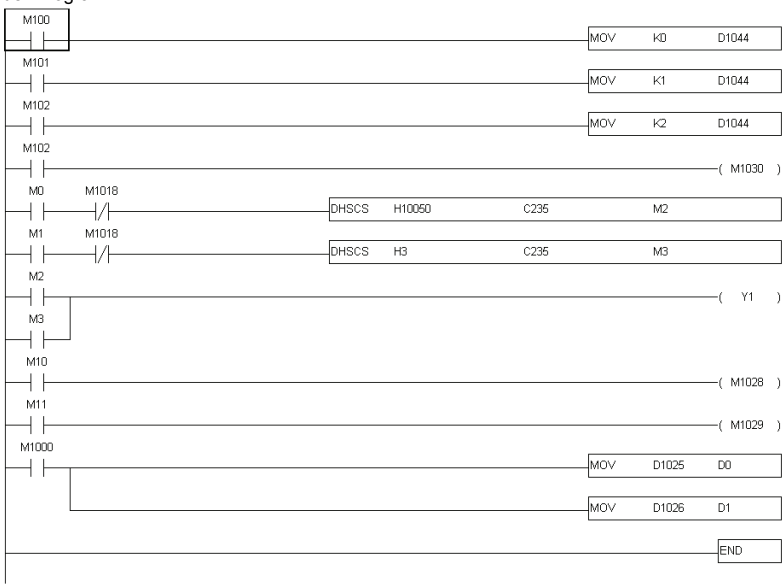
When X0 goes from OFF to ON, the 16 bit data of D10 will rotate 4 bits to the right, as shown in the diagram, and b3 that located at D10 originally will then be moved to the carry flag (CY) M1022.



Special function

Command Code	Function	Operands
DHSCS	High speed counter control  1:START/STOP (on/off) S1: Set the counter ID S2: Select counter S3: Output relay	Control high speed counter 1:(X, Y, M, T, C) S1: (K,H,D) S2: (C235) S3: (Y,M)

Ladder Program:

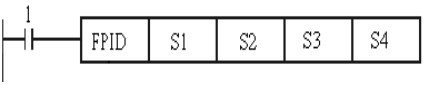


Description:

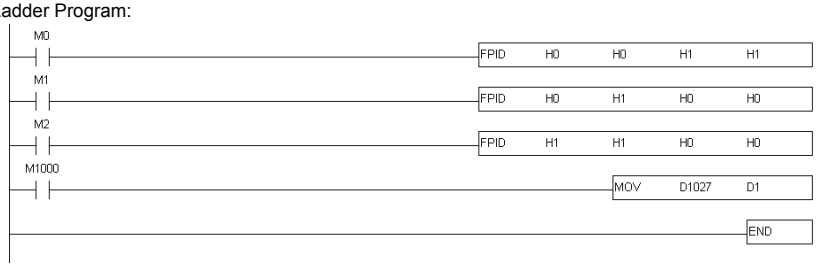
Before using high-speed counter, make sure that you have PG card. To count automatically, please set the target value by using DHSCS command and set M1028=On. The counter C235 will be ON when the count number = target value. If you want to clear C235, please set M1029=ON.

Three input modes for high-speed counter in the following can be set by D1044.

1. A-B phase mode: user can input the A and B pulse for counting. Make sure that $\overline{A}$, $\overline{B}$ and GND should be grounding.
2. Pulse + signal mode: user can count by pulse input or signal. A is for pulse and B is for signal. Make sure that $\overline{A}$, $\overline{B}$ and GND should be grounding.
3. Pulse + flag mode: user can count by M1030. Only A is needed for this mode and make sure that $\overline{A}$, and GND should be grounding.

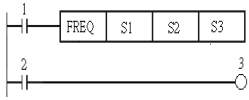
Command	Function	Operands
FPID	PID control  1:PID RUN/STOP (on/off) S1: PID set point selection. S2: Kp value of the PID function S3: Ki value of the PID function S4: Kd value of the PID function	Control PID function 1:(X, Y, M, T, C) S1: (K,H,D) S2: (K,H,D) S3: (K,H,D) S4: (K,H,D)

Ladder Program:

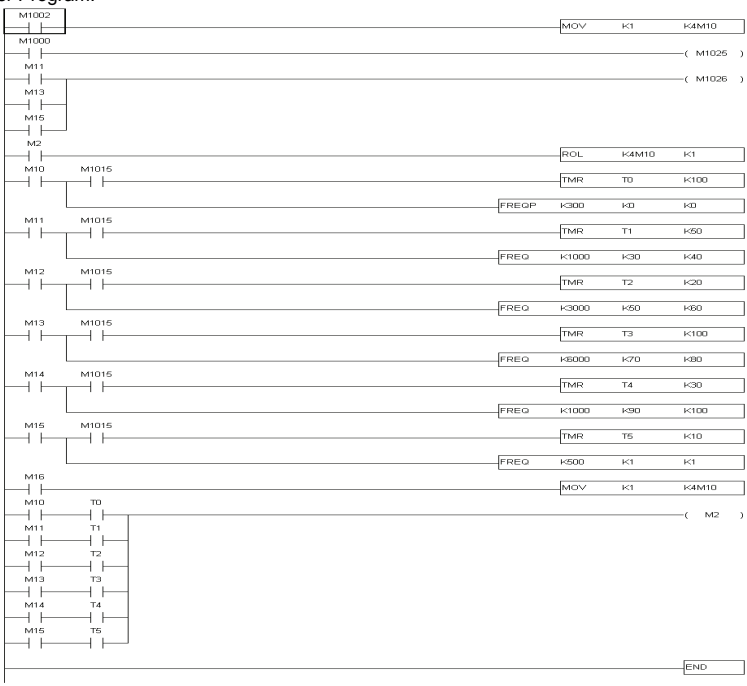


Description

This command controls PID parameters 10.00, 10.02 and 10.03 directly.

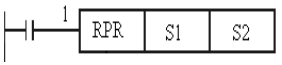
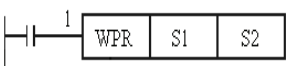
Command Code	Function	Operands
FREQ	Frequency control  1:RUN/STOP (on/off) S1: Setting frequency S2: Acceleration time S3: Deceleration time	Control Inverter Setting Frequency 1:(X, Y, M, T, C) S1: (K,H,D) S2: (K,H,D) S3: (K,H,D) 2:(X, Y, M, T, C) 3:M1028

Ladder Program:

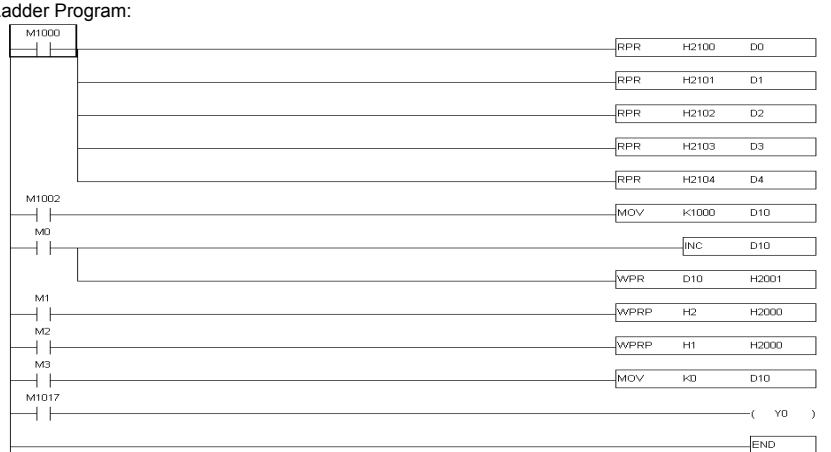


Description

The FREQ command can control frequency and acceleration/deceleration time. M1025 and M1026 can control RUN/STOP and running direction of the AC motor drive.

Command	Function	Operands
RPR	Read the parameter control  1:READ/NONE (on/off) S1: Parameter code S2: Read the parameter and save to S2	Read the parameter 1:(X, Y, M, T, C) S1: (K, H, D) S2: (D)
WPR	Write the parameter control  1:WRITE/NONE (on/off) S1: Write S2 to the parameter S1 S2: Parameter code	Write the parameter 1:(X, Y, M, T, C) S1: (K,H,D) S2: (D,H,K)

Ladder Program:



Description:

RPR and WPR commands can be used to read/write parameters and communication addresses.

ERROR CODE

Code	ID	Description	Corrective Actions
PLod	20	Data write error	Check if the program is error and download the program again
PLSv	21	Data write error when executing	Power on again and download the program again
PLdA	22	Program upload error	1. Please upload again. 2. Return to the factory if it occurs continuously
PLFn	23	Command error when download program	Check if the program is error and download program again
PLor	30	Program capacity exceeds memory capacity	Power on again and download program again
PLFF	31	Command error when executing	
PLSn	32	Check sum error	
PLEd	33	There is no “END” command in the program	
PLCr	34	The command MC is continuous used more than nine times	

D.8 PLC Application Table

External (1): External analog signal; External (2): External terminal

Source of the First Frequency Command (Pr.02.00)				Source of the Operation Command (Pr.02.01)				Explanation
External (1) (Pr.02.00=2/3)	PLC	COM (Pr.02.00=4/5)	KEYPAD (Pr.02.00=0/1)	External (2) (Pr.02.01=1/2)	PLC	COM (Pr.02.01=3/4)	KEYPAD (Pr.02.01=0)	
X	X	X	O	X	X	X	O	FREQ, M1025 and M1026 cannot be used in the PLC program.
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	
				O	X	X	X	
				O	X	X	O	
X	X	O	X	X	X	X	O	
				X	X	O	X	
				X	X	O	O	

Source of the First Frequency Command (Pr.02.00)				Source of the Operation Command (Pr.02.01)				
External (1) (Pr.02.00=2/3)	PLC	COM (Pr.02.00=4/5)	KEYPAD (Pr.02.00 =0/1)	External (2) (Pr.02.01=1/2)	PLC	COM (Pr.02.01=3/4)	KEYPAD (Pr.02.01 =0)	Explanation
				X	O	X	X	
				O	X	X	X	
				O	X	X	O	
X	X	O	O	X	X	X	O	
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	
				O	X	X	X	
				O	X	X	O	
X	O	X	X	X	X	X	O	M1025 and M1026 cannot be used in the PLC program.
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	FREQ, RPR, M1025 and M1026 can be used in the PLC program.
				O	X	X	X	M1025 and M1026 cannot be used in the PLC program.
				O	X	X	O	
X	O	X	O	X	X	X	O	M1025 and M1026 cannot be used in the PLC program.
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	None
				O	X	X	X	M1025 and M1026 cannot be used in the PLC program.
				O	X	X	O	
X	O	O	X	--	--	--	--	None
X	O	O	O	--	--	--	--	None

Source of the First Frequency Command (Pr.02.00)				Source of the Operation Command (Pr.02.01)				Explanation
External (1) (Pr.02.00=2/3)	PLC	COM (Pr.02.00=4/5)	KEYPAD (Pr.02.00=0/1)	External (2) (Pr.02.01=1/2)	PLC	COM (Pr.02.01=3/4)	KEYPAD (Pr.02.01=0)	
O	X	X	X	X	X	X	O	FREQ, M1025 and M1026 cannot be used in the PLC program.
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	
				O	X	X	X	
				O	X	X	O	
O	X	X	O	X	X	X	O	
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	
				O	X	X	X	
				O	X	X	O	
O	X	O	X	X	X	X	O	
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	
				O	X	X	X	
				O	X	X	O	
O	X	O	O	--	--	--	--	None
O	O	X	X	X	X	X	O	M1025 and M1026 cannot be used in the PLC program.
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	
				O	X	X	X	

Source of the First Frequency Command (Pr.02.00)				Source of the Operation Command (Pr.02.01)				
External (1) (Pr.02.00=2/3)	PLC	COM (Pr.02.00=4/5)	KEYPAD (Pr.02.00=0/1)	External (2) (Pr.02.01=1/2)	PLC	COM (Pr.02.01=3/4)	KEYPAD (Pr.02.01=0)	Explanation
				O	X	X	O	
O	O	X	O	X	X	X	O	M1025 and M1026 cannot be used in the PLC program.
				X	X	O	X	
				X	X	O	O	
				X	O	X	X	
				O	X	X	X	
				O	X	X	O	
O	O	O	X	--	--	--	--	None
O	O	O	O	--	--	--	--	None