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

DELTA_IA-MDS_LTC_UM_EN_20221125

Delta Telescopic Belt Conveyor Integrated Drive LTC Series User Manual

Digitized Automation for a Changing World

Delta Telescopic Belt Conveyor Integrated Drive LTC Series User Manual

www.deltaww.com

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(Translation of the original instructions)

READ PRIOR TO INSTALLATION FOR SAFETY.

DANGER

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

CAUTION

- ☑ Never connect the controller output terminals U1, V1, W1 or U2, V2, W2 directly to the AC mains circuit power supply.
- ☑ After finishing the wiring of the controller, check if U1, V1, W1； U2, V2, W2 are short-circuited to PE with a multimeter. Do NOT power the controller if short circuits occur. Eliminate the short circuits before the controller is powered.
- ☑ The rated voltage range for the controller must be from 342V to 528V for 460V models.
- ☑ Refer to the table below for short circuit rating:

Model (Power)	Short circuit rating
460V	5kA

- ☑ Even if the three-phase AC motor is stopped, a charge with hazardous voltages may still remain in the main circuit terminals of the controller.
- ☑ The performance of electrolytic capacitor will degrade if it is not charged for a long time. It is recommended to charge the controller which is stored in no charge condition every 2 years for 3–4 hours to restore the performance of electrolytic capacitor in the controller. Note: When power up the controller by using connecting AC power to R/S/T terminals, use 220–240 V_{AC} of single-phase power between R and S terminals to charge the controller for 30 minutes (do not run the controller). Then charge the controller at 380–480 V_{AC} rated voltage of three-phase power between R, S, and T terminals for one hour (do not run the controller). By doing these, restore the performance of electrolytic capacitor before starting to run the controller. Do NOT run the controller at 100% rated voltage right away.
- ☑ If the controller generates leakage current over AC 3.5 mA or over DC 10 mA on a grounding conductor, compliance with local grounding regulations or IEC61800-5-1 standard is the minimum requirement for grounding.
- ☑ LTC controller is designed for applications in normal industrial environments. If it is used in a public low-voltage power supply system such as housing buildings, install proper suppression devices like isolating transformer or input reactor because non-linear load may cause harmonic current. This helps suppress interference caused by harmonic current from public low-voltage power supply system. For more information, please contact Delta.

NOTE:

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

Table of Contents

Issued Edition: 00
Drive Firmware Version: V1.01 (Refer to Parameter 00-06 on the product to get the firmware version)
Issued Date: November, 2022

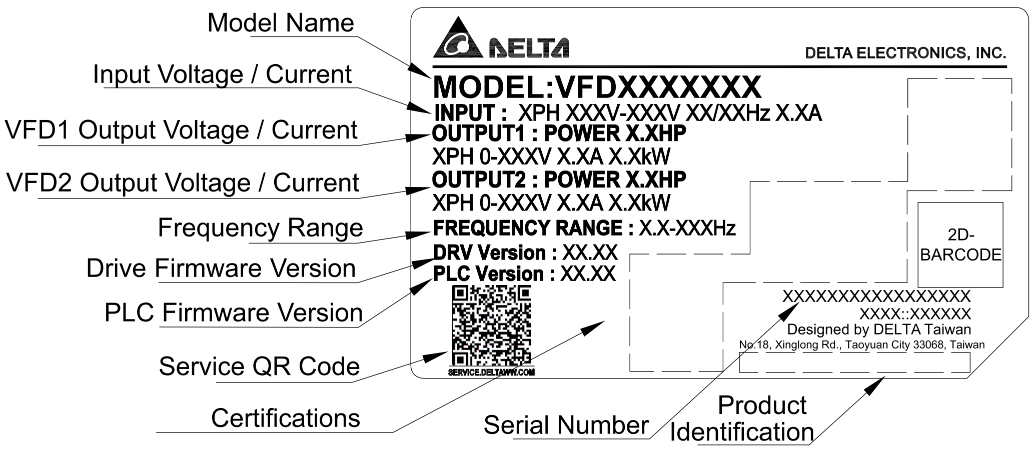
Chapter 1 Introduction

After you receive the product, check the following:

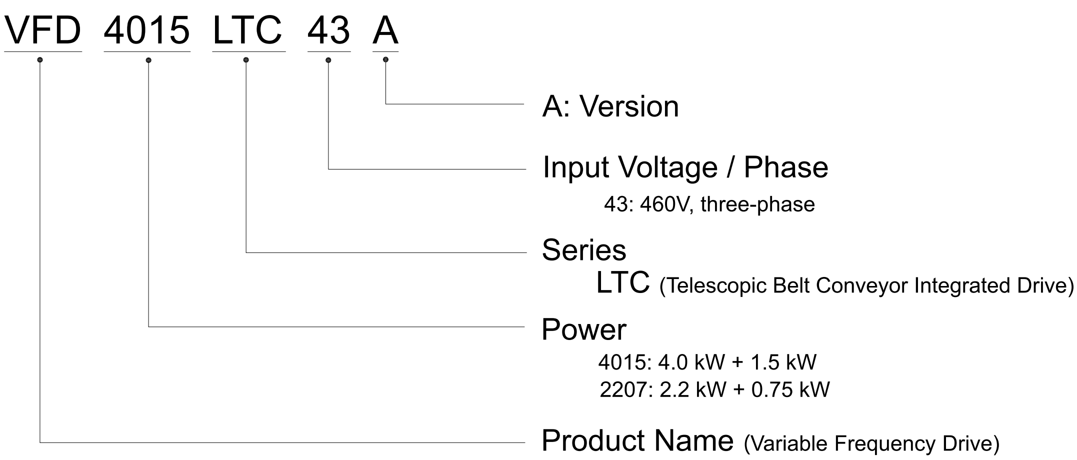
1. Inspect the unit after unpacking to ensure that it was not damaged during shipment. Make sure that the part number printed on the package corresponds with the part number indicated on the nameplate.
2. Make sure that the voltage for the wiring is in the range indicated on the nameplate. Install the controller according to this manual.
3. Before applying the power, make sure that all the devices, including power, motor, control board and digital keypad are connected correctly.
4. When wiring the controller, make sure that the wirings for input terminals “R, S, T” and output terminals “U1, V1, W1, U2, V2, W2” are correct to prevent damage to the controller.

1-1 Nameplate Information

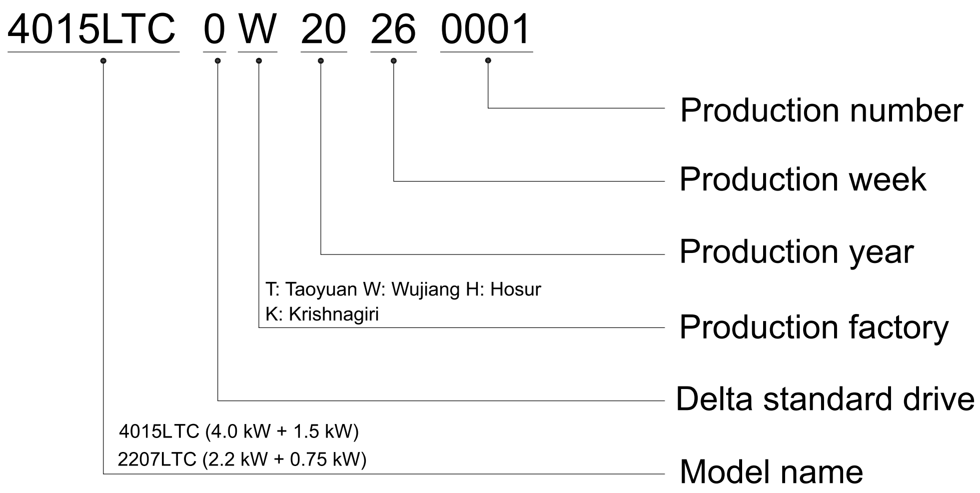
460V Models



1-2 Model Number



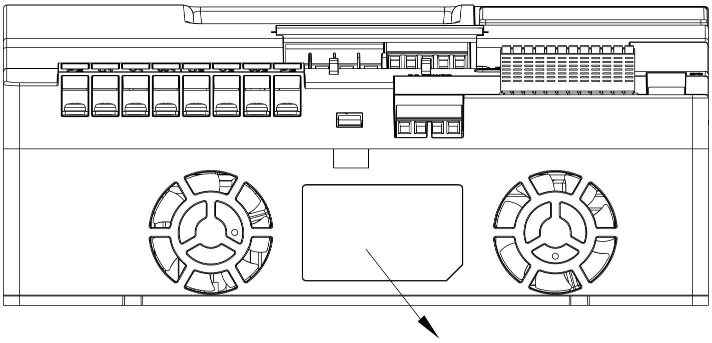
1-3 Serial Number



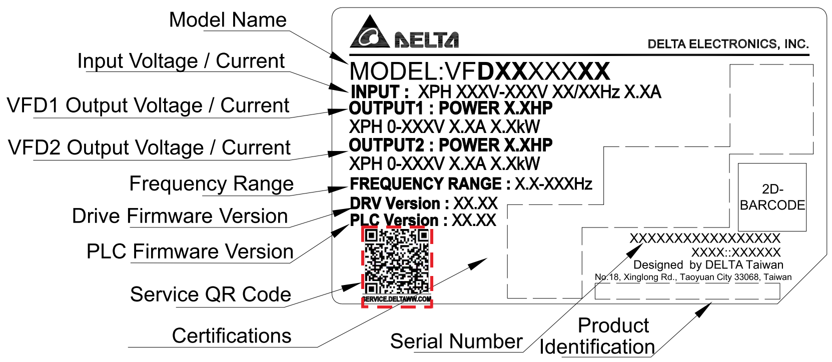
1-4 Apply After Service by Mobile Device

1-4-1 Location of Service Link Label

Service Link label is within the nameplate label



Location of Service Link Label



1-4-2 Service Link Label

Scan QR code to apply

1. Find the QR code sticker (as shown above).
2. Run the QR code reader App on your smart phone.
3. Point your camera at the QR Code. Hold your camera steady until the QR code comes into focus.
4. Access the Delta After-Sales Service website.
5. Fill in the information in the columns marked with an orange star.
6. Enter the CAPTCHA and click **Submit** to complete the request.

Cannot find the QR code?

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

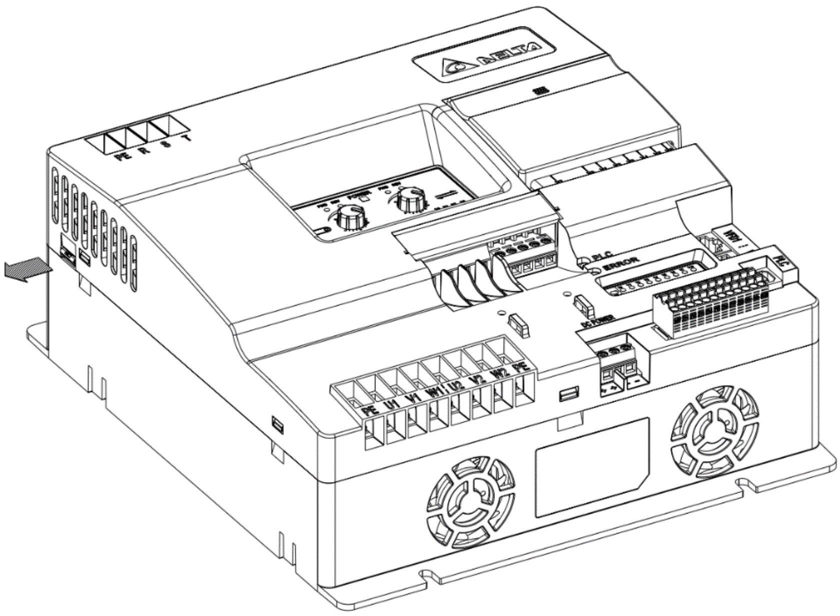
1-5 RFI Jumper

RFI jumper:

LTC controller contains Varistors / MOVs that are connected from phase to phase and from phase to ground to prevent the controller from unexpected stop or damage caused by mains surges or voltage spikes. Because the Varistors / MOVs from phase to ground are connected to ground with the RFI jumper, note that removing the RFI jumper will disable the protection.

Removing the RFI jumper:

Pry the RFI jumper with a slotted screwdriver.

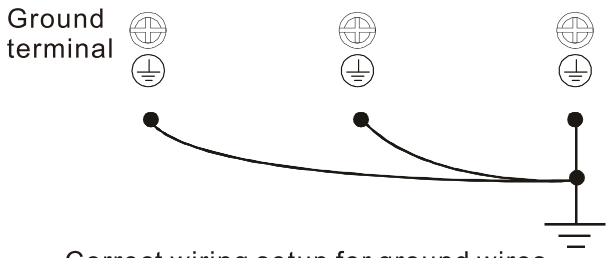


Isolating main power from ground:

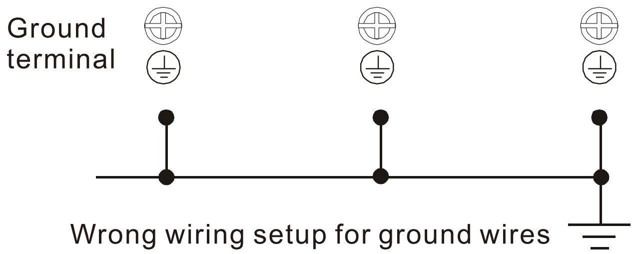
When the power distribution system for the controller is a floating ground system (IT Systems) or an asymmetric ground system (Corner Grounded TN Systems), you must remove the RFI jumper. Removing the RFI jumper disconnects the internal capacitors from ground to avoid damaging the internal circuits and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

Important points regarding ground connection:

- ☑ To ensure the safety of personnel, proper operation, and to reduce electromagnetic radiation, you must properly ground the motor and controller during installation.
- ☑ The diameter of the grounding cables must comply with the local safety regulations.
- ☑ You must connect the shielded cable to the controller's ground to meet safety regulations.
- ☑ Only use the shielded cable as the ground for equipment when the aforementioned points are met.
- ☑ When installing multiple controllers, do not connect the grounds of the controllers in series but connect each controller to ground. The following pictures show the correct and wrong ways to connect the grounds.



Correct wiring setup for ground wires



Wrong wiring setup for ground wires

Pay particular attention to the following points:

- ☑ Do not remove the RFI jumper while the power is ON.
- ☑ Make sure the main power is OFF before removing the RFI jumper.
- ☑ Removing the RFI jumper also cuts the capacitor conductivity of the surge absorber to ground and the built-in EMC filter capacitors. Compliance with the EMC specifications is no longer guaranteed.
- ☑ Do not remove the RFI jumper if the mains power is a symmetrical grounded power system in order to maintain the efficiency for EMC circuit.
- ☑ Remove the RFI jumper when conducting high voltage tests. When conducting a high voltage test to the entire facility, disconnect the mains power and the motor if the leakage current is too high.

Floating Ground System (IT Systems)

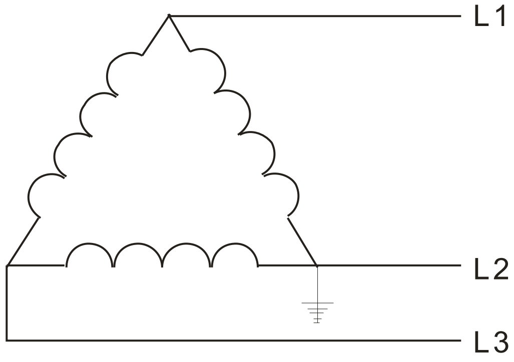
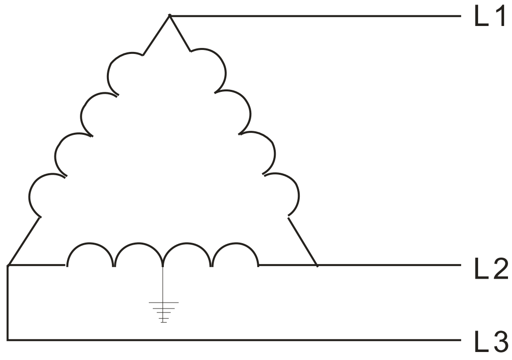
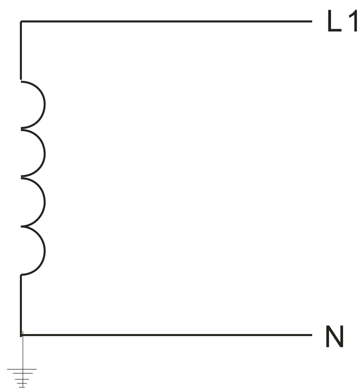
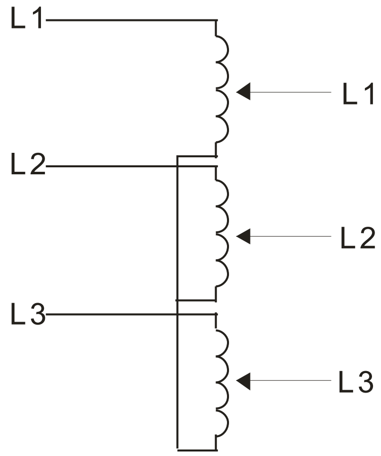
A floating ground system is also called an IT system, an ungrounded system, or a high impedance/ resistance (greater than 30 Ω) grounded system.

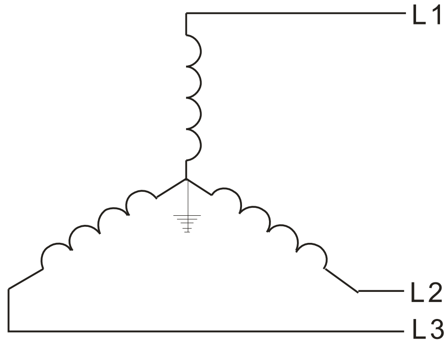
- ☑ Disconnect the ground cable from the internal EMC filter.
- ☑ In situations where EMC is required, check for excess electromagnetic radiation affecting nearby low-voltage circuits. In some situations, the adapter and cable naturally provide enough suppression. If in doubt, install an extra electrostatic shielded cable on the power supply side between the main circuit and the control terminals to increase shielding.
- ☑ Do not install an external RFI/EMC filter. The external EMC filter passes through a filter capacitor and connects power input to the ground. This is very dangerous and damages the controller.

Asymmetric Ground System (Corner Grounded TN Systems)

Caution: Do not remove the RFI jumper while power to the input terminal of the controller is ON.

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

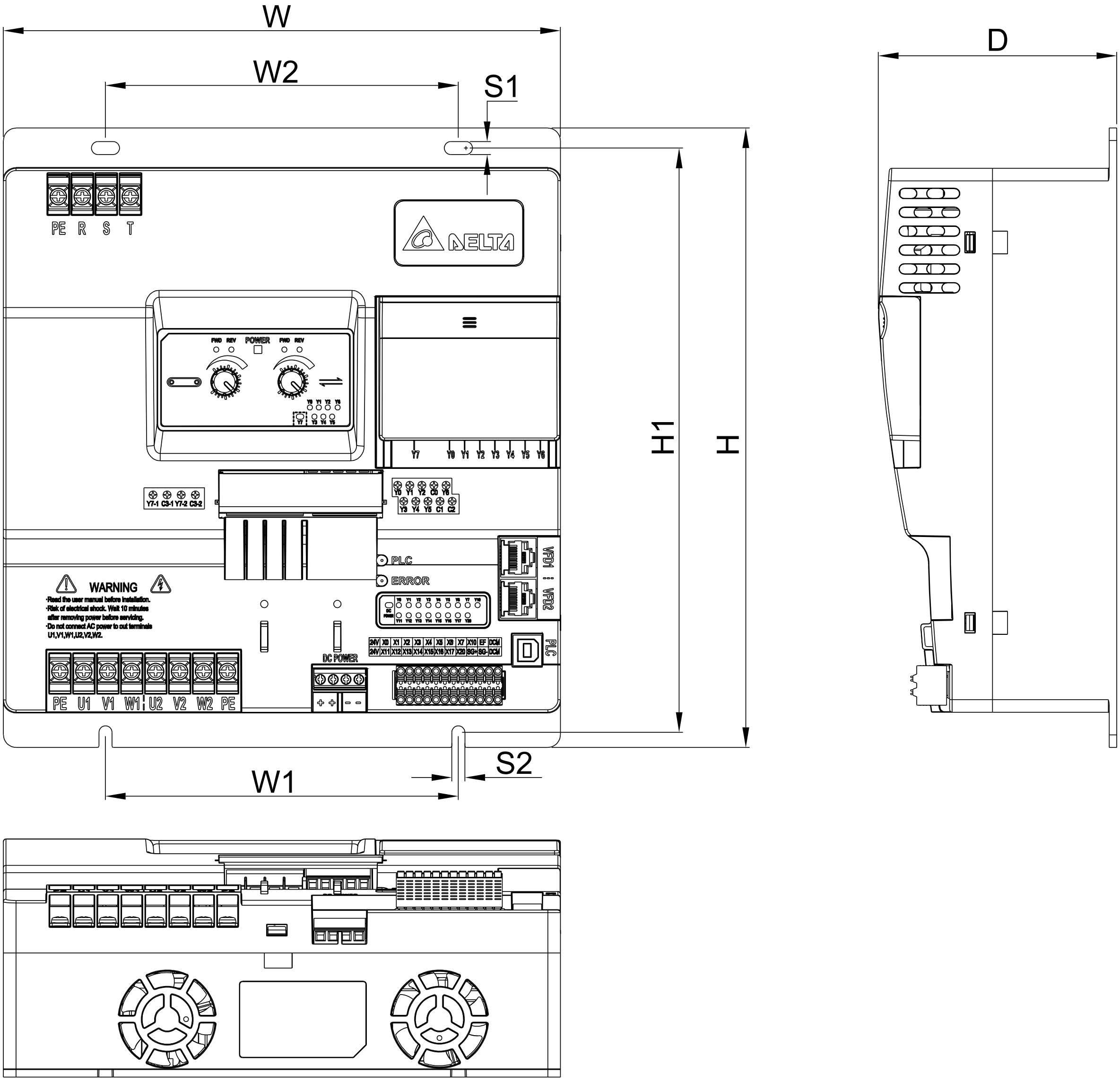
Conditions for removing the RFI jumper	
1. Grounding at a corner in a triangle configuration  	2. Grounding at a midpoint in a polygonal configuration 
3. Grounding at one end in a single-phase configuration  	4. No stable neutral grounding in a three-phase autotransformer configuration 

Using the RFI jumper	
In the situation as the diagram on the right shows, you can use the RFI jumper to pass through RFI capacitor to make an internal grounding and reduce electromagnetic radiation. In a situation with higher requirements for electromagnetic compatibility and a symmetrical grounding power system, you can install an EMC filter. For example, the diagram on the right is a symmetrical grounding power system.	

1-6 Dimensions

Frame A

VFD2207LTC43A, VFD4015LTC43A

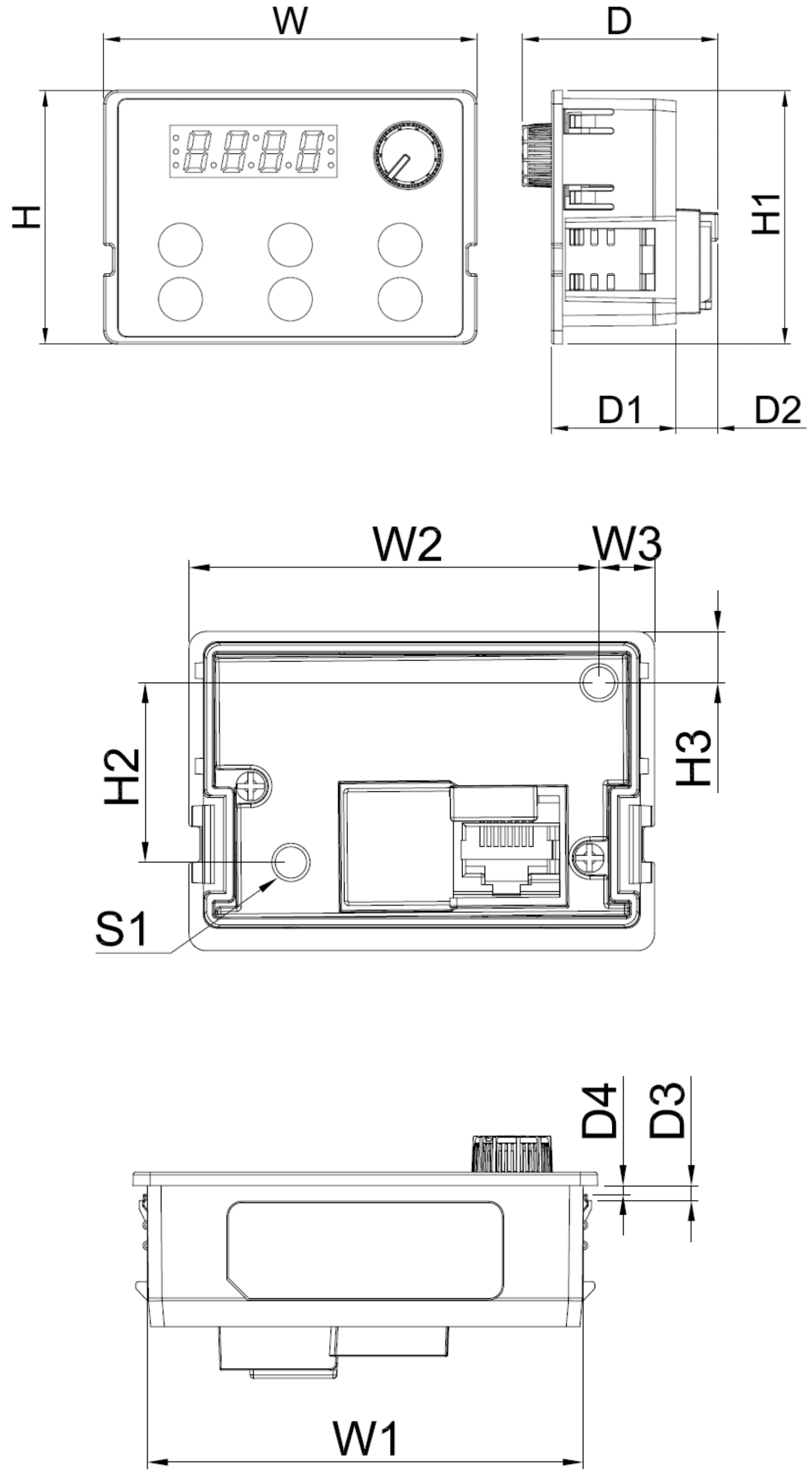


Unit: mm [inch]

Frame	W	W1	W2	H	H1	D	S1	S2
A	221.0 [8.70]	140.0 [5.51]	140.0 [5.51]	246.0 [9.69]	232.0 [9.13]	94.6 [3.72]	5.2 [0.20]	5.2 [0.20]

Digital Keypad (Optional)

VFD-PU08



Unit: mm [inch]

W	W1	W2	W3	H	H1	H2	H3	D	D1	D2	D3	D4	S1
68.0 [2.68]	63.8 [2.51]	59.9 [2.68]	8.1 [0.32]	46.8 [1.84]	42.0 [1.65]	26.3 [1.04]	7.5 [0.30]	35.6 [1.40]	22.7 [0.89]	7.6 [0.30]	2.2 [0.09]	1.3 [0.05]	M3*0.5 (2X)

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Chapter 2 Installation

2-1 Mounting Clearance

☑ Prevent fiber particles, scraps of paper, shredded wood, sawdust, metal particles, etc. from entering LTC or adhering to the heat sink.

☑ Install the controller in a metal cabinet to prevent the risk of fire.

☑ Install the controller in a Pollution Degree 2 (IEC 60664-1) environment with clean and circulating air. A clean and circulating environment means air without polluting substances and dust.

The products' figures shown below are for reference only. The actual products may look different.

Inflow   Outflow   Clearance

Mounted vertical installation / side-by-side horizontal installation (Frame A)

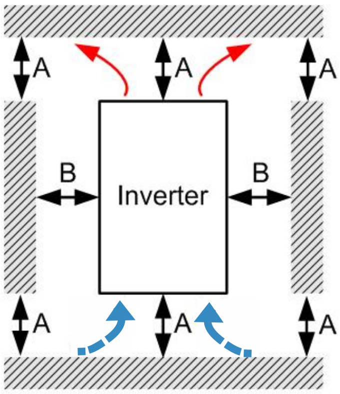


Figure 2-1

Mounted vertical installation / side-by-side horizontal installation (Frame A)

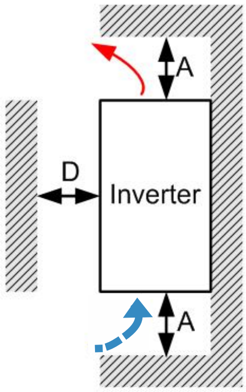


Figure 2-2

Minimum mounting clearance

Frame	A [mm]	B [mm]	D [mm]
A	50	30	0

NOTE:

Table 2-1

The minimum mounting clearances A–D stated in Table 2-1 apply to LTC Frame A. Failure to follow the minimum mounting clearances may cause the controller fan to malfunction and cause heat dissipation problems.

Frame A	VFD2207LTC43A; VFD4015LTC43A

Table 2-2

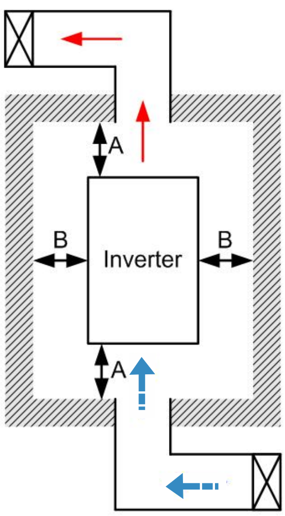


Figure 2-3

NOTE:

- The mounting clearance stated is for installing the controller in an open area, as shown in Figure 2-3. To install the controller in a confined space (such as cabinet or electric box), follow the following rules: (1) Keep the minimum mounting clearances. (2) Install a ventilation equipment or an air conditioner to keep surrounding temperature lower than operation temperature. (3) Refer to parameter setting and set up Pr.02.03.
- The table below shows the heat dissipation and the required air volume when installing a single controller in a confined space.
- Refer to the table below (Airflow Rate for Cooling) for ventilation equipment design and selection.
- Refer to the table below (Power Dissipation for Controller) for air conditioner design and selection.
- Ambient temperature derating curve shows the derating status in different temperature in relation to different protection level.

2-2 Airflow and Power Dissipation

Model	Airflow Rate for Cooling						Power Dissipation for Controller		
	Flow Rate [cfm]			Flow Rate [m^3/hr]			Power Dissipation [watt]		
	External	Internal	Total	External	Internal	Total	Loss External (Heat sink)	Internal	Total
VFD2207LTC43A	16	-	16	27.2	-	27.2	64	32	96
VFD4015LTC43A	16	-	16	27.2	-	27.2	122	53	175

Airflow notes:
- The required airflow shown in the table is for installing a single controller in a confined space.
- When installing multiple controllers, the required air volume should be the required air volume for single controller × the number of the controllers.

Power dissipation notes:
- The heat dissipation shown in the table is for installing a single controller in a confined space.
- When installing multiple controllers, volume of heat dissipation should be the heat dissipated for single controller × the number of the controllers.
- Heat dissipation for each model is calculated by rated voltage, current and default carrier.

Table 2-3

2-3 Packaging Method

As the diagram below shows, there are two layers of packaging for the controller. One controller is in the inner small carton, and three controllers are in the outer big carton.

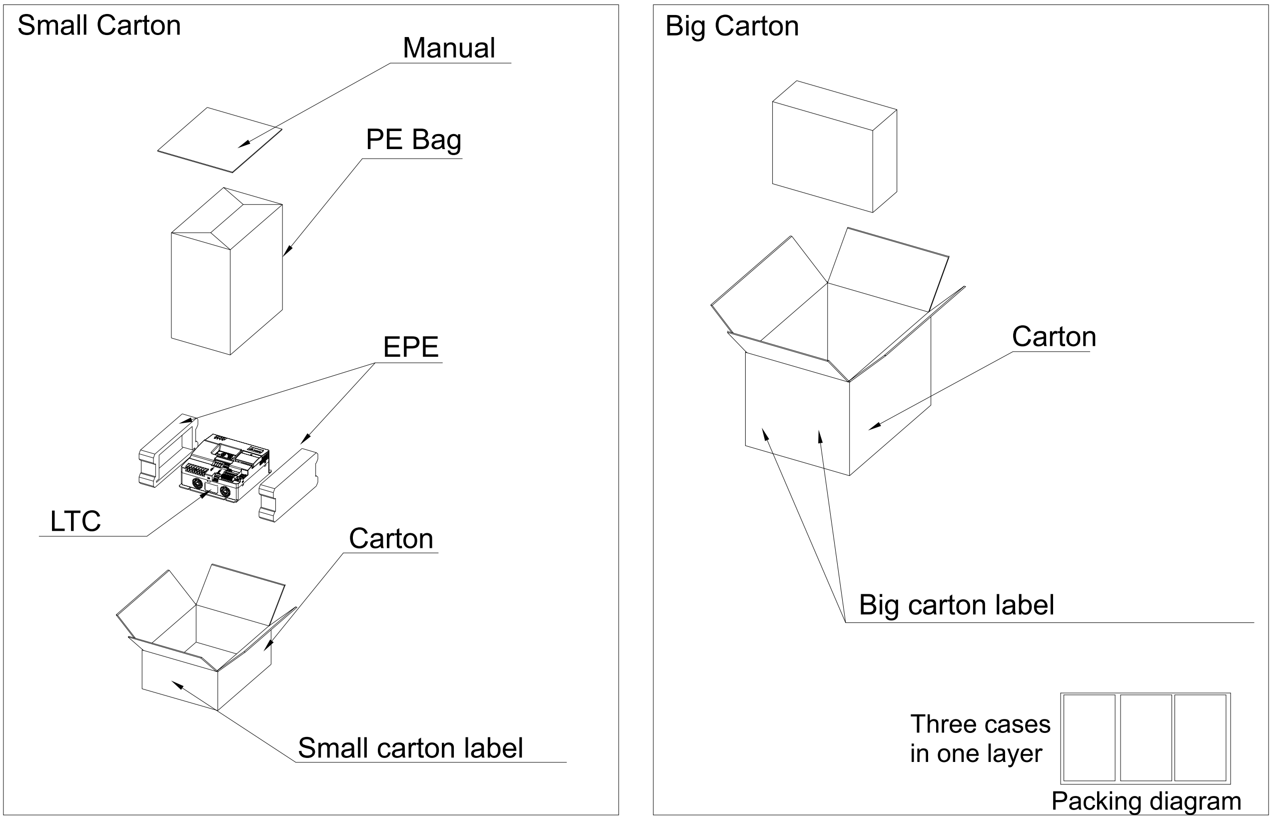


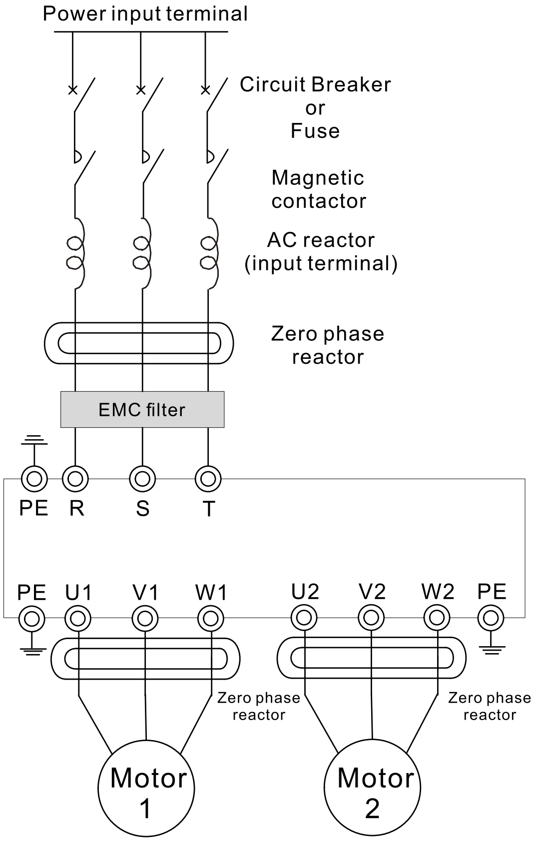
Figure 2-4

Chapter 3 Wiring

After removing the packaging, verify that the power and control terminals are clearly noted. Read the following precautions before wiring.

DANGER	☑ Disconnect AC input power before connecting any wiring to the controller. ☑ Even if the power has been turned off, a charge may still remain in the DC-link capacitors with hazardous voltages before the POWER LED is OFF. Do NOT touch the internal circuits and components. ☑ There are highly sensitive MOS components on the printed circuit boards. These components are especially sensitive to static electricity. Take anti-static measure before touching these components or the circuit boards. ☑ Never modify the internal components or wiring. ☑ Ground the controller by using the ground terminal. The grounding method must comply with the laws of the country where the controller is to be installed. ☑ Do NOT install the controller in a location with high temperature, direct sunlight or inflammable materials or gases.
CAUTION	☑ Never connect the controller output terminals U1, V1, W1 or U2, V2, W2 directly to the AC mains circuit power supply. ☑ After finishing the wiring of the controller, check if U1, V1, W1；U2, V2, W2 are short-circuited to PE with a multimeter. Do NOT power the controller if short circuits occur. Eliminate the short circuits before the controller is powered. ☑ The rated voltage range for the controller must be from 342V to 528V for 460V models. ☑ Even if the three-phase AC motor is stopped, a charge with hazardous voltages may still remain in the main circuit terminals of the controller. ☑ The performance of electrolytic capacitor will degrade if it is not charged for a long time. It is recommended to charge the controller which is stored in no charge condition every 2 years for 3–4 hours to restore the performance of electrolytic capacitor in the controller. **NOTE:** When power up the controller by using connecting AC power to R/S/T terminals, use 220–240 V_{AC} of single-phase power between R and S terminals to charge the controller for 30 minutes (do not run the controller). Then charge the controller at 380–480 V_{AC} rated voltage of three-phase power between R, S, and T terminals for one hour (do not run the controller). By doing these, restore the performance of electrolytic capacitor before starting to run the controller. Do NOT run the controller at 100% rated voltage right away. ☑ If the controller generates leakage current over AC 3.5 mA or over DC 10 mA on a grounding conductor, compliance with local grounding regulations or IEC61800-5-1 standard is the minimum requirement for grounding.

3-1 System Wiring Diagram

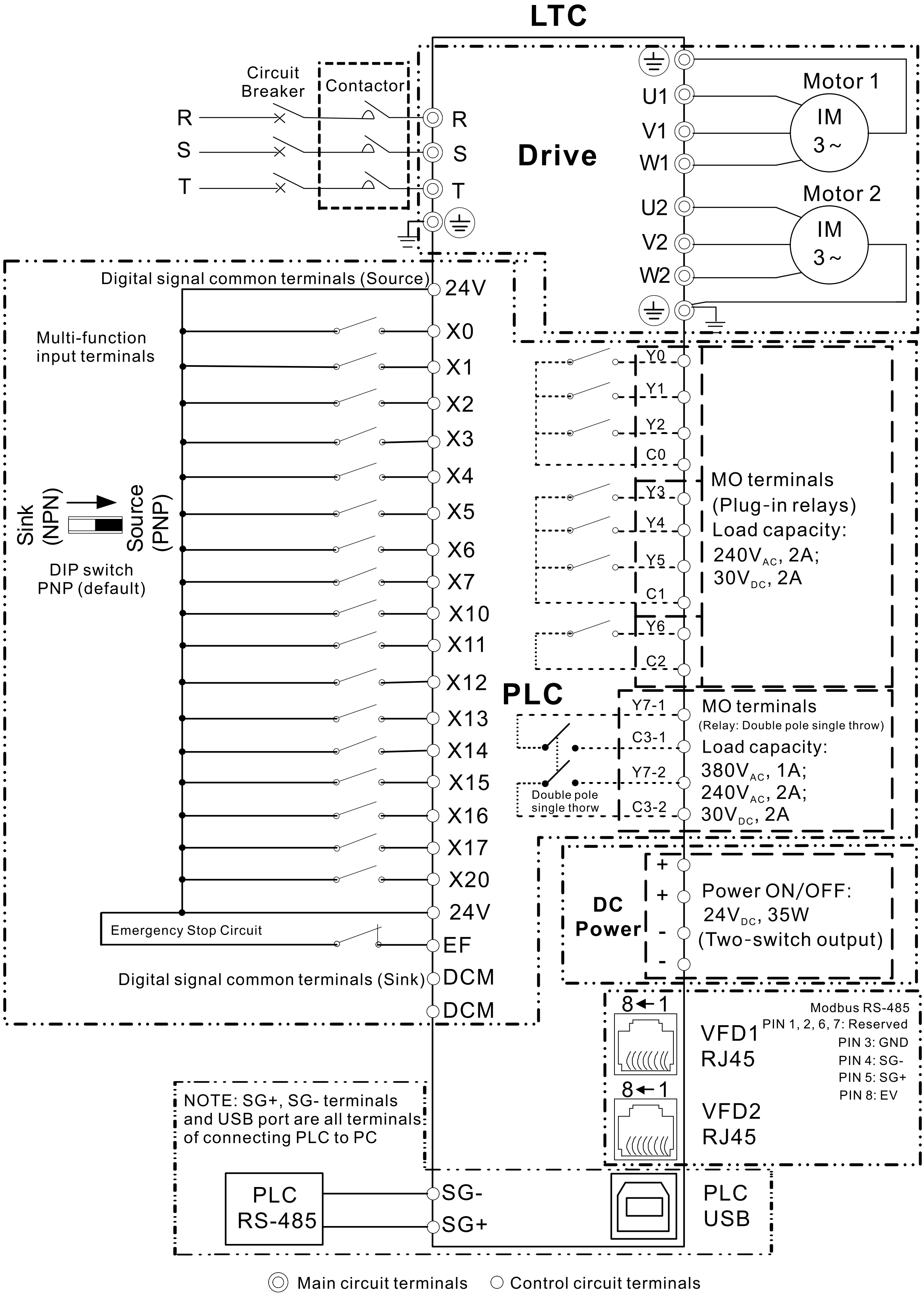


NOTE: For details on wiring method, see Section 3-2 Wiring.

Power input terminal	Supply power according to the rated power specifications indicated in the manual. See Chapter 7 Specification.
Circuit Breaker or Fuse	There may be a large inrush current during power on. Refer to Section 6-2 Circuit Breaker for details.
Magnetic contactor	Switching the power ON/OFF on the primary side of the magnetic contactor can turn the controller ON/OFF, but frequent switching can cause machine failure. Do not switch ON/OFF more than once an hour. Do not use the magnetic contactor as the power switch for the controller; doing so shortens the life of the controller.
AC reactor (input terminal)	When the main power supply capacity is greater than 500 kVA, or when it switches into the phase capacitor, the instantaneous peak voltage and current generated may destroy the internal circuit of the controller. It is recommended that you install an input side AC reactor in the controller. This also improves the power factor and reduces power harmonics. The wiring distance should be within 10 m. Refer to Section 6-3 AC Reactor for details.
Zero phase reactor	Used to reduce radiated interference, especially in environments with audio devices, and reduce input and output side interference. The effective range is AM band to 10 MHz. Refer to Section 6-3 AC Reactor for details.
EMC Filter	Can be used to reduce electromagnetic interference. Refer to Section 6-4 EMC Filter.

3-2 Wiring

3-2-1 Wiring Diagram



Terminals	Descriptions
R, S, T	Mains input terminals (three-phase)
U1, V1, W1	VFD1 drive output terminals for connecting a three-phase induction motor.
U2, V2, W2	VFD2 drive output terminals for connecting a three-phase induction motor.
⏚ E	Ground connection; comply with local regulations.

CAUTION

Main input power terminals

☑ DO NOT connect a three-phase model to single-phase power. R, S and T have no phase-sequence requirement; they can be connected in any sequence.

☑ You must install a NFB or circuit breaker between power input terminals and the main circuit terminals (R, S, T). Add a magnetic contactor (MC) to the power input wiring to cut off power quickly and reduce malfunctions when the controller protection function activates. Both ends of the MC should have an R-C surge absorber.

☑ Tighten the screws in the main circuit terminal to prevent sparks caused by screws loosened due to vibration.

☑ Use voltage and current within the specifications in Chapter 7.

☑ The controller generates leakage current that flows through protective ground conductor to ground during its operation. ADD Type B residual current devices (RCDs), and choose a residual current of 30 mA above. Or choose generic RCDs with residual current larger than 200 mA and action time longer than 0.1 sec..

Output terminals of the main circuit

☑ If necessary, use an inductive filter only at the motor output terminals U1, V1, W1; U2, V2, W2 of the controller. DO NOT use phase-compensation capacitors or L-C (Inductance-Capacitance) or R-C (Resistance-Capacitance), unless approved by Delta.

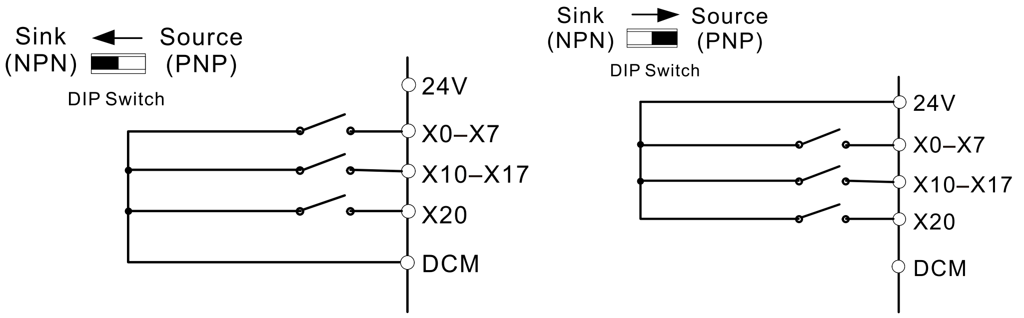
☑ DO NOT connect phase-compensation capacitors or surge absorbers at the output terminals of the controller.

☑ Use well-insulated motors to prevent any electric leakage from the motors.

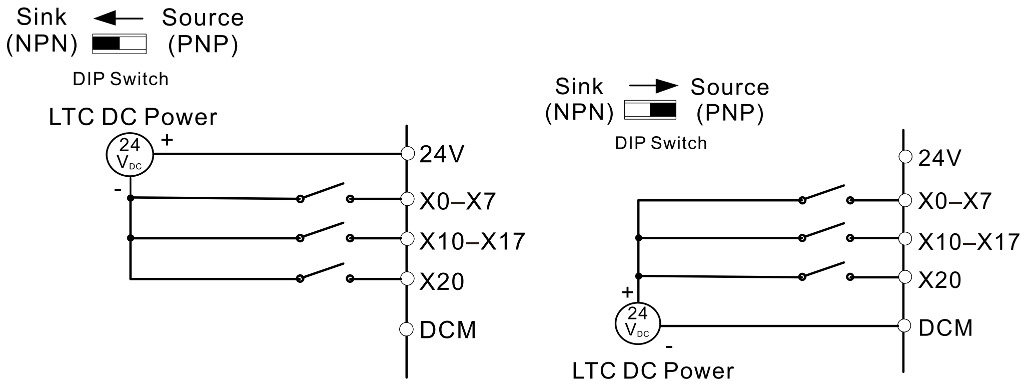
3-2-2 Switching between two modes: SINK (NPN) / SOURCE (PNP)

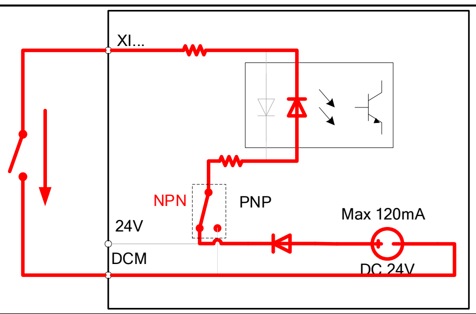
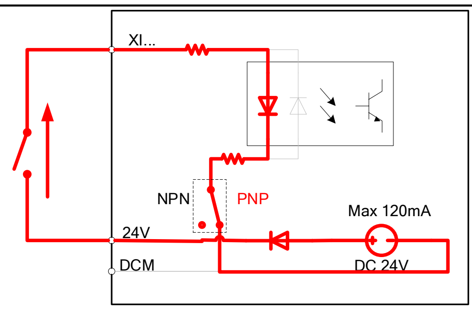
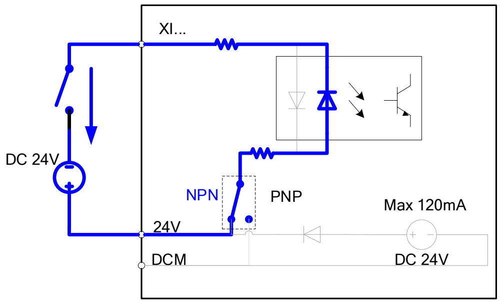
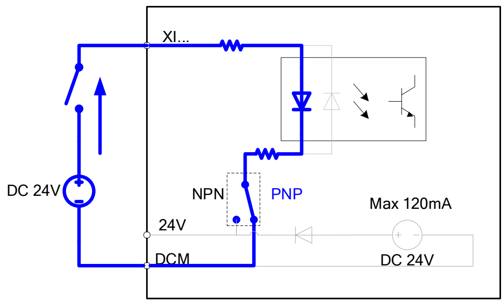
X terminals are compatible with NPN and PNP modes. For details on NPN and PNP mode wiring in internal and external power supply, see the figures below.

- Internal power supply



- External power supply



	Sink (NPN)	Source (PNP)
Internal Power Supply		
External Power Supply		

NOTE:

PNP (DIP switch to Source) is the factory default for NPN/PNP switch function. For using different modes, make sure the hardware wiring is correct, and select by DIP switches (DIP switch AS2). The total output capacity of 24V-DCM internal 24V power supply is 120 mA. For output capacity of external load, deduct the corresponding current consumption of the number of X terminals activated (6 mA for each terminal).

Chapter 4 Main Circuit Terminals

4-1 Main Circuit Diagram

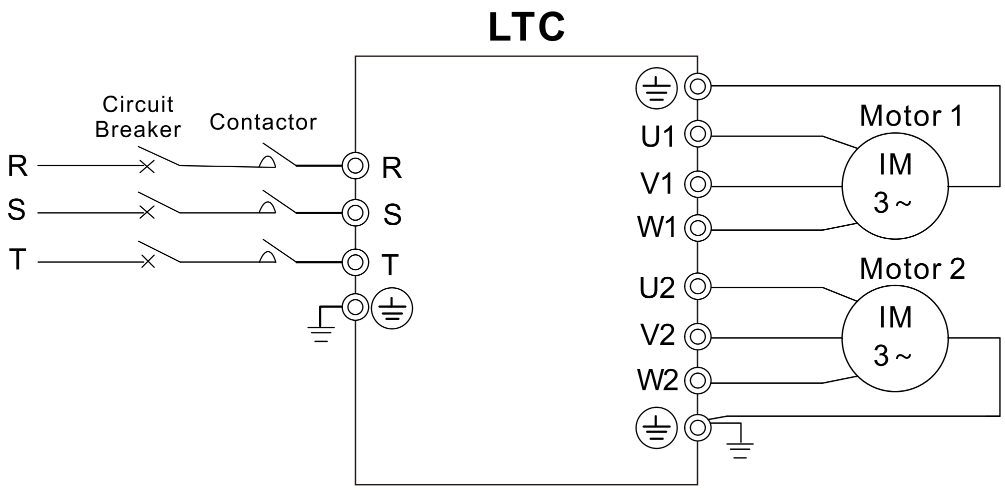


Figure 4-1

Terminals	Descriptions
R, S, T	Mains input terminals (three-phase)
U1, V1, W1	VFD1 drive output terminals for connecting a three-phase induction motor.
U2, V2, W2	VFD2 drive output terminals for connecting a three-phase induction motor.
⏚ E	Ground connection; comply with local regulations.

4-2 Main Circuit Terminal Specifications

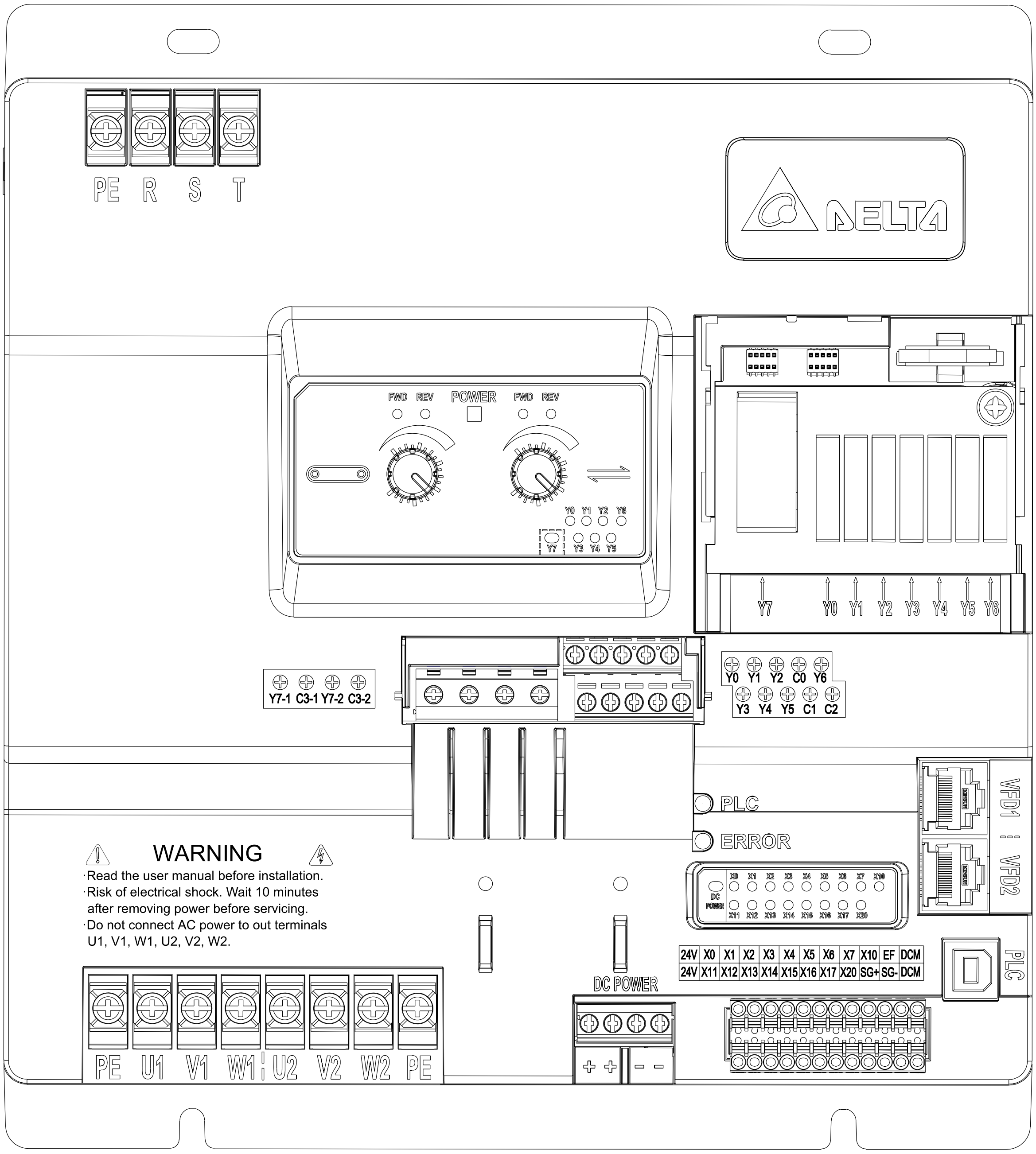


Figure 4-2

Wiring precautions:

- It is recommended to use LUG, and the wiring should comply with local regulations.
- Dimensions for LUG show as Figure 4-3 below. Recommended LUG model is SNYS2-3.7 or RNYS2-3.7 from K. S. TERMINALS INC..
- Use insulator that is resistant to 600 V and temperature resistant to 105°C.
- If you install at Ta 45°C environment, use copper wires that have a voltage rating of 600 V and are temperature resistant to 70°C or above.
- If you install at Ta 45°C above environment, use copper wires that have a voltage rating of 600 V and are temperature resistant to 90°C or above.

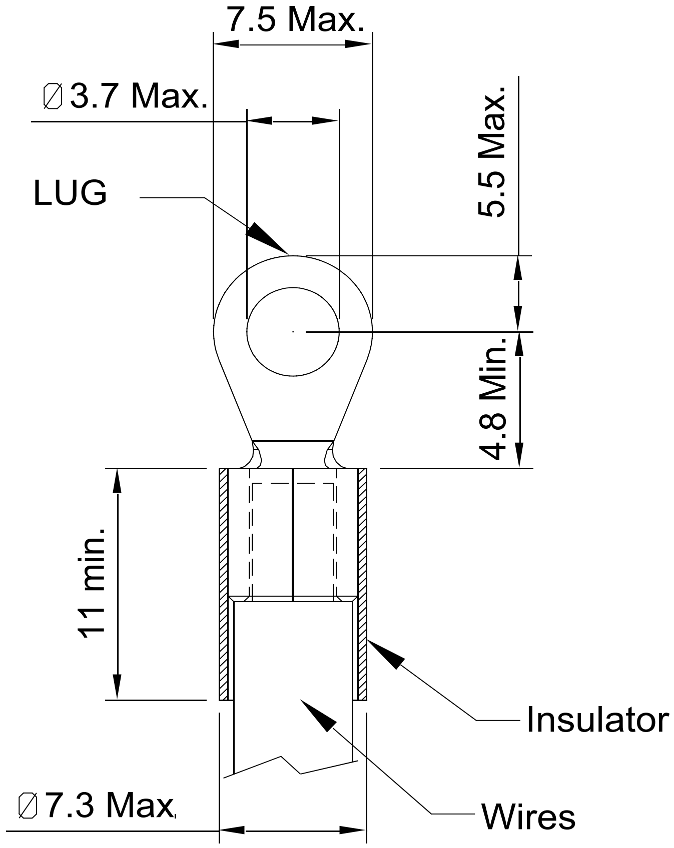


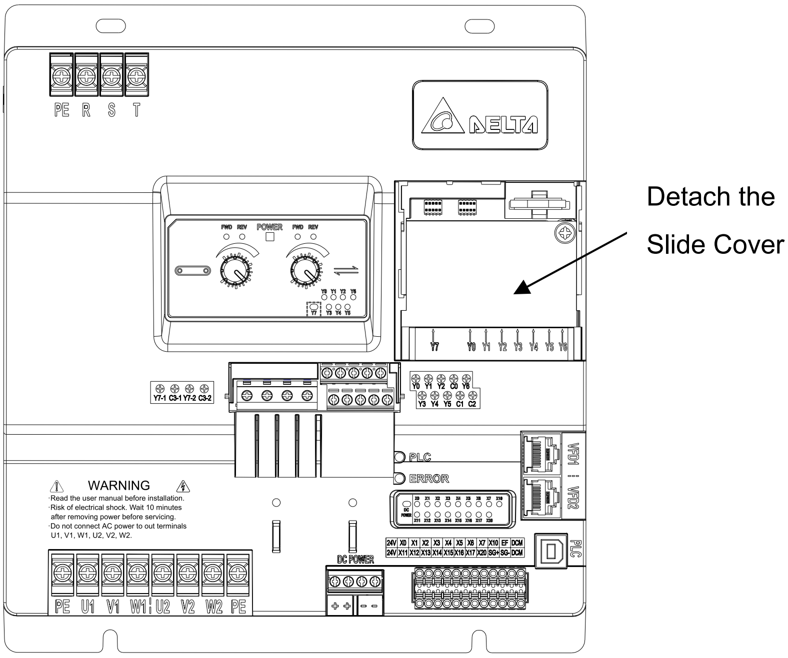
Figure 4-3

Model	Main Circuit Terminals R, S, T, U1, V1, W1, U2, V2, W2, PE			
	Wiring Specifications	Maximum Wire Gauge	Minimum Wire Gauge	Screw Size & Torque (±10%)
VFD2207LTC43A	IEC / GB	2.5 mm^2	1.5 mm^2	M3.5 13.7 kgf-cm [11.9 lbf-in.] [1.4 Nm]
	AWG	12 AWG	16 AWG	
VFD4015LTC43A	IEC / GB	2.5 mm^2	2.5 mm^2	
	AWG	12 AWG	14 AWG	

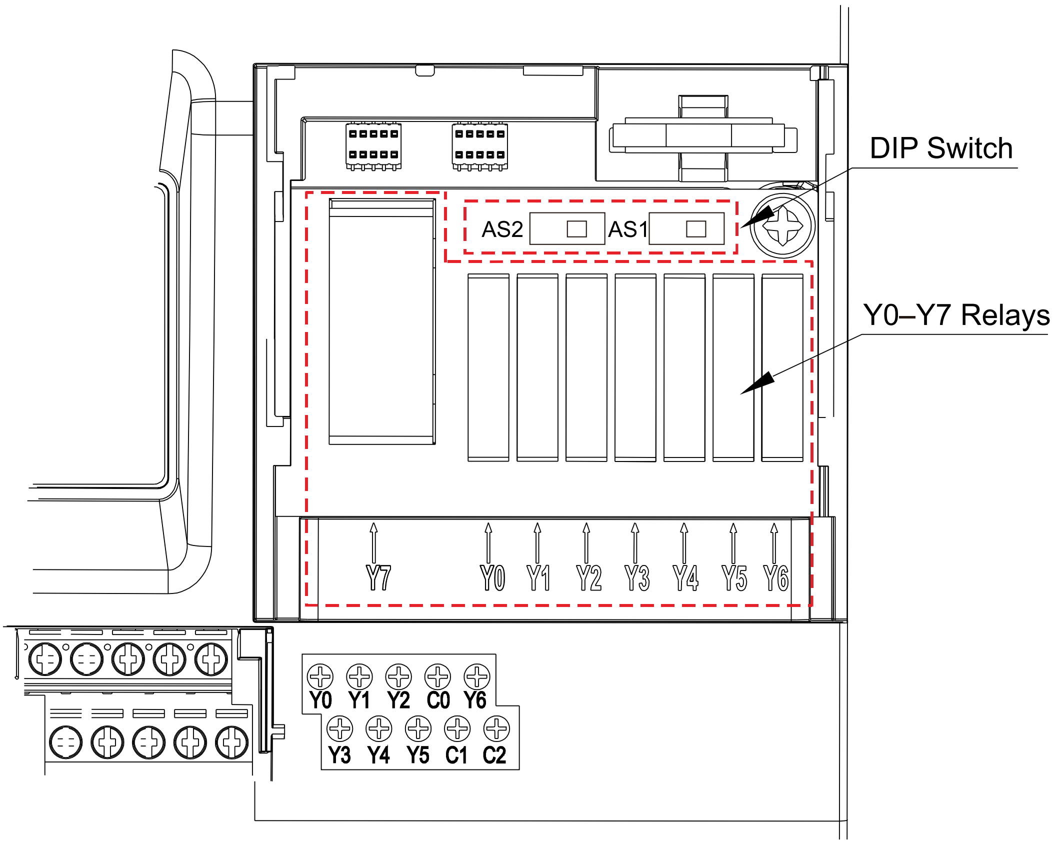
Chapter 5 Control Terminals

5-1 Slide Cover and Internal Devices

Detach the Slide Cover



Relay DIP Switch Layout

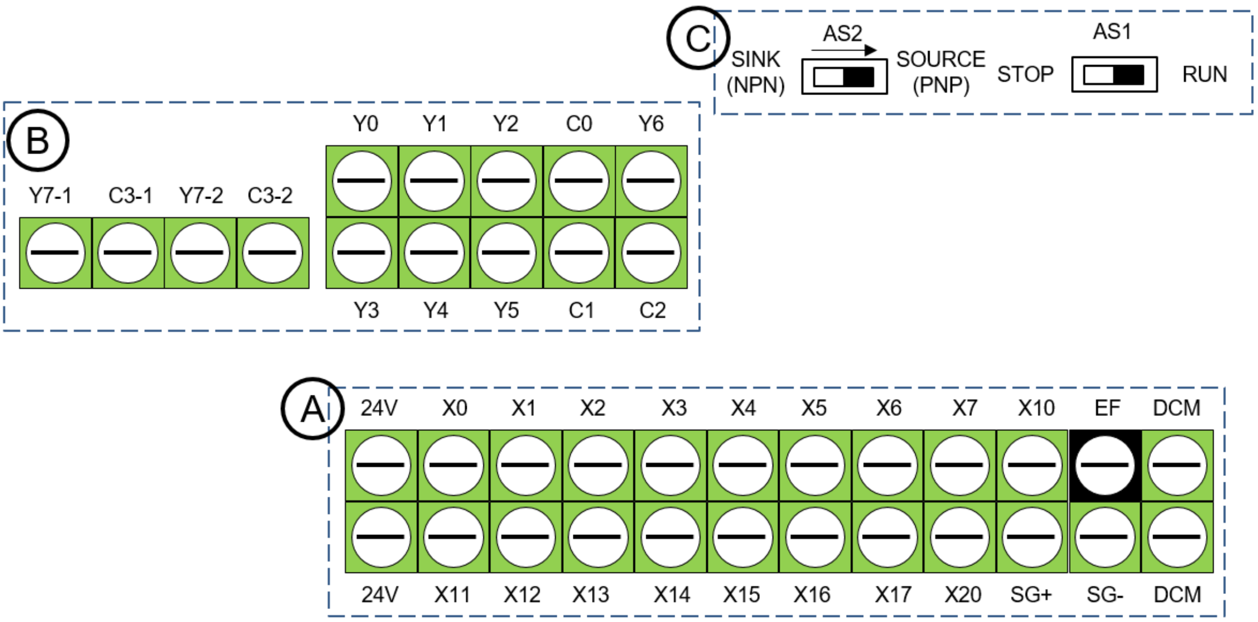


Descriptions of Relays:

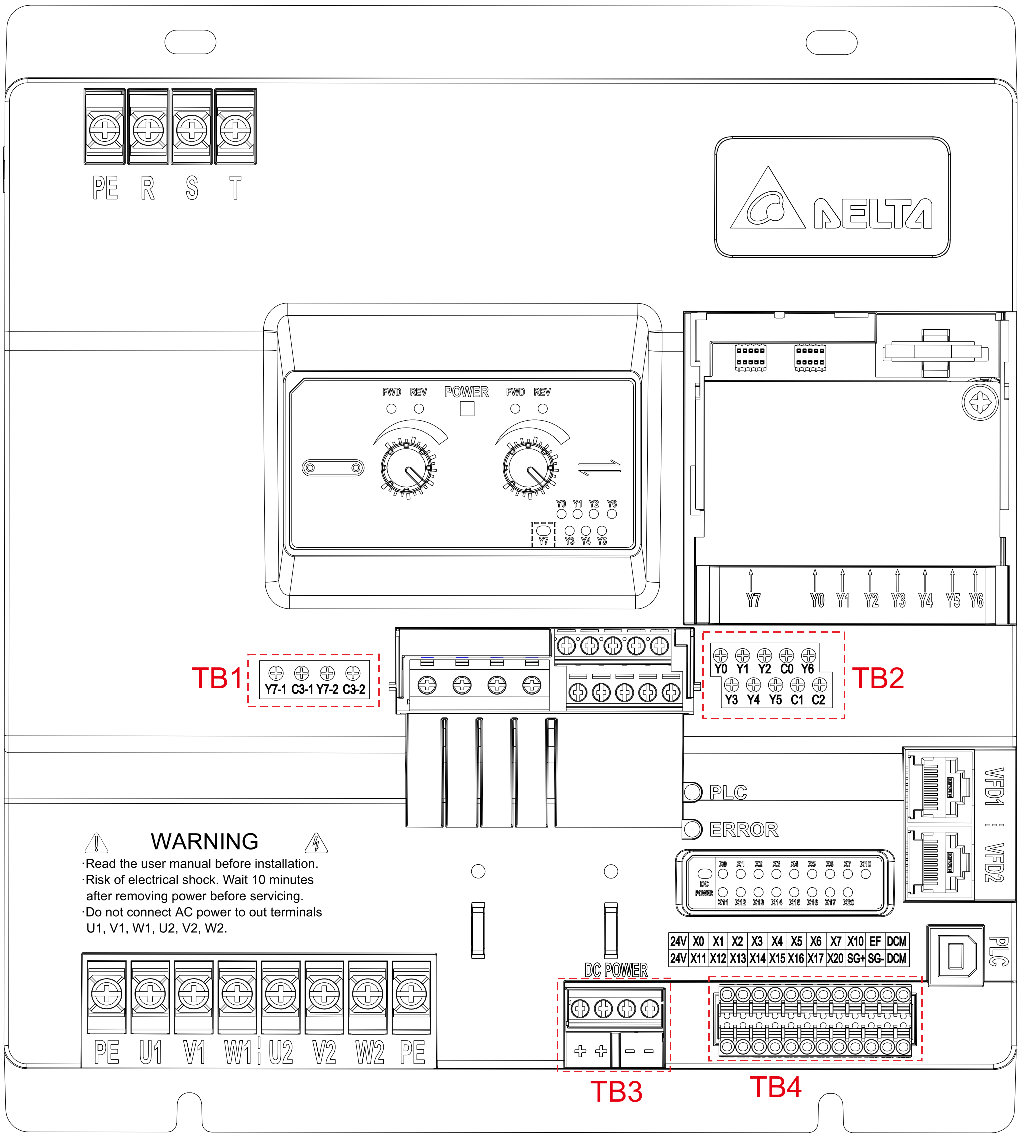
1. Y0–Y6: Removable, corresponding to multi-function output terminals Y0–Y6.
2. Y7: Removable, corresponding to multi-function output terminals Y7 (Y7-1 and Y7-2).
3. DIP switch AS2: Input contact X NPN (Sink) / PNP (Source) mode switch. Default is Source (PNP).
4. DIP switch AS1: PLC Run / Stop switch. Switch between Run/Stop status. Default is RUN.

NOTE: Do NOT touch the PIN of DIP switch AS1 or AS2 when switching them, as the figure above shows. This is to prevent electrical devices from being broken caused by static electricity through the human body.

5-2 Control Terminal Specifications



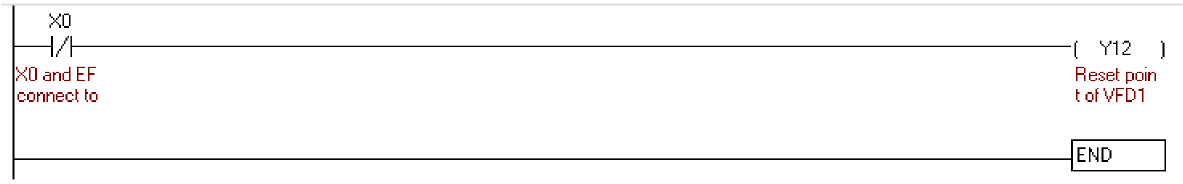
IO Terminal Block



Terminals	Terminal Type	Stripping Length (mm)	Maximum Wire Gauge AWG (mm²)	Minimum Wire Gauge AWG (mm²)	Tightening Torque (±10%) (±10%)
Contact Y terminals	TB1 Integrated	7–8	14 (2.5)	14 (2.5)	5.1 kgf-cm [4.43 lbf-in] [0.5 N-m]
	TB2 Integrated	6–7	18 (1.0)	24 (0.2)	5.7 kgf-cm [4.96 lbf-in] [0.56 N-m]
24V terminals	TB3 Integrated	5–6	18 (1.0)	24 (0.2)	4.1 kgf-cm [3.54 lbf-in] [0.4 N-m]
Contact X terminals	TB4 Removable	7–8	18 (1.0)	28 (0.2)	Screw-free

Wiring precautions:

- The contacts X/Y are not short-circuited to any wires at the factory default. As shown as Ⓒ in the figure above, AS1, the DIP switch for PLC Run/Stop for LTC, is switched to the right side RUN (PLC Run) by default, whereas AS2, the DIP switch for SINK (NPN) / SOURCE (PNP) modes of contacts X for PLC, is switched to the right side SOURCE (PNP) by default.
- As shown as Ⓐ in the figure above, 24V-X contacts are short-circuited to SOURCE (PNP) mode, whereas X contacts-DCM are short-circuited to SINK (NPN) mode. For more information, see the wiring diagrams in Chapter 3 Wiring.
- Tighten the wiring with a 3.5 mm width and 0.6 mm thickness slotted screwdriver.
- Tighten the wiring with a PH1 slotted screwdriver.
- When wiring bare wires, ensure that they are perfectly arranged to go through the wiring holes.
- Select 450V for TB1 wirings, and 250V for TB2 wirings.
- How to reset EF fault when using EF terminal to connect to emergency stop circuit::
  1. EF terminal is correctly connected to emergency stop circuit (channels between 24V (Digital signal common terminal Source) – emergency stop switch N.C. contact – EF terminal can be connected in series);
  2. Select one X contact (such as X0) to connect EF terminal in parallel to connect to emergency stop switch N.C. contact, and add one line of programming in PLC to realize:
     2.1 When pressing the emergency stop button, both VFD1 and VFD2 of LTC stop outputting, and ERROR indicator flashes (EF fault will be triggered both on VFD1 and VFD2 and fault code EF is displayed on communication panel PU08 or PU08V);
     2.2 When releasing the emergency stop button, ERROR indicator lights off, and at the same time, EF fault is reset (EF fault is no longer displayed on PU08 or PU08V).



NOTE: For details on using PLC for LTC, see Chapter 13 PLC Function Application in the user manual.

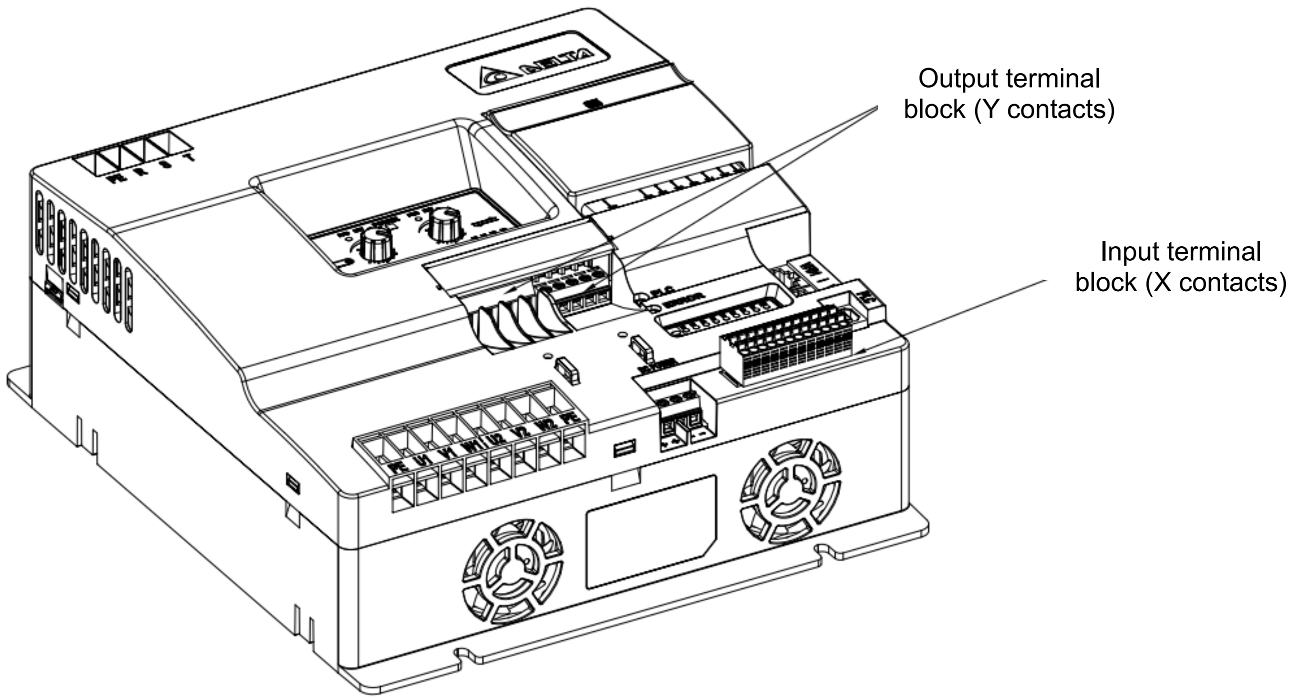
Terminals	Function	Default (PNP Mode)
24V	Digital control signal common (Source)	+24 V_{DC} ± 5% 120 mA
DCM	Digital control signal common (Sink)	Common terminal for multi-function input terminals
X0–X7, X10–X17, X20	Multi-function input terminals 0–20	Refer to address 15B3H bit0–7 external input status for function selections of terminals X0–X7 Refer to address 15B3H bit8–15 external input status for function selections of terminals X10–X17 Refer to address 15B4H bit0 external input status for function selections of terminal X20 ON: activation current 5.6 mA ≥ 18 V_{DC}

Terminals	Function	Default (PNP Mode)
		OFF: cut-off voltage ≤ 4 V_{DC}
EF	External fault input	ON: activation current 5.6 mA ≥ 18 V_{DC} OFF: cut-off voltage ≤ 4 V_{DC}
SG+	Modbus RS-485 **NOTE:** SG+ and SG- are RS-485 serial communication terminals for PLC, and can also be used for uploading/downloading PLC programs.	
SG-		
RJ45	PIN 1, 2, 6, 7: Reserved PIN 3: GND PIN 4: SG- PIN 5: SG+ PIN8: EV	
Y0	Multi-function relay output 0 (N.O.)	Resistive Load 2.5A (N.O.) / 2.5A (N.C.) 250 V_{AC} 2.5A (N.O.) / 2.5A (N.C.) 30 V_{DC} Inductive Load 2A (N.O.) / 2A (N.C.) 250 V_{AC} 2A (N.O.) / 2A (N.C.) 30 V_{DC}
Y1	Multi-function relay output 1 (N.O.)	
Y2	Multi-function relay output 2 (N.O.)	
C0	Y0–Y2 common terminal	
Y3	Multi-function relay output 3 (N.O.)	
Y4	Multi-function relay output 4 (N.O.)	
Y5	Multi-function relay output 5 (N.O.)	
C1	Y3–Y5 common terminal	
Y6	Multi-function relay output 6 (N.O.)	
C2	Y6 common terminal	
Y7-1	Multi-function relay output 7-1 (Double pole single throw N.O.)	Resistive Load 1.2A (N.O.) / 1.2A (N.C.) 380 V_{AC} 3A (N.O.) / 3A (N.C.) 250 V_{AC} 2A (N.O.) / 2A (N.C.) 30 V_{DC} Inductive Load 1A (N.O.) / 1A (N.C.) 380 V_{AC} 2.4A (N.O.) / 2.4A (N.C.) 250 V_{AC} 2A (N.O.) / 2A (N.C.) 30 V_{DC}
C3-1	Y7-1 common terminal	
Y7-2	Multi-function relay output 7-2 (Double pole single throw N.O.)	
C3-2	Y7-2 common terminal	
DC POWER+	24 V_{DC} output positive	+24 V_{DC} ± 3% 1.4A
DC POWER+		
DC POWER-	24 V_{DC} output negative	
DC POWER-		

* Analog control signal wiring specification: 0.75 mm^2 [18 AWG] with shielded stranded wire.

5-3 Removing a Control Terminal Block

As the figure below shows, input terminal block (X contacts) can be detached manually, and output terminal block (Y contacts) cannot be detached manually.



5-4 LED Indicators on Control Terminals

- LTC with three-phase 380–480V_{AC} power: Power indicator is ON (green).
- PLC indicator: Green (ON): PLC run; OFF: PLC stop.
- ERROR indicator: Red (ON):

No.	Indicator Status	ERROR DESCRIPTION	Flash Indication (“-”: ON; “.”: OFF)
1	ERROR is steady ON	PLC Error	--------
2	ERROR is ON for 1s and OFF for 1s (in circulation)	VFD1 Error	--..--..
3	ERROR is ON for 2s and OFF for 0.5s (in circulation)	VFD2 Error	----.----.

NOTE: Error indication priority: PLC Error > VFD1 Error > VFD2 Error

- FWD indicator: ON (green) when the running direction that VFD1 or VFD2 corresponds to the motor is forward.
- REV indicator: ON (green) when the running direction that VFD1 or VFD2 corresponds to the motor is reverse.
- Contact X input indicator: X0–X20, ON (green) when input signals are valid.
- Contact Y output indicator: Y0–Y7, ON (green) when output signals are valid. Among them, Y7-1 and Y7-2 use the same relay, that is, they use only one LED indicator to indicate ON/OFF.
- DC POWER output indicator: ON (green) when power output is normal.

NOTE: Only one color displays when each of the indicators lights ON for LTC.

Chapter 6 Optional Accessories

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

6-1 Digital Keypad PU08/PU08V

VFD-LTC series uses digital keypad panel to serve as function displays and operations

Digital Keypad Panel PU08:

Figure 6-1

There are four indicators on the panel

- STOP Stop indicator: lights ON when running stops.
- RUN Running indicator: lights ON when motor runs.
- FWD Forward running indicator: lights ON when motor runs in a forward direction.
- REV Reverse running indicator: lights ON when motor runs in a reverse direction.

Digital Keypad Panel PU08V:

Main Display Area
Displays frequency, current, voltage, user-defined, fault codes, etc.

Status Display Area
Indicates drive's running status: Run, Stop, Forward/Reverse, Potentiometer enable/disable

Up Key
Changes parameters or values

RUN Key
VFD Run

STOP/RESET Key
Makes the drive stop running and resets faults

Mode Selection
Displays mode changes step by step for selection

ENTER Key
1. Enters setting functions, such as forward (Frd), industry application functions (APP) etc.
2. Confirms parameter settings

Left-shift/Down Key
Changes value or parameters / Long press MODE key to switch between left-shift key and down key

Frequency Setting Potentiometer
Use this knob for main frequency command input

Figure 6-2

6-2 Circuit Breaker and Fuse

Air Circuit Breaker (ACB)

It is recommended the surrounding temperature for ACB should be ≥ 50°C. In the meanwhile, consider temperature derating for components with ON / OFF switch in accordance with the ambient temperature of the on-site distribution panel.

460V Models

Frame	Models	VFD1 Output Current [A]	VFD2 Output Current [A]	Input Current [A]	Selection of ACB [A]
A	VFD2207LTC43A	2.5	5.5	10.3	20
	VFD4015LTC43A	4.2	9.0	14.3	25

Table 6-1

Fuse Specification Chart:

Fuse

☑ Fuse specifications lower than the table below are allowed.
☑ Use certified fuses that comply with local regulations.

460V Models	Input Current [A]	Fuse Specification	
		I [A]	Bussmann P/N
VFD2207LTC43A	10.3	25	JJS-25
VFD4015LTC43A	14.3	30	JJS-30

Table 6-2

6-3 Reactors (AC and Zero Phase)

AC Input Reactor

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

Installation Method:

Install an AC input reactor in series between the mains power and the three input phases R, S, T, as shown in the figure below:

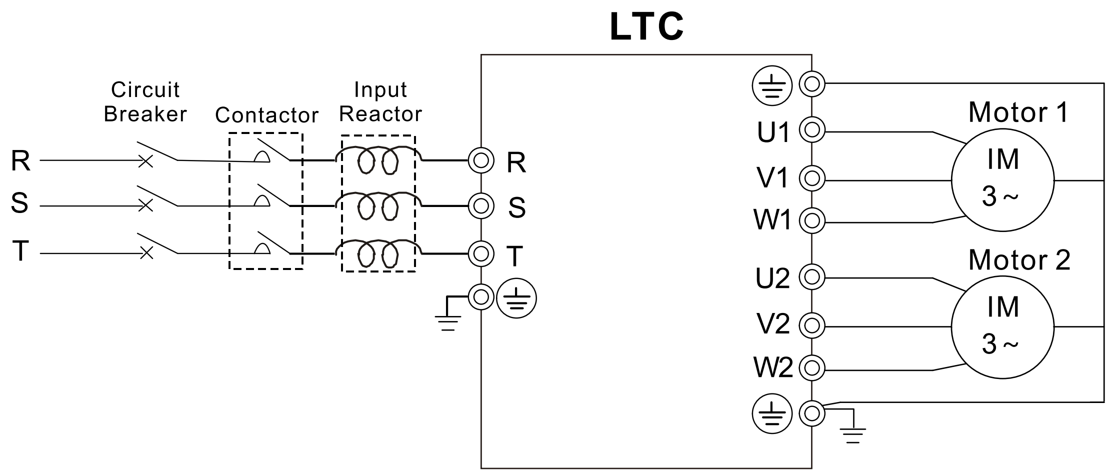


Figure 6-3: AC input reactor installation diagram

The table below lists the standard specifications for Delta LTC AC input reactors:

Models	Rated Current [Arms]	Saturation Current [Arms]	3% Reactor [mH]	5% Reactor [mH]	Built-in DC Reactor
VFD2207LTC43A	8	12	3.03	5.05	No
VFD4015LTC43A	14.7	22.1	1.65	2.75	No

Table 6-3

Zero Phase Reactor

	Recommended Wire Size		Wiring Method	Maximum Wiring Quantity
RF008X00A	≤ 8 AWG	≤ 8.37 mm^2	Diagram A	Single-core*3 or Four-core cable*1
T60006L2040W453	≤ 8 AWG	≤ 8.37 mm^2	Diagram B	

NOTE 1: *Motor cable is 600V insulated cable wire

Table 6-4

NOTE 2: The table above only considers the motor wire size

NOTE 3: For information on maximum wiring quantity, see Chapter 4 Main Circuit Terminals.

Diagram A

Pass the cable through at least one zero phase reactor.

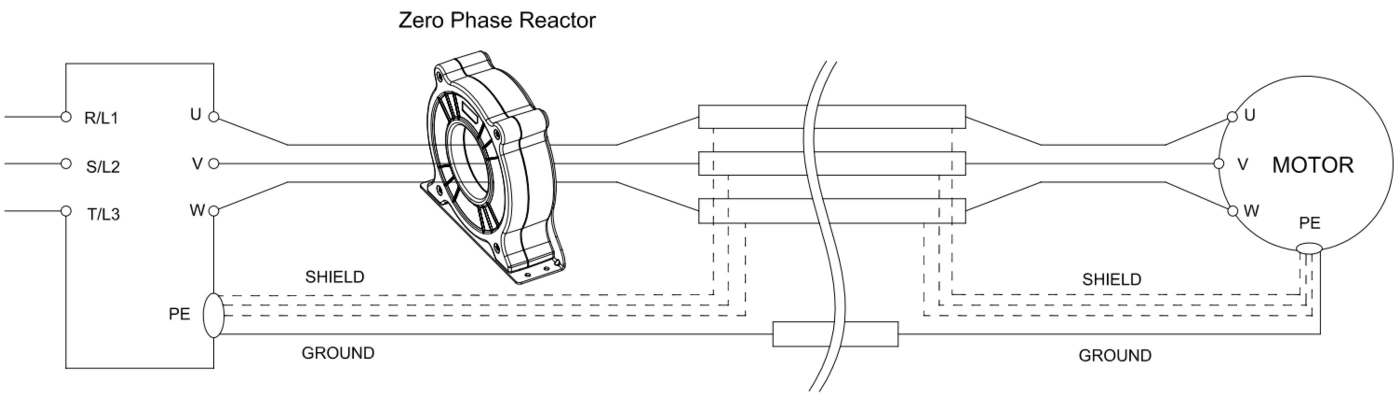


Figure 6-4

Diagram B

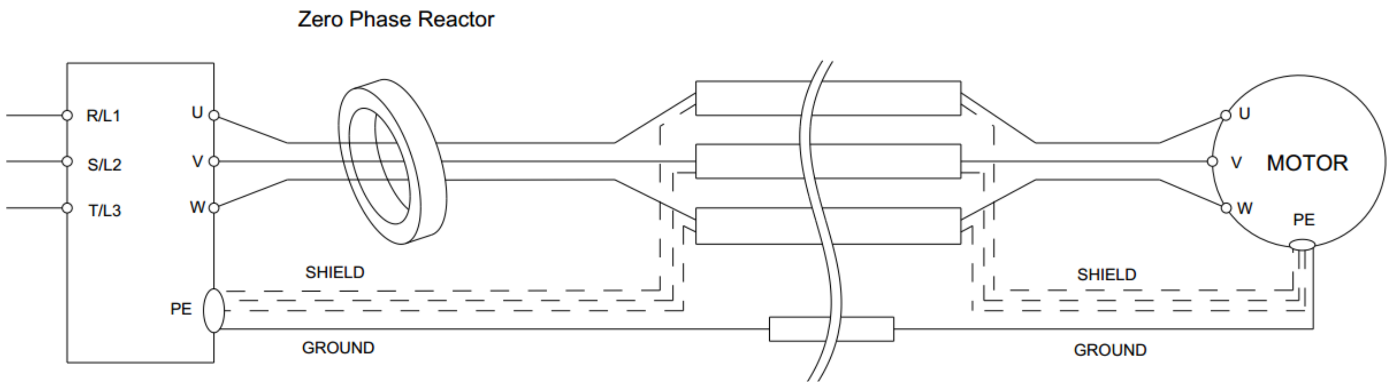


Figure 6-5

Diagram C

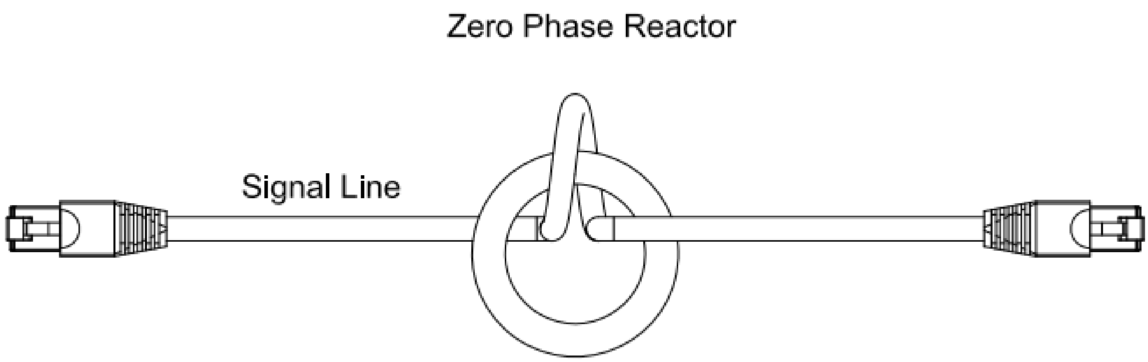


Figure 6-6

NOTE 1: The table above is for reference only. Use a suitable cable type and diameter so that the cable can easily pass through the center of the zero phase reactor.
NOTE 2: Do not pass the grounding cable through the zero phase reactor; only pass the motor wire and power cable through the zero phase reactor. Signal line is not subjected to the limits.
NOTE 3: For the zero phase reactor used for signal lines, make the position of the zero phase reactor adjacent to the drive, and fix it to prevent pulling caused by vibration.

Models*	Recommended Wire Size	Wiring Method	Qty	Applicable Network Wire / Signal Line
T60006L2040W453	≤ 8 AWG	Diagram C	1	Category 5e shielding, shielded twisted-pair cable, CAN standard cable (TAP-CB05, TAP-CB10)

Table 6-5

NOTE 1: *Select zero phase reactors according to actual wire gauges. This table is for reference only.
NOTE 2: The size of some signal lines and communication cables may have limits due to mechanical considerations. Therefore, it is suggested to select a larger zero phase reactor.

Reference table for maximum motor wiring gauge when installing a zero reactor (including LUG width and motor cable temperature resistance)

Zero phase reactor	Max. Wire Size / LUG Width	Max. Wire Gauge AWG (1C*3)		Max. Wire Gauge AWG (4C*1)	
		75°C	90°C	75°C	90°C
RF008X00A	13 MM	3 AWG	1 AWG	3 AWG	1 AWG
T60006L2040W453	11 MM	9 AWG	4 AWG	6 AWG	6 AWG

Table 6-6

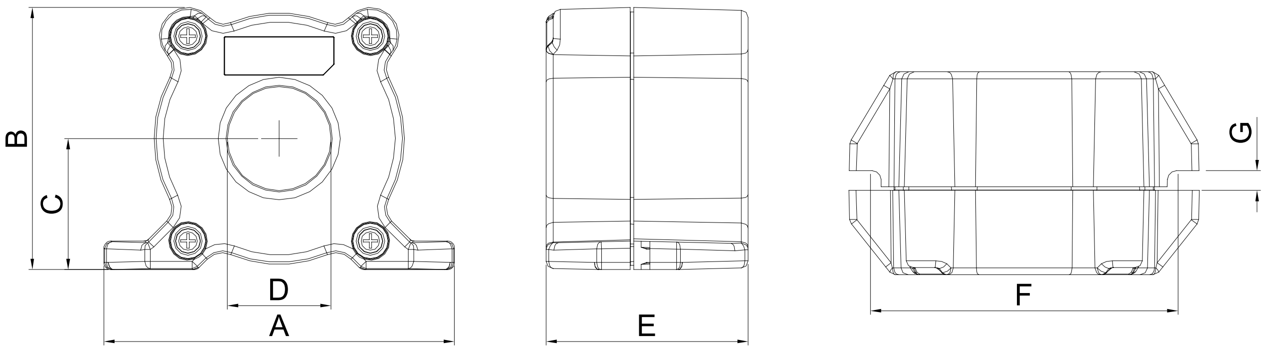


Figure 6-7

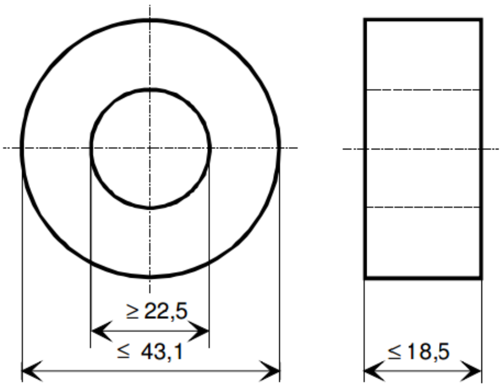
Unit: mm [inch]

Model	A	B	C	D	E	F	G (Ø)	Torque
RF008X00A	98 5.2 [3.858]	73 5.2 [2.874]	36.5 5.2 [1.437]	29 5.2 [1.142]	56.5 5.2 [2.224]	86 5.2 [3.386]	5.5 5.2 [0.217]	< 10 kgf/cm^2

Table 6-7

Ferrite Core

Model No.: T60006-L2040-W453



Unit: mm

Figure 6-8

6-4 EMC Filter

The table below shows external EMC filter models for each motor drive. Choose corresponding zero phase reactors and applicable shielding cables according to the required noise emission and electromagnetic interference rating for the best configuration and anti-interference performance. If radiation emission (RE) is not a concern on site and you only need conducted emission (CE) to reach Class C3, you do not need to install a zero phase reactor on the input side to reach the EMC standard.

460V Models

LTC			EMC Filter Model #	Zero Phase Reactor		Carrier Frequency	Conducted Emission (CE)	Radiated Emission (RE)
Frame	Drive Model #	Rated Input Current [A]		Input Side (R / S / T)	Output Side (U / V / W)		Length of Output Shielded Cable C3	EN61800-3
A	VFD2207LTC43A	10.3	EMF014A43A	RF008X00A or T60006L2040W453	RF008X00A or T60006L2040W453	≤ 8 kHz	25 m	C3
	VFD4015LTC43A	14.3	EMF018A43A					

Table 6-8

Zero phase reactor installation position diagram:

1*: Install at the cable between the power supply and the EMC filter

2*: Install at the cable between the EMC filter and the drive

3*: Install at the cable between the drive and the motor

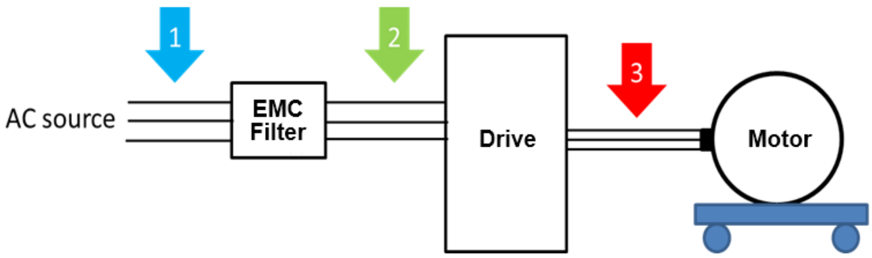


Figure 6-9

EMC Filter Dimension:

Model name: EMF014A43A

Unit: mm [inch]

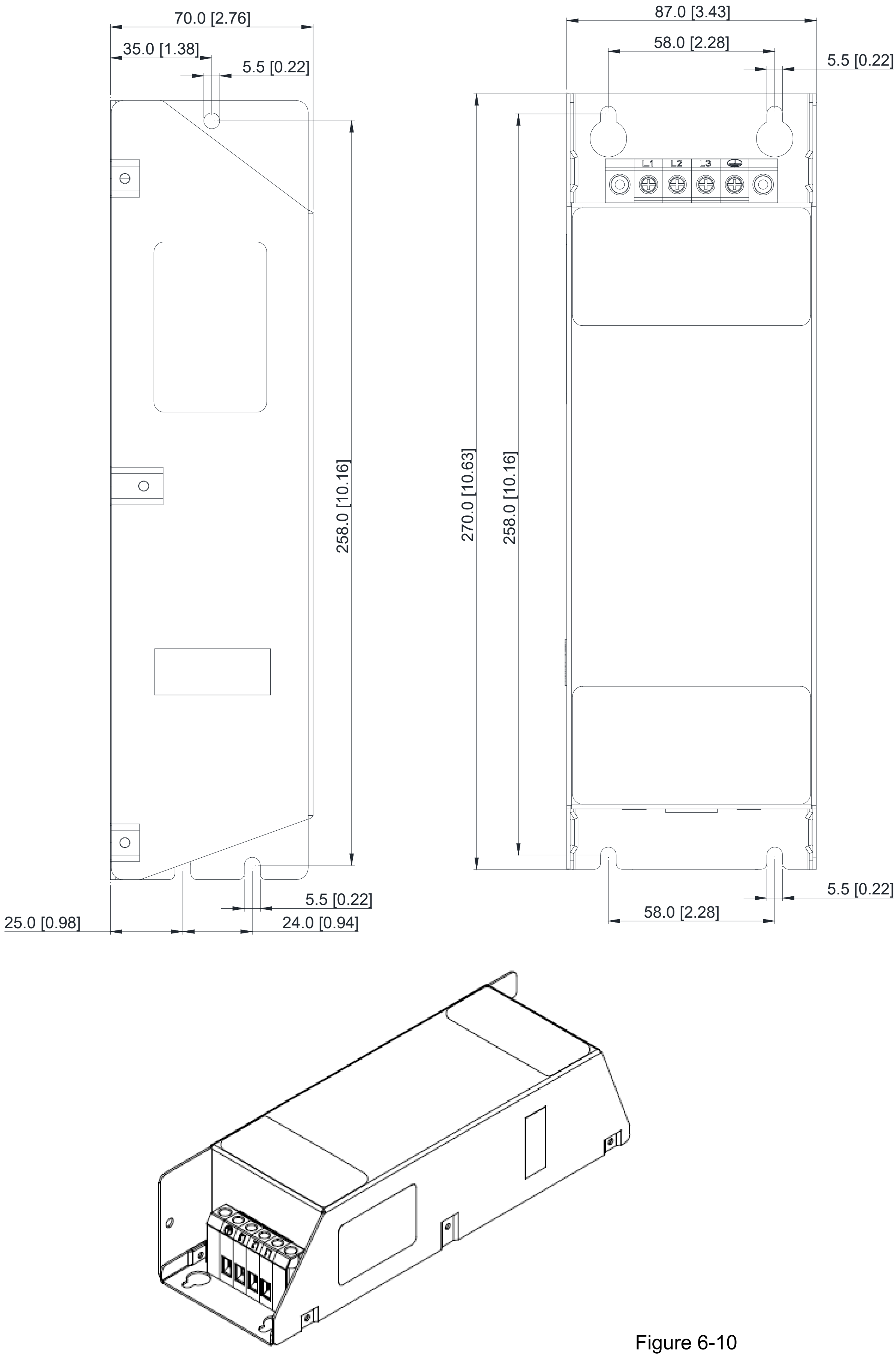


Figure 6-10

Model name: EMF018A43A

Unit: mm [inch]

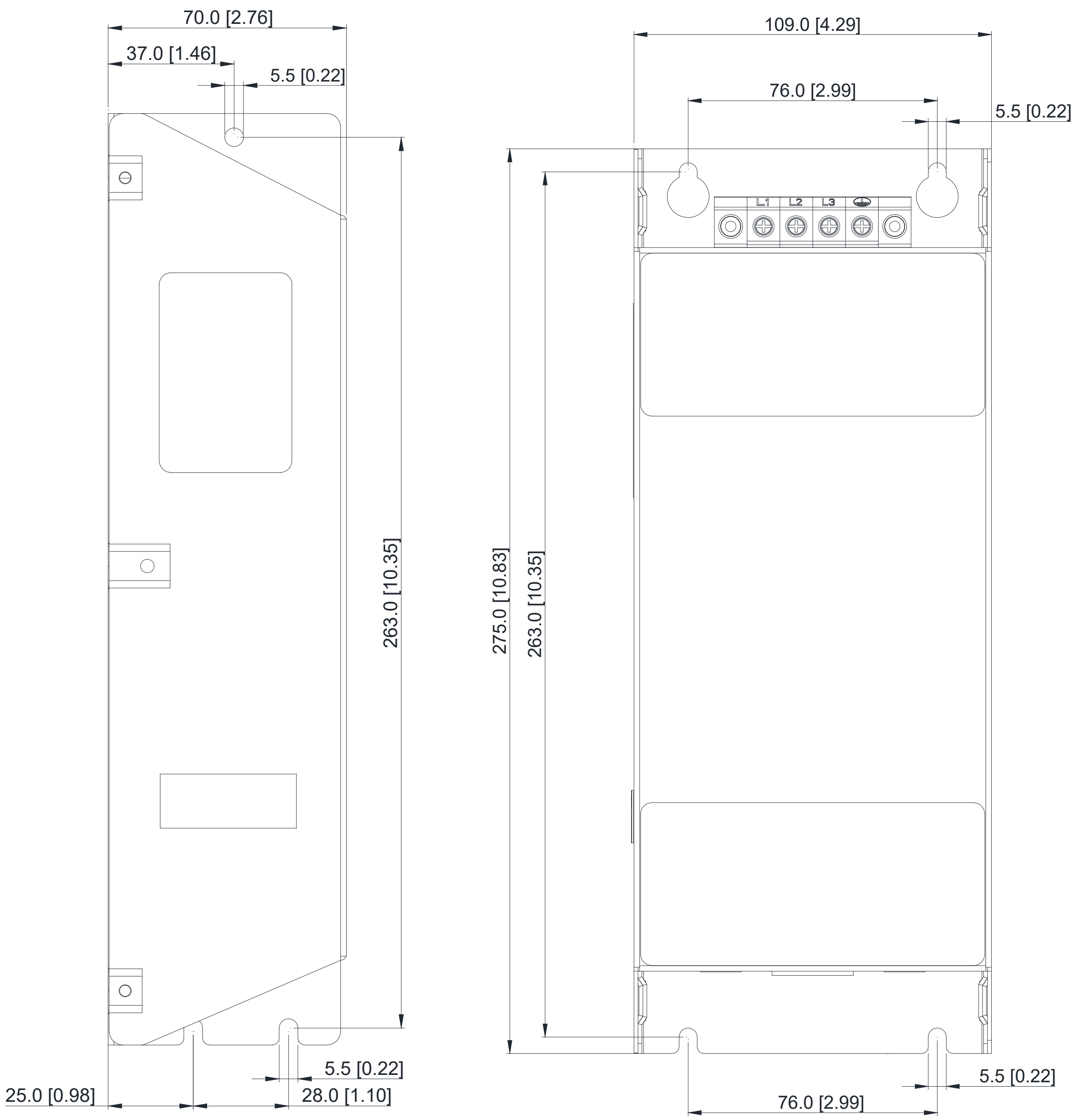


Figure 6-11

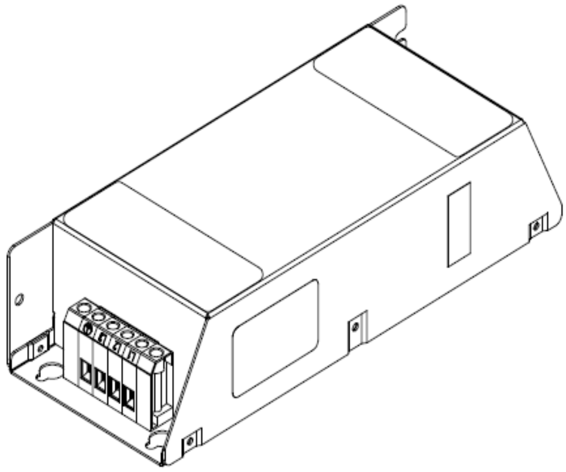


Figure 6-12

EMC Filter Installation

All electrical equipment, including AC motor drives, generates high frequency / low frequency noise and interferes with peripheral equipment by radiation or conduction during operation. Installing an EMC filter helps eliminate much interference. It is recommended to use DELTA EMC filter to have the best interference elimination performance.

Install and wire AC motor drive and EMC filter according to the instructions in the user manual to ensure compliance with the following regulations:

1. EN61000-6-4
2. EN61800-3: 1996
3. EN55011 (1991) Class A Group 1

General Precautions

To achieve optimal effect on suppressing interference of AC motor drive, follow the instructions in the user manual to install and wire the AC motor drive. Moreover, pay attention to the precautions below.

1. Install EMC filter and AC motor drive on the same metal plate.
2. Install AC motor drive on footprint EMC filter or install EMC filter as close as possible to the AC motor drive.
3. Do the wiring as short as possible.
4. Ground the metal plate.
5. Fix the cover of EMC filter and AC motor drive or grounding on the metal plate. Leave the contact area as large as possible.

Chapter 7 Specifications

7-1 460V Models

Frame		A			
Model VFD _ _ _ _ LTC_ _ _		VFD2207LTC43A		VFD4015LTC43A	
Descriptions		VFD1	VFD2	VFD1	VFD2
Output Rating	Rated Output Capacity (kVA)	4.4	2.0	7.4	3.3
	Rated Output Current (A)	5.5	2.5	9.0	4.2
	Applicable Motor Output (kW)	2.2	0.75	4.0	1.5
	Applicable Motor Output (HP)	3	1	5.5	2
	Overload Capacity	Sustains for 1 minute for every 5 minutes when the drive outputs 150% of the drive's rated output current.			
	Max. Output Frequency (Hz)	0.1–400.0			
	Carrier Frequency (kHz)	2–12 (Default: 8)			
Input Rating	Input Current (A)	10.3		14.3	
	Rated Voltage / Frequency	Three-phase 380–480 V_{AC} (-10 – +10%), 50 / 60 Hz			
	Operating Voltage Range	342–528 V_{AC}			
	Mains Frequency Range	47–63 Hz			
Efficiency (%)		95			
Weight (kg)		2.34		2.44	
Cooling Method		Fan cooling			
EMC Filter		Optional			
DC Power (W)		35W, 24 V_{DC}			

Table 7-1

NOTE:

1. Loading rate:
   1.1 While VFD1 continuously runs with 100% of rated output current, VFD2 can still continuously run with 50% of rated output current or periodically run with 100% of rated output current (sustains for 30 seconds for every minute).
   1.2 For applications other than telescopic belt conveyor, consider the loading conditions mentioned above. Contact Delta customer services for more information.
2. If carrier frequency is larger than 8 kHz, rated output current will decrease. See Figure 7-2 derating curve in Section 7-4.
3. Rated input current fluctuates due to not only connections between power adapter and reactors at input side, but also impedance at power side.

General Specifications

Item		Specifications
Control Characteristics	Control Mode	Sine wave PMW (V/F control)
	Frequency Setting Resolution	0.01 Hz
	Output Frequency Resolution	0.01 Hz
	Torque Characteristics	Auto-torque compensation, slip compensation, reaches 150% of rated torque when starting torque is 5.0 Hz.
	Overload Capacity	150% of rated output current for 60 seconds
	Skip Frequency	Three points can be set from 0.1–400.0 Hz
	Accel. / Decel. Time	0.1–600 seconds (two steps of acceleration/deceleration time can be set separately)
	Stall Prevention Level	Set by 0–200% of the drive's rated current
	DC Brake	Can be operated from 0.1–400.0 Hz when the drive receives stop signal. Starting time for DC current 0–100% of rated current is 0–60 seconds, and stopping time for that is also 0–60 seconds.
	V/F Curve	Adjustable V/F curve settings
Protection Functions		Over-voltage, over-current, low-voltage, external fault interruption, motor overload, drive overload, drive overheat
Built-in Functions for Integrated Drive		Built-in AVR (Automatic Voltage Regulation) function Acceleration/deceleration S-curve settings Over-voltage, over-current stall prevention Fault record Torque compensation Slip compensation EF (External Fault) function Carrier frequency adjustment Upper and lower limit settings of output frequency Parameter reset Restart after fault NPN/PNP mode selection
Digital Keypad Panel		Not included (optional accessories PU08/PU08V)
Product Compliance		CE GB/T12668.3

Table 7-2

PLC Specifications

Item	Specifications	Note
Control Mode	Alternating back-and-forth scanning method	
Inputs/Outputs Control Mode	Cyclic refresh mode	
Execution speed	Basic commands (several μs)	Application commands (1–dozens of μs)
Programming Language	Commands and ladder diagrams	
Program Capacity	14000 steps	
Inputs/Outputs Points	Digital inputs (X): 17 + 4 = 21 Digital outputs (Y): 8 + 5 = 13	X: 17 points for user-defined, and 4 for internal pre-defined Y: 8 points for user-defined, and 5 for internal pre-defined

Table 7-3

Type	Device	Item		Range		Function
Relay (bit)	X	External input relay		X0–X20, 17 points, octal	Total 34 points	Corresponds to external input points
	X	Internal input relay		X21–X24, 4 points, octal		Corresponds to internal input points
	Y	External output relay		Y0–Y7, 8 points, octal		Corresponds to external output points
	Y	Internal output relay		Y10–Y14, 5 points, octal		Corresponds to internal output points
	M	Auxiliary relay	General purpose	M0–M999, 1000 points	Total 1280 points	Contacts can be used as ON/OFF switch in the program
			Special purpose	M1000–M1279, 280 points		
	T	Timer	100 ms timer	T0–T159, 160 points	Total 160 points	Timer indicated by TMR instruction. If timing reaches its target, the T contact of the same number will be ON.
	C	Counter	16-bit counting up (general purpose)	C0–C79, 80 points	Total 80 points	Counter indicated by CNT (DCNT) instruction. If counting reaches its target, the C contact of the same number will be ON.
Register word data (2 byte)	T	Current value of timer		T0–T159, 160 points		When the timing reaches the target, the contact of the timer will be ON.
	C	Current value of counter		C0–C79, 16-bit counter, 80 points		When the counting reaches the target, the contact of the counter will be ON.
	D	Data register	Latched	D0–D999, 1000 points	Total 1620 points	Memory area for data storage
			Special purpose	D1000–D1619，620 points		
Constant	K	Decimal	Single byte	Available setting range: K-32,768 to K32,767		
			Double byte	Available setting range: K-2,147,483,648 to K2,147,483,647		
	H	Hexadecimal	Single byte	Available setting range: H0000 to HFFFF		
			Double byte	Available setting range: H00000000 to HFFFFFFFF		
Serial communication port (program write/read)				RS-485 USB Port		

Table 7-4

7-2 Environment for Operation, Storage and Transportation

Characteristics		Descriptions
EMI Filter		Without built-in
Environment	Protection Level	IP20
	Pollution Degree	2
	Installation Location	An altitude of lower than 1000 m, indoor (no corrosive gases, liquids, and dust)
	Surrounding Temperature	Non-condensing, non-freezing -10 – +45°C. Derate when operated with full-load in temperature above 45°C to protect service life.
	Storage Temperature	-20 – +60°C
	Humidity	Below 90% RH (non-condensing)
	Vibration	2.0 mm, peak to peak value range from 2–13.2 Hz; 0.7–1.0 G range from 13.2–55 Hz; 1.0 G, range from 55–512 Hz; Compliance with IEC 60068-2-6

Table 7-5

7-3 Specification for Operation Temperature and Protection Level

Model	Frame	Upper Cover at Outer Case	Protection Level	Operation Temperature
VFDxxxxLTCxxx	Frame A 460V: 2.2 kW + 0.75 kW 4.0kW + +1.5kW	N/A	IP20	-10–45°C

Table 7-6

7-4 Derating Curve

☑ When choosing the correct model, consider factors such as ambient temperature, altitude, carrier frequency, control mode, and so on. That is,

Actual rated current for application (A) = Rated output current (A) x Ambient temp. rated derating (%) x Altitude rated derating (%) x Carrier frequency rated derating (%)

Protection Level	Operating Environment
IP20	460V: If the AC motor drive operates at the rated current, the ambient temperature needs to be between -10–45ºC. If the temperature is above 45ºC, decrease 2% of the rated current for every 1ºC increase in temperature. The maximum allowable temperature is 60ºC.

Table 7-7

Ambient Temperature Derating Curve

460V

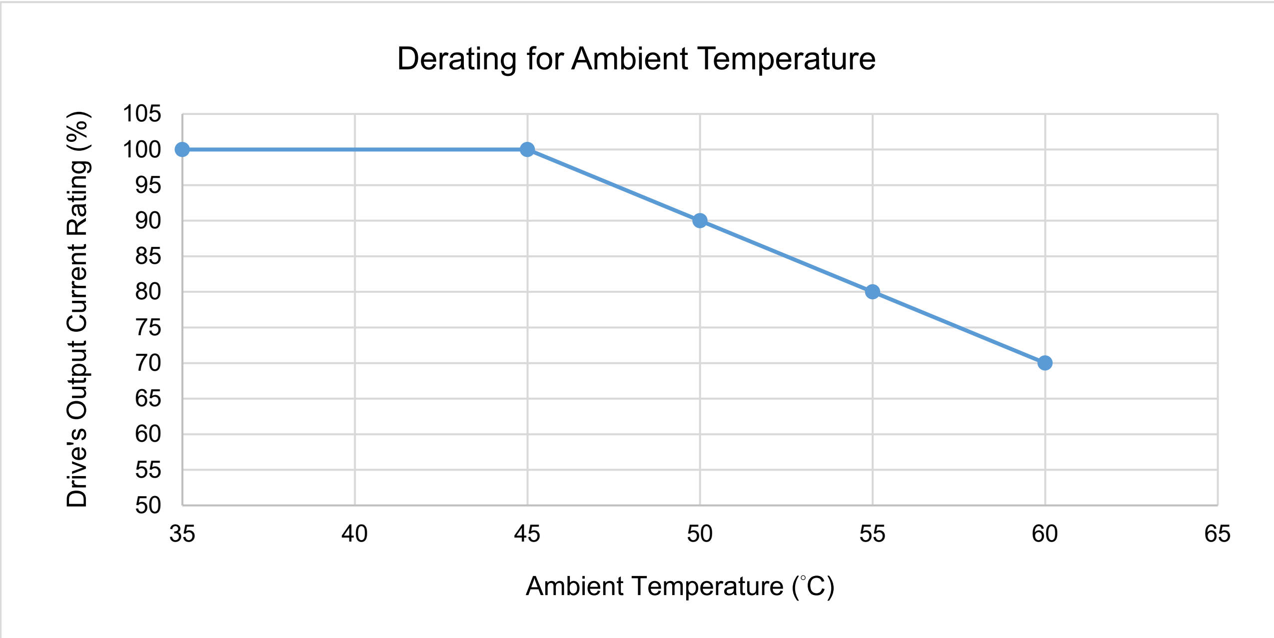


Figure 7-1

The rated output current derating (%) when carrier frequency is the default value:

Ambient Temp. (Ta) / 100% Load Fc (kHz)	35°C	45°C	50°C	60°C
Default value	100	100	90	70

Table 7-8

Carrier Frequency Derating Curve

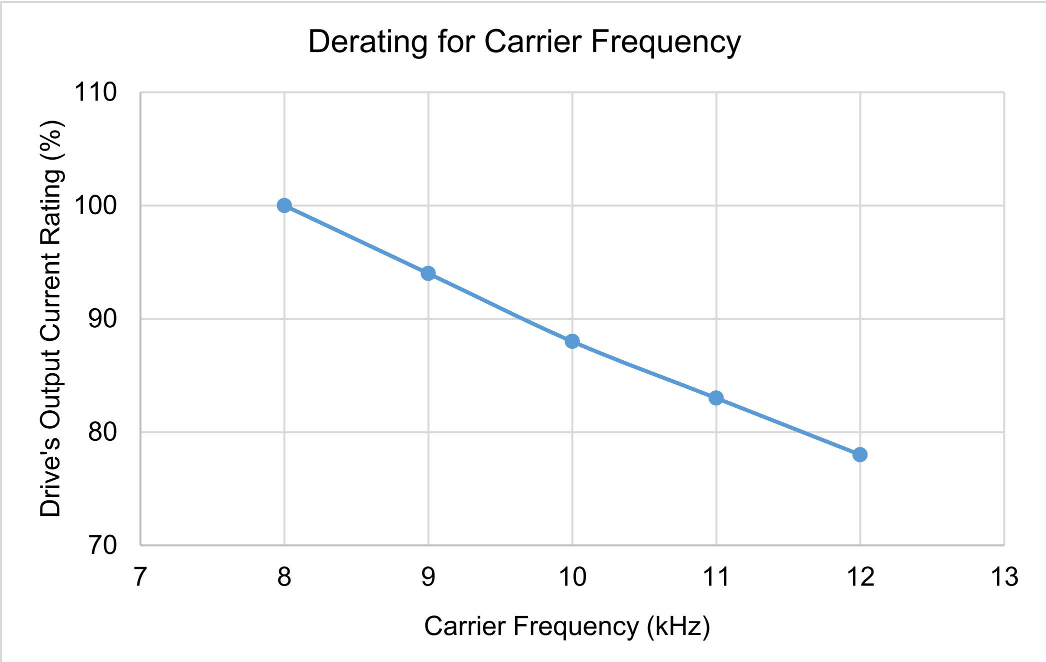


Figure 7-2

The rated output current derating (%) of 460V models for different carrier frequencies:

Model \ Fc (kHz)	8	9	10	11	12
VFD____LTC__A	100	94	88	83	78

Table 7-9

Altitude Derating Curve

Condition	Operating Environment
High Altitude	If the AC motor drive is installed at an altitude of 0–1000 m, follow normal operation restrictions. For altitudes of 1000–2000 m, decrease the drive's rated current by 1% or lower the temperature by 0.5ºC for every 100 m increase in altitude. The maximum altitude for corner grounded is 2000 m. If installing at an altitude higher than 2000 m is required, contact Delta for more information. 1 m = 1 meter

Table 7-10

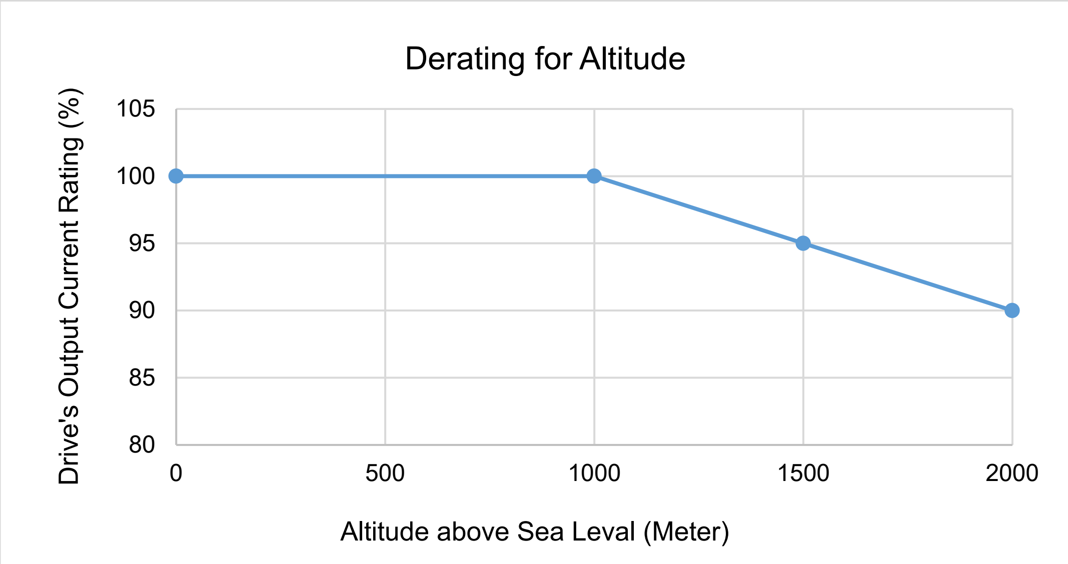


Figure 7-3

The rated output current derating (%) for different altitudes above sea level:

Altitude above Sea Level (Meter)	0	1000	1500	2000
Output Current / Rated Current (%)	100	100	95	90

Table 7-11

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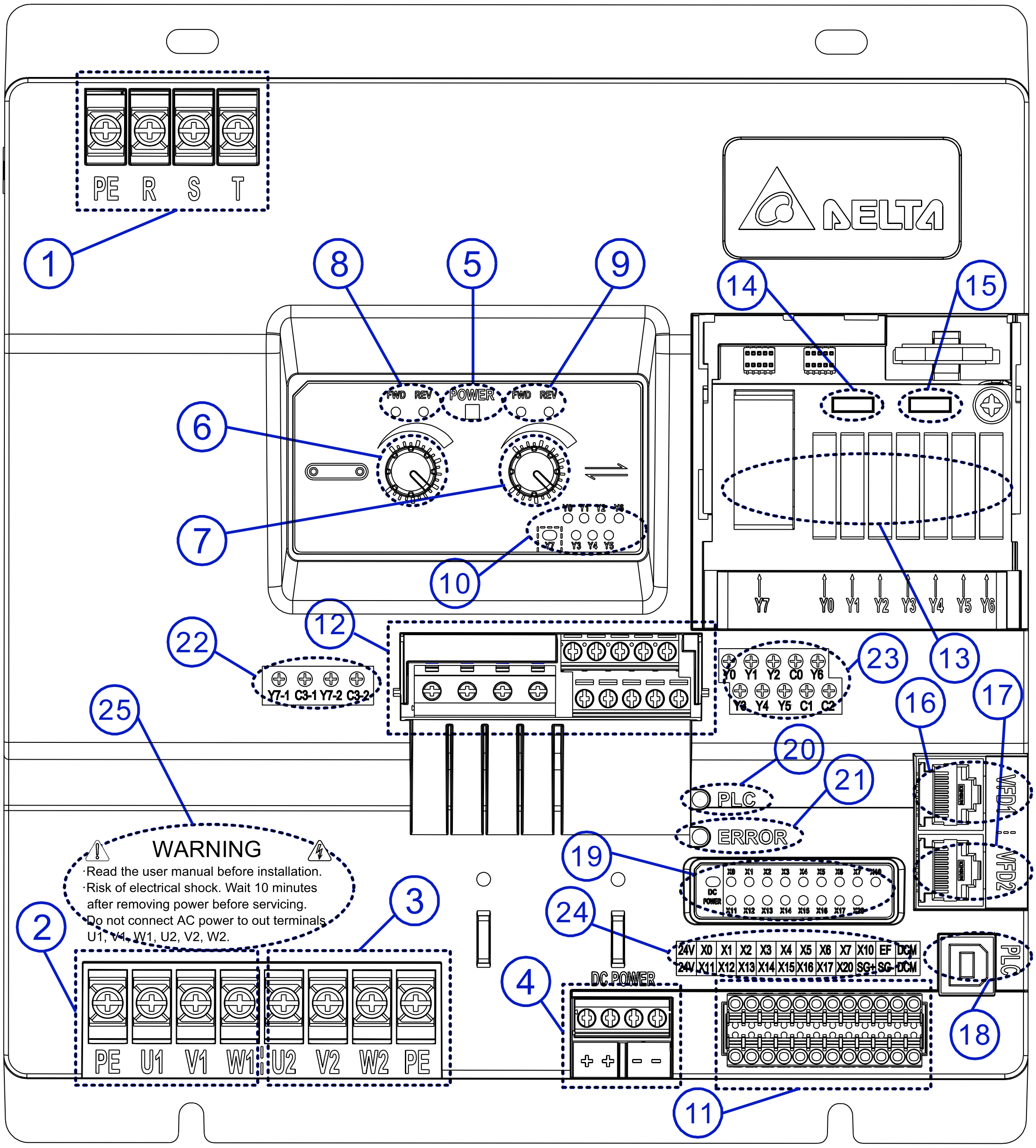
Chapter 8 Descriptions of Drive and PLC Operations

8-1 An Overview of Functions

Function descriptions of LTC:



The functions are described by numbers with circles in sequence, as shown in the diagram above:

(1) Power input (PE/R/S/T): Three-phase power and PE terminals.

(2) VFD1 drive output (PE/U1/V1/W1): VFD1 drive output and PE terminals.

(3) VFD2 drive output (U2/V2/W2/PE): VFD2 drive output and PE terminals.

(4) DC POWER (+/+/-/-): Built-in $24V_{DC}$ 35W power in the controller. For the use of external load.

(5) POWER indicator: Lights ON (green) when LTC is powered on.

(6) VFD1 potentiometer: Turn clockwise to increase the frequency command. Turn counterclockwise to decrease the frequency command.

(7) VFD2 potentiometer: Turn clockwise to increase the frequency command. Turn counterclockwise to decrease the frequency command.

(8) VFD1 FWD/REV indicator: FWD indicator lights ON (green) when VFD1 is set as motor's running direction in forward. REV indicator lights ON (green) when VFD1 is set as motor's running direction in reverse.

(9) VFD2 FWD/REV indicator: FWD indicator lights ON (green) when VFD2 is set as motor's running direction in forward. REV indicator lights ON (green) when VFD2 is set as motor's running direction in reverse.

(10) Y0–Y7 indicator: Output signal indicator of contacts Y. Lights ON (green) when the corresponding relays activate.

(11) Input terminal block:

(11.1) X0–X7, X10–X17, X20: Multi-function input terminals. You can switch between PNP/NPN modes. The default is PNP mode.

(11.2) 24V (two): Digital signal (contact X) common terminals (Source). The connection between 24V and contact X is PNP (Source) mode.

(11.3) DCM (two): Digital signal (contact X) common terminals (Sink). The connection between DCM and contact X is NPN (Sink) mode.

(11.4) EF: External fault signal input and can be connected in series to emergency stop switch (N.C.). If you do not use EF, EF must connect with digital signal common 24V (Source) terminal; otherwise, EF fault occurs.

(11.5) SG+, SG-: RS-485 serial communication terminals for PLC, and can also be used for uploading/downloading PLC programs.

(12) Output terminal block:

(12.1) Y0–Y6: Multi-function output terminals, corresponding to relays that support two load capacity: $240V_{AC}$ 2A and $30V_{DC}$ 2A.

(12.2) Y7-1, Y7-2: Multi-function output terminals (are activated simultaneously), corresponding to relays that support three load capacity: $380V_{AC}$ 1A, $240V_{AC}$ 2A, and $30V_{DC}$ 2A.

(12.3) C0–C2: Common terminals. C0 is the common terminal for Y0–Y2; C1 is the common terminal for Y3–Y5; C2 is the common terminal for Y6.

(12.4) C3-1 and C3-2: Common terminals. C3-1 is the common terminal for Y7-1; C3-2 is the common terminal for Y7-2.

(13) Relays:

(13.1) Y0–Y6: Removable, corresponding to multi-function output terminals Y0–Y6.

(13.2) Y7: Removable, corresponding to multi-function output terminals Y7 (Y7-1 and Y7-2).

(14) DIP switch AS2: Input contact X NPN (Sink) / PNP (Source) mode switch. Default is Source (PNP).

(15) DIP switch AS1: PLC Run / Stop switch. Switch between Run/Stop status. Default is RUN.

(16) VFD1 interface: RJ45 communication port. VFD1 RS-485 communication port is used for connection between VFD1 and PC (or communication panel PU08/PU08V).

(17) VFD2 interface: RJ45 communication port. VFD1 RS-485 communication port is used for connection between VFD1 and PC (or communication panel PU08/PU08V).

(18) PLC interface: USB communication port. Used for connection between PLC and PC for the controller.

(19) Input (contact X) terminal indicator: Corresponding indicators to X0–X7, X10–X17, and X20. DC POWER indicator.

(20) Left-side of PLC indicator: PLC Run indicator.

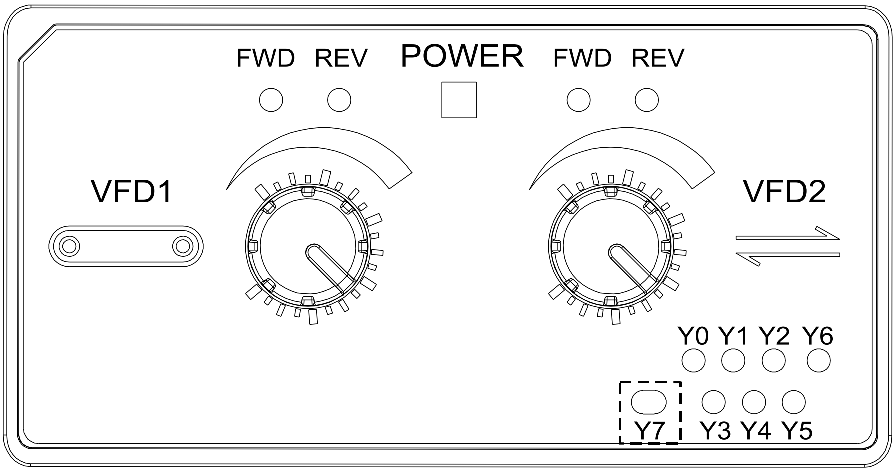
(21) Left-side of ERROR indicator: LTC fault indicator.

(22) Output terminal block: Y7-1, Y7-2, C3-1, and C3-2 terminals.

(23) Output terminal block: Y0–Y6 and C0–C2 terminals.

(24) Input terminal block: X0–X20, 24V, DCM, EF, SG+, and SG- terminals.

(25) WARNING: WARNING, and output terminals.



Panel Description:

Indication	Description
POWER indicator	POWER indicator: Lights ON when LTC is powered on.
Potentiometer at left-side	VFD1 potentiometer: Turn clockwise to increase the frequency command. Turn counterclockwise to decrease the frequency command.
Potentiometer at right-side	VFD2 potentiometer: Turn clockwise to increase the frequency command. Turn counterclockwise to decrease the frequency command.
FWD indicator	Forward running indicator: lights ON when motor runs in a forward direction.
REV indicator	Reverse running indicator: lights ON when motor runs in a reverse direction.
Y0–Y7	Output signal indicator: lights ON when corresponding relays output signals.

8-2 Descriptions of Digital Keypad PU08/PU08V

LTC series uses digital keypad panel to serve as function displays and operations

Digital Keypad Panel PU08 (see figure below)

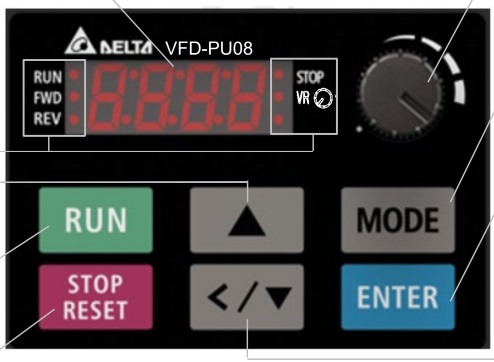
Main Display Area
Displays frequency, current, voltage, user-defined, fault codes, etc.

Status Display Area
Indicates drive's running status: Run, Stop, Forward/Reverse, Potentiometer enable/disable

Up Key
Changes parameters or values

RUN Key
VFD Run

STOP/RESET Key
Makes the drive stop running and resets faults



Frequency Setting Potentiometer
Use this knob for main frequency command input

Mode Selection
Displays mode changes step by step for selection

ENTER Key
1. Enters setting functions, such as forward (Frd), industry application functions (APP) etc.
2. Confirms parameter settings

Left-shift/Down Key
Changes value or parameters / Long press MODE key to switch between left-shift key and down key

There are four indicators on the panel:

- STOP Stop indicator: lights ON when running stops.
- RUN Running indicator: lights ON when motor runs.
- FWD Forward running indicator: lights ON when motor runs in a forward direction.
- REV Reverse running indicator: lights ON when motor runs in a reverse direction.

Digital Keypad Panel PU08V (see figure below)

Main Display Area
Displays frequency, current, voltage, user-defined, fault codes, etc.

Status Display Area
Indicates drive's running status: Run, Stop, Forward/Reverse, Potentiometer enable/disable

Up Key
Changes parameters or values

RUN Key
VFD Run

STOP/RESET Key
Makes the drive stop running and resets faults

Mode Selection
Displays mode changes step by step for selection

ENTER Key
1. Enters setting functions, such as forward (Frd), industry application functions (APP) etc.
2. Confirms parameter settings

Left-shift/Down Key
Changes value or parameters / Long press MODE key to switch between left-shift key and down key

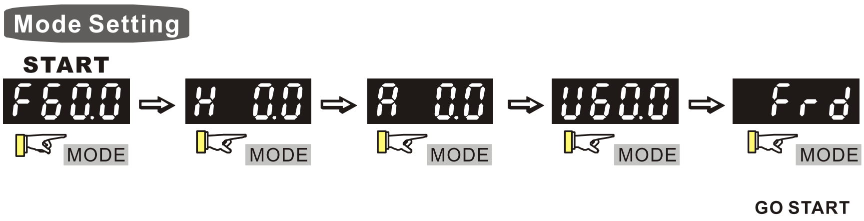
Frequency Setting Potentiometer
Use this knob for main frequency command input

Descriptions of Keypad Functions

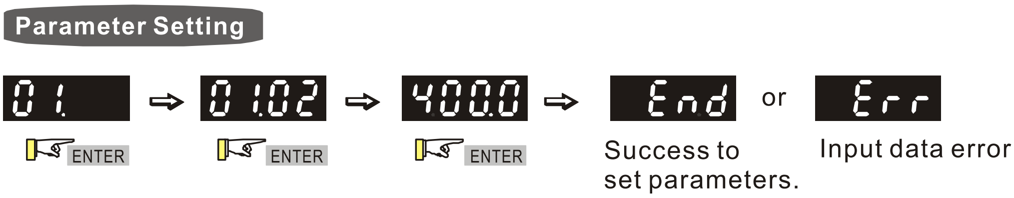
Display	Descriptions
	Displays the present frequency setting for the drive.
	Displays the actual frequency output from drive to motor
	Displays the user-defined value (U = F x Pr.00.05)
	Displays the load current.
	Forward command
	Reverse command
	Displays the count value.
	Displays a parameter item.
	Displays a parameter value.
	Displays an external fault.
	Displays "End" for approximately one second if the data has been accepted and automatically stored in the register.
	Displays if the setting data is not accepted or data value exceeds the allowed range.

8-3 Function of Digital Keypad PU08/PU08V

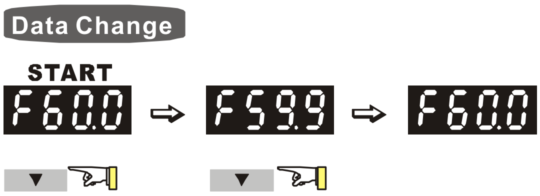
Keypad Operation Process

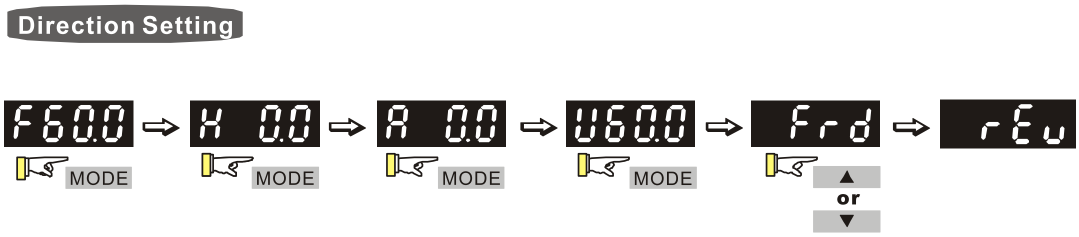


NOTE: In mode selections, press MODE to set the parameters.



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





Reference Table for the Seven-segment Digital Keypad LED Display

Number	0	1	2	3	4	5	6	7	8	9
7-segment display										
Letter	A	b	Cc	d	E	F	G	Hh	Ii	Jj
7-segment display										
Letter	K	L	n	Oo	P	q	r	S	Tt	U
7-segment display										
Letter	v	Y	Z							
7-segment display										

8-4 Fault Code Description of Digital Keypad PU08/PU08V

The following fault codes, descriptions and corrective actions are displayed when the operation command source is set as digital keypad.

Fault Code	Fault Descriptions	Corrective Actions
oc	**Over-current (oc)** Abnormal increase in current	Check if the motor power corresponds with the AC motor drive output power. Check the wiring connections to U, V and W for possible short circuits. Check the wiring connections between the AC motor drive and motor for possible short circuits, and for short to ground. Check for loose contacts between the AC motor drive and the motor. Increase the acceleration time. Check for possible excessive loading on the motor.
ov	**Over-voltage (ov)** DC bus over-voltage during deceleration.	Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If DC bus over-voltage is caused by motor regeneration, increase the deceleration time.
oH1	**IGBT overheating (oH1)** Heat sink temperature is too high, and exceeds the protection level.	Ensure that the ambient temperature is in the specified temperature range. Check if there is any obstruction on the heat sink or if the fan is running. Check if there is any insufficient ventilation space
Lv	**Low voltage (Lv)** The AC motor drive detects that the DC bus voltage has fallen below its minimum value.	Check whether the input voltage is in the AC motor drive rated input voltage range. Check for abnormal load on the motor. Check if any single phase power input to three-phase model or phases loss.
oL	**Overload (oL)** The AC motor drive detects excessive drive output current. **NOTE:** The AC motor drive can sustain up to 150% of the rated current for a maximum of 60 seconds.	Check if the motor is overloaded. Reduce the torque compensation setting (Pr.07.02). Increase the drive output capacity.
oL1	**Overload 1 (oL1)** Internal electronic overload trip	Check if the motor is overloaded. Check if the motor rated current setting (Pr.07.00) is appropriate.

Fault Code	Fault Descriptions	Corrective Actions
		Check the electronic thermal overload setting. Increase the motor capacity.
oL2	**Overload 2 (oL2)** Motor overload.	Check if the motor is overloaded. Adjust the over-torque detection settings to appropriate values (Pr.06.03–Pr.06.05).
HPF1	**Hardware protection fault 1 (HPF1)** Abnormal hardware protection wiring of the controller.	CC, OC (current clamp) abnormal hardware protection wiring, return the unit to the factory.
HPF2	**Hardware protection fault 2 (HPF2)** Abnormal hardware protection wiring of the controller.	OV abnormal hardware protection wiring, return the unit to the factory.
HPF4	**Hardware protection fault 4 (HPF4)** Abnormal hardware protection wiring of the controller.	OC abnormal hardware protection wiring, return the unit to the factory.
ocA	**Over-current during acceleration (ocA)**	Check for loose contacts between the AC motor drive and the motor. Check for poor insulation wiring from U-V-W to the motor. Increase the acceleration time Reduce the torque compensation setting (Pr.07.02). Replace the drive with a larger capacity model.
ocd	**Over-current during deceleration (ocd)**	Check for poor insulation wiring from U-V-W to the motor. Increase the deceleration time. Replace the drive with a larger capacity model.
ocn	**Over-current during steady operation (ocn)**	Check for poor insulation wiring from U-V-W to the motor. Check for possible shaft lock. Replace the drive with a larger capacity model.
EF	**External Fault (EF)** 1. When multi-function input terminals (MI1–MI4) are set to external fault, the AC motor drive stops output.	The “EF” disappears once the signal source is cleared and reset.

Fault Code	Fault Descriptions	Corrective Actions
	2. When changing the communication address 2002H bit0 = 1, the drive stops output.	
cF1.0	**EEPROM write error (cF1.0)** Internal EEPROM cannot be programmed.	Return to the factory for repair.
cF1.1	**EEPROM write error (cF1.1)** Internal EEPROM cannot be programmed.	Return to the factory for repair.
cF2.0	**EEPROM read error (cF2.0)** Internal EEPROM cannot be read.	Press RESET key to reset all parameters to defaults. If this solution does not work, return to the factory for repair.
cF2.1	**EEPROM read error (cF2.1)** Internal EEPROM cannot be read.	Press RESET key to reset all parameters to defaults. If this solution does not work, return to the factory for repair.
cF3.0	**Drive wiring detection fault (cF3.0)**	U-phase error, return to the factory for repair.
cF3.1	**Drive wiring detection fault (cF3.1)**	V-phase error, return to the factory for repair.
cF3.2	**Drive wiring detection fault (cF3.2)**	W-phase error, return to the factory for repair.
cF3.3	**Drive wiring detection fault (cF3.3)**	DC bus wiring detection error, return to the factory for repair.
cF3.4	**Drive wiring detection fault (cF3.4)**	Temperature sensor error, return to the factory for repair.
cFA	**Auto-acceleration/deceleration failure (cFA)**	Check if the drive capacity matches the motor's. Check if the regenerative energy is too high. Check for sudden load changes.
cE--	**Communication fault (cE--)**	Check the RJ45 connection between the AC motor drive for loose wires and wiring to the correct pins. Check if the communication format is correct. See the table of explanation of exception codes in Parameter Group 09 Communication Parameters in Chapter 10 for detailed information.
codE	**Software protection enabled (codE)**	Password is locked.
PHL	**Phase loss protection (PHL)**	Check if the input power is three-phase.

Fault Code	Fault Descriptions	Corrective Actions
oPHL	**Multi-motor fault protection (oPHL)**	Check if the motor wiring is normal.
ovS	**Over-voltage at stop (ovS)**	Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. Check if other fault codes such as cF3.0–cF3.2 occur after cycling the power. If yes, return to the factory for repair. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box and its internal terminals. Troubleshoot the ground fault.
ovA	**Over-voltage during acceleration (ovA)**	Check if acceleration is too slow (e.g. when lifting load decreases acceleration time). If yes, decrease the acceleration time. Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. Use over-voltage stall prevention function (Pr.06.00). Use Auto-acceleration and Auto-deceleration Setting (Pr.01.16) When ovA is triggered by too short acceleration time, execute the following actions: 1. Increase the acceleration time 2. Use Pr.06.00 over-voltage stall prevention function 3. Use Pr.01.17 S-curve for Acceleration Begin Time. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable,

Fault Code	Fault Descriptions	Corrective Actions
		wiring box and its internal terminals. Troubleshoot the ground fault. Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.
ovd	**Over-voltage during deceleration (ovd)**	Increase the setting values for Pr.01.10 and Pr.01.12 (deceleration time). Reduce the brake frequency. Use S-curve acceleration/deceleration. Use over-voltage stall prevention function (Pr.06.00). Use Auto-acceleration and Auto-deceleration Setting (Pr.01.16) Adjust the brake level (Pr.08.00). Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box and its internal terminals. Troubleshoot the ground fault. Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.
ovn	**Over-voltage during constant speed (ovn)**	Impulsive change of the load: 1. Reduce the load 2. Adjust the brake level (Pr.08.00). Use over-voltage stall prevention function (Pr.06.00). Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable,

Fault Code	Fault Descriptions	Corrective Actions
		wiring box and its internal terminals. Troubleshoot the ground fault. Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.
StAL	**Belt conveyor drive (VFD1) stall failure (StAL)**	Stall function is enabled for VDF1 of LTC. If materials are jammed and stall conditions are met, fault code StAL is triggered.

Reset

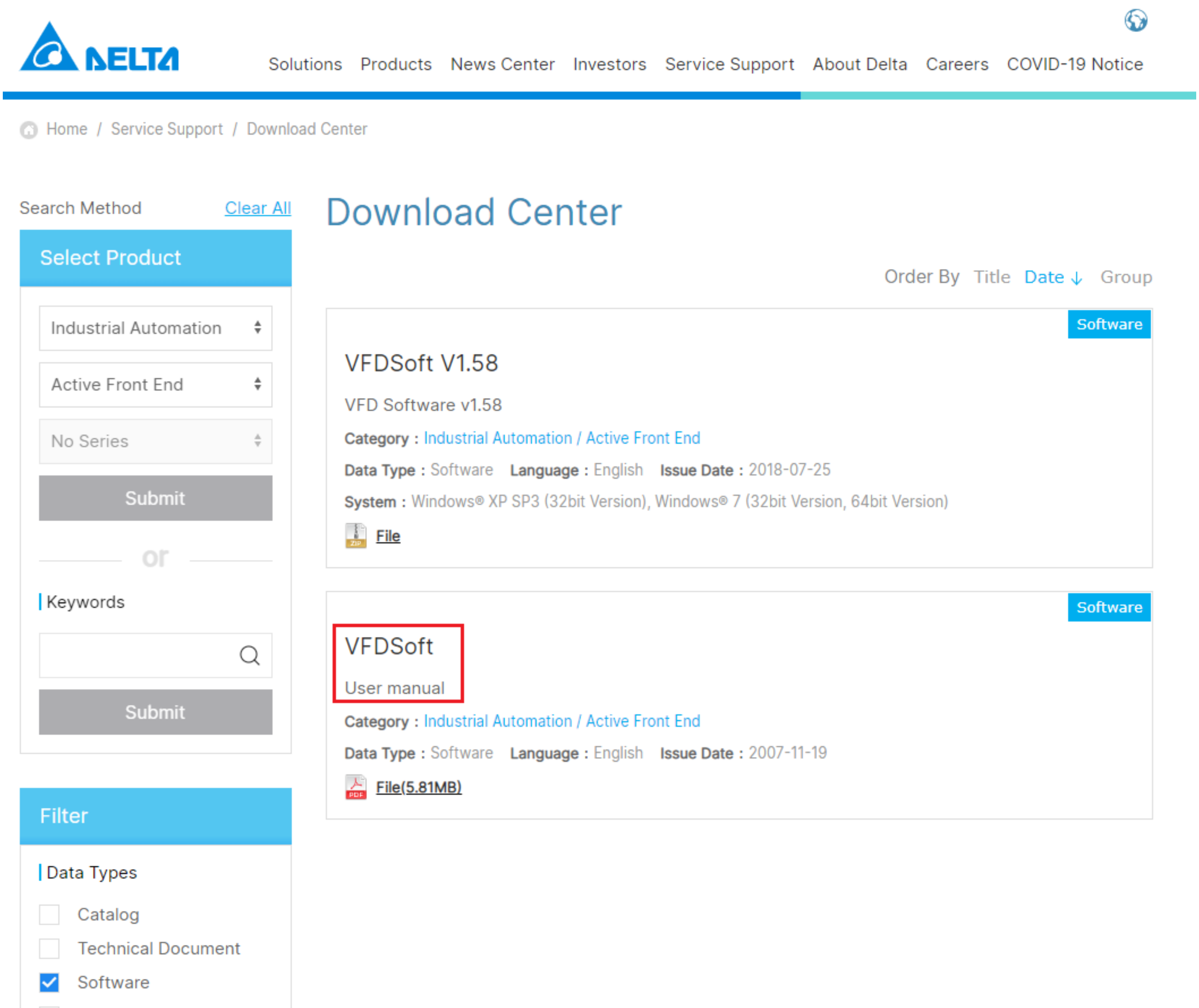
After the causes that may trigger fault codes are corrected, execute either of the following actions to clear the trip: 1. Press RESET key on the panel (as shown in the figure below); 2. Set the external terminal to "fault reset command" and set this terminal to be ON; 3. Send the fault reset command through communications. Make sure the RUN command or signal is OFF before executing RESET to prevent damage to the drive or personal injury due to immediate operation after reset.

Digital Keypad Panel

8-5 VFDSoft Software

VFDSoft, a monitoring software for Detla drives, widely supports a variety of VFD series such as VFD-EL, VFD-C2000, VFD-M300, and LTC. VFDSoft connects with VFD1 and VFD2 of LTC through either Delta USB/RS-485 converting module IFD6500 or RJ45 port to monitor VFD's working.

For detailed information, download VFDsoft User Manual (as shown in the figure below) at Delta website: https://downloadcenter.deltaww.com/en-US/DownloadCenter?v=1&CID=06&itemID=06010501&dataType=8&sort_expr=cdate&sort_dir=DESC



8-6 WPLSoft Software

WPLSoft is a program editing software used under WINDOWS operating system in Delta's DVP Series PLC for VFD-C2000 and VFD-LTC. WPLSoft not only provides functions of PLC program planning and Windows editing (such as cut, paste, copy, multi-window, etc.), but also Chinese/English notes editing function and other useful functions like register editing & setting, file reading & saving, as well as points diagram monitoring and setting, and so on.

Minimum system requirements for installing WPLSoft software:

Item	System Requirements
Operating System	Windows 95 / 98 / 2000 / NT / ME / XP / 10
CPU	Pentium 90 above
Storage	16MB above (32MB above recommended)
Drive	Disk space: 100MB above at a minimum An optical disc drive (for installing WPLSoft)
Display	Resolution: 800 × 600, 16 colors above. It is recommended to set screen width × height to 800 × 600 pixels.
Mouse	Mouse for general purposes or compatible with Windows
Printer	Printers with Windows drivers
RS-485 Port	At least one RS-485 port that can be connected with PLC

Visit the download center at Delta's website to download and install the software WPLSoft:
After finishing installation, WPLSoft program will be created in the specified default sub-directory under "C:\Program Files\Delta Industrial Automation\WPLSoft x.xx".

For detailed information on how to use WPLSoft, see Chapter 13 PLC Function Applications.

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Chapter 9 Summary of Parameter Settings

This chapter provides a summary of parameter (Pr.) setting ranges and defaults. You can set, change, and reset parameters through the digital keypad PU08/PU08V.

NOTE:

1. ✓: You can set this parameter during operation.
2. For more details on parameters, refer to Chapter 10 Descriptions of Parameter Settings.

00 User Parameters

	Pr.	Parameter Name	Setting Range	Default
	00.00	AC Motor Drive Identity Code	5: 460V, 1HP 7: 460V, 2HP 9: 460V, 3HP 11: 460V, 5.5HP	Read only
	00.01	AC Motor Drive Rated Current Display	Display by models	Read only
	00.02	Parameter Reset	0: Can be read/written 1: Read only 8: Keypad locked 9: Reset all parameter settings to defaults (50 Hz) 10: Reset all parameter settings to defaults (60 Hz)	0
✓	00.03	Start-up Display	0: F (frequency command) 1: H (output frequency) 2: A (output current) 3: U (user-defined) see Pr.00.04	0
✓	00.04	Content of Multi-function Display (User-Defined)	0: Display user-defined (U) 1: Display external terminal counter value (c) 2: Display the status of multi-function input terminal (d) 3: Displays DC bus voltage (u) (Unit: V_{DC}) 4: Display output voltage (E) (Unit: V_{AC}) 6: Display power factor angle (n) 7: Display power (P) (Unit: kW) 11: Display IGBT temperature (h) (Unit: °C)	0
✓	00.05	User-Defined Coefficient K	0.00–160.00	1.00
	00.06	Firmware Version	Read only (Display by default)	Read only
	00.07	Reserved	None	None
	00.08	Parameter Protection Password Input	0–9999 0–2: the number of wrong password attempts	0
	00.09	Parameter Protection Password Setting	0–9999 0: No password protection or password is entered correctly (Pr.00.08)	0

Pr.	Parameter Name	Setting Range	Default
		1: Password has been set	
00.10	Speed Control Mode	0: V/F control 1: SVC control	0
00.11	Reserved	None	None
00.12	50Hz Base Voltage Selection	0: 400V 1: 380V	1
00.13	User-defined Value (Maximum Output Frequency)	0–9999	0
00.14	Decimal Place of User-defined Value	0–3	0
00.15	Machine Type ID	0–5: Reserved 6: Telescopic motor 7: Belt conveyor motor	Read only

01 Basic Parameters

	Pr.	Parameter Name	Setting Range	Default
	01.00	Maximum Output Frequency	50.00–400.00 Hz	50.00
	01.01	Motor Rated Frequency	0.10–400.00 Hz	50.00
	01.02	Motor Rated Voltage	460V models: 0.1–510.0 V	380.0
	01.03	Mid-point Frequency	0.10–400.00 Hz	1.50
	01.04	Mid-point Voltage	460V models: 0.1–510.0 V	20.0
	01.05	Minimum Output Frequency	0.10–400.00 Hz	1.50
	01.06	Minimum Output Voltage	460V models: 0.0–480.0 V	20.0
	01.07	Output Frequency Upper Limit	0.1–120.0%	110
	01.08	Output Frequency Lower Limit	0.0–100.0%	0
✓	01.09	Acceleration Time 1	0.1–600.0 sec. / 0.01–600.00 sec.	3.0
✓	01.10	Deceleration Time 1	0.1–600.0 sec. / 0.01–600.00 sec.	3.0 (VFD1) 0.2 (VFD2)
✓	01.11	Acceleration Time 2	0.1–600.0 sec. / 0.01–600.00 sec.	3.0
✓	01.12	Deceleration Time 2	0.1–600.0 sec. / 0.01–600.00 sec.	3.0 (VFD1) 0.2 (VFD2)
✓	01.13	JOG Acceleration Time	0.1–600.0 sec. / 0.01–600.00 sec.	1.0
✓	01.14	JOG Deceleration Time	0.1–600.0 sec. / 0.01–600.00 sec.	1.0
✓	01.15	JOG Frequency	0.10–400.00 Hz	6
	01.16	Auto-acceleration and Auto-deceleration Setting	0: Linear acceleration and linear deceleration 1: Auto-acceleration and linear deceleration 2: Linear acceleration and auto-deceleration 3: Auto-acceleration and auto-deceleration (set by load) 4: Auto-acceleration and auto-deceleration (set by Acceleration/ Deceleration Time setting)	0
	01.17	S-curve for Acceleration Begin Time	0.0–10.0 sec. / 0.00–10.00 sec.	0
	01.18	S-curve for Acceleration Arrival Time	0.0–10.0 sec. / 0.00–10.00 sec.	0
	01.19	Acceleration and Deceleration Time Unit Setting	0: Unit: 0.1 sec. 1: Unit: 0.01 sec.	0
✓	01.20	Simple Positioning Stop Frequency 0		0.00
✓	01.21	Simple Positioning Stop Frequency 1		5.00
✓	01.22	Simple Positioning Stop Frequency 2	0.00–400.00 Hz	10.00
✓	01.23	Simple Positioning Stop Frequency 3		20.00
✓	01.24	Simple Positioning Stop Frequency 4		30.00

	Pr.	Parameter Name	Setting Range	Default
✎	01.25	Simple Positioning Stop Frequency 5		40.00
✎	01.26	Simple Positioning Stop Frequency 6		50.00
✎	01.27	Simple Positioning Stop Frequency 7		60.00
✎	01.28	Delay Time of Simple Positioning Stop 0	0.00–400.00 sec.	0.00
✎	01.29	Delay Time of Simple Positioning Stop 1		0.00
✎	01.30	Delay Time of Simple Positioning Stop 2		0.00
✎	01.31	Delay Time of Simple Positioning Stop 3		0.00
✎	01.32	Delay Time of Simple Positioning Stop 4		0.00
✎	01.33	Delay Time of Simple Positioning Stop 5		0.00
✎	01.34	Delay Time of Simple Positioning Stop 6		0.00
✎	01.35	Delay Time of Simple Positioning Stop 7		0.00
✎	01.36	Energy Restriction Mode (Only for V/F Control Mode)	0: Disabled 1: OFD (Over Flux Deceleration) mode 2: TEC (Traction Energy Control) mode	0
✎	01.37	TEC Current Restriction	Reserved	None
✎	01.38	TEC Voltage Compensation Gain	0.01–655.35	0.5
✎	01.39	TEC Voltage Compensation Filter	0.01–655.35 sec.	0.05
✎	01.40	OFD Voltage Compensation Gain	0.01–655.35	0.05

02 Operation Method Parameters

	Pr.	Parameter Name	Setting Range	Default
⌿	02.00	First Master Frequency Command Source	3: RS-485 communication (RJ45 for VFD1 and VFD2) 4: Digital keypad potentiometer	4
⌿	02.01	Operation Command Source	2: External terminals 4: RS-485 communication (RJ45 for VFD1 and VFD2)	2
	02.02	Motor Stop Method	0: STOP: ramp to stop; EF: coast to stop 1: STOP: coast to stop; EF: coast to stop 2: STOP: ramp to stop; EF: ramp to stop 3: STOP: coast to stop; EF: ramp to stop 4: Simple positioning stop; EF: coast to stop	0
	02.03	PWM Carrier Frequency Selection	2–12 kHz	8
	02.04	Motor Direction Control	0: Enable forward/reverse 1: Disable reverse 2: Disable forward	0
	02.05	Drive’s Operation Control when Power is ON and RUN Command Source is Changed (External Terminals Only)	1: Does not run when power is ON, and remains current operation status when RUN command is changed. 3: Does not run when power is ON, and follows new RUN command when RUN command is changed.	1
	02.06	Reserved	None	None
	02.07	Reserved	None	None
	02.08	Reserved	None	None
⌿	02.09	Second Master Frequency Command Source	3: RS-485 communication 4: Control by potentiometer on digital keypad	4
⌿	02.10	Combination of the First and Second Master Frequency Commands	0: First master frequency command only 1: First master frequency command + second master frequency command 2: First master frequency command – second master frequency command	0
	02.11	Reserved	None	None
⌿	02.12	Communication Frequency Command	0.00–400.00 Hz	50.00
	02.13	Frequency Command Saving Selection	0: Saves the frequency before power is off 2: Only saves the communication frequency command before power is off	0
	02.14	Initial Frequency Command Mode at Stop	0: Use current Frequency command 1: Use zero Frequency command 2: Refer to Pr.02.15 to set up	0
	02.15	Initial Frequency Command	0.00–400.00 Hz	60.00

Pr.	Parameter Name	Setting Range	Default
	Setting at Stop		
02.16	Master Frequency Command Source Display	bit0=1: The Master Frequency Command Source is the First Master Frequency Source (Pr.02.00). bit1=1: The Master Frequency Command Source is the Second Master Frequency Source (Pr.02.09). bit2=1: The Master Frequency Command Source is the external multi-function input terminal	Read only
02.17	Operation Command Source Display	bit1=1: Operation Command source is the RS-485 communication bt2=1: Operation Command Source is the external terminal (MI1) bit3=1: Operation Command Source is the external multi-function input terminals	Read only
02.18	User-defined Value 2 Setting	0–Pr.00.13	0
02.19	User-defined Value 2	0–9999	Read only

03 Output Function Parameters

Pr.	Parameter Name	Setting Range	Default
03.00	Multi-function Output (MO1)	0: No function	8
03.01	Multi-function Output (MO2)	1: Indication during RUN 2: Indication of frequency reached 3: Zero speed 4: Over-torque detection 5: Base Block (B.B.) indication 6: Low-voltage detection 7: Drive operation mode 8: Fault indication 9: Desired frequency reached 10: Terminal count value reached 11: Preliminary count value reached 12: Over-voltage stall prevention 13: Over-current stall prevention 14: IGBT overheating warning (ON: 110°C; OFF: 105°C) 15: Over-voltage 16: Reserved 17: Forward running (FWD) command 18: Reverse running (REV) command 19: Zero speed (including STOP) 20: Warning indication 21: Mechanical brake control (used with Pr.03.11, Pr.03.12) 22: Drive is ready 23–25: Reserved 26: Belt conveyor motor stall failure (activates when belt conveyor motor stall occurs)	VFD1: 26 VFD2: 6
03.02	Desired Frequency Reached	0.00–400.00 Hz	0.0
03.03	Reserved	None	None
03.04	Reserved	None	None
03.05	Terminal Count Value	0–9999	0
03.06	Preliminary Count Value	0–9999	0
03.07	EF Activates when the Terminal Count Value Reached	0: Terminal count value reached, no EF displays 1: Terminal count value reached, EF is triggered	0
03.08	Fan Cooling Control	0: Fan is always ON 1: Fan is OFF after the AC motor drive stops for one minute	0

Pr.	Parameter Name	Setting Range	Default
		2: Fan is ON when the AC motor drive runs; fan is OFF when the AC motor drive stops 3: Fan is ON after detecting heat sink temperature is reached (ON: 60°C; OFF: 40°C) 4: Fan is ON when the AC motor drive runs; fan is OFF when the AC motor drive stops. Fan is standby when at zero speed.	
03.09	Reserved	None	None
03.10	Reserved	None	None
03.11	Mechanical Brake Release Frequency	0.00–20.00 Hz	0
03.12	Mechanical Brake Engage Frequency	0.00–20.00 Hz	0
03.13	Display the Status of Multi-function Output Terminal	See parameter descriptions below	Read only
03.14	Reserved	None	None

04 Input Function Parameters

<table>
<tr><th></th><th>Pr.</th><th>Parameter Name</th><th>Setting Range</th><th>Default</th></tr>
<tr><td>⚡</td><td>04.00</td><td>Keypad Potentiometer Bias</td><td>0.0–100.0%</td><td>0.0</td></tr>
<tr><td>⚡</td><td>04.01</td><td>Keypad Potentiometer Bias Polarity</td><td>0: Positive bias
1: Negative bias</td><td>0</td></tr>
<tr><td>⚡</td><td>04.02</td><td>Keypad Potentiometer Gain</td><td>0.1–200.0%</td><td>100</td></tr>
<tr><td></td><td>04.03</td><td>Keypad Potentiometer Negative Bias, Reverse Motion Enable/Disable</td><td>0: No negative bias command
1: Negative bias: REV motion enabled</td><td>0</td></tr>
<tr><td></td><td>04.04</td><td>MI Terminal Control Mode Selection (MI1, MI2, MI3)</td><td>Mode 1 (Pr.04.19=0)
0: MI1 start-up (FWD) / stop
1: Reserved
2: Reserved
Mode 2 (Pr.04.19=1)
0: Two-wire operation control (1) MI1, MI2
1: Two-wire operation control (2) MI1, MI2
2: Three-wire operation control MI1, MI2, MI3</td><td>0</td></tr>
<tr><td></td><td>04.05</td><td>Reserved</td><td rowspan="4">0: No function
1: Reserved
2: Reserved
3: Reserved
4: Reserved
5: Fault reset
6: Acceleration / deceleration inhibit
7: 1st and 2nd acceleration / deceleration time selection
JOG command
B.B. inputs from external
10: Reserved
11: Reserved
12: Counter trigger
13: Clear the counter
14: External fault input
15: Reserved
16: Output stops
17: Parameter lock enabled
18: Operation command selection: external terminals
19: Reserved
20: Operation command selection: communication
21: Forward / reverse running command
22: Second master frequency command source enabled</td><td>None</td></tr>
<tr><td></td><td>04.06</td><td>Multi-function Input Command 1 (MI2)</td><td>1</td></tr>
<tr><td></td><td>04.07</td><td>Multi-function Input Command 2 (MI3)</td><td>14</td></tr>
<tr><td></td><td>04.08</td><td>Multi-function Input Command 3 (MI4)</td><td>5</td></tr>
</table>

Pr.	Parameter Name	Setting Range	Default
		23: Simple positioning stop by forward limit 24: Simple positioning stop by reverse limit	
04.09	Multi-function Input Contact Selection (N.O./N.C.)	0–15	0
04.10	Digital Terminal Input Response Time	1–20 (*2 ms)	1
04.11	Reserved	None	None
04.12	Reserved	None	None
04.13	Reserved	None	None
04.14	Reserved	None	None
04.15	Reserved	None	None
04.16	Reserved	None	None
04.17	Reserved	None	None
04.18	Reserved	None	None
04.19	MI Terminal Control Mode Selection	0: Mode 1, single-wire start-up/stop 1: Mode 2, two-wire/three-wire start-up/stop	1
04.20	Reserved	None	None
04.21	Reserved	None	None
04.22	Reserved	None	None
04.23	Reserved	None	None
04.24	Reserved	None	None
04.25	Reserved	None	None
04.26	Display the Status of Multi-function Input Terminal	See parameter descriptions below	Read only
✗ 04.27	Internal/External Multi-function Input Terminals Selection	0–15	0
✗ 04.28	Internal Multi-function Input Terminal Status	0–15	0
04.29	Reserved	None	None
04.30	Reserved	None	None
04.31	Reserved	None	None
04.32	Reserved	None	None
04.33	Reserved	None	None
04.34	Reserved	None	None

05 Multi-step Speed Parameters

Pr.	Parameter Name	Setting Range	Default
05.00	Reserved	None	None
05.01	Reserved	None	None
05.02	Reserved	None	None
05.03	Reserved	None	None
05.04	Reserved	None	None
05.05	Reserved	None	None
05.06	Reserved	None	None

06 Protection Function Parameters

	Pr.	Parameter Name	Setting Range	Default
	06.00	Over-voltage Stall Prevention	0: Disabled 660.0–820.0 V	780.0 V
✓	06.01	Over-current Stall Prevention during Acceleration	20–250% (0: Disabled)	170
✓	06.02	Over-current Stall Prevention during Operation	20–250% (0: Disabled)	170
	06.03	Over-torque Detection Selection	0: No detection 1: Drive continues operation until OL1 or OL protection is triggered after over-torque is detected during constant speed operation 2: Drive stops and OL2 fault is triggered after over-torque is detected during constant speed operation 3: Drive continues operation until OL1 protection is triggered after over-torque is detected during acceleration and constant speed operation 4: Drive stops and OL2 fault is triggered after over-torque is detected during acceleration and constant speed operation	0
✓	06.04	Over-torque Detection Level	10–200%	150
	06.05	Over-torque Detection Time	0.1–60.0 sec.	0.1
	06.06	Electronic Thermal Overload Relay Selection (OL1)	0: Standard motor (motor with the fan on the shaft) 1: Special motor (with external forced cooling) 2: Disabled	2
	06.07	Electronic Thermal Overload Relay Action Time	30–600 sec.	60
	06.08	Fault Record 1 (The Most Recent)	0: No fault record 1: Over-current (oc) 2: Over-voltage (ov) 3: IGBT overheating (oH1) 4: Reserved 5: Overload (oL) 6: Overload 1 (oL1) 7: Overload 2 (oL2) 8: External Fault (EF) 9: Over-current during acceleration (ocA) 10: Over-current during deceleration (ocd) 11: Over-current during steady operation (ocn) 12: Reserved	0
	06.09	Fault Record 2		0
	06.10	Fault Record 3		0
	06.11	Fault Record 4		0
	06.12	Fault Record 5		0

	Pr.	Parameter Name	Setting Range	Default
			13: Reserved 14: Phase loss protection (PHL) 15: Reserved 16: Auto-acceleration/deceleration failure (cFA) 17: Software protection enabled (codE) 18: EEPROM write error (cF1.0) 19: EEPROM read error (cF2.0) 20: Hardware protection fault 1 (HPF1) 21: Hardware protection fault 1 (HPF2) 22: Reserved 23: Hardware protection fault 1 (HPF4) 24: Drive wiring detection fault (cF3.0) 25: Drive wiring detection fault (cF3.1) 26: Drive wiring detection fault (cF3.2) 27: Drive wiring detection fault (cF3.3) 28: Drive wiring detection fault (cF3.4) 29: Reserved 30: Reserved 31: Reserved 32: Reserved 33: Reserved 34: Reserved 35: Reserved 36: Reserved 37: Multi-motor fault protection (oPHL) 38: IGBT temperature PTC OFF (TH1o) 39: Reserved 40: Reserved 41: Belt conveyor drive (VFD1) stall failure (StAL) 42: Over-voltage at stop (ovS) 43: Over-voltage during acceleration (ovA) 44: Over-voltage during deceleration (ovd) 45: Over-voltage during constant speed (ovn)	
〆	06.13	Motor Phase Loss Detection Time	0: Disabled 0–60 sec.	0
〆	06.14	Current Detection for Motor Phase Loss	10–100%	30

07 Motor Parameters

	Pr.	Parameter Name	Setting Range	Default
ϟ	07.00	Motor Rated Current	23% FLA–120% FLA	100
ϟ	07.01	Motor No-load Current	0% FLA–99% FLA	40
ϟ	07.02	Torque Compensation	0.0–10.0	0.0
ϟ	07.03	Slip Compensation Gain	0.00–10.00	0.00
ϟ	07.04	Motor Parameter Auto-tuning	0: Disabled 1: Auto-tuning R1 (motor does not run) 2: Auto-tuning R1 + no-load current (motor runs)	0
	07.05	Motor Line-to-line Resistance R1 (Motor 0)	0–65535 mΩ	0
	07.06	Motor Rated Slip (Motor 0)	0.00–20.00 Hz	3.00
	07.07	Slip Compensation Limit	0–250%	200
	07.08	Torque Compensation Low Pass Filter Time	0.01–10.00 sec.	0.10
	07.09	Slip Compensation Low Pass Filter Time	0.05–10.00 sec.	0.20
	07.10	Accumulated Motor Operation Time	00–1439 min.	0
	07.11	Accumulated Motor Operation Time	00–65535 days	0
	07.12	Reserved	None	None
	07.13	Reserved	None	None
	07.14	Reserved	None	None
	07.15	Reserved	None	None
	07.16	Reserved	None	None
	07.17	Reserved	None	None

08 Special Parameters

Pr.	Parameter Name	Setting Range	Default
08.00	DC Brake Current Level	0–100%	0
08.01	DC Brake Time At Start-up	0.0–60.0 sec.	0.0
08.02	DC Brake Time At STOP	0.0–60.0 sec.	0.0
08.03	DC Brake Frequency at STOP	0.00–400.00 Hz	0.00
08.04	Restart after Momentary Power Loss	0: Operation stops after momentary power loss 1: Operation continues after momentary power loss, speed tracking starts with the last frequency. 2: Operation continues after momentary power loss, speed tracking starts with the minimum frequency.	0
08.05	Maximum Allowable Power Loss Time	0.1–20.0 sec.	2.0
08.06	Base Block Speed Tracking	0: Disabled 1: Speed tracking starts with the last frequency 2: Speed tracking starts with the minimum output frequency (Pr.01.05)	1
08.07	Base Block Time for Speed Tracking	0.1–5.0 sec.	0.5
08.08	Current Limit for Speed Tracking	30–200%	150
✎ 08.09	Skip Frequency 1 (Upper Limit)	0.00–400.0 Hz	0.00
✎ 08.10	Skip Frequency 1 (Lower Limit)	0.00–400.0 Hz	0.00
✎ 08.11	Skip Frequency 2 (Upper Limit)	0.00–400.0 Hz	0.00
✎ 08.12	Skip Frequency 2 (Lower Limit)	0.00–400.0 Hz	0.00
✎ 08.13	Skip Frequency 3 (Upper Limit)	0.00–400.0 Hz	0.00
✎ 08.14	Skip Frequency 3 (Lower Limit)	0.00–400.0 Hz	0.00
08.15	Number of Times of Restart after Fault	0–10	0
08.16	Auto-restart Interval of Fault	0.1–6000 sec.	60.0
08.17	Automatic Energy-saving	0: Automatic energy-saving operation is disabled 1: Automatic energy-saving operation is enabled	0
08.18	Automatic Voltage Regulation (AVR)	0: AVR function is enabled 1: AVR function is disabled 2: AVR function is disabled during deceleration 3: AVR function is disabled at stop	0
08.19	Reserved	None	None
✎ 08.20	Vibration Suppression	0.0–5.0	0

Pr.	Parameter Name	Setting Range	Default
08.21	Reserved	None	None
08.22	Reserved	None	None
08.23	Reserved	None	None
08.24	Reserved	None	None
08.25	Reserved	None	None

09 Communication Parameters

	Pr.	Parameter Name	Setting Range	Default
✓	09.00	Communication Address	1–254	1
✓	09.01	Transmission Speed	0: Baud rate 4800 bps 1: Baud rate 9600 bps 2: Baud rate 19200 bps	2
✓	09.02	Transmission Fault Treatment	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning, no fault and continue operation	3
✓	09.03	Communication Time-out Detection	0.0: No function 0.1–120.0 sec.	0
✓	09.04	Communication Protocol	0: 7, N, 2 for ASCII 1: 7, E, 1 for ASCII 2: 7, O, 1 for ASCII 3: 8, N, 2 for RTU 4: 8, E, 1 for RTU 5: 8, O, 1 for RTU 6: 8, N, 1 for RTU 7: 8, E, 2 for RTU 8: 8, O, 2 for RTU 9: 7, N, 1 for ASCII 10: 7, E, 2 for ASCII 11: 7, O, 2 for ASCII	3
	09.05	Reserved	None	None
	09.06	Reserved	None	None
✓	09.07	Communication Response Delay Time	0.0–200.0 ms (One unit: 2 ms)	1
	09.08	Reserved	None	None

10 Speed Feedback Control Parameters

Pr.	Parameter Name	Setting Range	Default
10.00–10.50	Reserved	None	None

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Chapter 10 Descriptions of Parameter Settings

00 User Parameters

✓ You can set this parameter during operation.

00.00 AC Motor Drive Identity Code

Default: Read only

Settings Read only

00.01 AC Motor Drive Rated Current Display

Default: Read only

Settings Read only

- Pr.00.00 displays the AC motor drive identity code. Use the following specification table to check if Pr.00.01 setting is the rated current of the AC motor drive. Pr.00.01 corresponds to the identity code of Pr.00.00.
- Pr.00.01 indicates the rated output current of the AC motor drive. Use this parameter to check if the displayed values matches the drive used.

Specification table of drive capacity, identity code, and rated current:

Frame	A			
Models	VFD2207LTC43A		VFD4015LTC43A	
Description	Telescopic	Belt conveyor	Telescopic	Belt conveyor
Power (kW)	0.75	2.2	1.5	4.0
Power (HP)	1	3	2	5.5
Identity Code	5	9	7	11
Rated Current (A)	2.5	5.5	4.2	9.0

00.02 Parameter Reset

Default: 0

Settings 0: Can be read/written
1: Read only
8: Keypad locked
7: Reset CANopen Slave index
9: Reset all parameter settings to defaults (50 Hz)
10: Reset all parameter settings to defaults (60 Hz)

- 9 or 10: Resets all parameters to defaults when parameters are abnormal due to fault or incorrect tuning.
- 9: The base voltage of 50 Hz power system varies with Pr.00.12 settings.
- 1: All parameters cannot be changed and Err will be displayed if any values are entered. To write any parameters, set Pr.00.02= 0.
- When Pr.00.02=8, keypad is locked and can be unlocked by pressing ENTER key continuously for five seconds.

00.03 Start-up Display

Default: 0

Settings 0: F (frequency command)
1: H (output frequency)
2: A (output current)
3: U (user-defined) see Pr.00.04

- Determines the start-up display page after power is applied to the drive. The user-defined contents display according to the Pr.00.04 settings.
- When power is applied, the drive starts self-detecting and Pon is displayed. After flashing about five seconds, the default start-up display shows.

00.04 Content of Multi-function Display (User-Defined)

Default: 3

Settings 0: Display user-defined (U)


1: Display external terminal counter value (c)


2: Display the status of multi-function input terminal (d)


3: Displays DC bus voltage (u) (Unit: V_{DC})


4: Display output voltage (E) (Unit: V_{AC})


6: Display power factor angle (n)


7: Display power (P) (Unit: kW)


11: Display IGBT temperature (h) (Unit: °C)


- Used to select the display contents as required only when Pr.00.03=3.

00.05 User-Defined Coefficient K

Unit: 0.1
Default: 1.00

Settings 0.00–160.00

- Determines the multiplying factor (K) for the user-defined unit. The display value is calculated as follows: User-defined unit (U) = Output frequency (H) × User-defined Coefficient (K) (Pr.00.05)

00.06 Software Version

Default: Read only

Settings Read only

00.07 Reserved

00.08 Parameter Protection Password Input

Default: 0

Settings 0–9999

- Displayed value 0–2 is the number of wrong password attempts.
- Enter the password that is set in Pr.00.09. Enter the correct password here to enable changing parameter settings. You are limited to a maximum of three attempts. After three consecutive failed attempts, a blinking "codE" appears. You must restart the AC motor drive before you can try again to enter the correct password. To avoid problems in the future, be sure to write down the password after you set this parameter. If you forget the password, return the unit to Delta to unlock the password.

00.09 Parameter Protection Password Setting

Default: 0

Settings 0–9999

- 0: No password protection or password is entered correctly (Pr.00.08). 1: Password has been set.
- This parameter is for setting the password protection. Password can be set directly the first time. After you set the password, the value of Pr.00.09 is 1, which means password protection is activated. However, if the value of Pr.00.09 is 0, the password protection is deactivated, which means you can change any of the parameter settings (including resetting the parameter protection password for Pr.00.09). When Pr.00.09 is 1 and if you want to change any of the parameter settings, you must enter the correct password in Pr.00.08 to deactivate the password, and this would make Pr.00.09 become 0.

  NOTE:

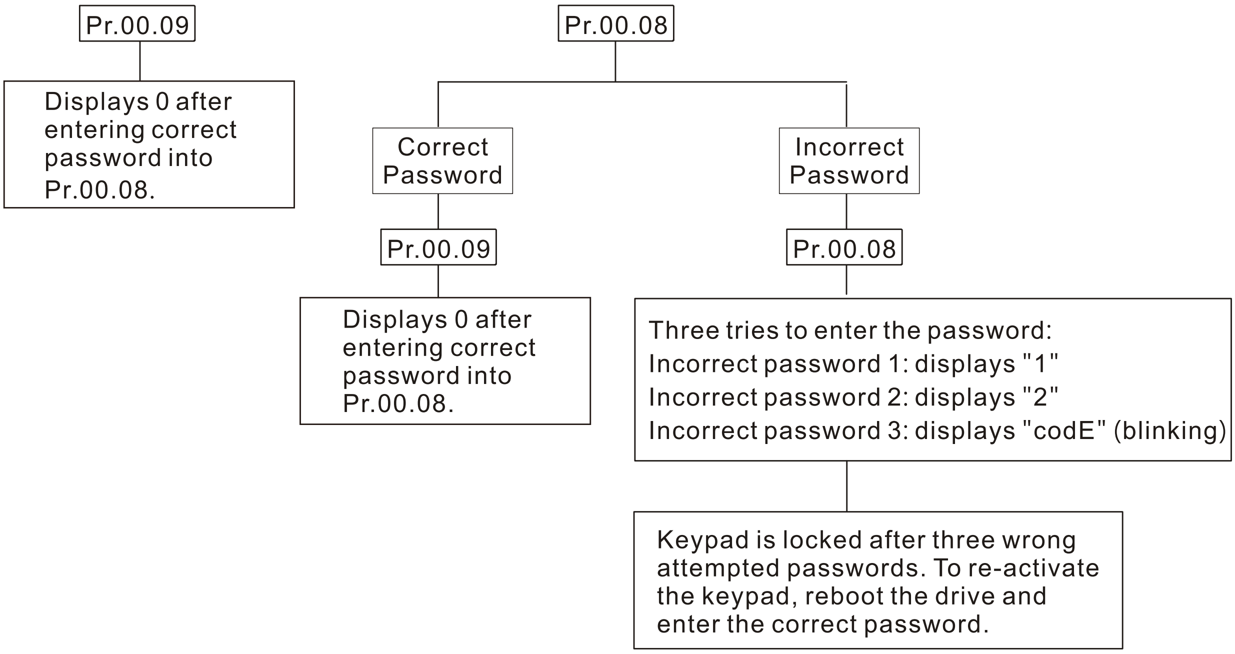
  If you set this parameter to 0 again, the password protection function is deactivated. No password protection is enabled for future rebooting. Otherwise, as long as you set a password other than 0, this password protection is always reactivated after you reboot the motor drive. If you want to change any of the parameter settings after rebooting the motor drive, enter the correct password in Pr.00.08 to deactivate the password.
- This parameter is used to prevent personnel from setting other parameters by accident.

  Method 1: Enter the original password into Pr.00.09 again (or you can enter a new password if you want; be sure to record it).

  Method 2: Reboot the drive to restore the password protection function.

  Method 3: Enter any value that is not the password into Pr.00.08. (Pr.00.08 displays End regardless of whether the password is entered correctly.)

Password Decode Flow Chart



00.10 Speed Control Mode

Default: 0

Settings 0: V/F control

1: SVC control

- Determines the control mode of the AC motor drive.
- V/F Control: (Voltage/Frequency Control)
  The V/F control is a constant value control mode. In this control mode, frequency decreasing and magnetic field increasing are under control. But as the frequency decreases, a problem rises: the insufficiency of motor's torque in a weaken low frequency magnetic field. To solve this problem, set Pr.07.02 Torque Compensation to compensate torque then to have the best operating performance.
- Common applications are water pumps, conveyors, compressors and treadmills.
- Vector Control:
  The vector control mode can eliminate the relationship between the field current vector and the armature flux, and auto-tune the torque compensation and slip compensation to increase the dynamic response of the motor drive.
- Common applications are textile equipment, printing equipment, crane equipment and drilling machinery.
- Related parameter: Pr.07.02 Torque Compensation

00.11 Reserved

00.12 50Hz Base Voltage Selection

Default: 1

Settings 0: 400V
1: 380V

📖 Determines the base voltage when the drive resets to 50 Hz.

00.13 User-defined Value

Default: 0

Settings 0–9999

📖 Corresponds to Maximum Output Frequency (Pr.01.00).

📖 When Pr.00.13 is not set to 0, "F" automatically disappears in frequency mode and the rightmost digit blinks. The ranges for many functions display according to Pr.00.13, including the UP/DOWN key on the keypad, multi-step speed function, and JOG function.

📖 When Pr.00.13 is not set to 0, and the frequency source is from communications, use Pr.02.18 to change the frequency command instead of using communication address 2001H.

00.14 Decimal Place of User-defined Value

Default: 0

Settings 0–3

📖 Sets the place of decimal point for Pr.00.13.
Example: If you want to set the user-defined value to 10.0, set Pr.00.13 to 100 and Pr.00.14 to 1.

00.15 Machine Type ID

Default: Read only

Settings 0–5: Reserved
6: Telescopic motor
7: Belt conveyor motor

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01 Basic Parameters

✓ You can set this parameter during operation.

01.00 Maximum Output Frequency

Default: 50.00

Settings 50.00–400.00 Hz

01.01 Motor Rated Frequency

Default: 50.00

Settings 0.10–400.00 Hz

- Set this value according to the rated motor frequency as indicated on the motor nameplate.

01.02 Motor Rated Voltage

Default: 380.0

Settings 460V models: 0.1–510.0 V

- For 460V models, the default is 380.0 V.
- Set the maximum output voltage. The setting must be smaller than or equal to the rated motor voltage as indicated on the motor nameplate.

01.03 Mid-point Frequency

Default: 1.50

Settings 0.10–400.00 Hz

- Sets the mid-point frequency of any V/F curve. This setting determines the V/F ratio between the Minimum Frequency and the Mid-point Frequency.

01.04 Mid-point Voltage

Default: 20.0

Settings 460V models: 0.1–510.0 V

- For 460V models, the default is 20.0 V.
- Sets the mid-point voltage of any V/F curve. This setting determines the V/F ratio between the Minimum Frequency and the Mid-point Frequency.

01.05 Minimum Output Frequency

Default: 1.50

Settings 0.10–400.00 Hz

- Sets the minimum output frequency of the AC motor drive in V/F curve.

01.06 Minimum Output Voltage

Default: 20.0

Settings 460V models: 0.0–480.0 V

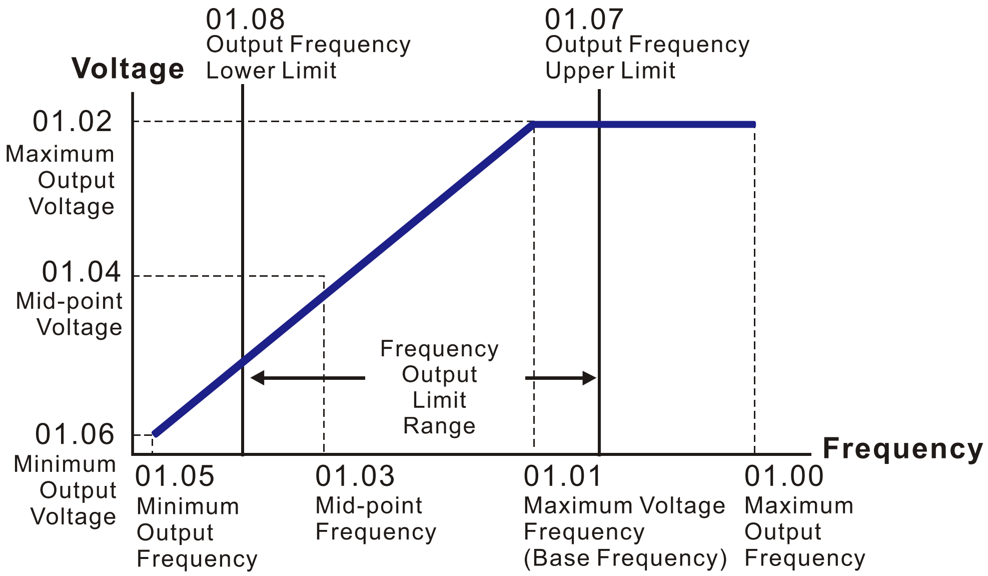
- For 460V models, the default is 20.0 V.
- Sets the minimum output voltage of the AC motor drive in V/F curve.
- The settings for Pr.01.01–Pr.01.06 must meet the condition of Pr.01.02 ≥ Pr.01.04 ≥ Pr.01.06; Pr.01.01 ≥ Pr.01.03 ≥ Pr.01.05.

01.07 Output Frequency Upper Limit

Default: 110

Settings 0.1–120%

- 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 equal to 100%.
- The Output Frequency Upper Limit value = (Pr.01.00 x Pr.01.07) /100



V/F Curve

01.08 Output Frequency Lower Limit

Default: 0

Settings 0.0–100%

- The Output Frequency Lower Limit value = (Pr.01.00 × Pr.01.08) / 100
- Use the output frequency upper and lower limit settings to prevent operator misuse, overheating caused by the motor's operating at a too low frequency, or mechanical wear due to a too high speed.
- If the output frequency upper limit calculated is 50 Hz and the frequency setting is 60 Hz, the maximum output frequency is 50 Hz.
- If the output frequency lower limit calculated is 10 Hz and the minimum output frequency setting (Pr.01.05) is 1.5 Hz, then the drive operates at 10 Hz when the Frequency command is higher than Pr.01.05 but lower than 10 Hz. If the Frequency command is lower than the minimum output frequency (Pr.01.05), the drive is in ready status without output.

✓ 01.09 Acceleration Time 1

Default: 3.0

Settings 0.1–600.0 sec. / 0.01–600.00 sec.

- You can switch the acceleration/deceleration time 1 or 2 by setting the external terminals MI2–MI4 to 7.

01.10 Deceleration Time 1

Default: 3.0 (VFD1) / 0.2 (VFD2)

Settings 0.1–600.0 sec. / 0.01–600.00 sec.

- You can switch the acceleration/deceleration time 1 or 2 by setting the external terminals MI2–MI4 to 7.

01.11 Acceleration Time 2

Default: 3.0

Settings 0.1–600.0 sec. / 0.01–600.00 sec.

- You can switch the acceleration/deceleration time 1 or 2 by setting the external terminals MI2–MI4 to 7.

01.12 Deceleration Time 2

Default: 3.0 (VFD1) / 0.2 (VFD2)

Settings 0.1–600.0 sec. / 0.01–600.00 sec.

- You can switch the acceleration/deceleration time 1 or 2 by setting the external terminals MI2–MI4 to 7.

01.13 JOG Acceleration Time

Default: 1.0

Settings 0.1–600.0 sec. / 0.01–600.00 sec.

01.14 JOG Deceleration Time

Default: 1.0

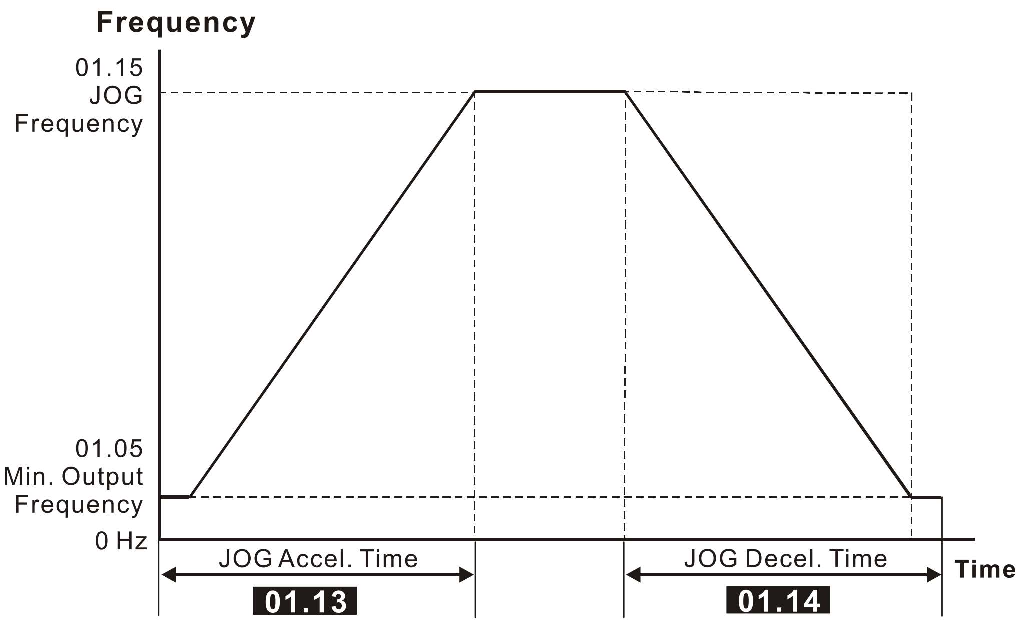
Settings 0.1–600.0 sec. / 0.01–600.00 sec.

01.15 JOG Frequency

Default: 6.00

Settings 0.10–400.00 Hz

- Use only external terminal setting MI2, MI3 or MI4 to 8 (JOG). When the JOG command is ON, the AC motor drive accelerates from the Minimum Output Frequency (Pr.01.05) to the Jog Frequency (Pr.01.15). When the JOG command is OFF, the AC motor drive decelerates from the JOG frequency to stop. The acceleration/deceleration time is set by the JOG Acceleration/Deceleration Time (Pr.01.13, Pr.01.14).
- The drive must be stopped before using the JOG command. During Jog operation, other operation commands are not accepted, except FORWARD/REVERSE commands.



The Definition of JOG Accel./Decel. Time

01.16 Auto-acceleration and Auto-deceleration Setting

Default: 0

Settings 0: Linear acceleration and linear deceleration

1: Auto-acceleration and linear deceleration

2: Linear acceleration and auto-deceleration

3: Auto-acceleration and auto-deceleration (set by load)

Auto-acceleration and auto-deceleration (set by Acceleration/Deceleration Time setting)

- With auto-acceleration and auto-deceleration, it is possible to reduce vibration and shocks during starting and stopping the load. During auto-acceleration, the torque is automatically measured and the drive accelerates to the set frequency with the shortest acceleration time and the smoothest starting current. During deceleration, the drive automatically determines the loaded regenerative energy to steadily and smoothly stop the motor in the shortest deceleration time. When this parameter is set to 4, the actual acceleration/deceleration time refers to acceleration/deceleration time settings in Pr.01.09–Pr.01.12. Thus the actual acceleration/deceleration time is equal to or greater than acceleration/deceleration time settings.
- Auto-acceleration and auto-deceleration makes the complicated processes of tuning unnecessary. It does not stall during acceleration and does not need a brake resistor during deceleration to stop. It can also improve operation efficiency and save energy.

01.17 S-curve for Acceleration Begin Time

Default: 0.0

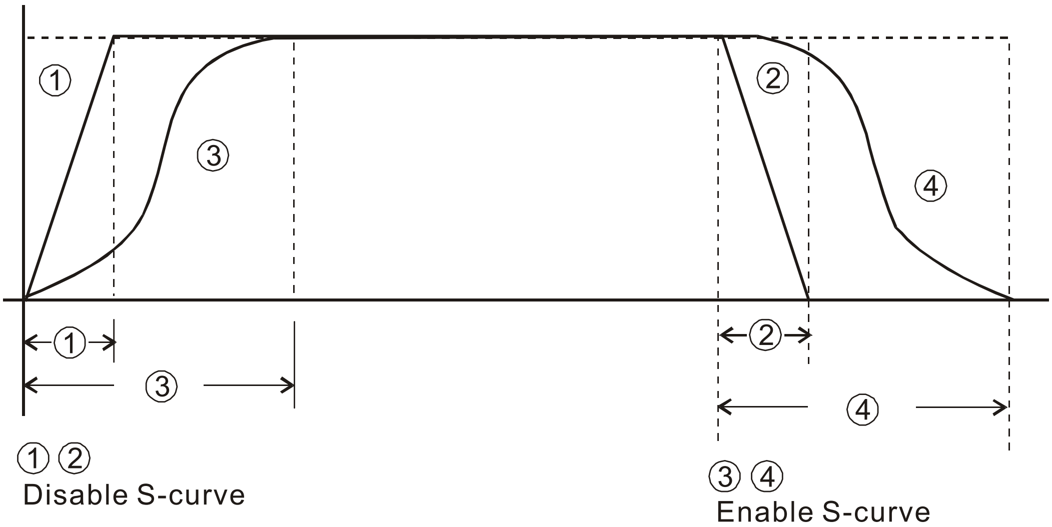
Settings 0: 0.0–10.0 sec. / 0.00–10.00 sec.

01.18 S-curve for Acceleration Arrival Time

Default: 0.0

Settings 0: 0.0–10.0 sec. / 0.00–10.00 sec.

- Using an S-curve gives the smoothest transition between speed changes. Pr.01.17–Pr.01.18 adjusts the acceleration and deceleration S-curve. When enabled, the drive produces a different acceleration and deceleration curve according to the acceleration and deceleration time. When setting this parameter to 0.0, it is linear acceleration and linear deceleration.
- The following diagram shows that the original setting of the Acceleration and Deceleration Time is only for reference when you enable the S-curve. The actual acceleration and deceleration time depends on the selected S-curve (0.1 to 10.0). Pr.01.17 must be smaller than Pr.01.09 or Pr.01.11; Pr.01.18 must be smaller than Pr.01.10 or Pr.01.12. Otherwise, the S-curve is invalid.
- The total acceleration time = Pr.01.09 + Pr.01.17 or Pr.01.11 + Pr.01.17
- The total deceleration time = Pr.01.10 + Pr.01.18 or Pr.01.12 + Pr.01.18



Acceleration/deceleration Characteristics

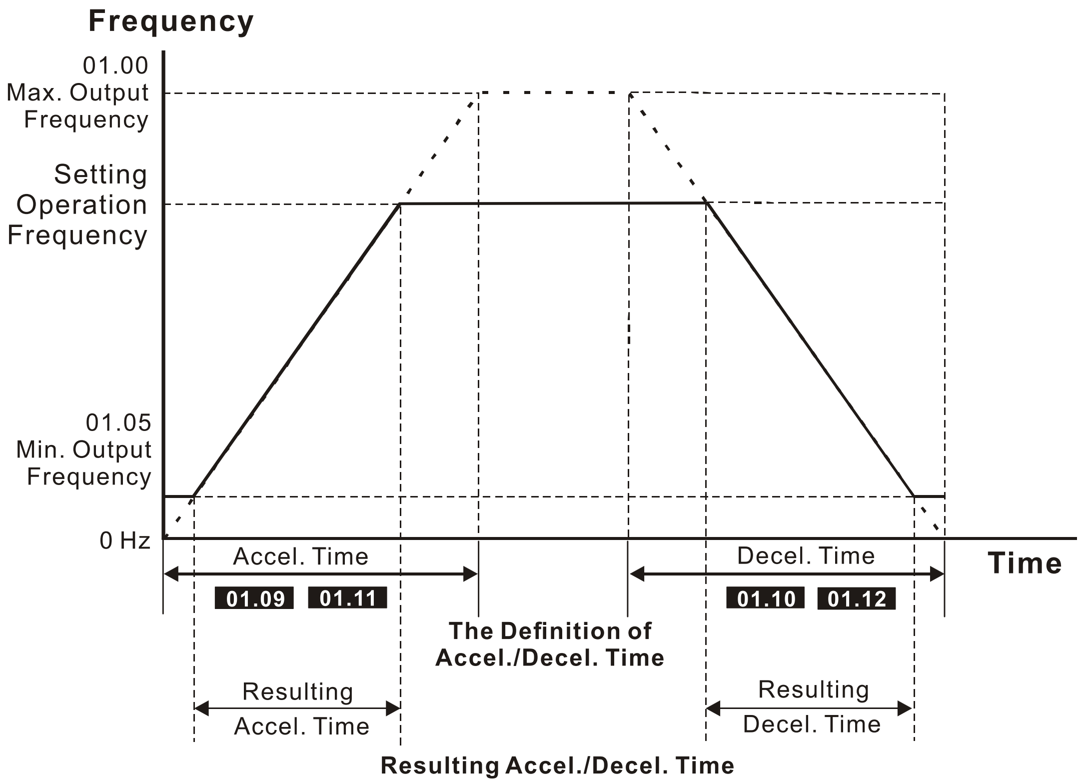
01.19 Acceleration and Deceleration Time Unit Setting

Default: 0

Settings 0: Unit: 0.1 sec.

1: Unit: 0.01 sec.

- The acceleration time determines the time required for the AC motor drive to ramp from 0.00 Hz to the Maximum Output Frequency (Pr.01.00). The deceleration time determines the time required for the AC motor drive to decelerate from the Maximum Output Frequency down to 0 Hz.
- Select the Acceleration / Deceleration Time 1, 2 with the multi-function input terminal settings. The defaults are Acceleration Time 1 and Deceleration Time 1.
- Pr.01.19 settings change the settings of acceleration and deceleration time unit, further changing the setting range of acceleration and deceleration time.



⌿ 01.20 Simple Positioning Stop Frequency 0

Default: 0.00

Settings 0.00–400.00 Hz

⌿ 01.21 Simple Positioning Stop Frequency 1

Default: 5.00

Settings 0.00–400.00 Hz

⌿ 01.22 Simple Positioning Stop Frequency 2

Default: 10.00

Settings 0.00–400.00 Hz

⌿ 01.23 Simple Positioning Stop Frequency 3

Default: 20.00

Settings 0.00–400.00 Hz

⌿ 01.24 Simple Positioning Stop Frequency 4

Default: 30.00

Settings 0.00–400.00 Hz

⌿ 01.25 Simple Positioning Stop Frequency 5

Default: 40.00

Settings 0.00–400.00 Hz

01.26 Simple Positioning Stop Frequency 6

Default: 50.00

Settings 0.00–400.00 Hz

01.27 Simple Positioning Stop Frequency 7

Default: 60.00

Settings 0.00–400.00 Hz

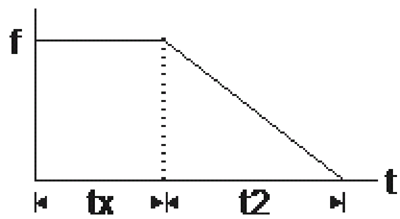
- The setting for Pr.01.20–Pr.01.27 must follow the condition below:
  Pr.01.20 ≤ Pr.01.21 ≤ Pr.01.22 ≤ Pr.01.23 ≤ Pr.01.24 ≤ Pr.01.25 ≤ Pr.01.26 ≤ Pr.01.27
- If any two of the parameters (between Pr.01.20–Pr.01.27) have the same stop frequency, set their Delay Time of Simple Positioning Stop to the same values.

01.28 Delay Time of Simple Positioning Stop 0
01.29 Delay Time of Simple Positioning Stop 1
01.30 Delay Time of Simple Positioning Stop 2
01.31 Delay Time of Simple Positioning Stop 3
01.32 Delay Time of Simple Positioning Stop 4
01.33 Delay Time of Simple Positioning Stop 5
01.34 Delay Time of Simple Positioning Stop 6
01.35 Delay Time of Simple Positioning Stop 7

Default: 0.00

Settings 0.00–400.00 sec.

- This is valid only when Pr.02.02 motor stop method is set to 4: simple positioning stop.
- The settings 0–7 for Pr.01.20–Pr.01.27 must work with the settings 0–7 for Pr.01.28–Pr.01.35 and correspond to each other. For example, Pr.01.20 must work with Pr.01.28.
- The function of Pr.01.28–Pr.01.35 is simple positioning. Speed starts to decelerate after the time set at Pr.01.28–Pr.01.35 elapses. The accuracy of positioning is self-assessed by user.



$$S = n \times \left(\frac{t_x + (t_x + t_2)}{2} \right)$$

S: operation distance (revolution)

n: rotation speed (revolution/second)

t_x: delay time (second)

t_2: deceleration time (second)

$$n = f \times \frac{120}{p}$$

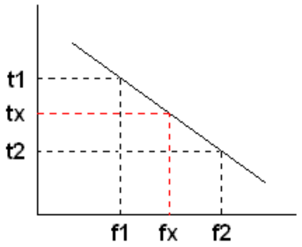
n: rotation speed (RPM) (revolution/minute)

P: number of poles in the motor

f: operation frequency

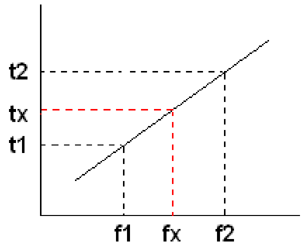
The value of t_x in the equation above describes as below.

1.1 When the slope is negative (t1 > t2)



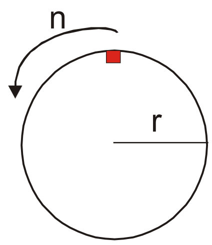
$$t_x = t_1 + \left(\frac{f_x - f_1}{f_2 - f_1}\right)\times(t_2 - t_1) = t_1 + \left(\frac{f_x - f_1}{10}\right)\times(t_2 - t_1)$$

1.2 When the slope is positive (t1 < t2)

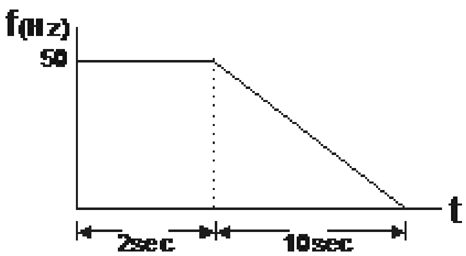


$$t_x = t_2 - \left(\frac{f_2 - f_x}{f_2 - f_1}\right)\times(t_2 - t_1) = t_2 - \left(\frac{f_2 - f_x}{10}\right)\times(t_2 - t_1)$$

As shown in the figure below, assume that the radius of the four-pole motor is r and rotation speed is n (RPM).



Example 1:
When the motor swivel table rotates at 50 Hz, and Pr.02.02 = 4 [Simple Positioning Stop; E.F.: coast to stop], and Pr.01.26 = 50 Hz [Simple Positioning Stop Frequency 6], and its corresponding Pr.01.34 = 2 sec. [Delay Time of Simple Positioning Stop 6], then the deceleration time from 50 Hz to 0 Hz is 10 seconds.
After executing the stop command, Simple Positioning Stop activates, its rotation speed is n = 120 x 50 / 4 (revolution / minute) = 25 (revolution / second)
The number of revolution of the swivel table = (25 x (2 + 12)) / 2 = 175 (revolutions)

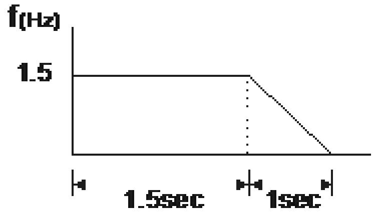


Therefore, the motor's operation distance after executing the stop command = number of revolutions x circumference = 175 x 2 πr. It also means that the swivel table goes back to the top after 175 revolutions.

Example 2:
Assume that the motor swivel table rotates at 1.5 Hz, and Pr.01.22 = 10 Hz [Simple Positioning Stop Frequency 2], and Pr.01.30 = 10 sec. [Delay Time of Simple Positioning Stop 2], then the deceleration time from 60 Hz to 0 Hz is 40 seconds. The delay time at stop for 1.5 Hz is 1.5 second; the deceleration time from 1.5 Hz to 0 Hz is 1 second.

After executing the stop command, Simple Positioning Stop activates, its rotation speed is n = 120 x 1.5 / 4 (revolution / minute) = 1.5 / 2 (revolution / second)

The number of revolution of the swivel table = (1.5 / 2 x (1.5 + 2.5)) / 2 = 1.5 (revolutions)



Therefore, the motor's operation distance after executing the stop command = number of revolutions x circumference = 1.5 x 2 πr. It also means the swivel table stops after running 1.5 revolutions (red point is at the bottom).

01.36 Energy Restriction Mode (Only for V/F Control Mode)

Default: 0

Settings 0: Disabled
1: OFD (Over Flux Deceleration) mode
2: TEC (Traction Energy Control) mode

- 0: Decelerates or stops according to original deceleration time settings.
- 1: Acceleration, constant speed, and deceleration adjust automatically. Increase output frequency to reduce DC bus. After DC bus is reduced, output frequency is back to setting values.
- 2: Slope of acceleration, constant speed, and deceleration are fixed.

01.37 TEC Current Restriction (Reserved)

01.38 TEC Voltage Compensation Gain

Default: 0.5

Settings 0.01–655.35

01.39 TEC Voltage Compensation Filter

Default: 0.05

Settings 0.01–655.35 sec.

01.40 OFD Voltage Compensation Gain

Default: 0.05

Settings 0.01–655.35

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02 Operation Method Parameters

⌿ You can set this parameter during operation.

⌿ 02.00 First Master Frequency Command Source

Default: 4

Settings 3: RS-485 communication (RJ45 for VFD1 and VFD2)

4: Digital keypad potentiometer

⌿ 02.01 Operation Command Source

Default: 2

Settings 2: External terminals

4: RS-485 communication (RJ45 for VFD1 and VFD2)

- Sets the Master Frequency Command Source for the AC motor drive.
- Pr.02.09 is only valid when you set one of Pr.04.06 or Pr.04.08 = 22. When setting 22 is activated, the frequency command source is the setting for Pr.02.09. You can only enable only one of the first master frequency command and second master frequency command sources at one time.

02.02 Motor Stop Method

Default: 0

Settings 0: STOP: ramp to stop; EF: coast to stop

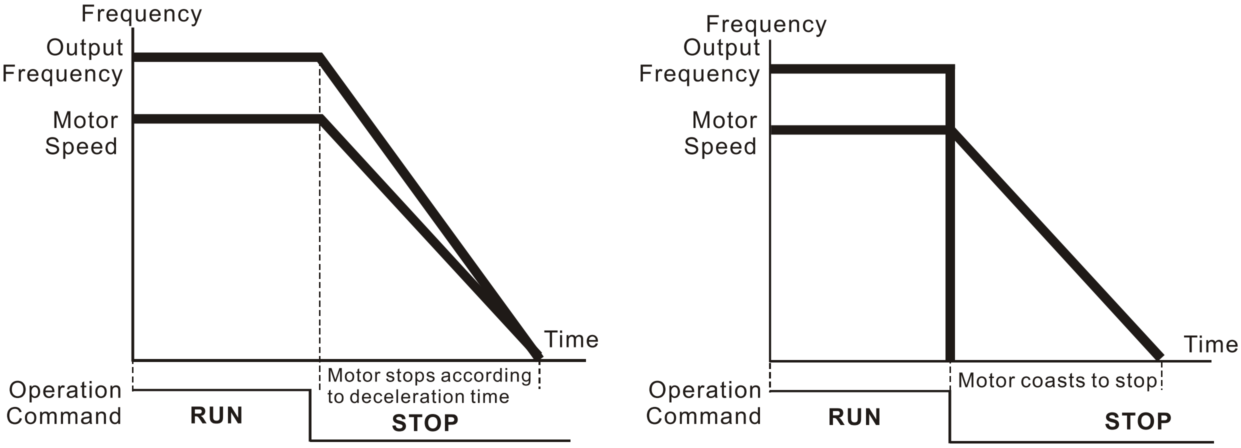
1: STOP: coast to stop; EF: coast to stop

2: STOP: ramp to stop; EF: ramp to stop

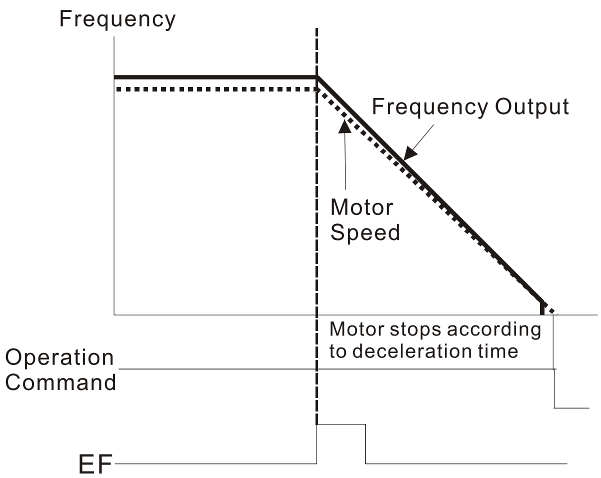
3: STOP: coast to stop; EF: ramp to stop

4: Simple positioning stop; EF: coast to stop

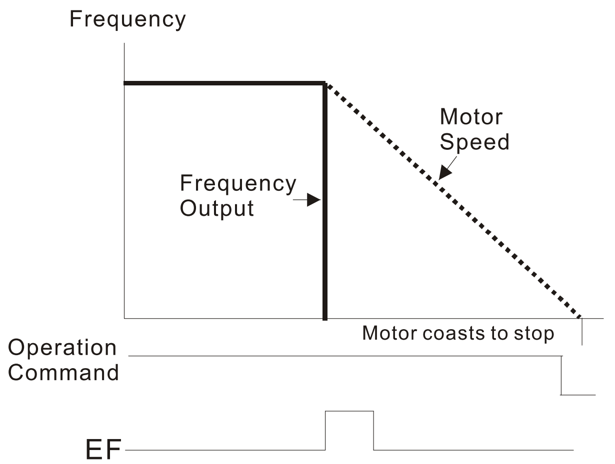
- Determines how the motor is stopped when the drive receives the Stop command.
- Ramp to stop: According to the set deceleration time, the AC motor drive decelerates to the Minimum Output Frequency (Pr.01.05), and then stops.
- Coast to stop: According to the load inertia, the AC motor drive stops output immediately, and the motor coasts to stop.
- The motor stop method is usually determined by the characteristics of the motor load and how frequently it is stopped.
- (1) Use “ramp to stop” for the safety of personnel or to prevent material from being wasted in applications where the motor must stop immediately after the drive stops. You must set the deceleration time accordingly.
- (2) If idling is allowed or the load inertia is large, use “coast to stop”.
- Example uses are blowers, punching machines, centrifuges and pumps.



Ramp to stop and Coast 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 Selection

Default:
8 (≤ 5.5 HP) / 4 (7.5 HP)

Settings 2–12 kHz

📖 Determines the PWM carrier frequency for the AC motor drive.

Carrier Frequency	Acoustic Noise	Electromagnetic Noise or Leakage Current	Heat Dissipation	Current Wave
2 kHz	Significant	Minimal	Minimal	
8 kHz				
12 kHz	Minimal	Significant	Significant	

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

02.04 Motor Direction Control

Default: 0

Settings 0: Enable forward/reverse
1: Disable reverse
2: Disable forward

📖 Prevents damage caused by misoperation of the motor FWD/REV directions.

02.05 Drive's Operation Control when Power is ON and RUN Command Source is Changed (External Terminals Only)

Default: 1

Settings 1: Does not run when power is ON, and remains current operation status when RUN command is changed.
3: Does not run when power is ON, and follows new RUN command when RUN command is changed.

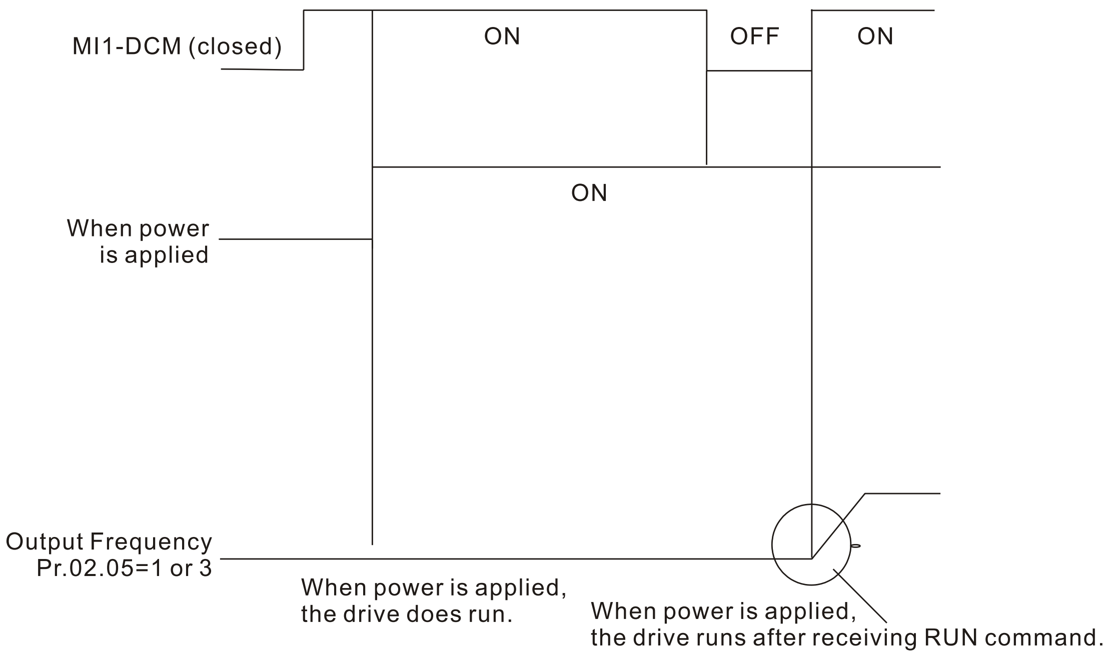
📖 As the table below shows, this parameter sets the drive operation status when power is ON or RUN command source (from external terminals only) is changed.

02.05 Settings	Power is ON	RUN Command Source is Changed
1	Drive does not run	Remains current operation status
3	Drive does not run	Operation status varies with the changed RUN command

This parameter sets whether the drive receives the RUN command when RUN command source is from external terminals, RUN command remains and drive power is ON. If Pr.02.05=1, the drive does not receive the RUN command. To make the motor run, disable the RUN command first, and enable it again.

📖 Power is ON:
When the RUN command source is from external terminals and RUN command is ON (MI1-DCM=closed), the drive runs according to Pr.02.05 settings after power is applied.

(1) If Pr.02.05=1 or 3, the drive does not run. Disable the RUN command first, and then enable it again to make the drive run.

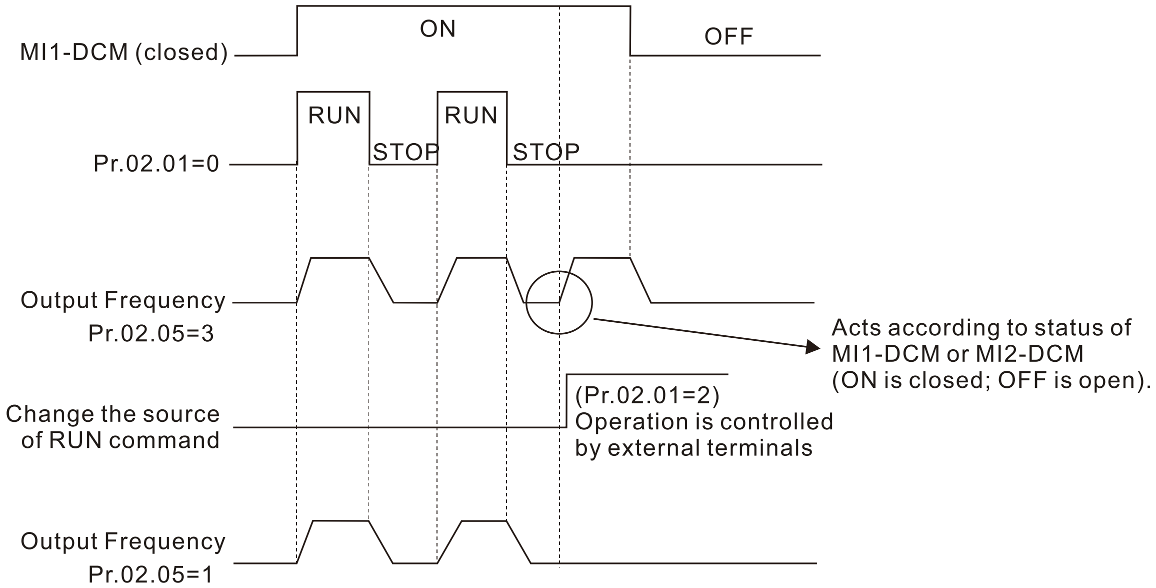


📖 RUN Command Source is Changed:

Regardless of whether the drive is in operation or at stop, when new RUN command source is from external terminal, and its terminal status (ON: RUN; OFF: STOP) is different from the current status of the drive, the drive's running status is determined by Pr.02.05 settings:

(1) If Pr.02.05=1, the drive's running status does not vary with external terminal status.

(2) If Pr.02.05=3, the drive runs or stops immediately in accordance with external terminal status.



📖 When Pr.02.05=1 or 3, it does not guarantee that the drive will never run under this condition. It is possible the drive may be set in motion by a mechanical vibration or malfunctioning switch. Pay extra attention when using this function.

02.06 Reserved

02.07 Reserved

02.08 Reserved

✎ 02.09 Second Master Frequency Command Source

Default: 3

Settings 3: RS-485 communication

4: Control by potentiometer on digital keypad

✎ 02.10 Combination of the First and Second Master Frequency Commands

Default: 0

Settings 0: First master frequency command only

1: First master frequency command + second master frequency command

2: First master frequency command – second master frequency command

02.11 Reserved

✎ 02.12 Communication Frequency Command

Default: 50.00

Settings 0.00–400.00 Hz

📖 Sets the frequency command or reads the communication frequency command.

02.13 Frequency Command Saving Selection

Default: 0

Settings 0: Saves the frequency before power is off
2: Only saves the communication frequency command before power is off

📖 Determines whether to save the frequency set by users before power is off.

02.14 Initial Frequency Command Mode at Stop

Default: 0

Settings 0: Use current Frequency command
1: Use zero Frequency command
2: Refer to Pr.02.15 to set up

📖 Determines whether to save the frequency set by users before power is off.

02.15 Initial Frequency Command Setting at Stop

Default: 60.00

Settings 0.00–400.00 Hz

📖 Pr.02.14 and Pr.02.15 are used to determine the initial frequency command at stop.
📖 Pr.02.14=0: The initial frequency at stop is the current frequency.
📖 Pr.02.14=1: The initial frequency at stop is 0.
📖 Pr.02.14=2: The initial frequency at stop is the Pr.02.05 setting.

02.16 Master Frequency Command Source Display

Default: Read only

Settings bit0=1: The Master Frequency Command Source is the First Master Frequency Source (Pr.02.00).
bt1=1: The Master Frequency Command Source is the Second Master Frequency Source (Pr.02.09).
bt2=1: The Master Frequency Command Source is the external multi-function input terminal

📖 Master frequency command source can only be read from this parameter.

02.17 Operation Command Source Display

Default: Read only

Settings bt1=1: Operation Command source is the RS-485 communication
bt2=1: Operation Command Source is the external terminal (MI1)
bt3=1: Operation Command Source is the external multi-function input terminals

📖 Operation command source can only be read from this parameter.

02.18 User-defined Value 2 Setting

Default: 0

Settings 0–Pr.00.13

📖 When Pr.00.13 is not set to 0 and frequency source is from communication, Pr.02.18 will be used to read/write to change the operation frequency.

02.19 User-defined Value 2

Default: Read only

Settings 0–9999

03 Output Function Parameters

⚡ You can set this parameter during operation.

03.00 Multi-function Output (MO1)

Default: 8

03.01 Multi-function Output (MO2)

Default:
VFD1: 26
VFD2: 6

📖 Summary of Function Settings

Settings	Functions	Descriptions
0	No function	Output terminal with no function
1	Indication during RUN	Activates when the drive outputs voltage or RUN command is given.
2	Indication of frequency reached	Activates when output frequency of the drive reaches to the setting frequency.
3	Zero speed	Activates when output frequency of the drive is lower than the minimum output frequency.
4	Over-torque detection	Activates when the drive detects over-torque. Pr.06.04 sets the over-torque detection level, and Pr.06.05 sets the over-torque detection time.
5	Base Block (B.B.) indication	Activates when external interruption (B.B.) occurs in the drive and stops outputting.
6	Low-voltage detection	Activates when the drive detects input voltage is too low.
7	Drive operation mode	Activates when the drive RUN command is controlled by external terminals.
8	Fault indication	Activates when the drive detects fault occurs. (oc, ov, ovA, ovd, ovn, oH1, oL, oL1, EF, cF3.0–5, HPF1,2,4, ocA, ocd, ocn).
9	Desired frequency reached	Activates when the desired frequency (Pr.03.02) is reached.
10	Terminal count value reached	Activates if the count value is equal to the setting value for Pr.03.05 when the drive executes external counter.
11	Preliminary count value reached	When the drive executes external counter, this contact activates if the count value is equal to the setting value for Pr.03.06.
12	Over-voltage stall prevention	Activates when over-voltage stall prevention is detected.
13	Over-current stall prevention	Activates when the over-current stall prevention is detected.
14	IGBT overheating warning (ON: 110°C; OFF: 105°C)	Activates when IGBT overheats to prevent the drive from shutting down due to overheating. ON: >110°C; OFF: <105°C.

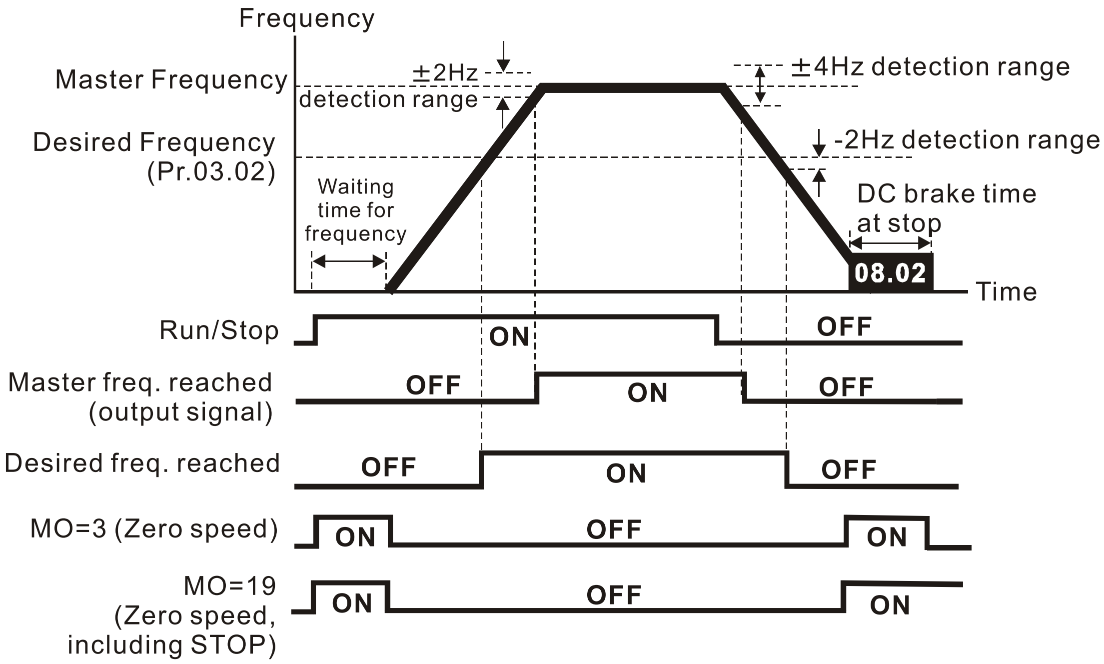
Settings	Functions	Descriptions
15	Over-voltage	Activates when DC bus over-voltage is detected.
16	Reserved	None
17	Forward running (FWD) command	Activates when the drive running direction is forward (FWD).
18	Reverse running (REV) command	Activates when the drive running direction is reverse (REV).
19	Zero speed (including STOP)	Activates when the drive is in standby or stop.
20	Warning indication	Activates when the drive detects warning occurs (CExx, AUE, FbE, SAvE).
21	Mechanical brake control	Activates when output frequency ≥ Pr.03.11 setting value. Deactivates when output frequency ≤ Pr.0312 setting value after STOP command.
22	Drive is ready	Activates when the drive is ready.
23	Reserved	None
24	Reserved	None
25	Reserved	None
26	Belt conveyor motor stall failure	Activates when belt conveyor motor stall occurs.

03.02 Desired Frequency Reached

Default: 0.0

Settings 0.00–400.00 Hz

📖 Once the output frequency reaches the desired frequency, if the corresponding multi-function output terminal is set to 9 (Pr.03.00 and Pr.03.01), this multi-function output terminal is “closed”.



Timing diagram of multi-function terminals and frequency reached

03.03	Reserved
03.04	Reserved
03.05	Terminal Count Value

Default: 0

Settings 0–9999

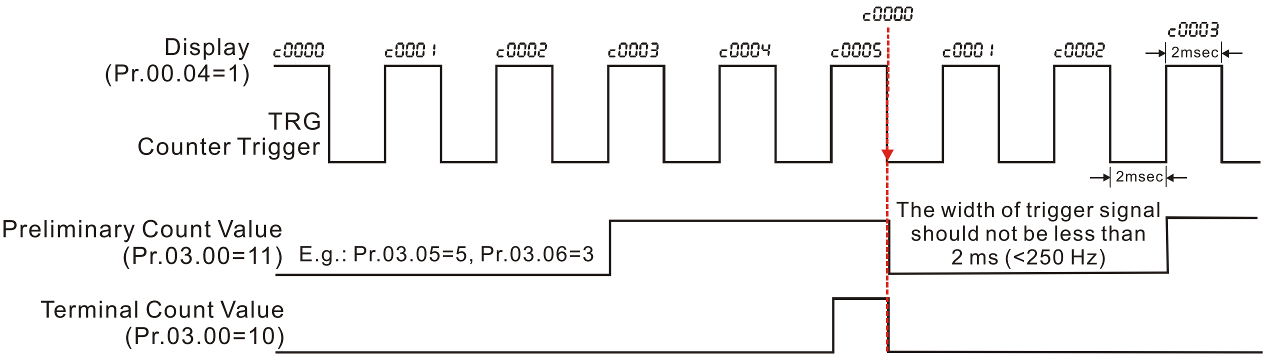
- Sets the count value of the LTC internal counter, which can be triggered by using the external multi-function input terminals on the control circuit. When the count reaches the setting value, the specified output terminal activates by setting one of the multi-function input terminals (the count value resets after reaching the setting for Pr.03.05).

03.06 Preliminary Count Value

Default: 0

Settings 0–9999

- When the count value counts from c1 to reach this value, the corresponding multi-function output terminal is activated (MO#11: Preliminary count value reached). You can use this parameter as the end of counting to make the drive run from the low speed to stop.
- The timing diagram shows as follows.



03.07 EF Activates when the Terminal Count Value Reached

Default: 0

Settings 0: Terminal count value reached, no EF displays
1: Terminal count value reached, EF is triggered

- When Pr.03.07=1, the drive stops and EF is triggered when the count value is reached until EF is reset.

03.08 Fan Cooling Control

Default: 0

Settings 0: Fan is always ON

1: Fan is OFF after the AC motor drive stops for one minute

2: Fan is ON when the AC motor drive runs; fan is OFF when the AC motor drive stops

3: Fan is ON after detecting heat sink temperature is reached (ON: 60°C; OFF: 40°C)

4: Fan is ON when the AC motor drive runs; fan is OFF when the AC motor drive stops. Fan is standby when at zero speed.

- Use this parameter to control the fan.
- Because fan is controlled by both belt conveyor motor and telescopic motor, fan will be ON when either fan of drives is ON, but can only be OFF when both fans of drives are OFF.

03.09 Reserved

03.10 Reserved

03.11 Mechanical Brake Release Frequency

Default: 0.00

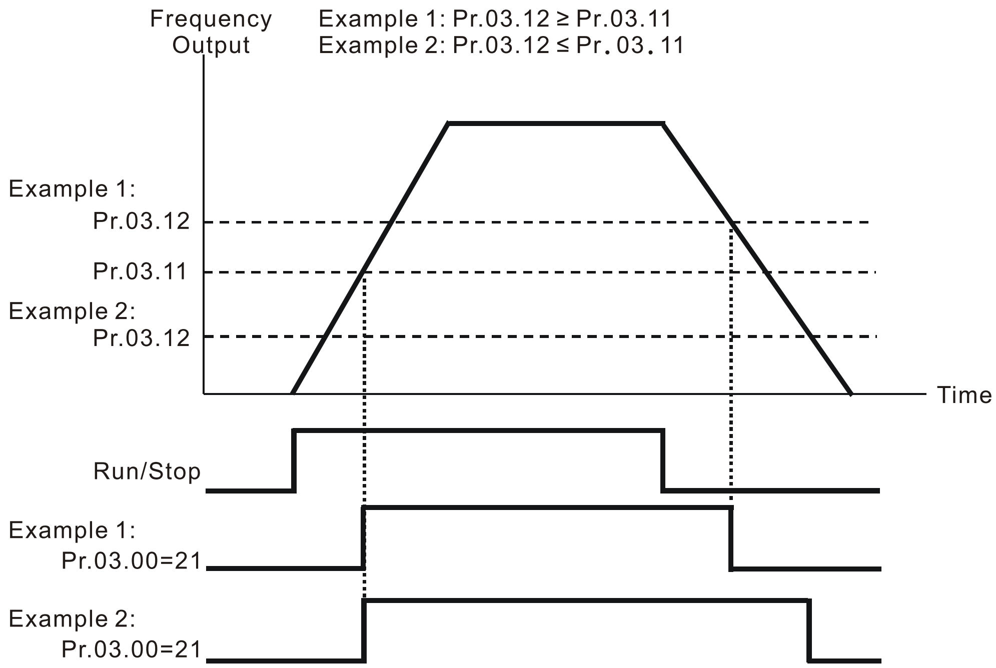
Settings 0.00–20.00 Hz

03.12 Mechanical Brake Engage Frequency

Default: 0.00

Settings 0.00–20.00 Hz

- These two parameters set control of the mechanical brake through the output terminals (Relay) by setting Pr.03.00 to 21.



- Pr.03.00 multi-function output terminal 21 (Mechanical Brake Control): When the output frequency reaches Pr.03.11 (Mechanical Brake Release Frequency), the multi-function output terminal is closed (ON). When the output frequency reaches Pr.03.12 (Mechanical Brake Engage Frequency), the multi-function output terminal is open (OFF).

03.13 Display the Status of Multi-function Output Terminal

Default: Read only

Settings Read only

The multi-function output terminals are falling-edge triggered. Thus if terminals are not activated, Pr.03.13 displays 3.

03.14 Reserved

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04 Input Function Parameters

✔ You can set this parameter during operation.

✔ 04.00 Keypad Potentiometer Bias

Default: 0.0

Settings 0.0–100.0%

✔ 04.01 Keypad Potentiometer Bias Polarity

Default: 0

Settings 0: Positive bias

1: Negative bias

✔ 04.02 Keypad Potentiometer Gain

Default: 100

Settings 0.1–200.0%

04.03 Keypad Potentiometer Negative Bias, Reverse Motion Enable/Disable

Default: 0

Settings 0: No negative bias command

1: Negative bias: REV motion enabled

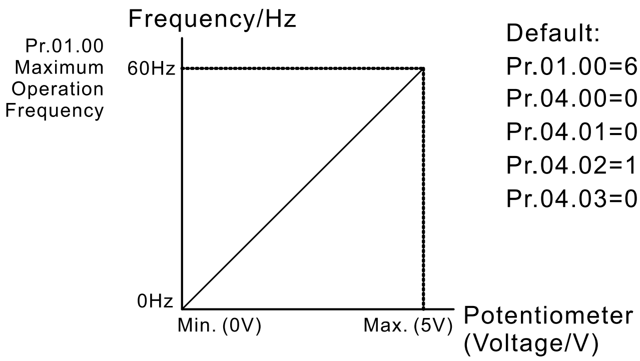
- Use Pr.04.00–Pr.04.03 for applications that use the potentiometer signal on the digital keypad to adjust the setting frequency. The potentiometer is not an external device, but you need to use it when setting parameters. Refer to the following examples to know how to use it.
- As shown in the left figure below, operating the potentiometer on the digital keypad to the leftmost means the minimum value that the lowest voltage 0 V_{DC} corresponds to. As shown in the right figure below, operating the potentiometer on the digital keypad to the rightmost means the maximum value that the highest voltage 5 V_{DC} corresponds to.

The minimum

The maximum

Example 1:

You set Pr.02.00 to 4 (the master frequency command comes from keypad potentiometer), set Pr.04.00–Pr.04.03 to defaults, and then you can set the main frequency command through the keypad potentiometer.

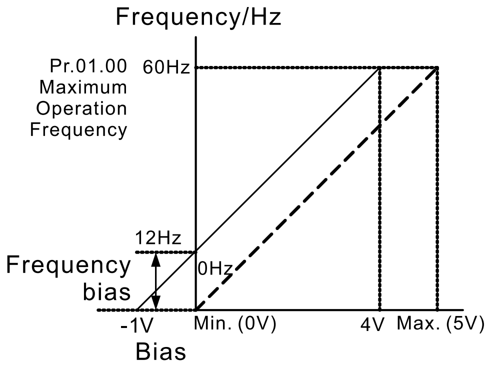


Default:

Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=0%	Bias adjustment
Pr.04.01=0	Bias direction adjustment
Pr.04.02=100%	Gain of frequency adjustment
Pr.04.03=0	No negative bias command

Example 2:

If you want the corresponded minimum value to be 12 Hz (the master frequency setting) when operating the keypad potentiometer to the leftmost, and then you can set other frequency settings as required. As can be seen from the diagram below, the correspondence between the keypad potentiometer (voltage) and setting frequency has been changed from 0–5 V (min.–max.) / 0–60 Hz to 0–4 V / 0–60 Hz. Therefore, the 4 V and above from the keypad potentiometer all correspond to 60 Hz. To use the full potentiometer range, refer to Example 3.



Default:

Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=20%	Bias adjustment
Pr.04.01=0	Bias direction adjustment
Pr.04.02=100%	Gain of frequency adjustment
Pr.04.03=0	No negative bias command

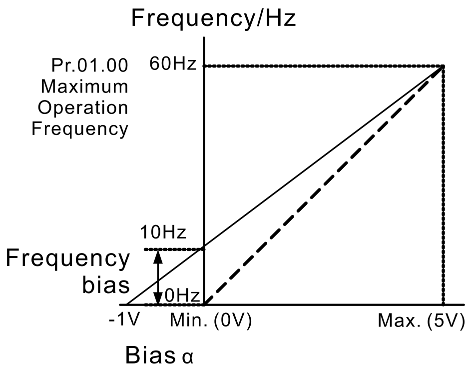
To count the bias (See α in the formula):

$$\frac{60\text{-}0\ \text{Hz}}{5\text{V}} = \frac{12\text{-}0\ \text{Hz}}{\alpha\text{V}} \rightarrow \alpha = 1\text{V}$$

$$\therefore\ \text{Pr.04.00} = \frac{1\text{V}}{5\text{V}} \times 100\% = 20\%$$

Example 3:

As shown in this example, the keypad potentiometer can be used for all ranges of 0–5 V / 0–60 Hz settings. This increases flexibility.



Default:

Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=20%	Bias adjustment
Pr.04.01=0	Bias direction adjustment
Pr.04.02=83.3%	Gain of frequency adjustment
Pr.04.03=0	No negative bias command

To count the bias (See α in the formula):

$$\frac{60\text{-}10\ \text{Hz}}{5\text{V}} = \frac{10\text{-}0\ \text{Hz}}{\alpha\ \text{V}} \rightarrow \alpha = 1\text{V}$$

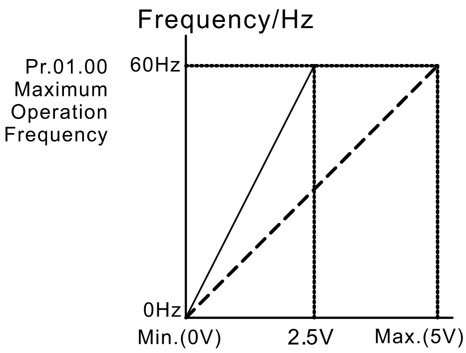
$$\therefore\ 04.00 = \frac{1\text{V}}{5\text{V}} \times 100\% = 20\%$$

To count the gain value:

$$\text{Pr.04.02} = \frac{5\text{V}}{[5\text{-}(\text{-}1)]\ \text{V}} \times 100\% = 83.3\%$$

Example 4:

This example shows how to use the first half range 0–2.5 V (min.–1/2 × max.) from the keypad potentiometer to set 0–60 Hz frequency settings. You can achieve the same results by either adjusting Pr.04.02 gain or setting Pr.01.00 to 120 Hz.



Default:

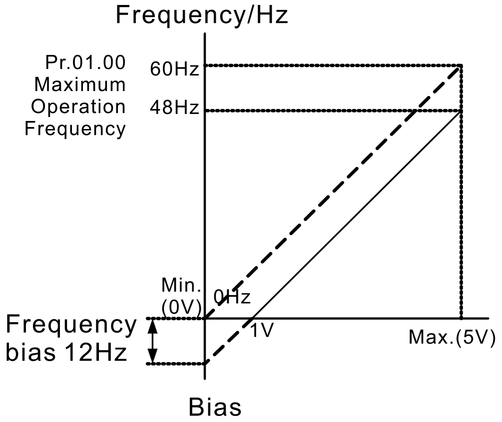
Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=0.0%	Bias adjustment
Pr.04.01=0	Bias direction adjustment
Pr.04.02=200%	Gain of frequency adjustment
Pr.04.03=0	No negative bias command

To count the gain value:

$$\text{Pr.04.02} = \frac{5\text{V}}{(5\text{-}2.5)\text{V}} \times 100\% = 200\%$$

Example 5:

This example is a typical negative bias application. Using negative bias to set the frequency greatly reduces the noise interference. In a noisy environment, do NOT use signals less than 1 V to set the drive's operation frequency.

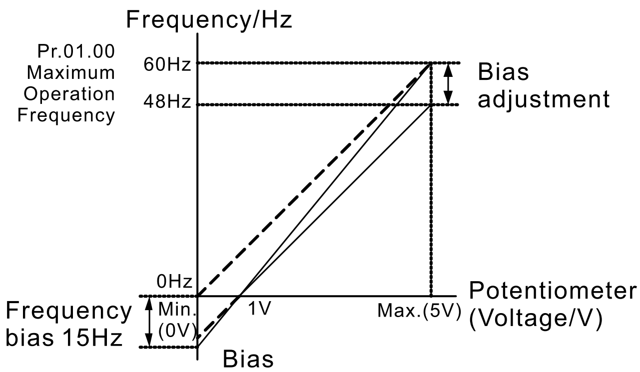


Default:

Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=20.0%	Bias adjustment
Pr.04.01=1	Bias direction adjustment
Pr.04.02=100%	Gain of frequency adjustment
Pr.04.03=0	No negative bias command

Example 6:

This example uses a negative bias to provide a noise margin. In additional, it uses a potentiometer frequency gain to reach the Maximum Output Frequency. This applies to a wide range of applications, and increases flexibility.



Default:

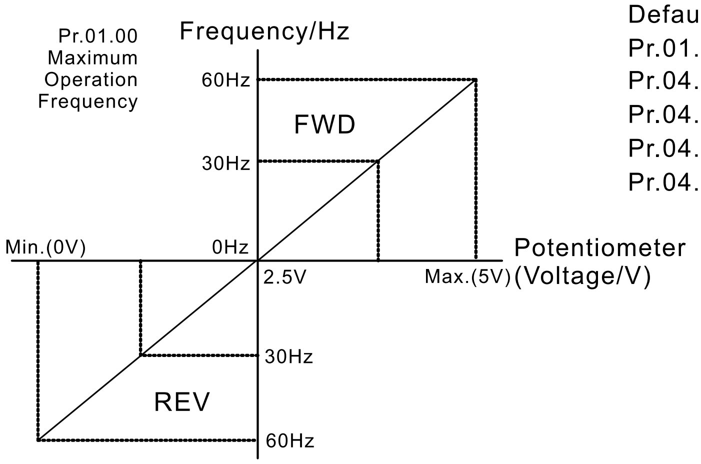
Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=20.0%	Bias adjustment
Pr.04.01=1	Bias direction adjustment
Pr.04.02=125%	Gain of frequency adjustment
Pr.04.03=0	No negative bias command

To count the gain value:

$$\text{Pr.04.02} = \frac{5V}{(5-1)V} \times 100\% = 125\%$$

Example 7:

This example uses potentiometer applications in all aspects, and its applications in forward and reverse control make it easy to combine with system for complex applications. Note that using the settings in this example disables the external FWD and REV controls.



Default:

Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=50.0%	Bias adjustment
Pr.04.01=1	Bias direction adjustment
Pr.04.02=200%	Gain of frequency adjustment
Pr.04.03=1	No negative bias command

To count the bias (See α in the formula):

$$\frac{60-(-60)\ \text{Hz}}{5V} = \frac{60-0\ \text{Hz}}{\alpha\ V} \rightarrow \alpha = 2.5V$$

$$\therefore\ \text{Pr.04.00} = \frac{2.5V}{5V} \times 100\% = 50\%$$

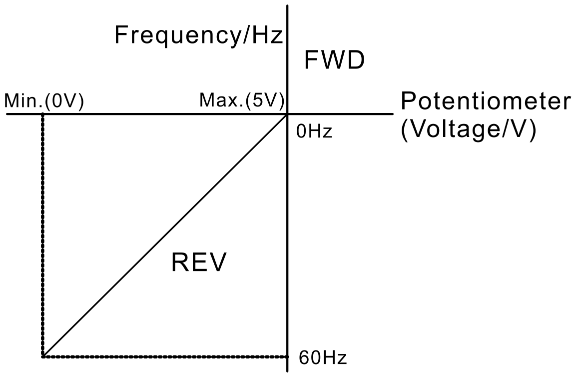
To count the gain value:

$$\text{Pr.04.02} = \frac{5V}{[5-(2.5)]V} \times 100\% = 200\%$$

Example 8:

This example uses negative slope.

With these settings, the AC motor drive always runs in only one direction (reverse).



Default:

Pr.01.00=60 Hz	Max. operation frequency
Pr.04.00=100%	Bias adjustment
Pr.04.01=1	Bias direction adjustment
Pr.04.02=100%	Gain of frequency adjustment
Pr.04.03=1	No negative bias command

04.04 MI Terminal Control Mode Selection (MI1, MI2, MI3)

Default: 0

Settings Mode 1 (Pr.04.19=0)

0: MI1 start-up (FWD) / stop

1: Reserved

2: Reserved

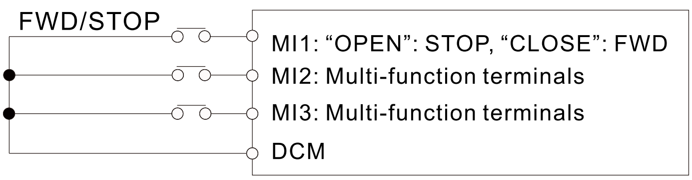
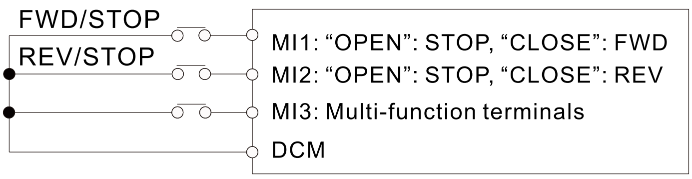
Mode 2 (Pr.04.19=1)

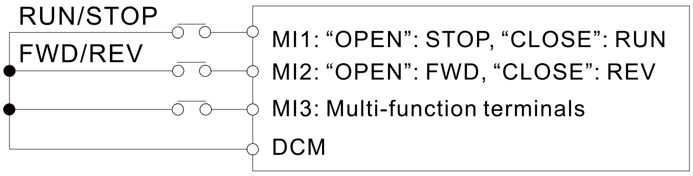
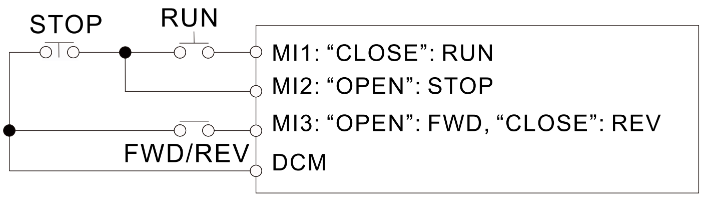
0: Two-wire operation control (1) MI1, MI2

1: Two-wire operation control (2) MI1, MI2

2: Three-wire operation control MI1, MI2, MI3

- **NOTE:** MI in the two VFDs of LTC has been pre-defined as two-wire operation control (1) in mode 2, so do NOT change the setting values in Pr.04.04 and Pr.04.19.
- Settings and functions of Pr.04.04 depend on Pr.04.19 settings.
- When Pr.04-19=0 in mode 1, MI1 is used to control start-up and stop, and MI2 to MI4 are used to set multi-function terminals.
- When Pr.04.19=1 in mode 2, MI1 and MI2 in two-wire operation control (1) \ two-wire operation control (2) are used to control start-up/stop and FWD/REV, MI3 and MI4 are used to set multi-function terminals; MI1 to MI3 in three-wire operation control are used to control start-up/stop and FWD/REV, MI4 is used to set multi-function terminal.

Pr.04.19 Settings	Pr.04.04 Settings	External Terminal Control Circuits
Mode 1 Pr.04.19=0	Pr.04.04=0 Single-wire FWD / STOP	
Mode 2 Pr.04.19=1	Pr.04.04=0 Two-wire operation control (1) FWD / STOP, REV / STOP	

Pr.04.19 Settings	Pr.04.04 Settings	External Terminal Control Circuits
	Pr.04.04=1 Two-wire operation control (2) RUN / STOP, REV / FWD	
	Pr.04.04=2 Three-wire operation control	

04.05 Reserved

04.06 Multi-function Input Command 1 (MI2)

Default: 1

04.07 Multi-function Input Command 2 (MI3)

Default: 14

04.08 Multi-function Input Command 3 (MI4)

Default: 5

Settings 0: No function

1: Reserved

2: Reserved

3: Reserved

4: Reserved

5: Fault reset

6: Acceleration / deceleration inhibit

7: 1st and 2nd acceleration / deceleration time selection

8: JOG command

9: B.B. inputs from external

10: Reserved

11: Reserved

12: Counter trigger

13: Clear the counter

14: External fault input

15: Reserved

16: Output stops

17: Parameter lock enabled

18: Operation command selection: external terminals

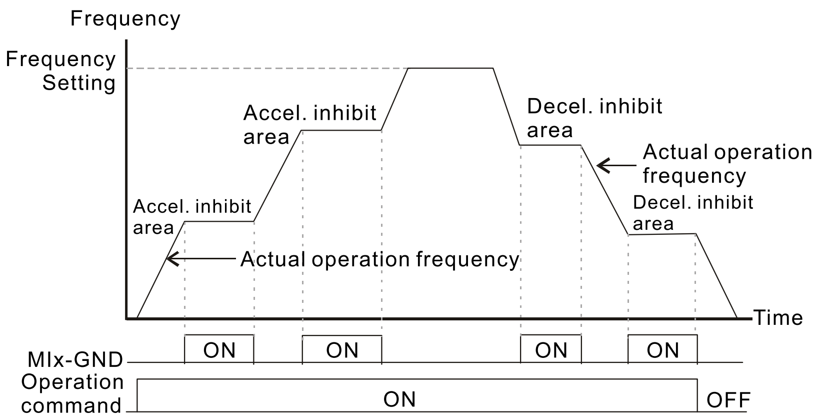
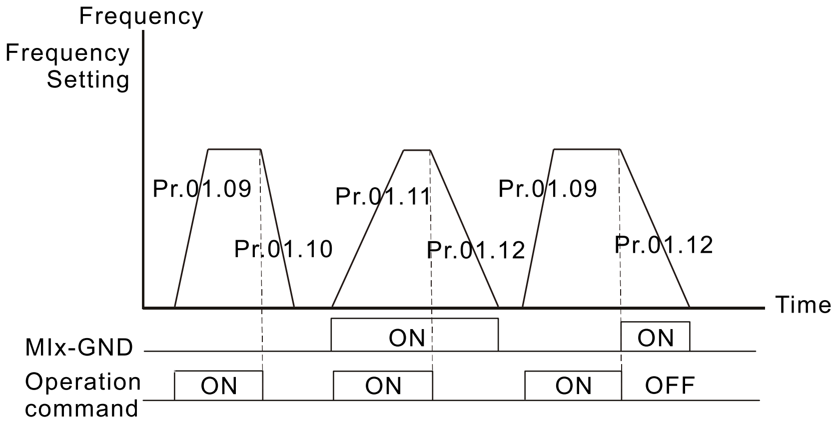
19: Reserved

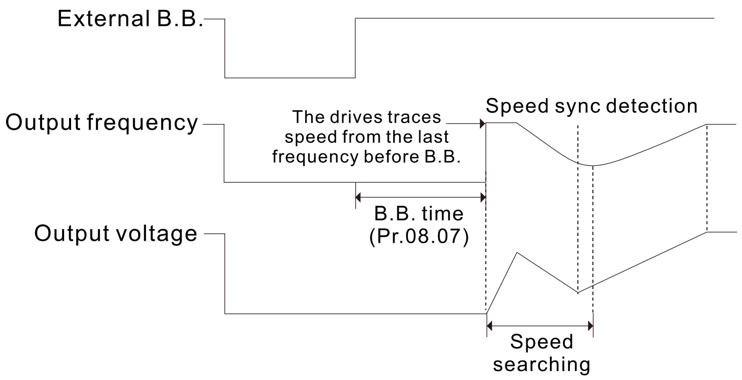
20: Operation command selection: communication

21: Forward / reverse running command

22: Second master frequency command source enabled
23: Simple positioning stop by forward limit
24: Simple positioning stop by reverse limit

📖 Summary of Function Settings

Settings	Functions	Descriptions
0	No function	Set terminals to have no function to ensure they have no effect on operations. Set any unused terminals to 0 to avoid errors caused by incorrect wiring or malfunction.
1	Reserved	None.
2	Reserved	
3	Reserved	
4	Reserved	
5	Fault reset	Use this terminal to reset the drive after drive faults are cleared.
6	Acceleration / deceleration inhibit	When this function is enabled, the drive stops acceleration or deceleration immediately. The drive resumes from the inhibit point once this function is disabled. 
7	1st and 2nd acceleration / deceleration time selection	You can select the acceleration and deceleration time of the drive with the digital status of the terminals; there are two acceleration and deceleration selections. 
8	JOG command	Executes the JOG operation only when the drive stops completely. While running, you can still change the operation direction, and the STOP key on the keypad is valid. Once the external terminal receives the OFF

Settings	Functions	Descriptions
		command, the motor stops in the JOG deceleration time. Refer to Pr.01.13–Pr.01.15 for details.
9	B.B. (Base Block) inputs from external	When the AC motor drive receives a Base Block signal, it blocks all output and the motor coasts. When Base Block control is deactivated, the AC drive starts speed tracking from the frequency before blocking and synchronizes with the motor speed. It then accelerates to the master frequency. Even if the motor has been completely stopped after blocking, the drive executes speed tracking immediately once Base Block control is deactivated. (**NOTE:** bb: Base Block) (See Pr.08.06–Pr.08.07 for details) 
10	Reserved	None
11	Reserved	
12	Counter trigger	Uses external signals such as connecting ON/OFF switch, lightening senor, etc., to trigger the counter. You can also use signals of the multi-function output terminal (counter reached, desired counter reached) to control the applications that based on the counter. For example: winding machine, packing machine. (See Pr.03.05 and Pr.03.06 for details.)
13	Clear the counter	ON: the current counter value is cleared and displays c0. The drive counts up when this function is disabled.
14	External Fault (EF) input	When the drive receives status change from the EF terminal, the drive stops output immediately, and EF is displayed on the keypad. The motor coasts. The drive does not run until the external fault is cleared after you press RESET on the keypad. (EF: External Fault)
15	Reserved	None
16	Output stops	This terminal is to stop output. AC motor drive stops output and the motor coasts to stop if one of these settings is enabled. If status of the terminal is changed, AC motor drive restarts from 0 Hz.
17	Parameter lock enabled	ON: all parameter data are read 0. OFF: all parameters can be read.

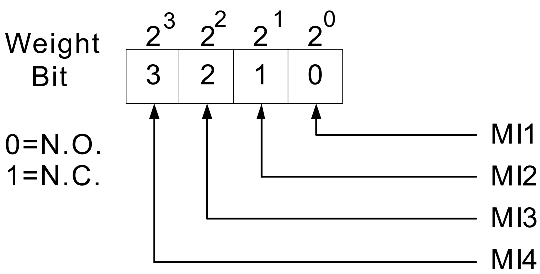
Settings	Functions	Descriptions
18	Operation command selection (Pr.02.01 setting / external terminals)	ON: operation command through external terminals; OFF: operation command through Pr.02.01 setting. (**NOTE:** When 18 and 20 are ON at the same time, the priority is settings 18 > setting 20.)
19	Reserved	None
20	Operation command selection (Pr.02.01 setting / communication)	ON: operation command through communication; OFF: operation command through Pr.02.01 setting. (**NOTE:** When 18 and 20 are ON at the same time, the priority is settings 18 > setting 20.)
21	Forward / reverse running command	Once this function is enabled, ON: reverse running / OFF: forward running, and up/down keys on the keypad cannot be used to change the running direction.
22	Second master frequency command source enabled	Pr.02.09 settings are valid only when this terminal is ON. Used to switch between first / second master frequency command and operation command source.
23	Simple positioning stop by forward limit	If a motor receives such signal while running forward, it stops running forward.
24	Simple positioning stop by reverse limit	If a motor receives such signal while running in reverse, it stops running in reverse.

04.09 Multi-function Input Contact Selection (N.O./N.C.)

Default: 0

Settings 0–15

- Sets the contact status of external multi-function input terminals MI2–MI4 to be normally open (N.O.) or normally closed (N.C.) according to the start-up / stop mode (Pr.04.19 and Pr.04.04).
- When the start-up/stop mode is single-wired (Pr.04.04=0, Pr.04.19=0), MI1 setting is invalid; when the start-up/stop mode is two-wired (Pr.04.04=0 or 1, Pr.04.19=1), MI2 setting is invalid; when the start-up/stop mode is three-wired (Pr.04.04=2, Pr.04.19=1), MI2 and MI3 settings are invalid. See the table below for details.

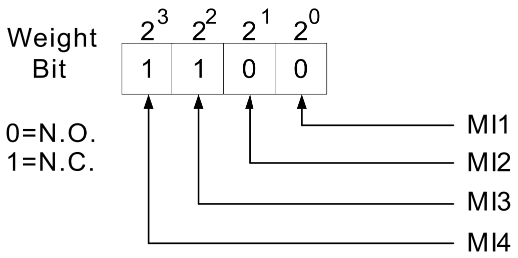


Start-up / Stop Mode			MI4	MI3	MI2	MI1	The Setting of the MI Terminals	
Mode	Pr.04.19	Pr.04.04	Bit 3	Bit 2	Bit 1	Bit 0	Multi-function Input Terminals	The Terminals Occupied by the Start-up / Stop Function
Single-wire	0	0	0/1	0/1	0/1	-	MI4, MI3, MI2 can be set as N.O. or N.C.	MI1 is only controlled by external terminals
Two-wire	1	0 or 1	0/1	0/1	-	-	MI4, MI3 can be set as N.O. or N.C.	MI1, MI2 are only controlled by external terminals
Three-wire	1	2	0/1	-	-	-	MI4 can be set as N.O. or N.C.	MI1, MI2, MI3 are only controlled by external terminals

Setting method:

Before setting this parameter, convert Bit3–Bit0 that represent the status of MI4–MI1 from binary to decimal.

For example: setting MI3 and MI4 to be 1 = N.C.; setting MI1 and MI2 to be 0 = N.O.. The setting value for Pr.04.09 should be 12.



Setting value

$= bit3 \times 2^3 + bit2 \times 2^2 + bit1 \times 2^1 + bit0 \times 2^0 = 8+4+0+0 = 12$

04.10 Digital Terminal Input Response Time

Default: 1

Settings 1–20 (*2 ms)

📖 This function is to delay and confirm the digital input terminal signal. 2 ms is one unit. The time for delay is also the time for confirmation. The confirmation prevents interference that could cause error in the input to the digital terminals. But in the meanwhile, it delays the response time though confirmation improves accuracy.

04.11 Reserved

04.12 Reserved

04.13 Reserved

04.14 Reserved

04.15 Reserved

04.16 Reserved

04.17 Reserved

04.18 Reserved

04.19 MI Terminal Control Mode Selection

Default: 1

Settings 0: Mode 1, single-wire start-up/stop

1: Mode 2, two-wire/three-wire start-up/stop

- **NOTE:** MI in the two VFDs of LTC has been pre-defined as two-wire operation control (1) in mode 2, so do NOT change the setting values in Pr.04.04 and Pr.04.19.
- Determines the MI terminal control modes.
- Mode 1: MI1 is the start-up/stop terminal; MI2 and MI3 are the multi-function input terminals.
- Mode 2: MI1, MI2 and MI3 support the two-wire / three-wire start-up.

04.20 Reserved

04.21 Reserved

04.22 Reserved

04.23 Reserved

04.24 Reserved

04.25 Reserved

04.26 Display the Status of Multi-function Input Terminal

Default: Read only

Settings See parameter descriptions below

- Displays 15 in Pr.04.26 when all the MI terminals are not active.

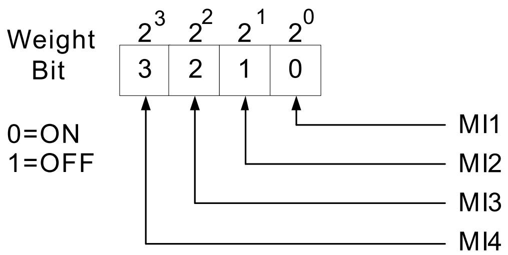
  When MI1 (corresponds to bit0) is triggered, and the weight is 1, Pr.04-26=14 (15-1).

  When MI2 (corresponds to bit1) is triggered, and the weight is 2, Pr.04-26=13 (15-2).

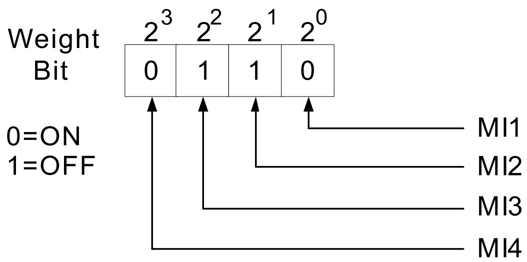
  When MI3 (corresponds to bit2) is triggered, and the weight is 4, Pr.04-26=11 (15-4).

  When MI4 (corresponds to bit3) is triggered, and the weight is 8, Pr.04-26=7 (15-8).

  If more than one MI terminals are triggered, use 15 minus the weight that corresponds to the MI terminal.



For example, if you set MI2 and MI3 to be active (ON), Pr.04.26 displays 9 (15-2-4=9, decimal).



Setting value

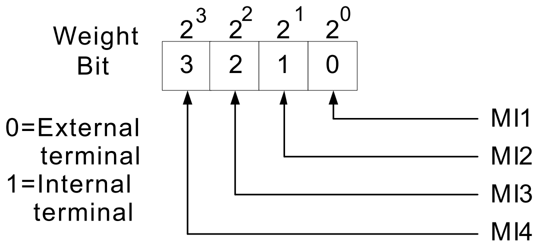
$= 15 - (bit3 \times 2^3 + bit2 \times 2^2 + bit1 \times 2^1 + bit0 \times 2^0) = 15 - (0+4+2+0) = 9$

04.27 Internal/External Multi-function Input Terminals Selection

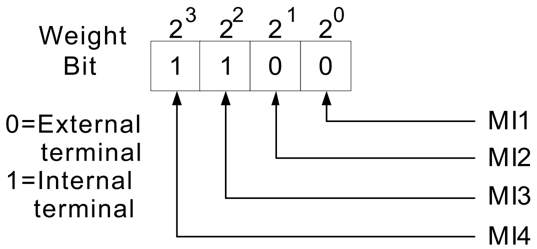
Default: 0

Settings 0–15

Selects the terminals MI1–MI4 to be either internal terminal or external terminal. You can activate internal terminals with Pr.04.28. A terminal cannot be both an internal terminal and an external terminal at the same time.



Setting method: Before setting this parameter, convert Bit3–Bit0 that represent the status of MI4–MI1 from binary to decimal. Set MI3 and MI4 as internal terminals; set MI1 and MI2 as external terminals. Pr.04-27 should be set to 12.



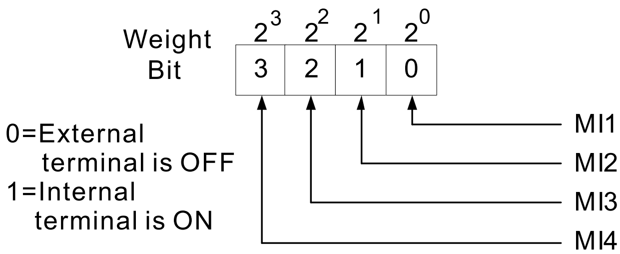
Setting value
$= bit3 \times 2^3 + bit2 \times 2^2 + bit1 \times 2^1 + bit0 \times 2^0 = 8+4+0+0 = 12$

04.28 Internal Multi-function Input Terminal Status

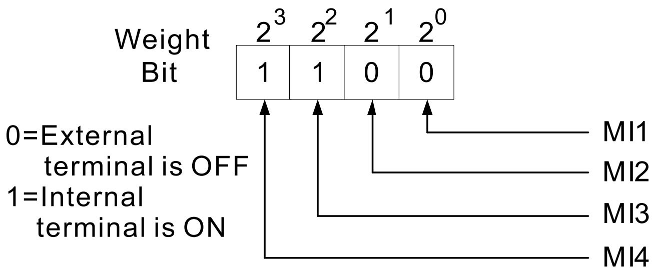
Default: 0

Settings 0–15

Sets the internal terminal action (ON/OFF) through the keypad or communication. And use this parameter with Pr.04.27.



Setting method: To activate MI3 and MI4, set Pr.04.28 to 12.



Setting value
$= bit3 \times 2^3 + bit2 \times 2^2 + bit1 \times 2^1 + bit0 \times 2^0 = 8+4+0+0 = 12$

04.29	Reserved
04.30	Reserved
04.31	Reserved
04.32	Reserved
04.33	Reserved
04.34	Reserved

05 Multi-step Speed Parameters

⌿ You can set this parameter during operation.

⌿ **05.00**	Reserved
⌿ **05.01**	Reserved
⌿ **05.02**	Reserved
⌿ **05.03**	Reserved
⌿ **05.04**	Reserved
⌿ **05.05**	Reserved
⌿ **05.06**	Reserved

Default: None

Settings None

📖 MI1 to MI4 in VFD1 and VFD2 of LTC was defined as MI1 (FWD/Stop), MI2 (REV/Stop), MI3 (Emergency Stop), and MI4 (Fault Rest), and cannot be used as multi-step speed.

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06 Protection Function Parameters

✓ You can set this parameter during operation.

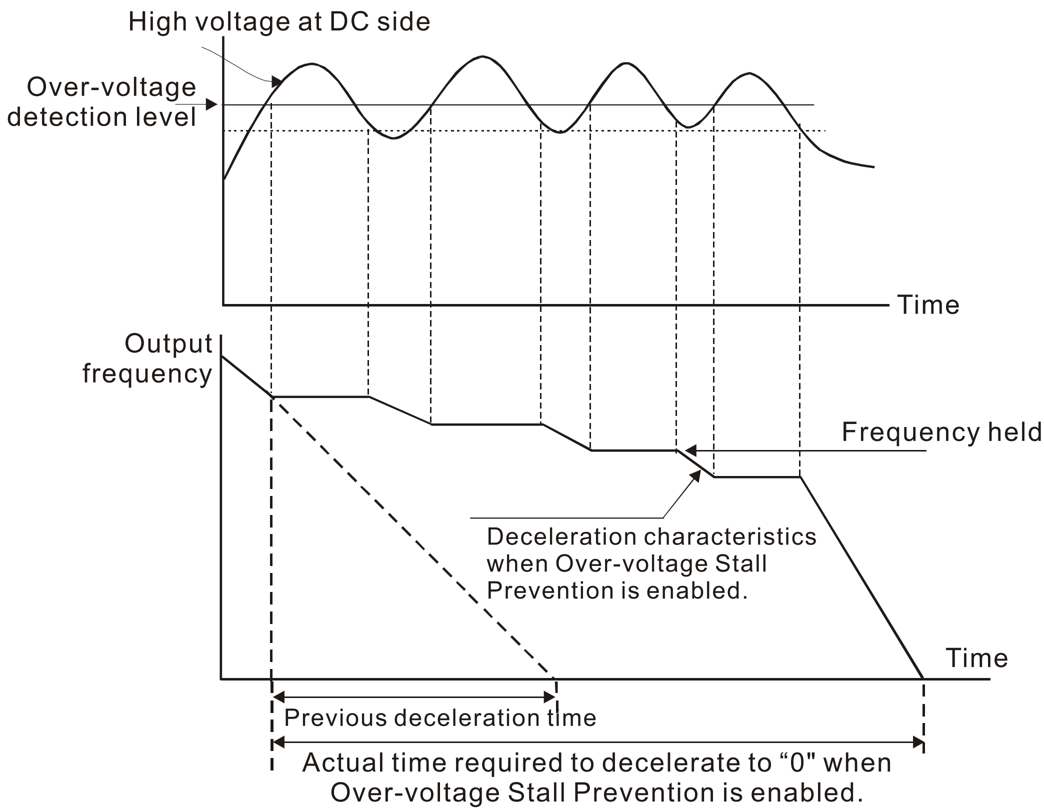
06.00 Over-voltage Stall Prevention

Default: 780 V

Settings 0: Disabled

660.0–820.0 V

- Setting Pr.06.00 to 0.0 disables the over-voltage stall prevention function (connected with braking unit or brake resistor).
- During deceleration, the DC bus voltage may exceed its maximum allowable value due to motor regeneration in some situations, such as motor's loading inertia being too high. When over-voltage stall prevention is enabled and the DC bus voltage detected is too high, the drive stops decelerating (output frequency remains unchanged) until the DC bus voltage drops below the setting value.
- Use this function when you are unsure about the load inertia. When stopping under normal load, the over-voltage does not occur during deceleration and meet the deceleration time setting. Sometimes it may not stop due to over-voltage during decelerating to STOP when the load regenerative inertia increases. In this case, the AC motor drive extends the deceleration time automatically until the drive stops. If you encounter any problem with the deceleration time, refer to the following guides for troubleshooting. 1. Increase the deceleration time.
  2. Install a brake resistor to dissipate the electrical energy that is regenerated from the motor.

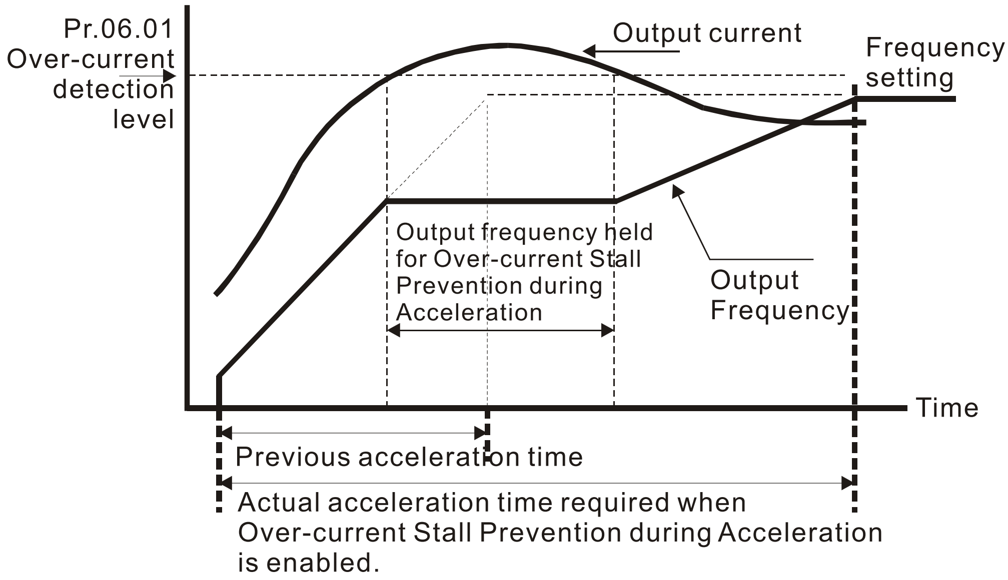


06.01 Over-current Stall Prevention during Acceleration

Default: 170

Settings 20–250% (0: Disabled)

During acceleration, the AC motor drive output current may increase abruptly and exceed the value specified in Pr.06.01 due to rapid acceleration or excessive load on the motor. When this function is enabled, the AC motor drive stops accelerating and keeps the output frequency constant until the current drops below this setting.

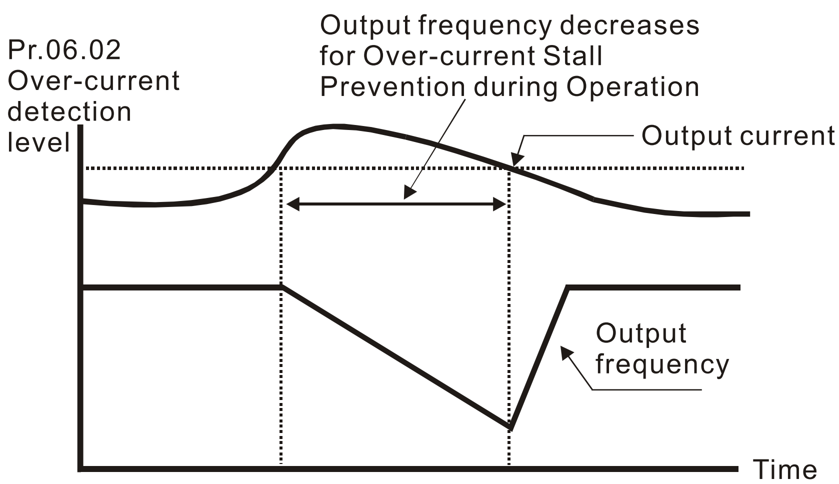


06.02 Over-current Stall Prevention during Operation

Default: 170

Settings 20–250% (0: Disabled)

If the output current exceeds the setting value for Pr.06.02 when the drive is operating, the drive decreases its output frequency to prevent the motor from stalling. If the output current is lower than the setting value for Pr.06.02, the drive accelerates again to the setting frequency.



06.03 Over-torque Detection Selection

Default: 0

Settings 0: No detection

1: Drive continues operation until OL1 or OL protection is triggered after over-torque is detected during constant speed operation

2: Drive stops and OL2 fault is triggered after over-torque is detected during constant speed operation

3: Drive continues operation until OL1 protection is triggered after over-torque is detected during acceleration and constant speed operation

4: Drive stops and OL2 fault is triggered after over-torque is detected during acceleration and constant speed operation

- Determines the operation of the drive after OL2 is triggered. Detection method: If the output current exceeds the Over-torque Detection Level (Pr.06.04) and the detection time is longer than the setting for Pr.06.05 (Over-torque Detection Time), the fault code "OL2" is displayed on the drive. If a multi-function output terminal is set to over-torque detection (Pr.03.00=4), the output is ON. Refer to Pr.03.00 for details.

✓ 06.04 Over-torque Detection Level

Default: 150

Settings 10–200%

- 100% corresponds to the rated current of the drive (Pr.00.01).

06.05 Over-torque Detection Time

Default: 0.1

Settings 0.1–60.0 sec.

- Sets the drive's treatments after over-torque detection criteria is defined and after over-torque is detected.
- Over-torque detection criteria: The output current exceeds the Over-torque Detection Level (Pr.06.04) and the detection time is longer than the setting for Pr.06.05 (Over-torque Detection Time). If a multi-function output terminal is set to over-torque detection (Pr.03.00=4) , the contact is ON (closed). Refer to Pr.03.00 for details.

06.06 Electronic Thermal Overload Relay Selection (OL1)

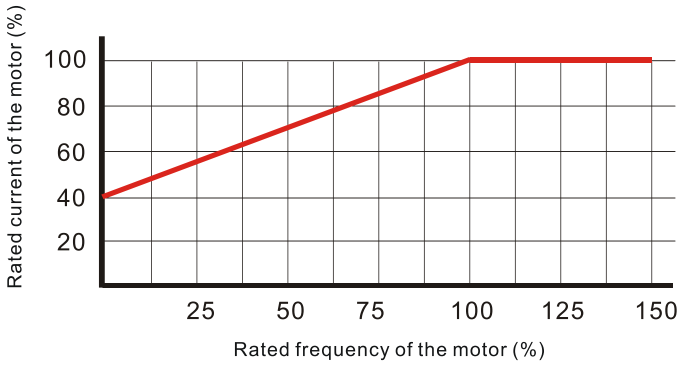
Default: 2

Settings 0: Standard motor (motor with the fan on the shaft)

1: Special motor (with external forced cooling)

2: Disabled

- Prevents self-cooled motor from overheating under low speed. Use an electronic thermal relay to avoid motor burnout due to overheating.



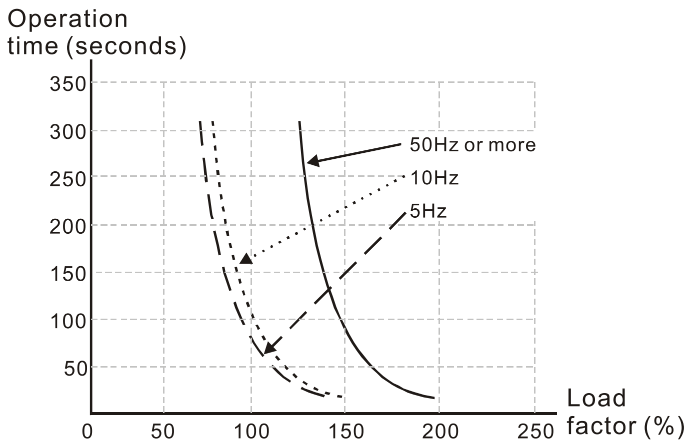
Standard motor
(self-cooled by fan)

06.07 Electronic Thermal Overload Relay Action Time

Default: 60

Settings 30–600 sec.

- Use this parameter to set the action time of the electronic thermal relay. It works based on the I^2t characteristic curve of electronic thermal relay, the output frequency and current of the drive, and the operation time to prevent the motor from overheating.



06.08 Fault Record 1 (The Most Recent)
06.09 Fault Record 2
06.10 Fault Record 3
06.11 Fault Record 4
06.12 Fault Record 5

Default: 0

Display 0–40

- Fault Record Descriptions

ID*	Fault Descriptions
0	No fault record
1	Over-current (oc)
2	Over-voltage (ov)
3	IGBT overheating (oH1)
4	Reserved

ID*	Fault Descriptions
5	Overload (oL)
6	Overload 1 (oL1)
7	Overload 2 (oL2)
8	External Fault (EF)
9	Over-current during acceleration (ocA)
10	Over-current during deceleration (ocd)
11	Over-current during steady operation (ocn)
12	Reserved
13	Reserved
14	Phase loss protection (PHL)
15	Reserved
16	Auto-acceleration/deceleration failure (cFA)
17	Software protection enabled (codE)
18	EEPROM write error (cF1.0)
19	EEPROM read error (cF2.0)
20	Hardware protection fault 1 (HPF1)
21	Hardware protection fault 2 (HPF2)
22	Reserved
23	Hardware protection fault 4 (HPF4)
24	Drive wiring detection fault (cF3.0)
25	Drive wiring detection fault (cF3.1)
26	Drive wiring detection fault (cF3.2)
27	Drive wiring detection fault (cF3.3)
28	Drive wiring detection fault (cF3.4)
29–36	Reserved
37	Multi-motor fault protection (oPHL)
38	IGBT temperature PTC OFF (tH1o)
39–40	Reserved
41	Belt conveyor drive (VFD1) stall failure (StAL)
42	Over-voltage at stop (ovS)
43	Over-voltage during acceleration (ovA)
44	Over-voltage during deceleration (ovd)
45	Over-voltage during constant speed (ovn)

⚡ 06.13 Motor Phase Loss Detection Time

Default: 0

Settings 0–60 sec.

⚡ 06.14 Current Detection for Motor Phase Loss

Default: 30

Settings 10–100%

📖 Use Pr.06.13 with Pr.06.14. When three-phase imbalance occurs among three-phase motors and the imbalance reaches Pr.06.14 setting percentage (the percentage is 100% equal to the AC motor drives rated current settings in Pr.00.01), and lasts the time set in Pr.06.13, fault code oPHL is triggered and the drive stops to prevent the motor from damage due to the three-phase unbalanced operation.

07 Motor Parameters

〆 You can set this parameter during operation.

〆 07.00 Motor Rated Current

Default: 100

Settings 23% FLA–120% FLA

- Sets this value according to the rated current of the motor as indicated on the motor nameplate. The factory settings are set according to the drive's rated current. The default is 100% of the drive's rated current (FLA).
- There is 0.1 error between the drive's actual setting value and minimum value.
- If drive's power is larger than motor's power, overload protection (OL2) should be enabled against the motor in case motor runs with its rated current in a long time. For motor over-torque protection parameters, set Pr.06.03 to Pr.06.05. Suggested settings are as follows.
- Set Pr.06.03 = 4 to enable overload protection against the motor during acceleration and constant speed operation
- Set Pr.06.04 = (motor rated current ÷ drive rated output current) × (100–150%)
- Set Pr.06.05 = 0.1–60.0 sec. (as required)

〆 07.01 Motor No-load Current

Default: 40

Settings 0% FLA–99% FLA

- Sets no-load current of the motor. This directly affects slip compensation.

〆 07.02 Torque Compensation

Default: 0

Settings 0.0–10.0

- Sets the AC motor drive to automatically increase voltages to get a higher torque when the AC motor drive is running.

〆 07.03 Slip Compensation Gain

Default: 0

Settings 0.0–10.0

- For an asynchronous motor, increasing the load on the AC motor drive causes slip to increase and results in decreased speed. Use this parameter to set the compensation frequency, and reduce the slip to maintain the synchronous speed when the motor runs at the rated current. When the drive output current is higher than motor no-load current (Pr.07.01), the drive compensates the frequency according to this parameter. If the actual speed ratio is slower than expected, increase the parameter setting value; otherwise, decrease the setting value.

07.04 Motor Parameter Auto-tuning

Default: 0

Settings 0: Disabled
1: Auto-tuning R1 (motor does not run)
2: Auto-tuning R1 + no-load current (motor runs)

- 1 and 2: Executes motor parameter auto-tuning once the drive receives RUN command. 1: Only the R1 value is automatically detected, and Pr.07.01 should be manually entered.

2: Unload the AC motor drive, and values for Pr.07.01 and Pr.07.05 will be automatically entered.

The steps for motor auto-tuning are:

1. Ensure that all the drive parameters are set to defaults and the motor wiring is correct.
2. Ensure that the motor is not loaded before executing auto-tuning and that the shaft is not connected to any belt or reducer.
3. Enter the correct values for Pr.01.01 Motor Rated Frequency, Pr.01.02 Motor Rated Voltage, Pr.07.00 Motor Rated Current, and Pr.07.06 Motor Rated Slip (Motor 0).
4. After you set Pr.07.04 to 2, the AC motor drive executes auto-tuning immediately after receiving a RUN command **(CAUTION: The motor will run! Avoid damage to the drive or personal injury caused by motor running.)**. The total auto-tuning time is 15 seconds = Pr.01.09 + Pr.01.10. (Higher-power drives need longer acceleration and deceleration time.)
5. After auto-tuning is finished, check if Pr.07.01 and Pr.07.05 all have values. If not, set Pr.07.04 again, and then press the RUN key on the keypad to repeat auto-tuning.
6. Finally, set Pr.00.10 to 1 and set other parameters according to your application requirements.

➢ Related parameters: Pr.01.01 Motor Rated Frequency, Pr.01.02 Motor Rated Voltage, Pr.07.00 Motor Rated Current, Pr.07.01 Motor No-load Current, Pr.07.05 Motor Line-to-line Resistance R1 (Motor 0), Pr.07.06 Motor Rated Slip (Motor 0)

NOTE:

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

07.05 Motor Line-to-line Resistance R1 (Motor 0)

Default: 0

Settings 0–65535 mΩ

📖 This parameter value is automatically set after motor auto-tuning process. You can also set this parameter without using motor parameter auto-tuning. This resistance value is the R value between phase and phase of the motor. Regardless of the motor wiring method, this resistance value is the measured value of any two motor leads.

07.06 Motor Rated Slip (Motor 0)

Default: 3

Settings 0.00–20.00 Hz

📖 Sets the rated slip of motor load. Enter the actual rated RPM from the motor nameplate.

📖 Refer to the rated RPM and the number of poles from the motor nameplate and use the following formula to calculate the rated slip:

Rated slip = F - (N × P ÷ 120)

F: Rated frequency (Hz)

N: Rated speed (RPM)

P: Number of poles in the motor (Pole)

- Assume that the rated frequency of the motor is 60 Hz with 4 poles, and the rated RPM is 1650. The rated slip calculated by the formula is 60 Hz - (1650 rpm × 4 ÷ 120) = 5 Hz.
- This parameter is related to Pr.07.03 Slip Compensation Gain. To get the best slip compensation effect, you must enter the correct settings for this parameter. Incorrect settings may cause invalid slip compensation and even damage the motor and the AC motor drive.
- Related parameter: Pr.07.03 Slip Compensation Gain

07.07 Slip Compensation Limit

Default: 200

Settings 0–250%

- Sets the upper limit of the compensation frequency (the percentage of Pr.07.06). If the motor speed is lower than the target speed and the speed does not change after adjusting the Pr.07.03 setting, the AC motor drive may have reached the upper limit of the compensation frequency. In this case, increase the Pr.07.07 setting, and then confirm again.
- Related parameters: Pr.07.03 Slip Compensation Gain, Pr.07.06 Motor Rated Slip (Motor 0)

07.08 Torque Compensation Low Pass Filter Time

Default: 0.1

Settings 0.01–10.00 sec.

- This function is usually applied in applications with heavy load where the motor current changes frequently for the current compensation to increase the output torque. The frequent current change can cause machine vibration. In this case, increase the Pr.07.08 setting to solve this problem.

07.09 Slip Compensation Low Pass Filter Time

Default: 0.2

Settings 0.05–10.00 sec.

- This function is usually applied in applications with heavy load where the motor speed changes frequently for the speed compensation to reach the synchronous speed. The frequent speed change can cause machine vibration. In this case, increase the Pr.07.09 setting to solve this problem.
- If you set Pr.07.08 and Pr.07.09 to 10 seconds, the compensation response time is the slowest; however, the system may be unstable if you set the time too short. It depends on actual conditions.

07.10 Accumulated Motor Operation Time

Default: 0

Settings 0: Disabled

00–1439 min.

07.11 Accumulated Motor Operation Time

Default: 0

Settings 00–65535 days

- Use Pr.07.10 and Pr.07.11 to record the motor operation time. To clear the operation time, set Pr.07.10 and Pr.07.11 to 0. An operation time shorter than 60 seconds is not recorded in Pr.07.10.

07.12	Reserved
07.13	Reserved
07.14	Reserved
07.15	Reserved
07.16	Reserved
07.17	Reserved

08 Special Parameters

✔ You can set this parameter during operation.

08.00 DC Brake Current Level

Default: 0

Settings 0–100%

- Sets the level of the DC brake current output to the motor at start-up and stop. When setting the DC brake current, the rated current of the drive is 100%. Therefore, when you set this parameter, increase the level slowly to reach the desired braking torque. But the maximum cannot be larger than rated current of the motor.

08.01 DC Brake Time At Start-up

Default: 0.0

Settings 0.0–60.0 sec.

- Determines the duration of the DC brake current output to the motor when the drive starts up.

08.02 DC Brake Time At STOP

Default: 0.0

Settings 0.0–60.0 sec.

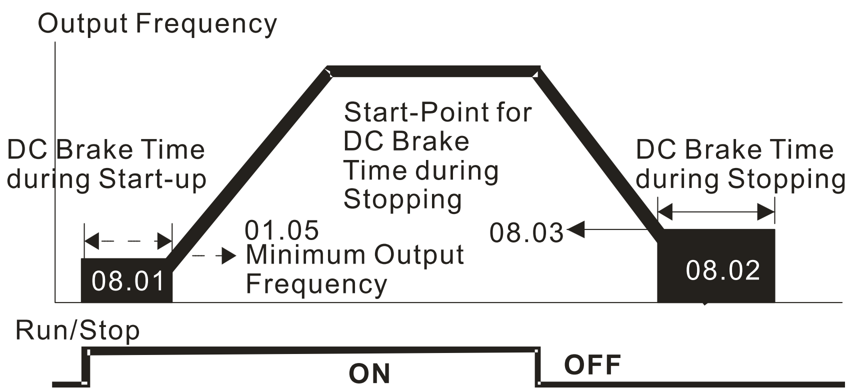
- Determines the duration of the DC brake current during stopping. To enable the DC brake when the drive stops, you must set Pr.02.02 (Motor Stop Method) to 0 and 2 (ramp to stop).

08.03 DC Brake Frequency at STOP

Default: 0.00

Settings 0.00–400.00 Hz

- Determines the starting frequency of the DC brake before the drive ramps to stop. When this setting is less than Pr.01.05 (Minimum Output Frequency), the starting frequency for the DC brake begins at the minimum frequency.



DC Brake Time

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

08.04 Restart after Momentary Power Loss

Default: 0

Settings 0: Operation stops after momentary power loss

1: Operation continues after momentary power loss, speed tracking starts with the last frequency.

2: Operation continues after momentary power loss, speed tracking starts with the minimum frequency.

📖 Determines the operation mode when the drive restarts from a momentary power loss.

08.05 Maximum Allowable Power Loss Time

Default: 2.0

Settings 0.1–20.0 sec.

📖 Determines the maximum time of allowable power loss. If the duration of a power loss exceeds this parameter setting, the AC motor drive stops output after the power recovers.

📖 Pr.08.04 is valid when the maximum allowable power loss time is ≤ 5 seconds and the AC motor drive displays Lu. If the AC motor drive is powered off due to overload, even if the maximum allowable power loss time is ≤ 5 seconds, Pr.08.04 is invalid after the power recovers.

08.06 Base Block Speed Tracking

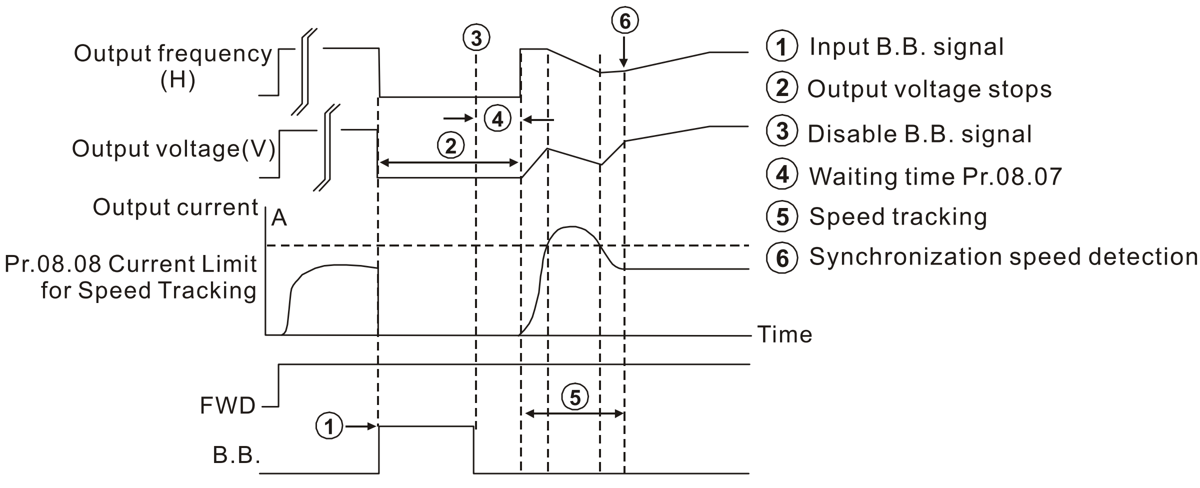
Default: 1

Settings 0: Disabled

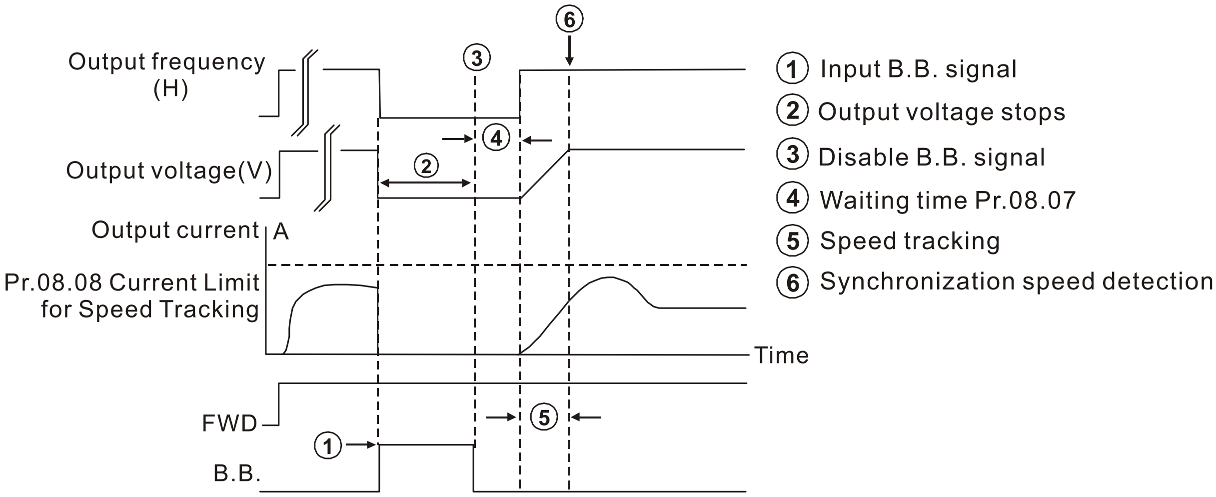
1: Speed tracking starts with the last frequency

2: Speed tracking starts with the minimum output frequency (Pr.01.05)

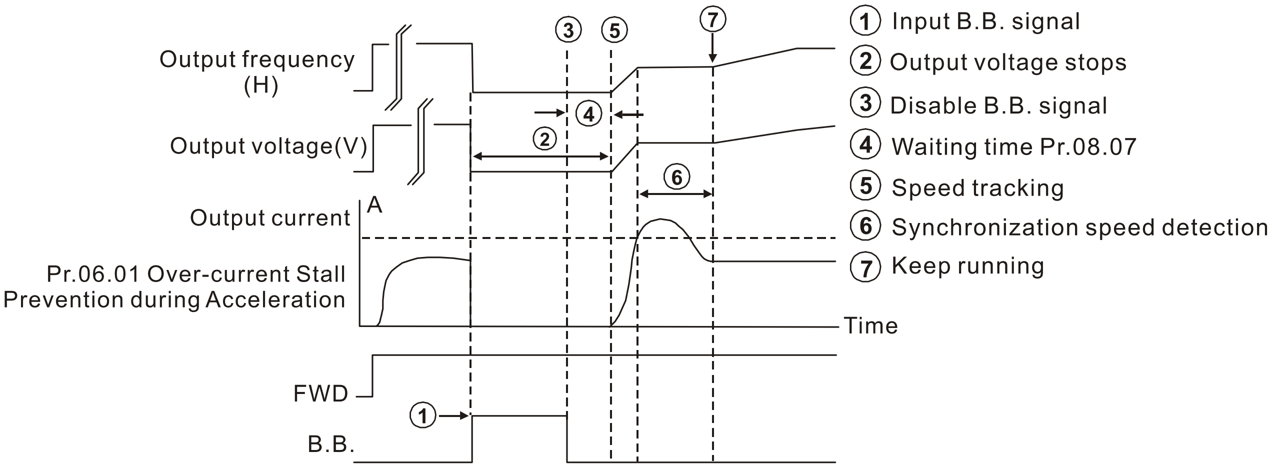
📖 Determines the AC motor drive restart method after an external base block is enabled.



B.B. Speed tracking with the last output frequency
(Speed tracking current reaches speed tracking level)



B.B. Speed tracking with the last output frequency
(Speed tracking current does not reach speed tracking level)



B.B. Speed tracking with the minimum output frequency

08.07 Base Block Time for Speed Tracking

Default: 0.5

Settings 0.1–5.0 sec.

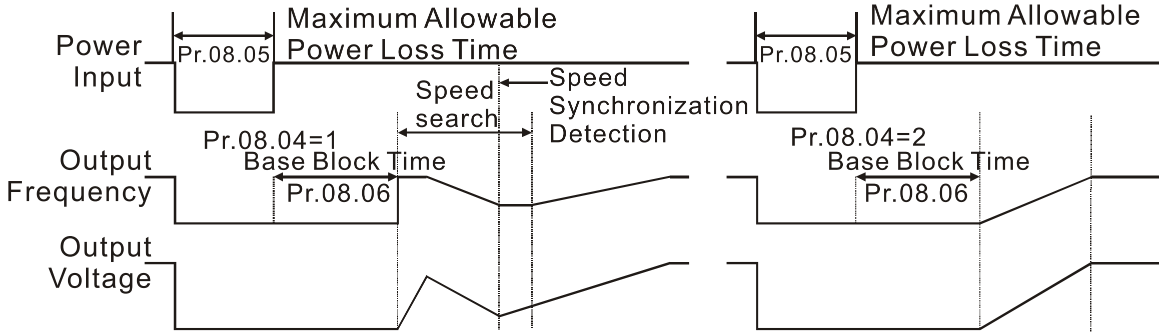
- When momentary power loss is detected, the AC motor drive blocks its output and then waits for a specified period of time (determined by Pr.08.07, called Base Block Time) before resuming operation. Set this parameter to the time that allows the residual voltage at the output side to decrease to 0V before activating the drive again.
- This parameter also determines the waiting time before resuming operation after an external base block and Number of Times of Restart after Fault (Pr.08.15).

08.08 Current Limit for Speed Tracking

Default: 150

Settings 30–200%

- Limits the drive output current during a speed tracking.
- When executing a speed tracking, the V/F curve is defined by the settings in Parameter Group 01.



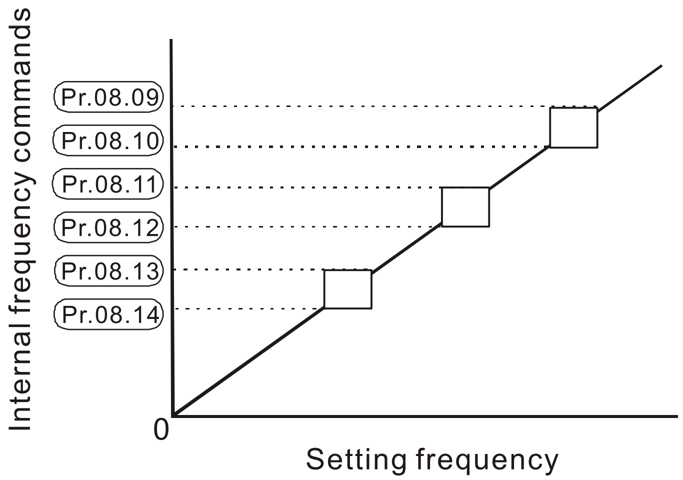
Timing Diagram of Restart after Momentary Power Loss

08.09	Skip Frequency 1 (Upper Limit)
08.10	Skip Frequency 1 (Lower Limit)
08.11	Skip Frequency 2 (Upper Limit)
08.12	Skip Frequency 2 (Lower Limit)
08.13	Skip Frequency 3 (Upper Limit)
08.14	Skip Frequency 3 (Lower Limit)

Default: 0.00

Settings 0.00–400.0 Hz

- Sets the AC motor drives skip frequency. The drives frequency setting skips these frequency ranges. However, the frequency output is continuous. Set these six parameters as follows Pr.08.09 ≥ Pr.08.10 ≥ Pr.08.11 ≥ Pr.08.12 ≥ Pr.08.13 ≥ Pr.08.14.



08.15 Number of Times of Restart after Fault

Default: 0

Settings 0–10

08.16 Auto-restart Interval of Fault

Default: 60

Settings 0.1–6000 sec.

- Sets the times that the AC motor drive can reset and restart automatically after fault (allowed fault: oc, ov) is triggered.
- If Pr.08.15 is set to 0, the drive does not reset or restart automatically after faults are triggered. The drive starts speed tracking with the last frequency after restarting after fault.

📖 Use this parameter with Pr.08.15. For example, when Pr.08.15=10 and Pr.08.16=600 seconds (10 minutes), the number of times of restart after fault will be automatically reset to 10 if no more fault occurs over 600 seconds since restart from previous fault.

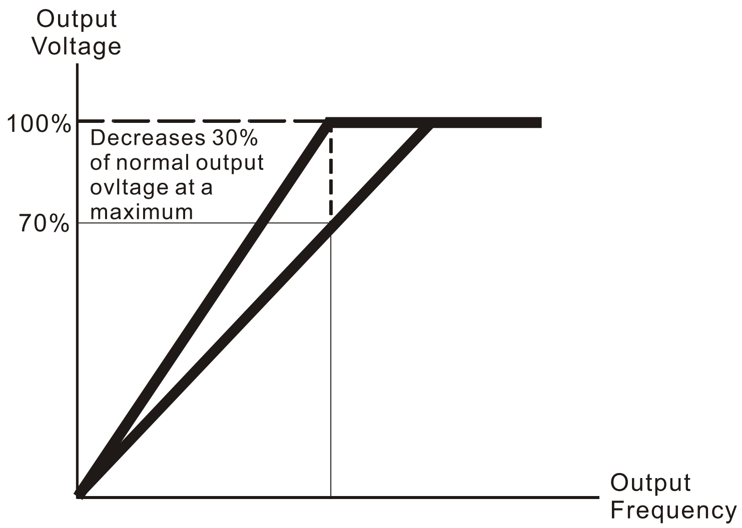
08.17 Automatic Energy-saving

Default: 0

Settings 0: Automatic energy-saving operation is disabled

1: Automatic energy-saving operation is enabled

📖 When energy-saving is enabled, the motor acceleration/deceleration operates with full voltage. During constant speed operation, it automatically calculates the best voltage value according to the load power. This function is not suitable for fluctuating loads or loads which are nearly full during operation.



08.18 Automatic Voltage Regulation (AVR)

Default: 0

Settings 0: AVR function is enabled

1: AVR function is disabled

2: AVR function is disabled during deceleration

3: AVR function is disabled at stop

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

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

📖 When the motor ramps to stop, disabling the AVR function would shorten the deceleration time. Moreover, using with the auto-acceleration and auto-deceleration functions makes the motor's deceleration quicker.

	08.19	Reserved
⚡	**08.20**	Vibration Suppression

Default: 0

Settings 0.0–5.0

📖 The drift current occurs in a specific frequency area of the motor and it causes serious motor vibration. It is recommended to use this parameter (the recommended value is 2.0) to greatly improve this situation. (The drift current zone for high-power motors is usually in the low frequency area.)

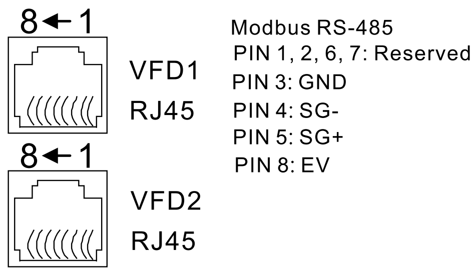
08.21	Reserved
08.22	Reserved
08.23	Reserved
08.24	Reserved
08.25	Reserved

09 Communication Parameters

〆 You can set this parameter during operation.

VFD1 and VFD2 RJ45 ports:

1. To connect to PC, use Delta IFD6500 as a communication converter (from RS-485 to USB).
2. To connect to panel, use digital keypad PU08 or PU08V.
3. PIN 8: EV (power Vcc port). Used as power and works only with optional digital keypad PU08 or PU08V.



〆 09.00 Communication Address

Default: 1

Settings 1–254

📖 Sets the communication address for the drive if the AC motor drive is controlled through RS-485 serial communication. The communication address for each AC motor drive must be unique.

〆 09.01 Transmission Speed

Default: 2

Settings 0: Baud rate 4800 bps
1: Baud rate 9600 bps
2: Baud rate 19200 bps

📖 Sets the transmission speed between the computer and the AC motor drive.

〆 09.02 Transmission Fault Treatment

Default: 3

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

📖 Determines how the AC motor drive reacts if a transmission fault occurs.

〆 09.03 Communication Time-out Detection

Default: 0

Settings 0.1–120.0 sec.
0.0: No function

📖 Sets detection time of communication time-out for serial communications. If Pr.09.03 is not equal to 0.0, and Pr.09.02=0–2, and there is no communication on the bus during the timeout detection period (set by Pr.09.03), the digital keypad displays “cE10”.

09.04 Communication Protocol

Default: 3

Settings
0: 7, N, 2 for ASCII
1: 7, E, 1 for ASCII
2: 7, O, 1 for ASCII
3: 8, N, 2 for RTU
4: 8, E, 1 for RTU
5: 8, O, 1 for RTU
6: 8, N, 1 for RTU
7: 8, E, 2 for RTU
8: 8, O, 2 for RTU
9: 7, N, 1 for ASCII
10: 7, E, 2 for ASCII
11: 7, O, 2 for ASCII

- Control by PC (Computer Link): When using the RS-485 serial communication interface, each drive's communication address must be specified in Pr.09.00. The computer then implements control using the drives' individual addresses.
- LTC series drive uses Modbus network protocol. You can set a LTC drive to communicate over Modbus networks using one of the following modes: ASCII (American Standard Code for Information Interchange) or RTU (Remote Terminal Unit). Data transmitted using ASCII mode must be converted to ASCII code first before transmission; data transmitted using RTU mode can transfer directly without converting. See below for code descriptions for ASCII mode.
- 1. Code Description

The CPU delays about 1 second when using the communication reset; therefore, there is at least 1 second delay time in the master station.

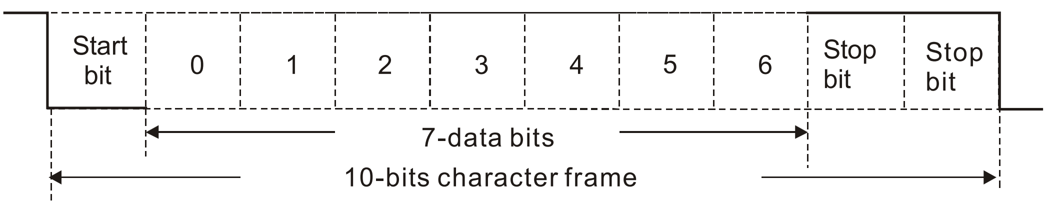
Each data byte is the combination of two ASCII characters. For example, a 1-byte of data: 64 Hex, is shown as '64' in ASCII, and consists of '6' (36Hex) and '4' (34Hex). The communication protocol is in hexadecimal, ASCII: "0"…"9", "A"…"F", every hexadecimal value represents an ASCII code. The table below shows some example.

Character	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'
ASCII code	30H	31H	32H	33H	34H	35H	36H	37H
Character	'8'	'9'	'A'	'B'	'C'	'D'	'E'	'F'
ASCII code	38H	39H	41H	42H	43H	44H	45H	46H

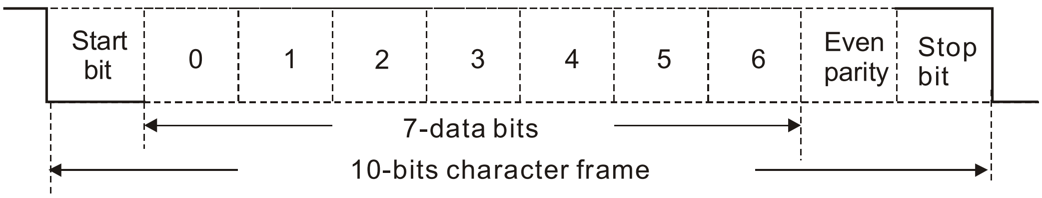
2. Data Format

For ASCII

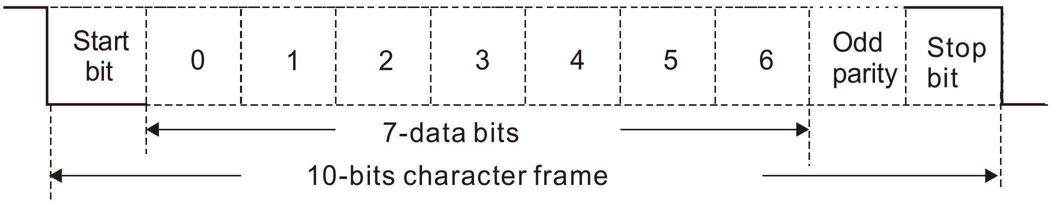
(Format: 7, N, 2)



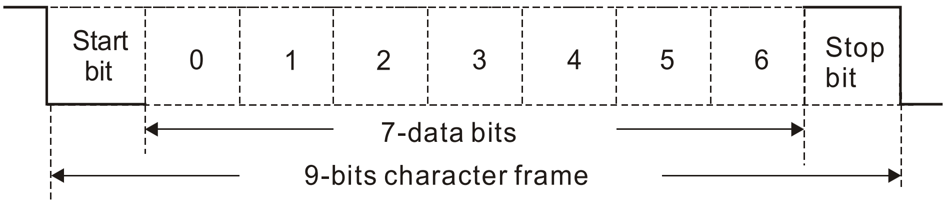
(Format: 7, E, 1)



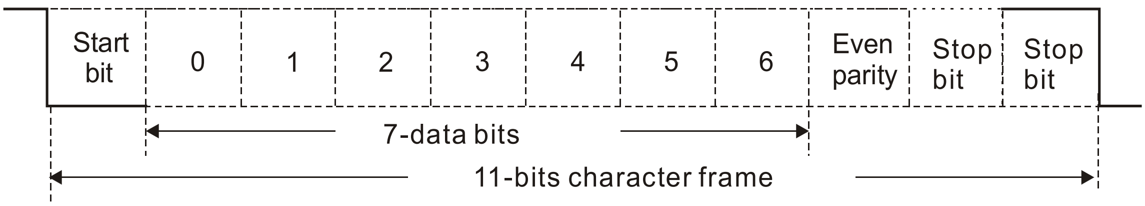
(Format: 7, O, 1)



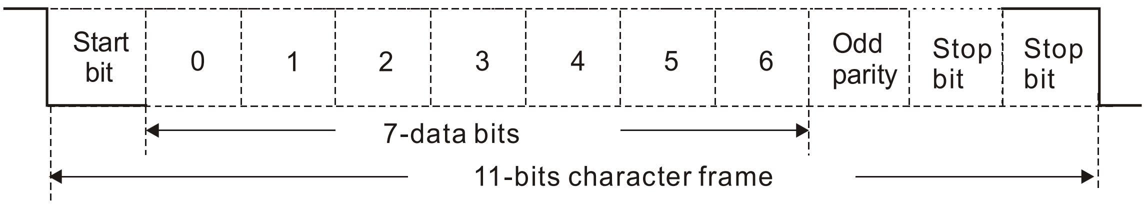
(Format: 7, N, 1)



(Format: 7, E, 2)

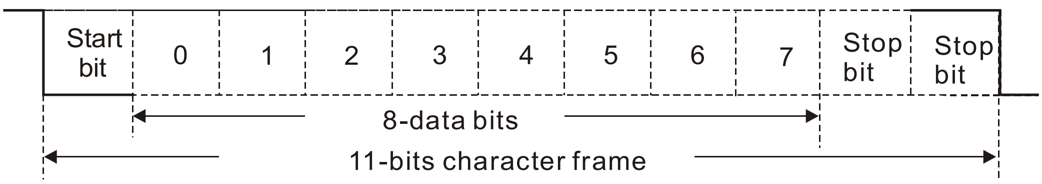


(Format: 7, O, 2)

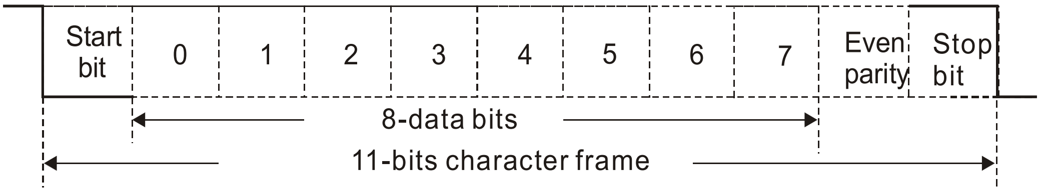


For RTU

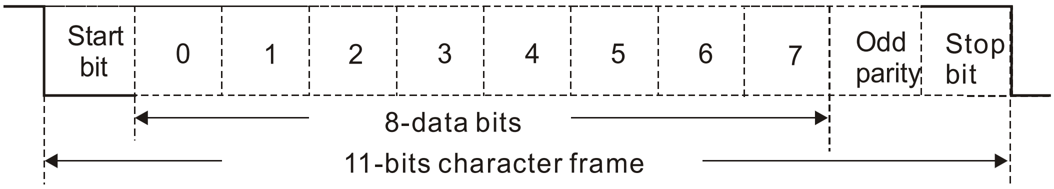
(Format: 8, N, 2)



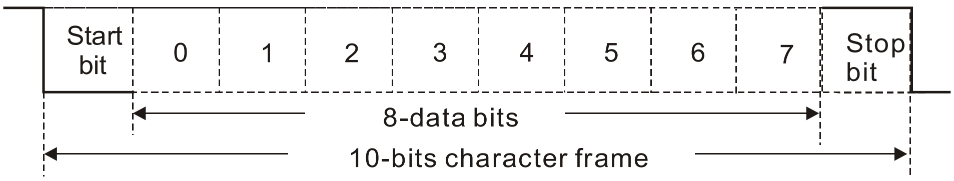
(Format: 8, E, 1)



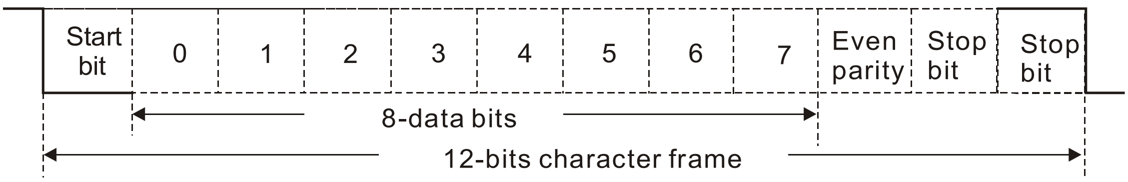
(Format: 8, O, 1)



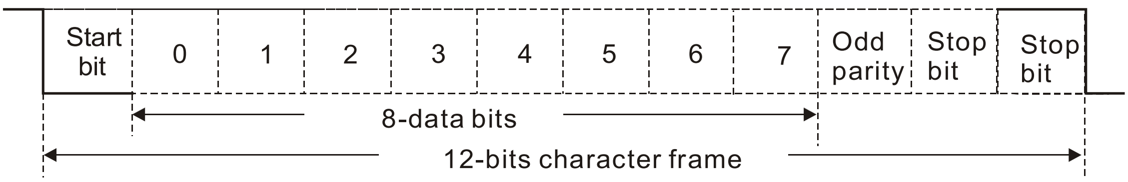
(Format: 8, N, 1)



(Format: 8, E, 2)



(Format: 8, O, 2)



3. Communication Protocol

3.1 Communication Data Frame

ASCII mode:

STX	Start character = ‘ : ’ (3AH)
Address High	Communication address:
Address Low	one 8-bit address consists of 2 ASCII codes
Function High	Command code:
Function Low	one 8-bit command consists of 2 ASCII codes
DATA (n-1)	Contents of data:
to	n × 8-bit data consists of 2n ASCII codes
DATA 0	n ≤ 20, maximum of 40 ASCII codes (20 sets of data)
LRC Check High	LRC checksum:
LRC Check Low	one 8-bit checksum consists of 2 ASCII codes
END High	End characters:
END Low	END High = CR (0DH), END Low = LF (0AH)

RTU mode:

START	Defined by a silent interval of larger than / equal to 10 ms
Address	Communication address: 8-bit binary address
Function	Command code: 8-bit binary command
DATA (n-1)	Contents of data:
to	n × 8-bit data, n ≤ 40 (20 sets of 16-bit data)
DATA 0	
CRC Check Low	CRC checksum:
CRC Check High	one 16-bit CRC checksum consists of 2 8-bit binary characters
END	Defined by a silent interval of larger than / equal to 10 ms

3.2 Communication Address (Address)

00H: broadcast to all AC motor drives

01H: AC motor drive of address 01

0FH: AC motor drive of address 15

10H: AC motor drive of address 16 . . . . . . FEH: AC motor drive of address 254

3.3 Function (Function Code) and DATA (Data Characters)

03H: read data from a register

06H: single write, write single data to a register

08H: Loop detection

(1) 03H: read data from a register (can read at most 20 sets of data simultaneously)

Example: Reading two continuous data from register address 2102H, AMD address is 01H.

ASCII mode:

Command Message

STX	':'
Address	'0'
	'1'
Function	'0'
	'3'
Starting 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 Check Low	6FH
CRC Check High	F7H

Response Message

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

(2) 06H: single write, write single data to a register (can write at most 20 sets of data simultaneously)

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'

Response Message

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

	'0'		'0'
Data content	'1'	Data content	'1'
	'7'		'7'
	'7'		'7'
	'0'		'0'
LRC Check	'7'	LRC Check	'7'
	'1'		'1'
END	CR	END	CR
	LF		LF

RTU mode:

Command Message / Response Message

Command Message		Response Message	
ADR	01H	ADR	01H
CMD	08H	CMD	08H
Data	00H	Data	00H
	00H		00H
Data	17H	Data	17H
	70H		70H
CRC Check Low	8EH	CRC Check Low	8EH
CRC Check High	0EH	CRC Check High	0EH

3.4 Checksum

ASCII mode (LRC Check):

LRC (Longitudinal Redundancy Check) is calculated by summing up the values of the bytes from ADR1 to the last data character then calculating the hexadecimal representation of the 2's-complement negation of the sum. For example, as shown in the above Section 3.3.(1): 01H + 03H + 21H + 02H + 00H + 02H = 29H, the 2's-complement negation of 29H is D7H.

RTU mode (CRC Check):

Starts from Address and ends at Data Content. It is calculated by the following steps:

Step 1: Load a 16-bit register (called CRC register) with FFFFh.

Step 2: Exclusive OR the first 8-bit byte of the command message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.

Step 3: Examine the LSB of CRC register.

Step 4: If the LSB of CRC register is 0, shift the CRC register one bit to the right, fill MSB with zero, then repeat step 3. If the LSB of CRC register is 1, shift the CRC register one bit to the right, fill MSB with zero, Exclusive OR the CRC register with the polynomial value A001H, then repeat step 3.

Step 5: Repeat step 3 and 4 until you perform eight shifts. This processes a complete 8-bit byte.

Step 6: Repeat step 2 through 5 for the next 8-bit byte of the command message. Continue doing this until all bytes are processed. The final contents of the CRC register are the CRC value. When transmitting the CRC value in the message, the upper and lower bytes of the CRC value must be swapped, that is, the lower order byte is transmitted first.

The following is an example of CRC generation using C language. The function takes two arguments:

```
unsigned char* data      ← // a pointer to the message buffer
unsigned char length     ← // the quantity of bytes in the message buffer
unsigned int crc_chk(unsigned char* data, unsigned char length)
  {
  int j;
  unsigned int reg_crc=0xffff;
  while(length--){
    reg_crc ^= *data++;
    for(j=0;j<8;j++){
      if(reg_crc & 0x01){   /* LSB(b0)=1 */
        reg_crc=(reg_crc>>1) ^ 0xa001;
      }else{
        reg_crc=reg_crc >>1;
      }
    }
  }
  return reg_crc; // return register to CRC
```

4. Address list

Content	Address	Function	
AC motor drive parameters	GGnnH	GG means parameter group, nn means parameter number. For example, the address of Pr.04.01 is 0401H.	
Operation command	2000H	bit0–1	00B: No function
			01B: Stop
			10B: Run
			11B: JOG + RUN
		bit2–3	Reserved
		bit4–5	00B: No function
			01B: FWD
			10B: REV
			11B: Change direction
		bit6–7	00B: 1st step accel./decel.
			01B: 2nd step accel./decel.
		bit8–15	Reserved
	2001H	Frequency command	
	2002H	bit0	1: External Fault (E.F.) ON
		bit1	1: Reset
		bit2	1: Base Block (B.B.) ON
		bit3–4 bit6–15	Reserved
Fault status	2100H	Fault code:	
		0: No fault record	
		1: Over-current (oc)	
		2: Over-voltage (ov)	

Content	Address	Function	
		3: IGBT overheating (oH1)	
		4: Reserved	
		5: Overload (oL)	
		6: Overload 1 (oL1)	
		7: Overload 2 (oL2)	
		8: External Fault (EF)	
		9: Over-current during acceleration (ocA)	
		10: Over-current during deceleration (ocd)	
		11: Over-current during steady operation (ocn)	
		12: Reserved	
		13: Low voltage (Lv)	
		14: Phase loss protection (PHL)	
		15: Reserved	
		16: Auto-acceleration/deceleration failure (cFA)	
		17: Software protection enabled (codE)	
		18: EEPROM write error (cF1.0)	
		19: EEPROM read error (cF2.0)	
		20: Hardware protection fault 1 (HPF1)	
		21: Hardware protection fault 2 (HPF2)	
		22: Reserved	
		23: Hardware protection fault 4 (HPF4)	
		24: Drive wiring detection fault (cF3.0)	
		25: Drive wiring detection fault (cF3.1)	
		26: Drive wiring detection fault (cF3.2)	
		27: Drive wiring detection fault (cF3.3)	
		28: Drive wiring detection fault (cF3.4)	
		29: Reserved	
		30: Reserved	
		31: Reserved	
		32: Reserved	
		33: Reserved	
		34: Reserved	
		35: Reserved	
		36: Reserved	
		37: Multi-motor fault protection (oPHL)	
		38: IGBT temperature PTC OFF (tH1o)	
		39–40: Reserved	
		41: Belt conveyor drive (VFD1) stall failure (StAL)	
		42: Over-voltage at stop (ovS)	
		43: Over-voltage during acceleration (ovA)	
		44: Over-voltage during deceleration (ovd)	
		45: Over-voltage during constant speed (ovn)	
	2101H	bit0–1	Drive operation status 00B: Drive fully stops (RUN indicator is OFF / STOP indicator is ON) 01B: Drive is stopping (RUN indicator flashes / STOP indicator is ON)

Content	Address	Function	
			10B: Drive is in standby status (RUN indicator is ON / STOP indicator flashes) 11B: Drive is running (RUN indicator is ON / STOP indicator is OFF)
		bit2	1: JOG command
		bit3–4	00B: Drive runs forward (FWD indicator is ON / REV indicator is OFF) 01B: Drive runs from reverse to forward (FWD indicator is ON / REV indicator flashes) 10B: Drive runs from forward to reverse (FWD indicator flashes / REV indicator is ON) 11B: Drive runs in reverse (FWD indicator is OFF / REV indicator is ON)
		bit5–7	Reserved
		bit8	1: Master frequency controlled by the communication interface
		bit9	1: Master Frequency command controlled by analog signal input
		bit10	1: Operation command controlled by the communication interface
		bit11–15	Reserved
	2102H	Frequency command (F)	
	2103H	Output frequency (H)	
	2104H	Output current (AXX.X)	
	2105H	Reserved	
	2106H	Reserved	
	2107H	Reserved	
	2108H	DC bus voltage (uXXX.X)	
	2109H	Output voltage (EXXX.X)	
	210AH	IGBT temperature (°C)	
	2116H	User-defined (Low word)	
	2117H	User-defined (High word)	

NOTE:

2116H is the data value of Pr.00.04, 2117H high byte is the decimal places of Pr.00.04, and low byte is the ASCII code of Pr.00.04.

Exception response

When the drive is using the communication connection, if an error occurs, the drive responds to the error code and sets the highest bit (bit 7) of the command code to 1 (function code AND 80H) then responds to the control system to signal that an error occurred. If the keypad displays "CE.XX" as a warning message, "XX" is the error code at that time. Refer to the table of error codes below for communication error for reference.

The table below shows some example.

ASCII mode:

STX	':'
Address	'0'
	'1'
Function	'8'
	'6'
Exception code	'0'
	'2'
LRC CHK	'7'
	'7'
END	CR
	LF

RTU mode:

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

The explanation of exception codes:

Error code	Description
01	Function code error: recognized function codes by the drive are 03H, 06H, 08H, and 10H.
02	Incorrect data address: unrecognized data address by the drive.
03	Incorrect data content: data content is too large, and cannot be recognized by the drive.
04	Unable to be processed by the drive: commands cannot be executed by the drive.
10	Transmission time-out.

Communication program of PC:

The following is a simple example of how to write a communication program for Modbus ASCII mode on a PC by 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 */
    }     }       }
```

09.05 Reserved

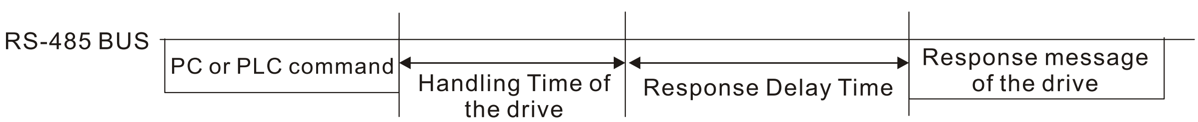
09.06 Reserved

✓ 09.07 Communication Response Delay Time

Default: 1.0

Settings   0.0–200.0 ms (One unit: 2 ms)

- If the host controller does not finish the transmitting/receiving process, you can use this parameter to set the response delay time after the AC motor drive receives communication command as shown in the following picture.



10 Speed Feedback Control Parameters

✓ You can set this parameter during operation.

Parameter Group 10, from Pr.10.00 to Pr.10.50, are all "reserved".

10.00 – 10.50	Reserved

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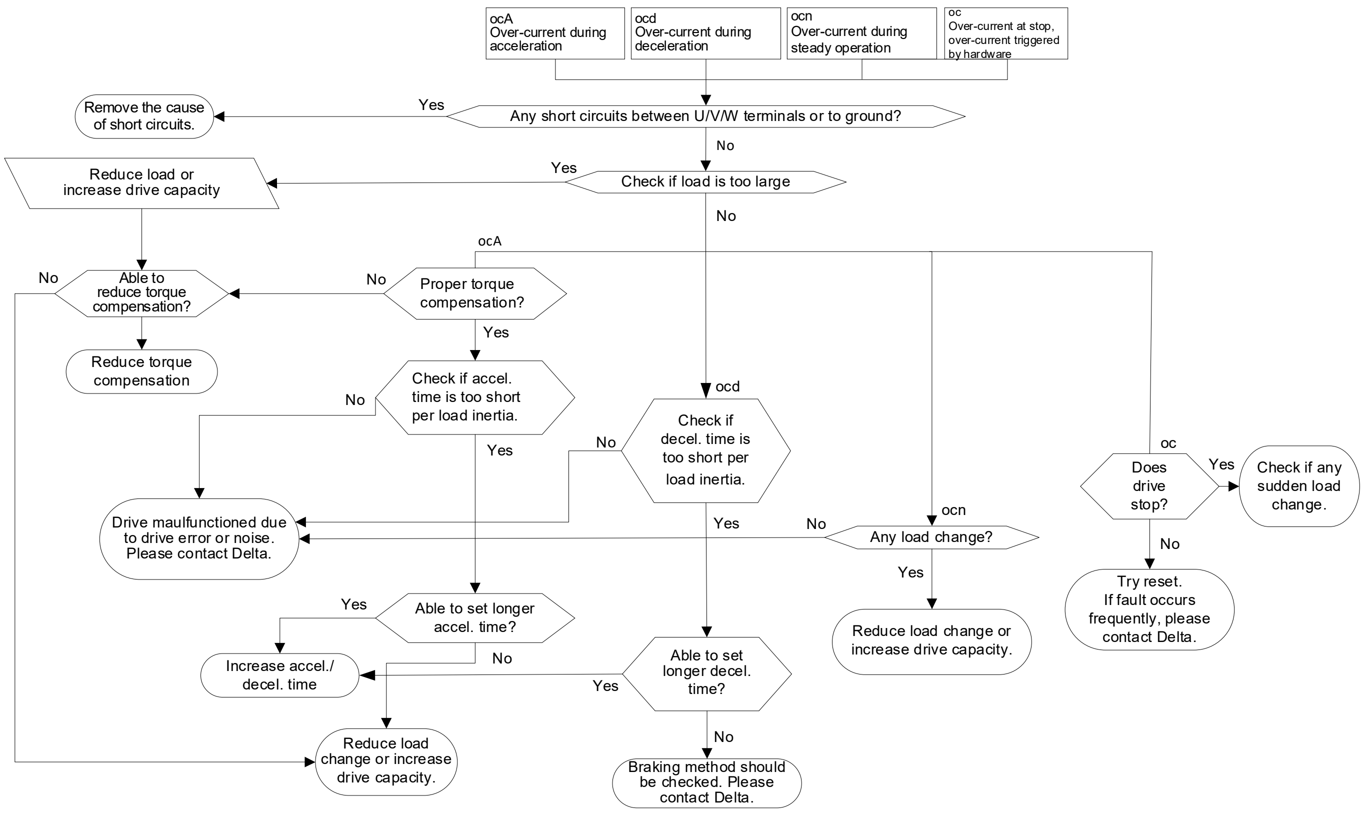
Chapter 11 Troubleshooting

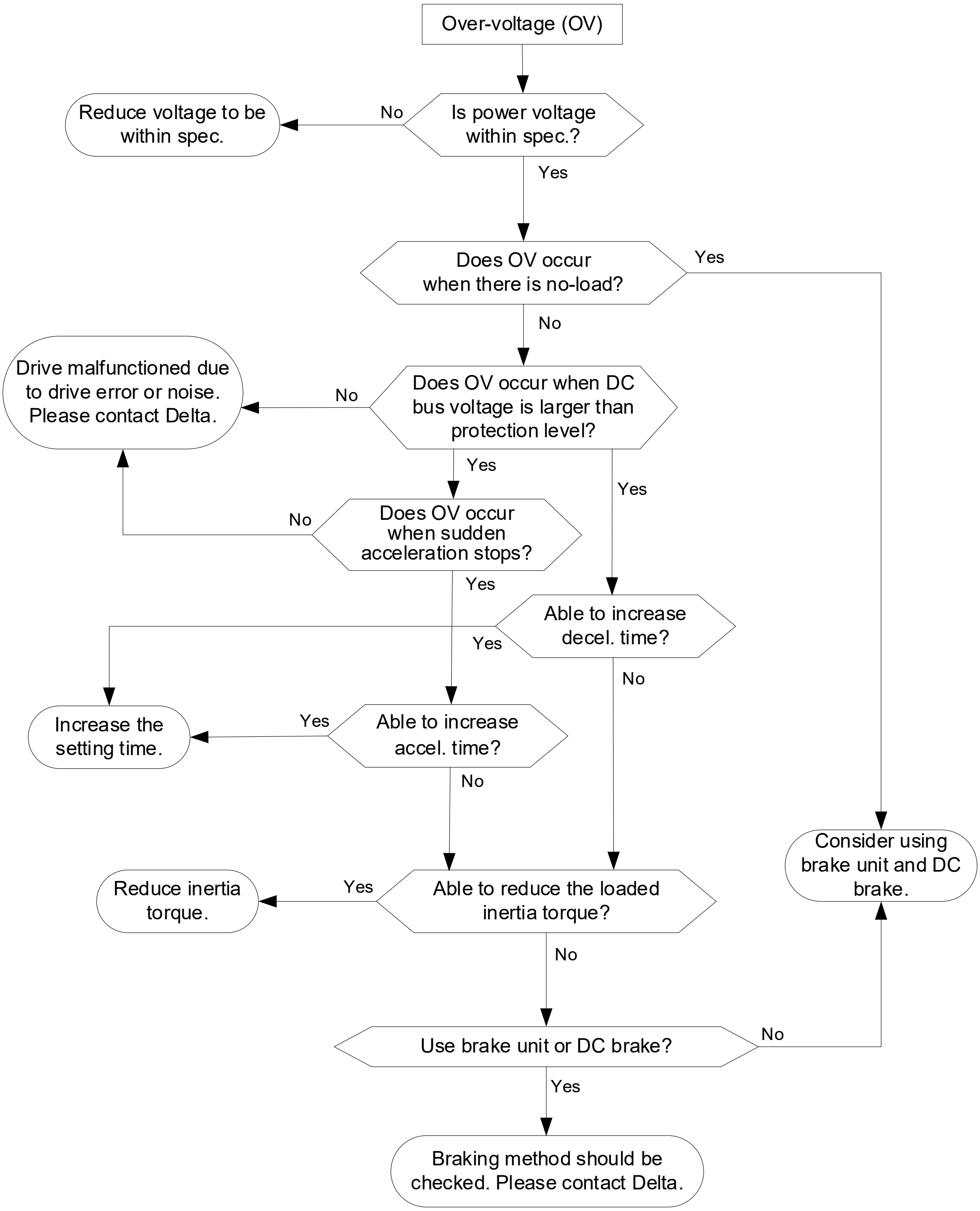
For users to easily find common errors and solutions

☑ Only qualified personnel can work on troubleshooting to prevent accidents.

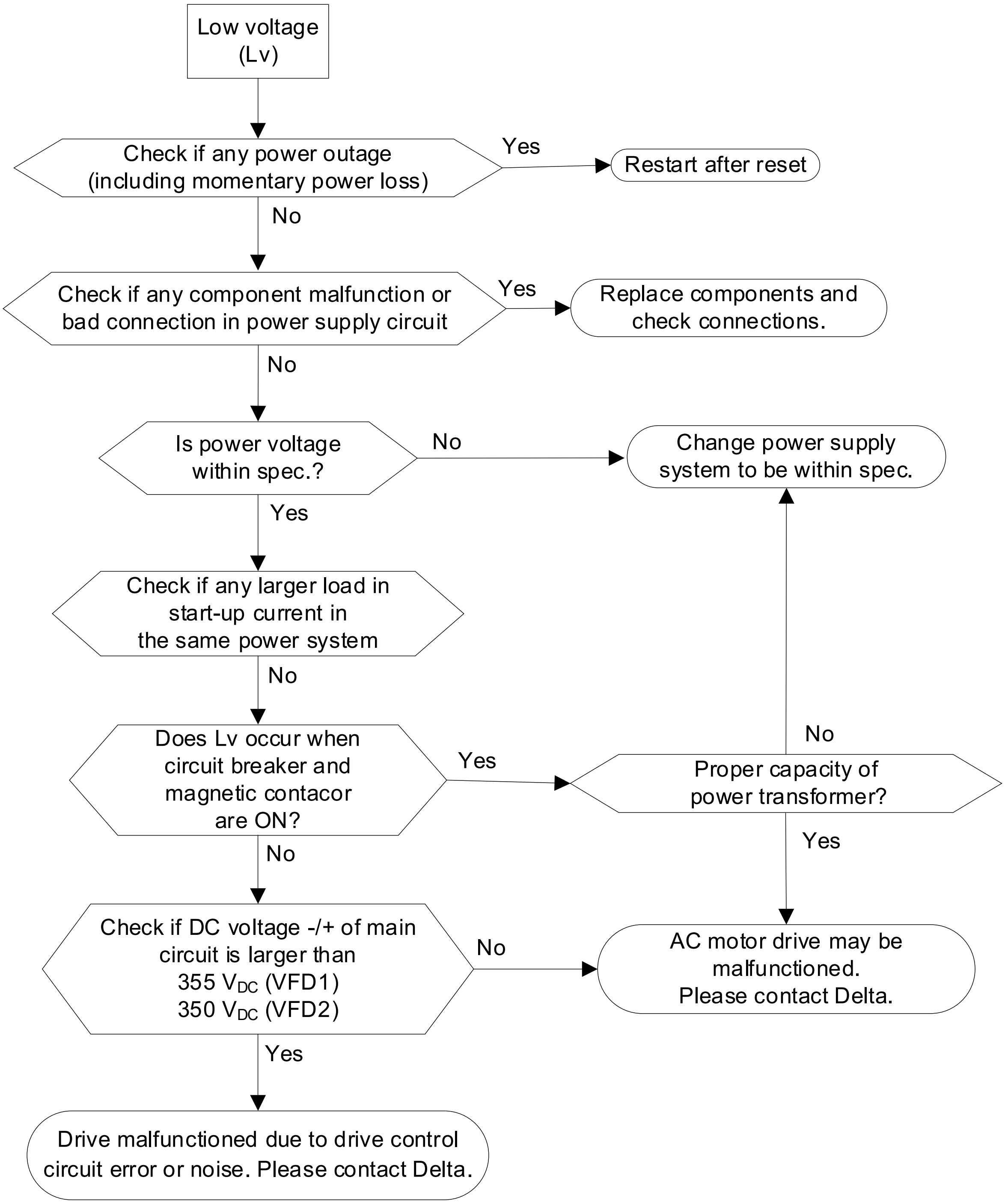
11-1 Over-current (oc)



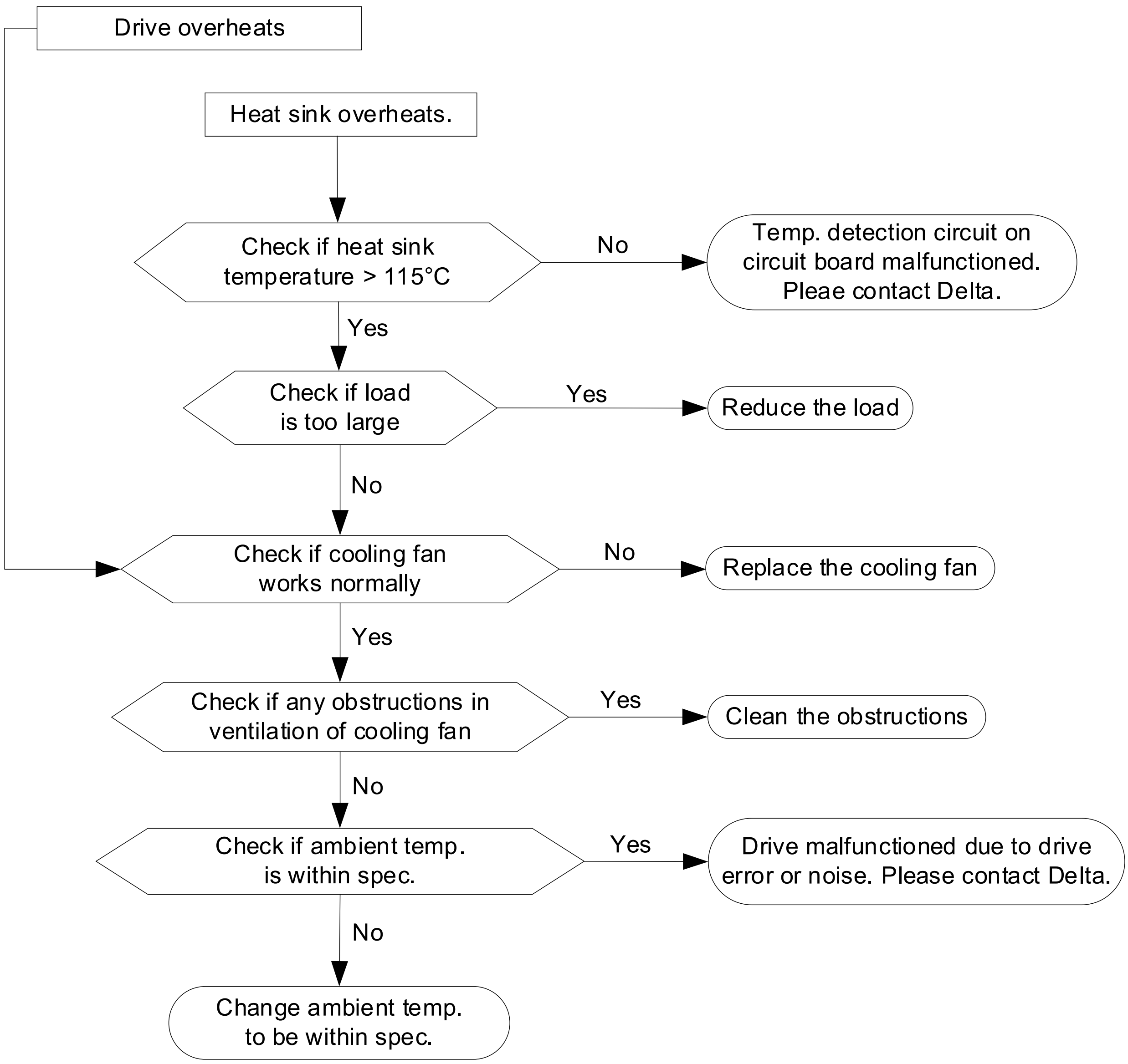
11-2 Over-voltage (ov)



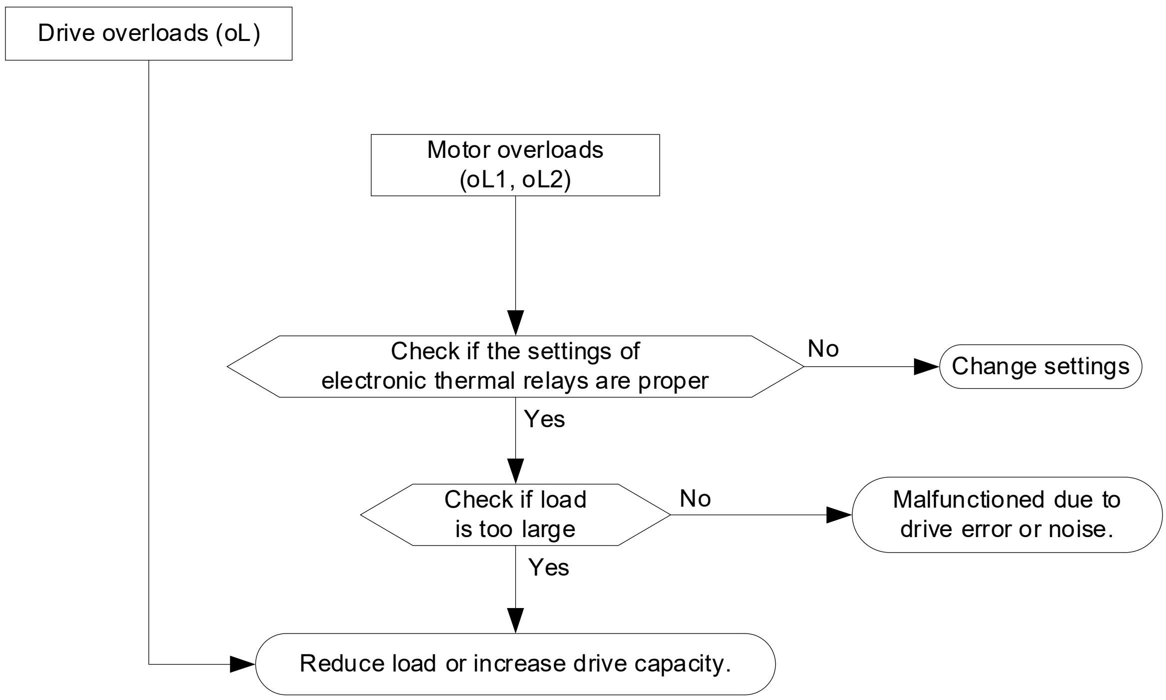
11-3 Low voltage (Lv)



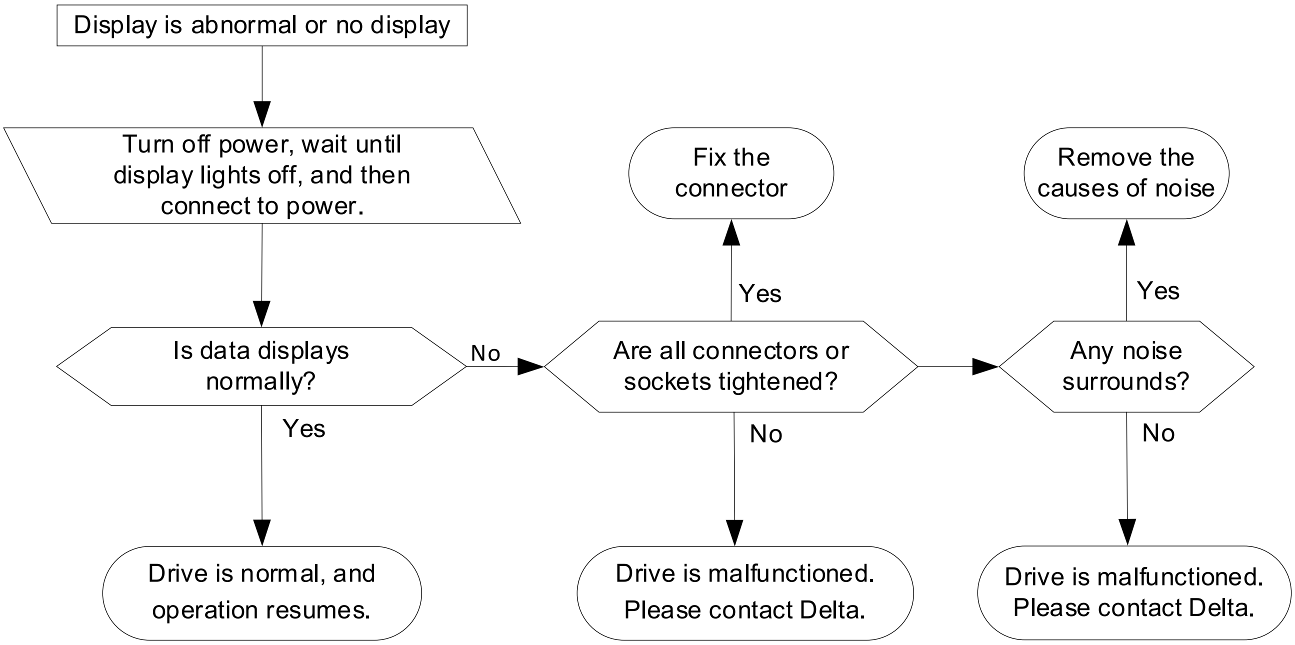
11-4 Overheat (oH1)



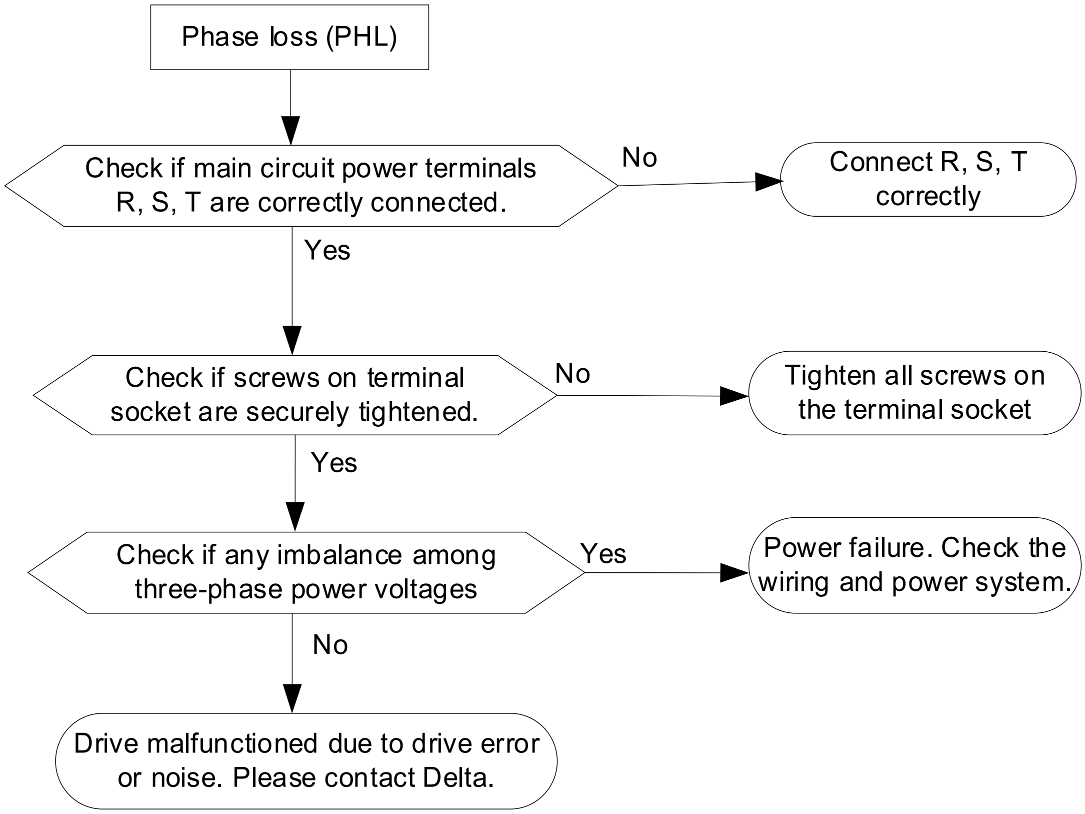
11-5 Overload (oL)



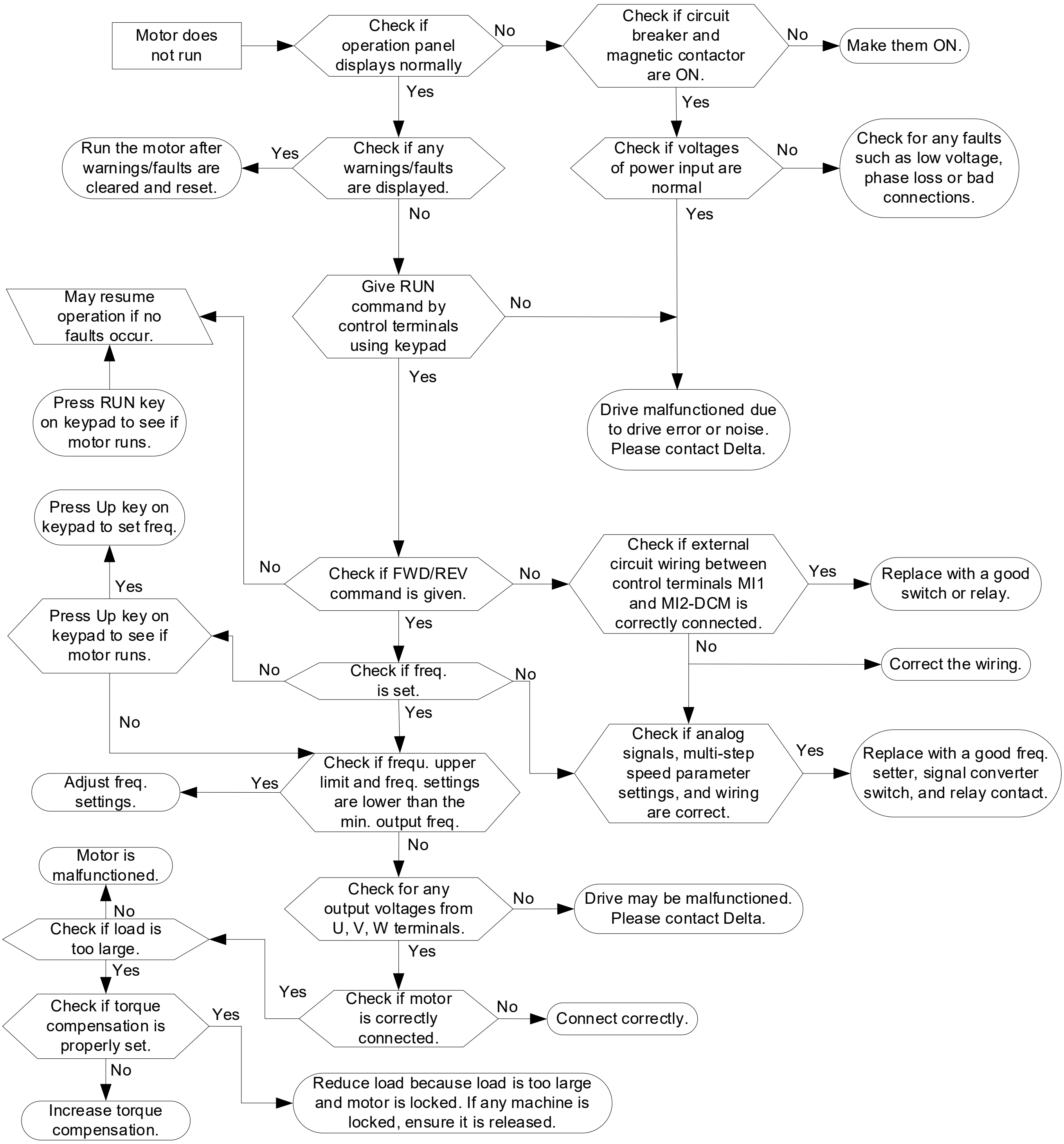
11-6 Keypad Display is Abnormal



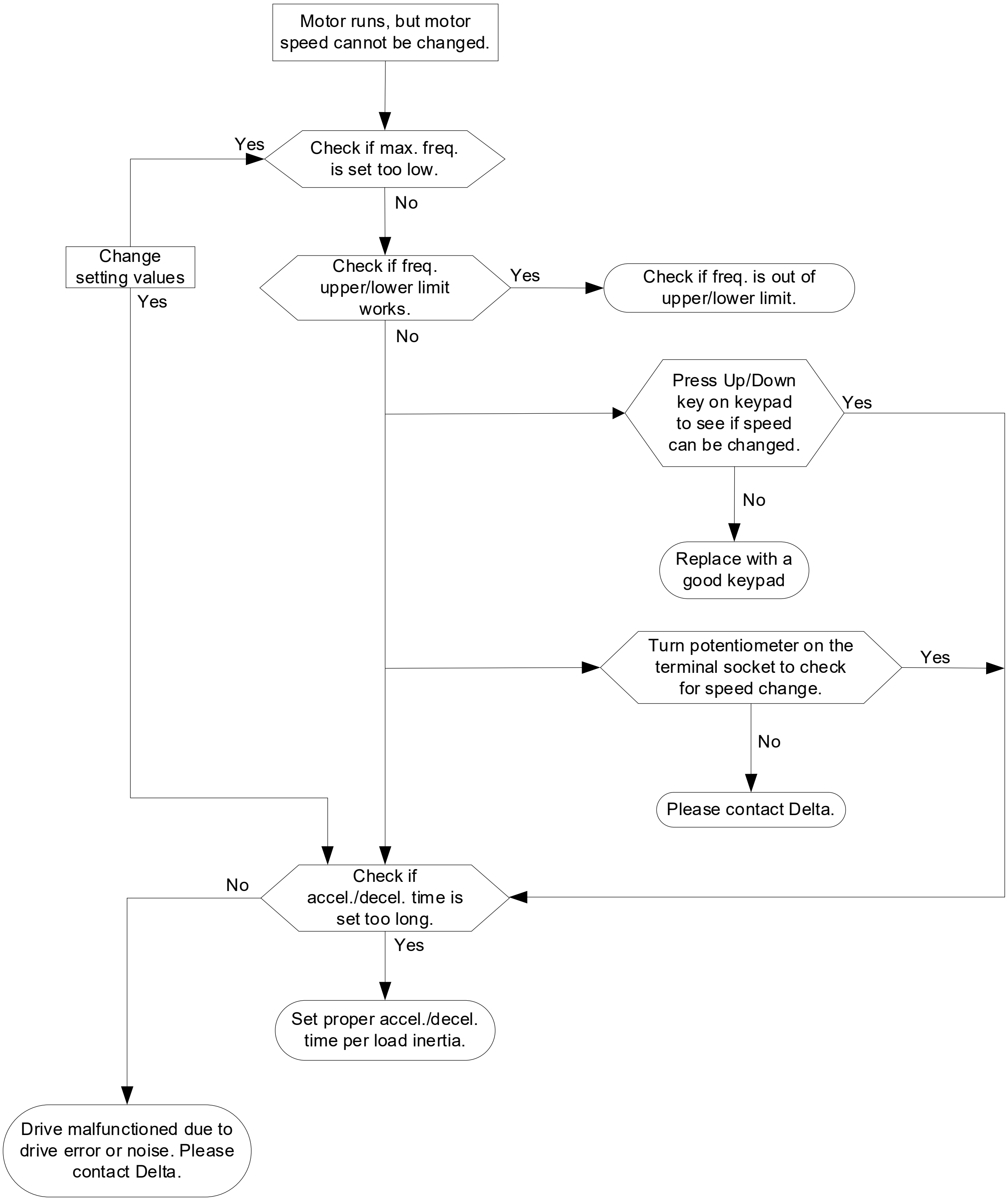
11-7 Phase Loss (PHL)



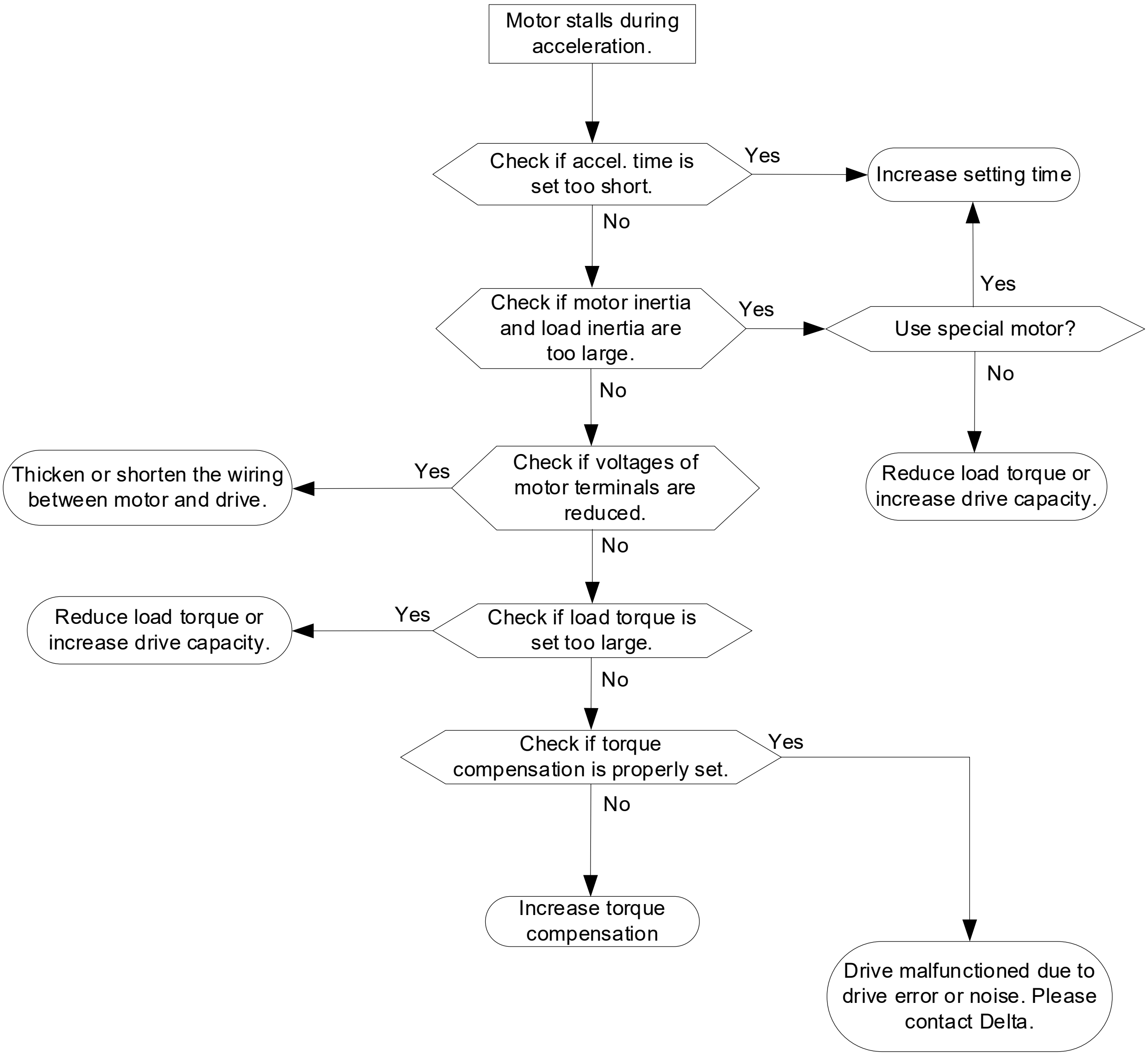
11-8 Motor Does Not Run



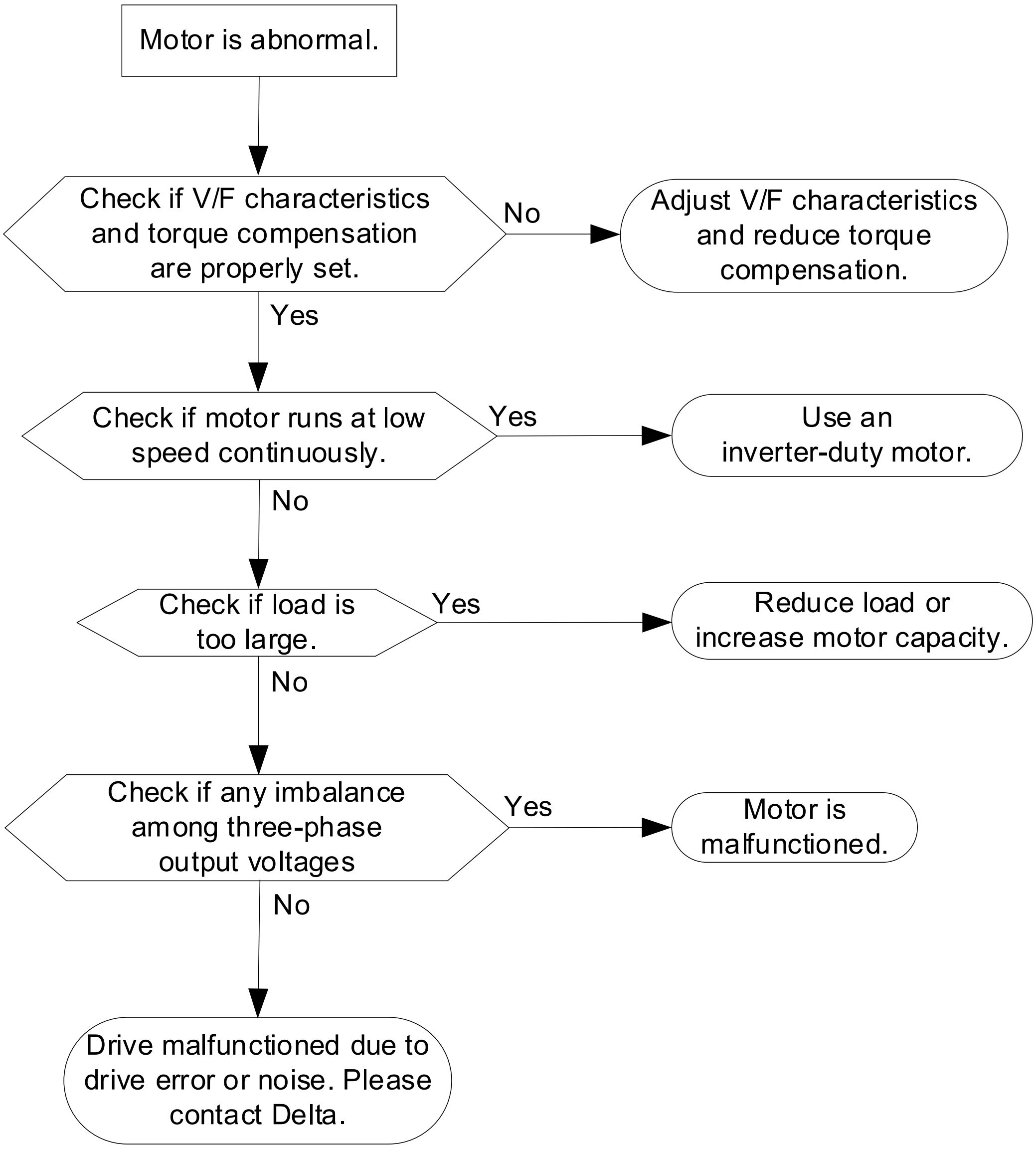
11-9 Motor Speed Cannot be Changed



11-10 Motor Stalls During Acceleration



11-11 Motor is Abnormal



11-12 Electromagnetic / Induction Noise

Many sources of noise surround AC motor drives and affect them by radiation or conduction. This may cause the control circuits to malfunction and even trip or 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. Solving the problem from the outside as follows is the best.

1. Add a surge suppressor on relays or contactors to suppress noise caused by switching surges during switch ON and OFF.
2. Shorten the length of the wiring for 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 wire length.
4. The grounding terminal must comply with the local regulations and be grounded independently; that is, do not use a 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.

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

11-13 Operating Environment Condition

Since the AC motor drive is an electronic device, you must deal with the operating environment conditions. Here are some remedial measures to use if necessary.

1. To prevent vibration, anti-vibration dampers are the last choice. Vibration 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. If necessary in particular situations, use a completely sealed enclosure.

3. The ambient temperature should be within the specification. Too high or too low temperature affects the lifetime and reliability of the AC motor drive. For semiconductor components, damage occurs once any specification is out of range. It is necessary to periodically check air quality and the cooling fan and provide extra cooling if required. In addition, the microcomputer may not work in extremely low temperatures, making cabinet heating necessary.

4. Store the AC motor drive in a relative humidity range of 0% to 90% (non-condensing). Use an air conditioner and/or desiccator if necessary.

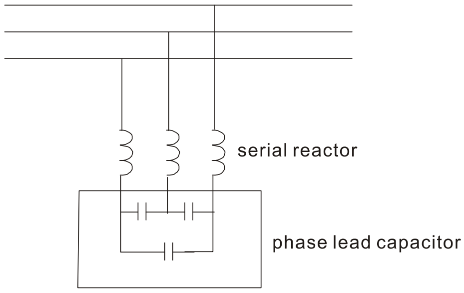
11-14 Affecting Other Machines

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

High Harmonics at Power Side

You can reduce high harmonics at the power side during running.

1. Separate the power system: use a transformer for the AC motor drive.
2. Use a reactor at the power input terminal of the AC motor drive, as the figure below shows.



3. If using phase lead capacitors (never on the AC motor drive output!), use serial reactors to prevent damage to the capacitors from high harmonics.

Motor Temperature Rises

When the motor is a standard induction motor with a fan, the cooling will be insufficient at low speed, causing the motor to overheat. In addition, high harmonics at the output increases copper and core losses. Use the following measures depending on load and operation range.

1. Use a motor with independent ventilation (forced external cooling) or increase the motor rated power.
2. Use an inverter-duty motor.
3. Do NOT run at low speed for long periods of time.

11-15 Indicator Description

No.	LED Indicator Name	Color	Description
1	POWER	Green	ON: LTC is powered with three-phase power
2	PLC	Green	OFF: PLC stops running
3	ERROR	Red	1. ON: PLC error 2. Flashes (ON for 1s and OFF for 1s) in circulation: Belt conveyor motor drive error 3. Flashes (ON for 2s and OFF for 0.5s) in circulation: Telescopic motor drive error Error indication priority: PLC error > belt conveyor motor drive error > telescopic motor drive error
4	FWD (left side)	Green	ON: The running direction that VFD1 corresponds to the motor is forward
5	REV (left side)	Green	ON: The running direction that VFD1 corresponds to the motor is reverse
6	FWD (right side)	Green	ON: The running direction that VFD2 corresponds to the motor is forward
7	REV (right side)	Green	ON: The running direction that VFD2 corresponds to the motor is reverse
8	DI input (X contacts)	Green	ON: X0 to X20, corresponding DI signal inputs are valid
9	DO output (Y contacts)	Green	ON: Y0 to Y7, corresponding DO signal outputs are valid. Among them, Y7-1 and Y7-2 use the same relay, that is, they use only one LED indicator to indicate ON/OFF.
10	DC POWER	Green	ON: Power 24 V_{DC} is normal

Chapter 12 Fault Codes and Maintenance

The AC motor drive has various warnings and protections against errors such as over-voltage, low voltage, or over-current. Once an error occurs, the protections activate, the AC motor drive stops output, activates the error contacts, and the motor coasts to stop. Please refer to the warning/fault display from the AC motor drive and look up the corresponding causes and corrective actions in this chapter. The fault record is stored in the AC motor drive internal memory and can store the five most recent error messages. You can read it from the digital keypad or through the communications by accessing the parameters.

The AC motor drive includes a large number of electronic components, including ICs, resistors, capacitors, transistors, and cooling fans. These components do not last forever. Even under normal circumstances, they will eventually become error-prone if used past their lifespans. Therefore, you must perform periodic preventive maintenance to identify defective and worn out parts, and eliminate the causes of malfunctions in the AC motor drive at an early stage. At the same time, parts that have exceeded their product life should be replaced whenever possible to ensure safe operation.

Visual checks should be done regularly to monitor the AC motor drives operation, and to make sure nothing unusual happens. Check the situations listed in the following table.

 CAUTION	☑ Wait five seconds after a fault has been cleared before pressing RESET key on the keypad. ☑ The drive must first be switched off for at least five minutes for ≤ 22 kW models until the charging indicator turns off. ☑ Only qualified personnel can work on maintenance or replace parts. (Remove metal items such as watch, rings, and other metal items before operation, and use only insulated tools.) ☑ Never modify internal components or wiring. ☑ The performance and the surrounding environment should meet the standard specifications. There should be no abnormal noise, vibration, or odor. ☑ Verify if the keypad displays normally. Check if there is any abnormality such as overheating or color change. Prevent the drive from electric shock and equipment accident.

12-1 Faults and Corrective Action

No.	Fault Descriptions	Corrective Actions
1	ERROR indicator flashes with red light when LTC is powered ON.	1. Check if EF fault occurs by using VFDSoft software, communication panel PU08 or PU08V. 2. If EF fault occurs, make sure that EF terminal is correctly connected to emergency stop circuit (channels between 24V (Digital signal common terminal Source) – emergency stop switch N.C. contact – EF terminal can be connected in series). 3. If EF function is unnecessary for your application, set Pr.04.07 of both VFD1 and VFD2 to 0 by using VFDSoft software, communication panel PU08 or PU08V. 4. If it is not an EF fault, see other fault corrective actions in this user manual.
2	Contact Y does not light on, does not output, and cannot drive the load.	1. Check if PLC program runs normally. 2. Check if the relay is correctly installed. 3. Replace with a new one if the relay is malfunctioned.
3	Contact Y lights on, but does not output.	1. Check if the relay is correctly installed. 2. Replace with a new one if the relay is malfunctioned.
4	Motor 1 or Motor 2 does not run.	Connect VFDSoft software, communication panel PU08 or PU08V with communication interface (RJ45) of VFD1 and VFD2 respectively to check the fault of the drive. Troubleshoot the fault (such as mechanism, electricity) according to the descriptions in Chapter 11 and 12 in LTC user manual. Then, press RESET key on the keypad.

12-2 Fault Codes and Descriptions

The following messages display when the operation command source is set as digital keypad.

Fault Code	Fault Descriptions	Corrective Actions
oc	**Over-current (oc)** Abnormal increase in current	Check if the motor power corresponds with the AC motor drive output power. Check the wiring connections to U, V and W for possible short circuits. Check the wiring connections between the AC motor drive and motor for possible short circuits, and for short to ground. Check for loose contacts between the AC motor drive and the motor. Increase the acceleration time. Check for possible excessive loading on the motor.
ou	**Over-voltage (ov)** DC bus over-voltage during deceleration.	Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If DC bus over-voltage is caused by motor regeneration, increase the deceleration time.
oH1	**IGBT overheating (oH1)** Heat sink temperature is too high, and exceeds the protection level.	Ensure that the ambient temperature is in the specified temperature range. Check if there is any obstruction on the heat sink or if the fan is running. Check if there is any insufficient ventilation space
Lu	**Low voltage (Lv)** The AC motor drive detects that the DC bus voltage has fallen below its minimum value.	Check whether the input voltage is in the AC motor drive rated input voltage range. Check for abnormal load on the motor. Check if any single phase power input to three-phase model or phases loss.
oL	**Overload (oL)** The AC motor drive detects excessive drive output current. **NOTE:** The AC motor drive can sustain up to 150% of the rated current for a maximum of 60 seconds.	Check if the motor is overloaded. Reduce the torque compensation setting (Pr.07.02). Increase the drive output capacity.
oL1	**Overload 1 (oL1)** Internal electronic overload trip	Check if the motor is overloaded. Check if the motor rated current setting (Pr.07.00) is appropriate. Check the electronic thermal overload setting. Increase the motor capacity.

Fault Code	Fault Descriptions	Corrective Actions
oL2	**Overload 2 (oL2)** Motor overload.	Check if the motor is overloaded. Adjust the over-torque detection settings to appropriate values (Pr.06.03–Pr.06.05).
HPF1	**Hardware protection fault 2 (HPF1)** Abnormal hardware protection wiring of the controller.	CC, OC (current clamp) abnormal hardware protection wiring, return the unit to the factory.
HPF2	**Hardware protection fault 2 (HPF2)** Abnormal hardware protection wiring of the controller.	OV abnormal hardware protection wiring, return the unit to the factory.
HPF4	**Hardware protection fault 2 (HPF4)** Abnormal hardware protection wiring of the controller.	OC abnormal hardware protection wiring, return the unit to the factory.
ocA	**Over-current during acceleration (ocA)**	Check for loose contacts between the AC motor drive and the motor. Check for poor insulation wiring from U-V-W to the motor. Increase the acceleration time Reduce the torque compensation setting (Pr.07.02). Replace the drive with a larger capacity model.
ocd	**Over-current during deceleration (ocd)**	Check for poor insulation wiring from U-V-W to the motor. Increase the deceleration time. Replace the drive with a larger capacity model.
ocn	**Over-current during steady operation (ocn)**	Check for poor insulation wiring from U-V-W to the motor. Check for possible shaft lock. Replace the drive with a larger capacity model.
EF	**External Fault (EF)** 1. When multi-function input terminals (MI1–MI4) are set to external fault, the AC motor drive stops output. 2.When changing the communication address 2002H bit0 = 1, the drive stops output.	The "EF" disappears once the signal source is cleared and reset.
cF1.0	**EEPROM write error (cF1.0)** Internal EEPROM cannot be programmed.	Return to the factory for repair.

Fault Code	Fault Descriptions	Corrective Actions
cF1.1	**EEPROM write error (cF1.1)** Internal EEPROM cannot be programmed.	Return to the factory for repair.
cF2.0	**EEPROM read error (cF2.0)** Internal EEPROM cannot be read.	Press RESET key to reset all parameters to defaults. If this solution does not work, return to the factory for repair.
cF2.1	**EEPROM read error (cF2.1)** Internal EEPROM cannot be read.	Press RESET key to reset all parameters to defaults. If this solution does not work, return to the factory for repair.
cF3.0	**Drive wiring detection fault (cF3.0)**	U-phase error, return to the factory for repair.
cF3.1	**Drive wiring detection fault (cF3.1)**	V-phase error, return to the factory for repair.
cF3.2	**Drive wiring detection fault (cF3.2)**	W-phase error, return to the factory for repair.
cF3.3	**Drive wiring detection fault (cF3.3)**	DC bus wiring detection error, return to the factory for repair.
cF3.4	**Drive wiring detection fault (cF3.4)**	Temperature sensor error, return to the factory for repair.
cFA	**Auto-acceleration/deceleration failure (cFA)**	Check if the drive capacity matches the motor's. Check if the regenerative energy is too high. Check for sudden load changes.
cE--	**Communication fault (cE--)**	Check the RJ45 connection between the AC motor drive for loose wires and wiring to the correct pins. Check if the communication format is correct. See the table of explanation of exception codes in Parameter Group 09 Communication Parameters in Chapter 10 for detailed information.
codE	**Software protection enabled (codE)**	Password is locked.
PHL	**Phase loss protection (PHL)**	Check if the input power is three-phase.
oPHL	**Multi-motor fault protection (oPHL)**	Check if the motor wiring is normal.

Fault Code	Fault Descriptions	Corrective Actions
	**Over-voltage at stop (ovS)**	Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. Check if other fault codes such as cF3.0–cF3.2 occur after cycling the power. If yes, return to the factory for repair. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box and its internal terminals. Troubleshoot the ground fault.
	**Over-voltage during acceleration (ovA)**	Check if acceleration is too slow (e.g. when lifting load decreases acceleration time). If yes, decrease the acceleration time. Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. Use over-voltage stall prevention function (Pr.06.00). Use Auto-acceleration and Auto-deceleration Setting (Pr.01.16) When ovA is triggered by too short acceleration time, execute the following actions: 1. Increase the acceleration time 2. Use Pr.06.00 over-voltage stall prevention function 3. Use Pr.01.17 S-curve for Acceleration Begin Time. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box and its internal terminals. Troubleshoot the ground fault.

Fault Code	Fault Descriptions	Corrective Actions
		Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.
ovd	**Over-voltage during deceleration (ovd)**	Increase the setting values for Pr.01.10 and Pr.01.12 (deceleration time). Reduce the brake frequency. Use S-curve acceleration/deceleration. Use over-voltage stall prevention function (Pr.06.00). Use Auto-acceleration and Auto-deceleration Setting (Pr.01.16) Adjust the brake level (Pr.08.00). Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box and its internal terminals. Troubleshoot the ground fault. Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.
ovn	**Over-voltage during constant speed (ovn)**	Impulsive change of the load: 1. Reduce the load 2. Adjust the brake level (Pr.08.00). Use over-voltage stall prevention function (Pr.06.00). Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box and its internal terminals. Troubleshoot the ground fault.

Fault Code	Fault Descriptions	Corrective Actions
		Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.
	**Belt conveyor drive (VFD1) stall failure (StAL)**	Stall function is enabled for VDF1 of LTC. If materials are jammed and stall conditions are met, fault code StAL is triggered.

Reset

After the causes that may trigger fault codes are corrected, execute either of the following actions to clear the trip: 1. Press RESET key on the panel (as shown in the figure below); 2. Set the external terminal to "fault reset command" and set this terminal to be ON; 3. Send the fault reset command through communications. Make sure the RUN command or signal is OFF before executing RESET to prevent damage to the drive or personal injury due to immediate operation after reset.

Digital Keypad Panel

12-3 Maintenance and Inspections

For regular maintenance, first stop operation, then turn off the power, and then take off the outer cover. Even after turning off the power supply, charging voltages remaining in the filter capacitor require some time to discharge. To avoid danger, operation must not start until the charging indicator goes off, and you confirm the voltage with a voltmeter to be below the safety value (≤ 25 V_{DC}).

Ambient environment

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check the ambient temperature, humidity, and vibration and check for any dust, gas, oil or water drops.	Visual inspection and measurement with equipment with standard specification	○		
Check for any dangerous objects	Visual inspection	○		

Voltage

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check that the voltage of main circuit and control circuit are correct.	Measure with multimeter with standard specifications	○		

Digital keypad display

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check that the display is clear for reading.	Visual inspection	○		
Check for any missing characters		○		

Mechanical parts

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any abnormal sound or vibration	Visual and audible inspection		○	
Check for any loose bolts (firm parts)	Securely tighten		○	
Check for any deformed or damaged parts	Visual inspection		○	
Check for any color change caused by overheating	Visual inspection		○	
Check for any dust or dirt	Visual inspection		○	

Main circuit

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any loose or missing bolts	Securely tighten	○		
Check for machine or insulator deformation, crack, damage or color change due to overheating or aging	Visual inspection		○	
Check for any dust or dirt	Visual inspection		○	

Main circuit terminals and wiring

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check the terminal and copper plate for any color change or deformation caused by overheating	Visual inspection		○	
Check for damage to the wiring insulation or color change	Visual inspection		○	

Main circuit terminal block

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any damage	Visual inspection		○	

Main circuit filter capacitor

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any liquid leaks, color change, crack or buckling of the exterior cover	Visual inspection	○		
Check if the safety valve is not removed. Check if the valve is obviously expanded.	Visual inspection	○		
Measure static capacity when required			○	

Main circuit resistor

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any odors or insulation cracks due to overheating	Visual and audible inspection		○	
Check for any disconnections	Visual inspection		○	
Check for damaged connections	Measure with multimeter with standard specifications		○	

Main circuit transformer and reactor

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any abnormal vibration or odors	Visual and audible inspection	○		

Main circuit magnetic contactor and relay

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any sound of vibration while running	Audible inspection	○		
Check that the contact works correctly	Visual inspection	○		

Main circuit PCB and connector

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any loose screws and connectors	Securely tighten		○	
Check for any odors and color change	Visual inspection		○	
Check for any crack, damage, deformation or corrosion	Visual inspection		○	
Check for any liquid leaks or deformation in capacity	Visual inspection		○	

Cooling system cooling fan

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any abnormal sound or vibration	Audible, visual inspection, and turn the fan by hand to see if it rotates smoothly. (turn off the power before inspection)			○
Check for any loose bolts	Securely tighten			○
Check for any color change caused by overheating	Visual inspection			○

Cooling system ventilation channel

Items to Check	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check for any obstruction or substance adhered in the heat sink, air intake or air outlet	Audible inspection		○	

NOTE: Use a chemically neutral cloth to clean and use a dust cleaner to remove dust when necessary.

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Chapter 13 PLC Function Applications

13-1 PLC Summary

13-1-1 Introduction

The commands provided by the LTC's built-in PLC functions, including the ladder diagram editing tool WPLSoft, as well as the usage of basic commands and applications commands, mainly retain the operating methods of Deltas PLC DVP series.

13-1-2 WPLSoft Ladder Diagram Editing Tool

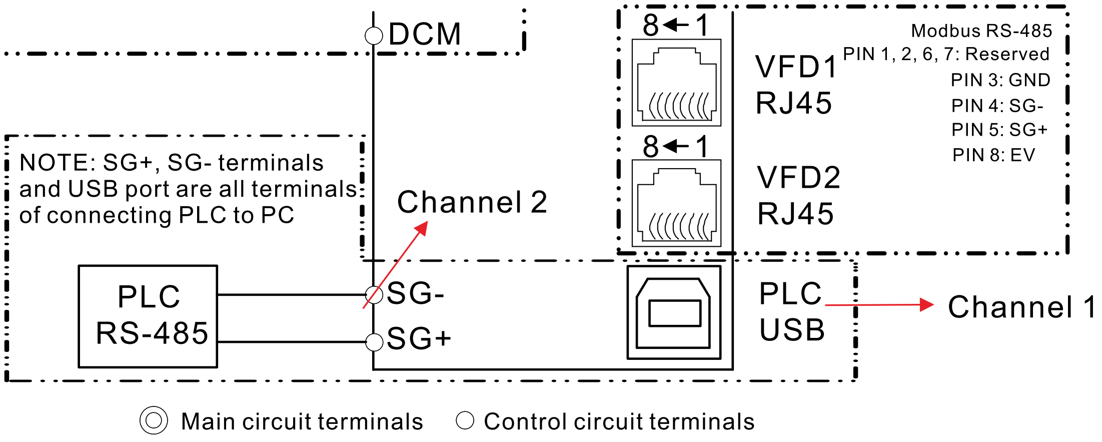
WPLSoft is a program editing software used under WINDOWS operating system in Delta's DVP Series PLC for VFD-C2000 and VFD-LTC. WPLSoft not only provides functions of PLC program planning and Windows editing (such as cut, paste, copy, multi-window, etc.), but also Chinese/English notes editing function and other useful functions like register editing & setting, file reading & saving, as well as points diagram monitoring and setting, and so on.

Minimum system requirements for installing WPLSoft software:

Item	System Requirements
Operating System	Windows 95 / 98 / 2000 / NT / ME / XP / 10
CPU	Pentium 90 above
Storage	16MB above (32MB above recommended)
Drive	Disk space: 100MB above at a minimum An optical disc drive (for installing WPLSoft)
Display	Resolution: 800 × 600, 16 colors above. It is recommended to set screen width × height to 800 × 600 pixels.
Mouse	Mouse for general purposes or compatible with Windows
Printer	Printers with Windows drivers
RS-485 port	At least one RS-485 port that can be connected with PLC

13-2 Notes Before Using PLC

1. LTC provides two communication ports to upload/download PLC programs, as the figure below shows. Communication format for Channel 1 is ASCII (serial baud rate is at random). Communication format for Channel 2 is 19200, 8, N, 2 (RTU), and communication station address is 1.



The communication station address, serial baud rate, and communication format of SG+ and SG- terminals (i.e. Channel 2) for LTC's PLC **can be changed as required**. See below for detailed descriptions.

(1) D1290 = 0 (default): D1295–1297 are fixed values, D1295 (station address) = 1, D1296 (communication serial baud rate) = 19200 bps, and D1297 (communication format) = 13 (8, N, 2, RTU).

(2) Change D1290 from 0 to 1, then D1295–1297 can be changed.

(2.1) Change station address as required

(2.2) Change serial baud rate from 4.8k, 9.6k, 19.2k, 38.4k, 57.6k to 115.2k. If the setting value of D1296 is larger than 1152, the setting value will be automatically set as the default value 192 (that is, 192 kbps).

(2.3) Set communication format for D1297 based on the following protocols. If the setting value of D1297 is larger than 17, the setting value will be automatically set as the default value 13 (that is, 8, N, 2 (RTU)).

Settings	1: 7, N, 2 (ASCII)	9: 8, O, 1 (ASCII)
	2: 7, E, 1 (ASCII)	10: 8, E, 2 (ASCII)
	3: 7, O, 1 (ASCII)	11: 8, O, 2 (ASCII)
	4: 7, E, 2 (ASCII)	12: 8, N, 1 (RTU)
	5: 7, O, 2 (ASCII)	13: 8, N, 2 (RTU)
	6: 8, N, 1 (ASCII)	14: 8, E, 1 (RTU)
	7: 8, N, 2 (ASCII)	15: 8, O, 1 (RTU)
	8: 8, E, 1 (ASCII)	16: 8, E, 2 (RTU)
		17: 8, O, 2 (RTU)

2. When uploading or downloading programs, PLC program will be disabled.
3. When using WPR commands to write in parameters, note that allowable maximum number of

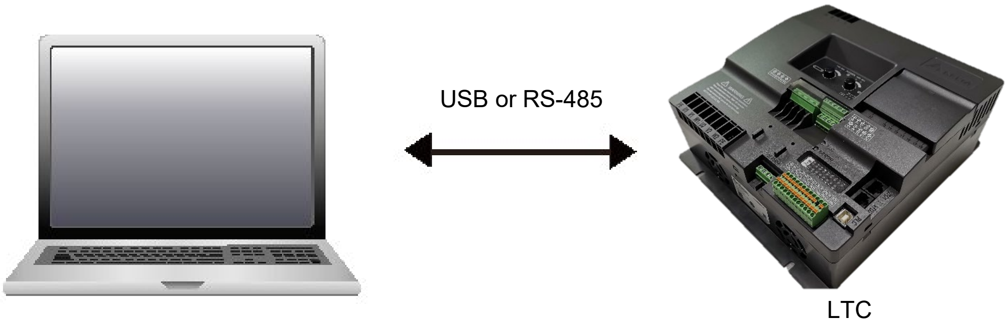
times to change is 10^9. Otherwise, a memory writing error may occur. The number of times to change depends on the writing value to be changed. If the writing value is not changed, the number of times will not be counted accumulatively; if the writing value is different from the last time, it will be counted as one time.

4. Set D1505=13445, D1503=11111 can restore PLC to default values.

13-3 Start-up

13-3-1 Connect to PC

Wiring: Connect LTC's PLC using USB or RS-485 through USB port to connect to PC.



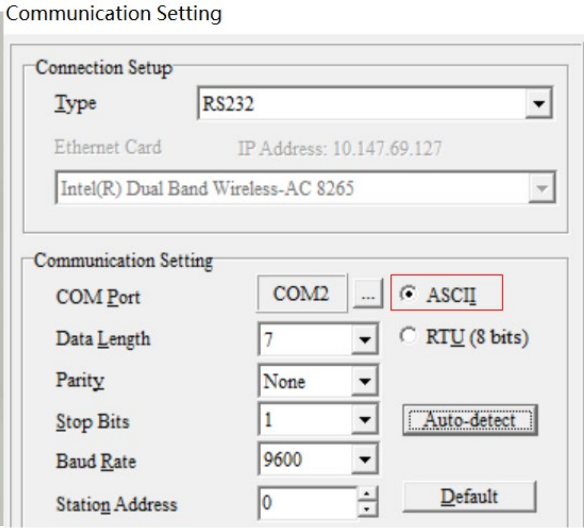
Method of Running PLC programs:

1. If PLC programs already exist in the PLC board of LTC, power-on the LTC, detach the slide cover, and switch "ASI" dip switch to the right side (as the red frame in the figure below shows). Then, PLC programs can be run.

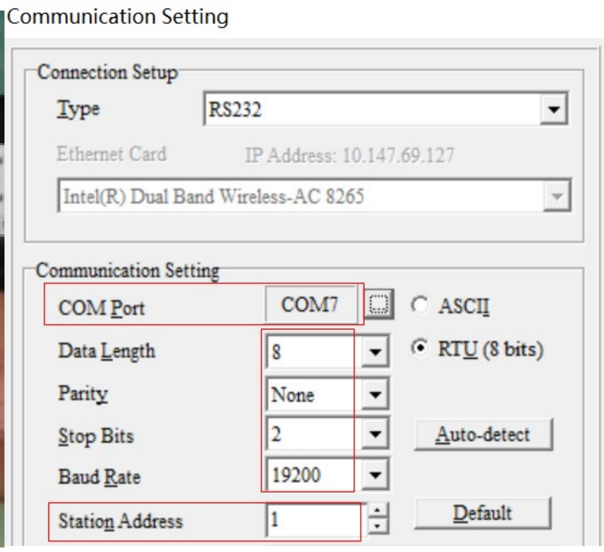
2. PLC programs can also be run by USB port and input terminals SG+, SG-. Connect them to WPLSoft software in PC to upload/download and monitor PLC programs.

Method of Uploading/Downloading PLC programs:

(1) Use USB cable (AM/BM) to connect USB port to PC without supplying three-phase 380–480 V_{AC} power to LTC. Two ends of the USB cable (AM/BM) show as the left figure below. Communication format should be ASCII, and serial baud rate is at random, as the right figure below shows.

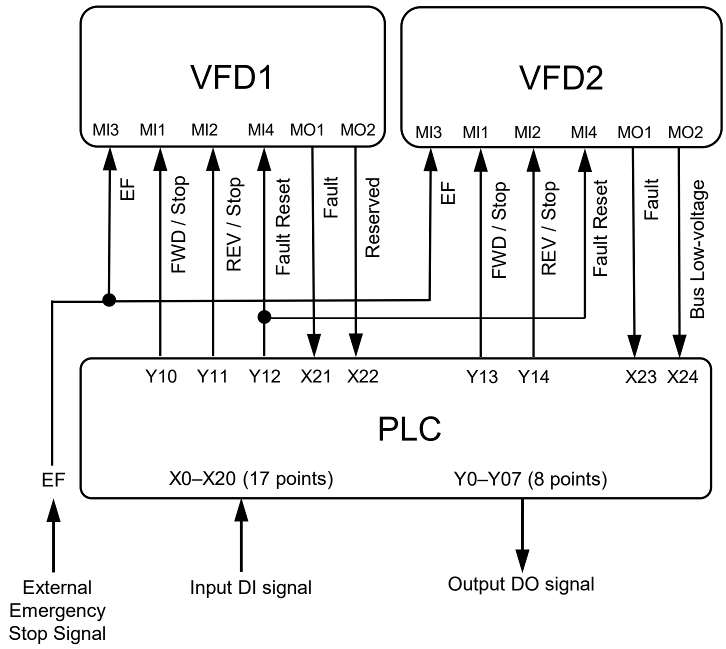


(2) Use Delta IFD6500 package (one gray flat cable and one black cable included). One end of the black cable is registered jack; the other end are two signal cables (green and yellow). Green cable connects to SG+, and yellow cable connects to SG-, as the left figure below shows. Communication format should be 19200, 8, N, 2, RTU, and station address should be 1, as the right figure below shows. Before uploading/downloading PLC programs, supply LTC with three-phase 380–480 V_{AC} power.



13-3-2 I/O Device Correspondence

The diagram below shows the connection of contact X and contact Y between VFD1 and VFD2 in the internal PLC board.



NOTE: If external emergency stop signal is connected to EF terminal, pay attention that when external emergency stop occurs, EF fault will be triggered both on VFD1 and VFD2 and ERROR indicator flashes. Fault code EF is displayed on the communication panel PU08 or PU08V. In this case, set Y12 to be ON to reset the EF fault triggered on VFD1 and VFD2.

LTC PLC Input Port (External Points):

No.	1	2	3	4	5	6	7	8	9	10	11	12
Function	24V	X0	X1	X2	X3	X4	X5	X6	X7	X10	EF	DCM
No.	13	14	15	16	17	18	19	20	21	22	23	24
Function	24V	X11	X12	X13	X14	X15	X16	X17	X20	SG+	SG-	DCM

LTC PLC Input/Output Port (Internal Points):

No.	1	2	3	4	5	6	7	8	9	10	11	12
Function	X21	X22	X23	X24	Y10	Y11	Y12	Y13	Y14		GND	GND
Pre-defined	Fault	Reserved	Fault	Bus low-voltage	FWD / STOP	REV / STOP	Fault reset	FWD / STOP	REV / STOP			

LTC PLC Output Port (External Points):

No.	1	2	3	4	5	6	7	8	9	10
Function	Y0	Y1	Y3	C0	Y3	Y4	Y5	C1	Y6	C2

LTC PLC Output Port (External Points):

No.	1	2	3	4
Function	Y7-1	C3-1	Y7-2	C3-2

For diagram regarding output port (external points) corresponding to relays, see Section 3-2-1 Wiring Diagram.

13-3-3 WPLSoft Installation

Visit the download center at Delta's website to download and install the software WPLSoft (v2.05 or above): 

After finishing installation, WPLSoft program will be created in the specified default sub-directory under "C:\Program Files\Delta Industrial Automation\WPLSoft x.xx".

13-3-4 Program Writing

Step 1. Click on the WPLSoft icon to start the editing software (see Figure 13-3-4-1).

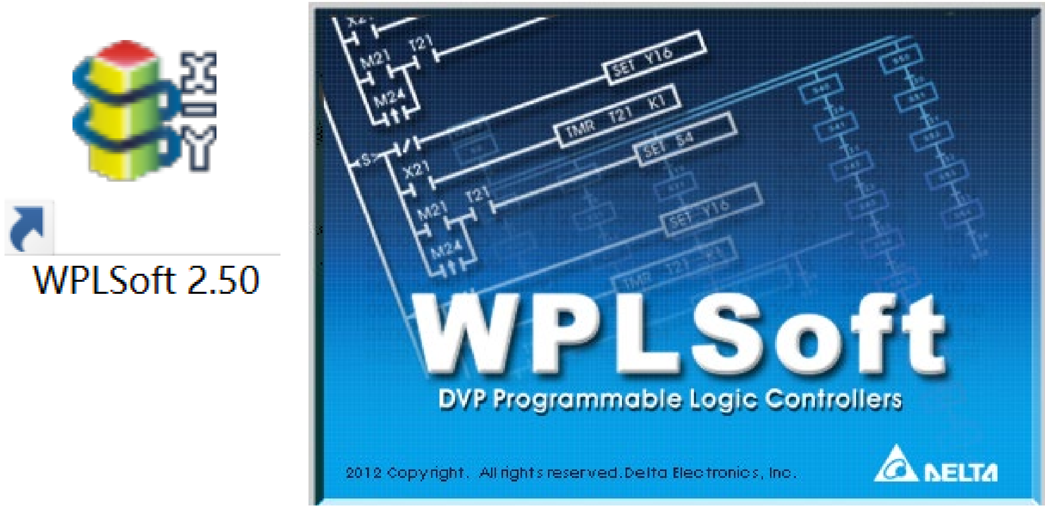


Figure 13-3-4-1 (Left: WPLSoft icon; right: WPLSoft starting page)

Step 2: **WPLsoft Editor** window appears (see Figure 13-3-4-2). When running WPLSoft for the first time, as there is no existing file, only **File (F)**, **Communication (C)**, **View (V)**, **Options (O)**, and **Help (H)** are available on the function menu.

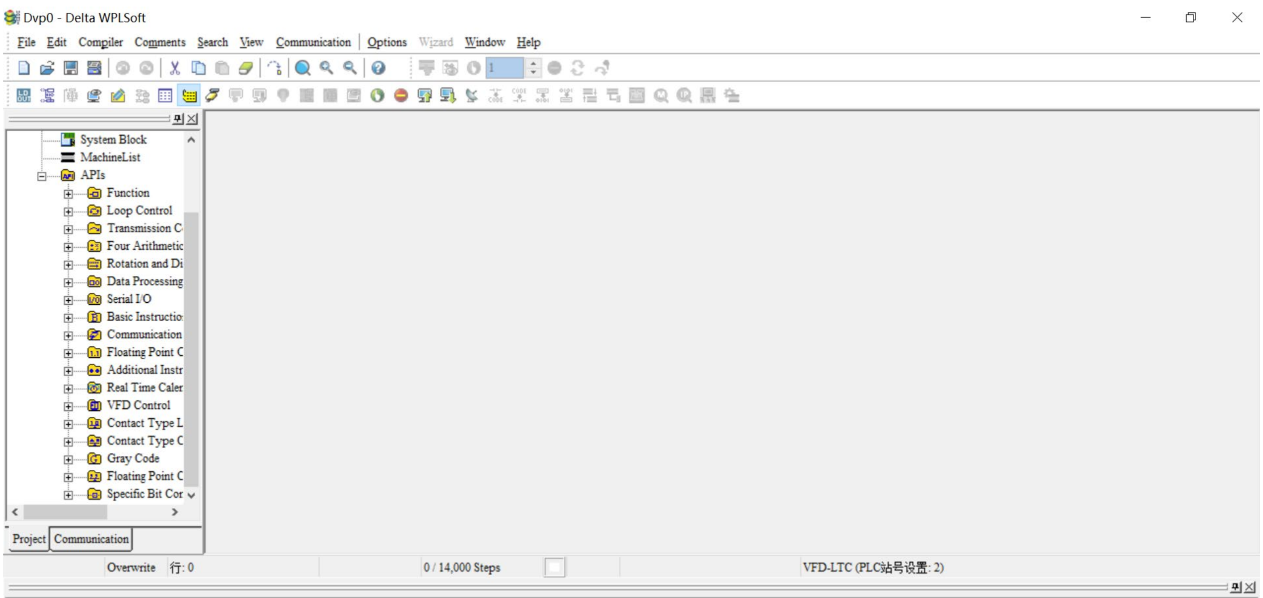


Figure 13-3-4-2

NOTE:

When starting WPLSoft for the second time, the last editing file will be opened directly and displayed in the editor window. WPLSoft editor window is described as Figure 13-3-4-3.

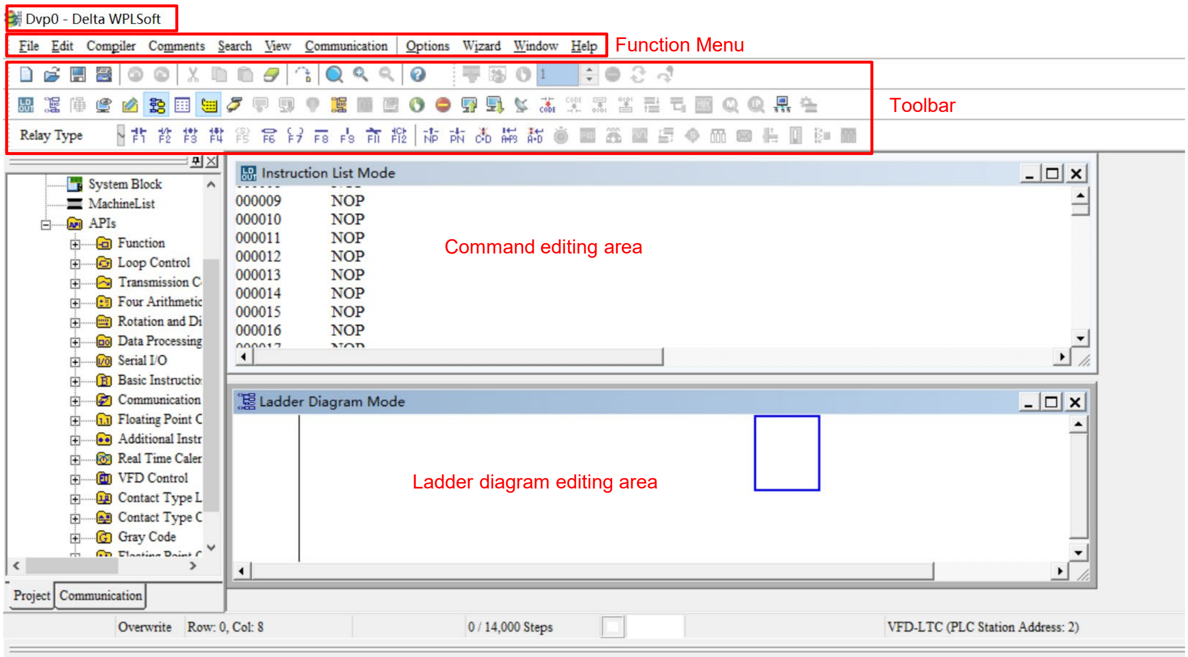


Figure 13-3-4-3

Step 3. Click on the  button on the toolbar: New (Ctrl+N) to open a new file, as Figure 13-3-4-4 shows.

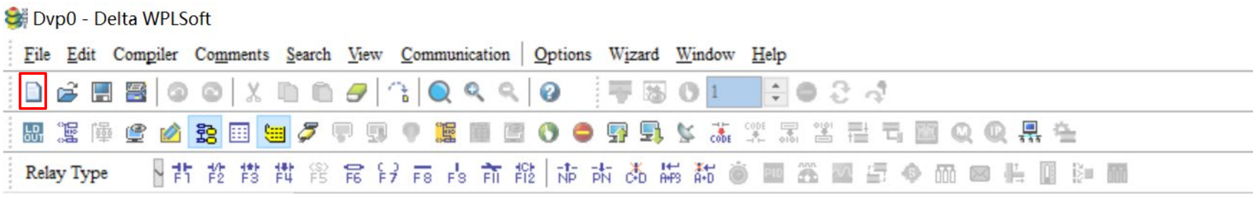


Figure 13-3-4-4

NOTE:

You can also select **New (Ctr+N)** under function menu **File (F)** to open a new file.

Figure 13-3-4-5

Step 4. **Select a PLC Model** window will then appear (see Figure 13-3-4-6). Set **Program Title**, **File Name**, **Model Type**, **VFD Type**, and **Communication Setting**.

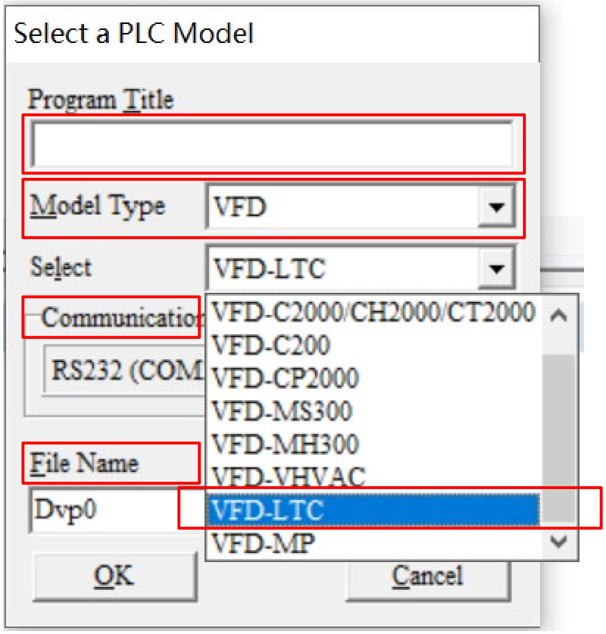


Figure 13-3-4-6

Communication Setting: Set the communication method as required (see Figure 13-3-4-7).

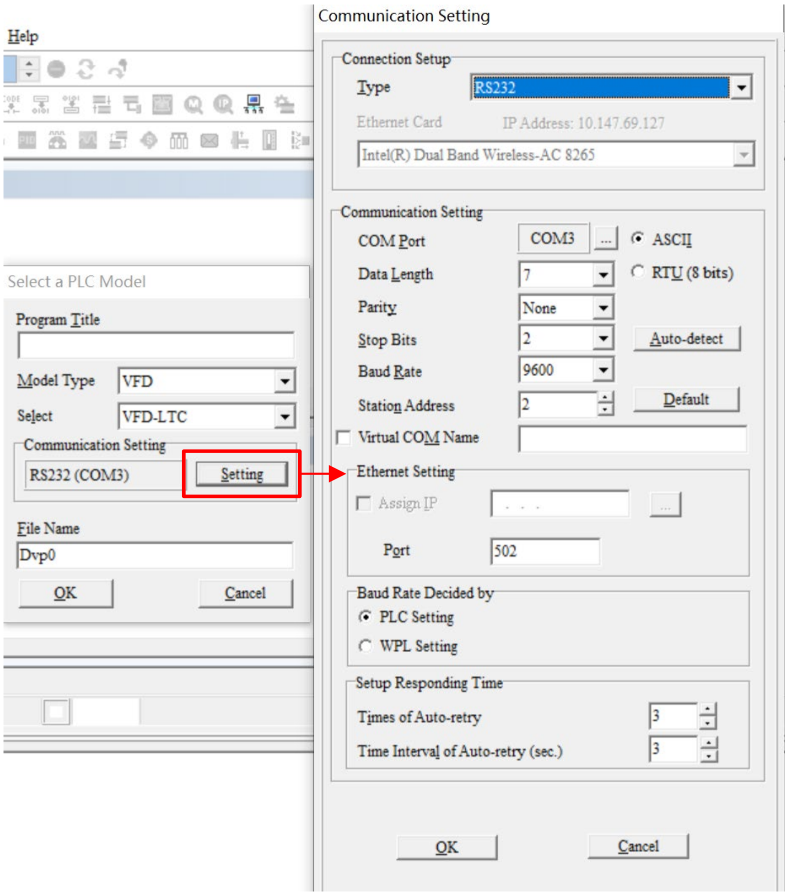


Figure 13-3-4-7

Step 5. After settings are finished, click **OK** to start editing the programs. Methods of editing programs: 1. **Instruction List Mode** and 2. **Ladder Diagram Mode**, as Figure 13-3-4-8 shows. Use the method as required.

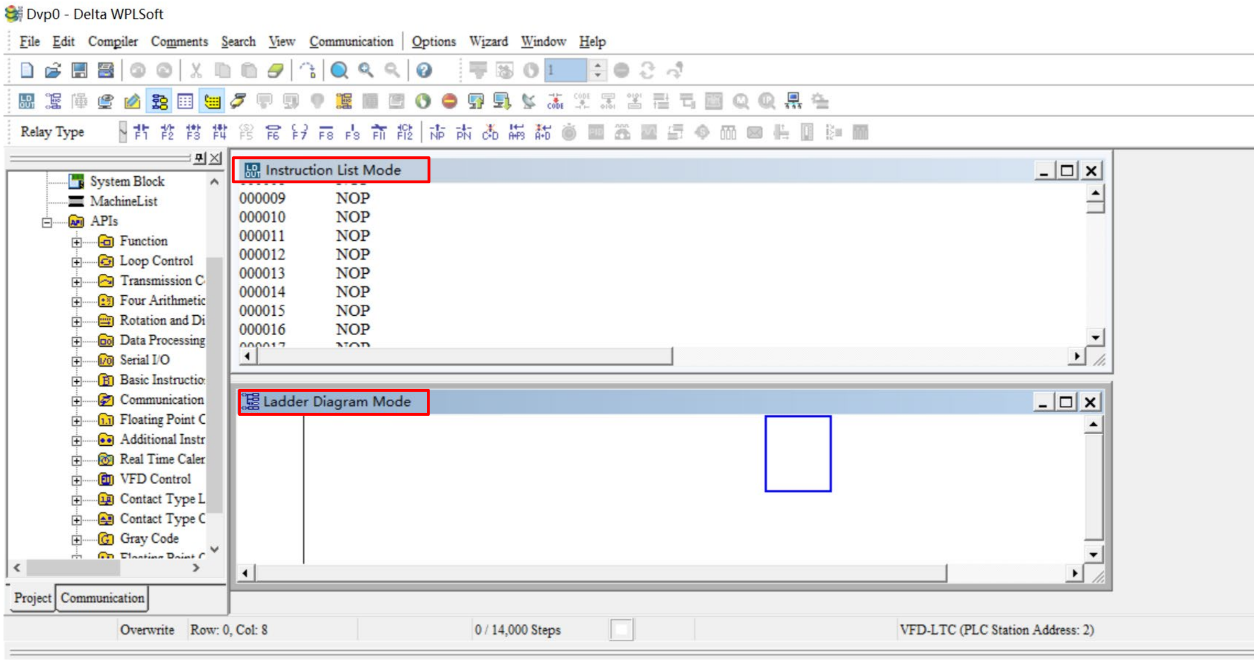


Figure 13-3-4-8

NOTE:

In the ladder diagram mode, you can edit programs using buttons on the ladder diagram toolbar (see Figure 13-3-4-9).

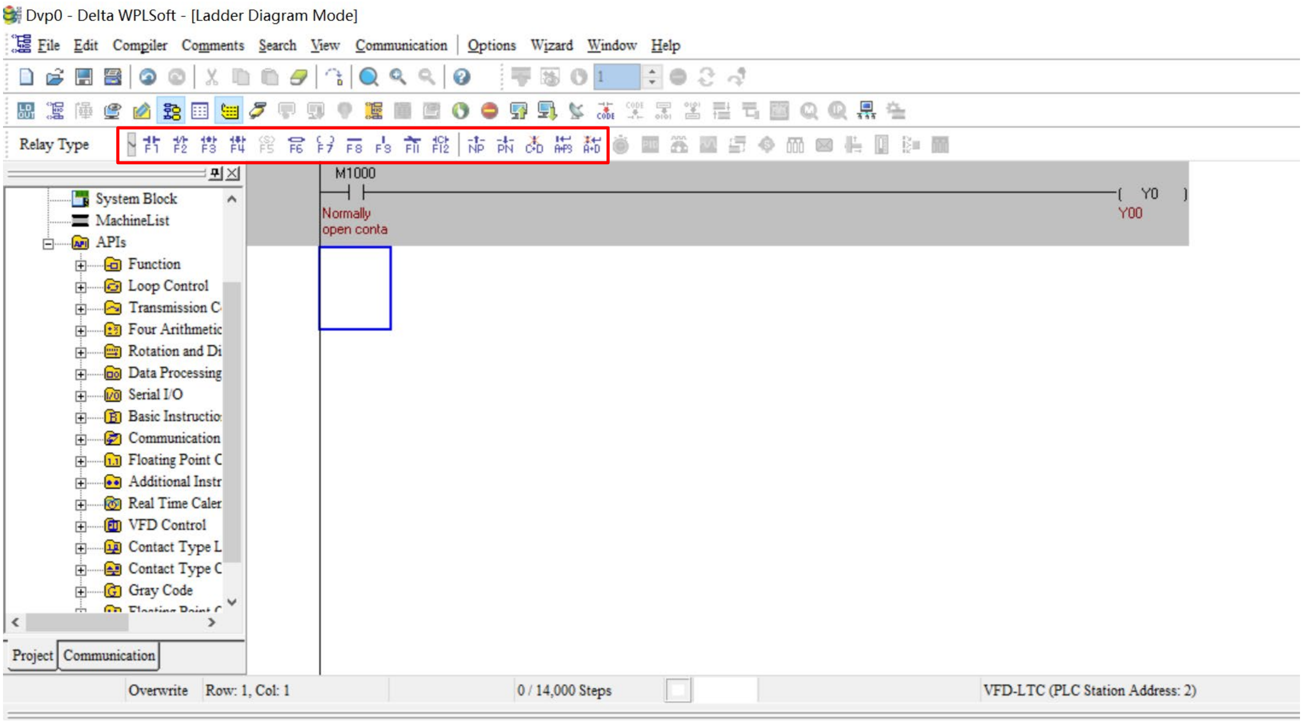


Figure 13-3-4-9

Example of Basic Operation

Input a ladder diagram as Figure 13-3-4-10 shows. The following steps show how to use mouse and keypad functions (F1 to F12) to edit programs.

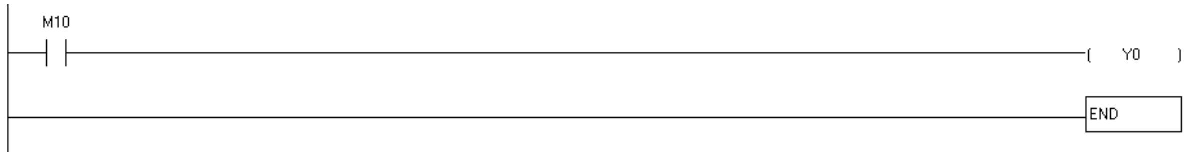


Figure 13-3-4-10

Step 1. Create a new file, and then the page below appears.

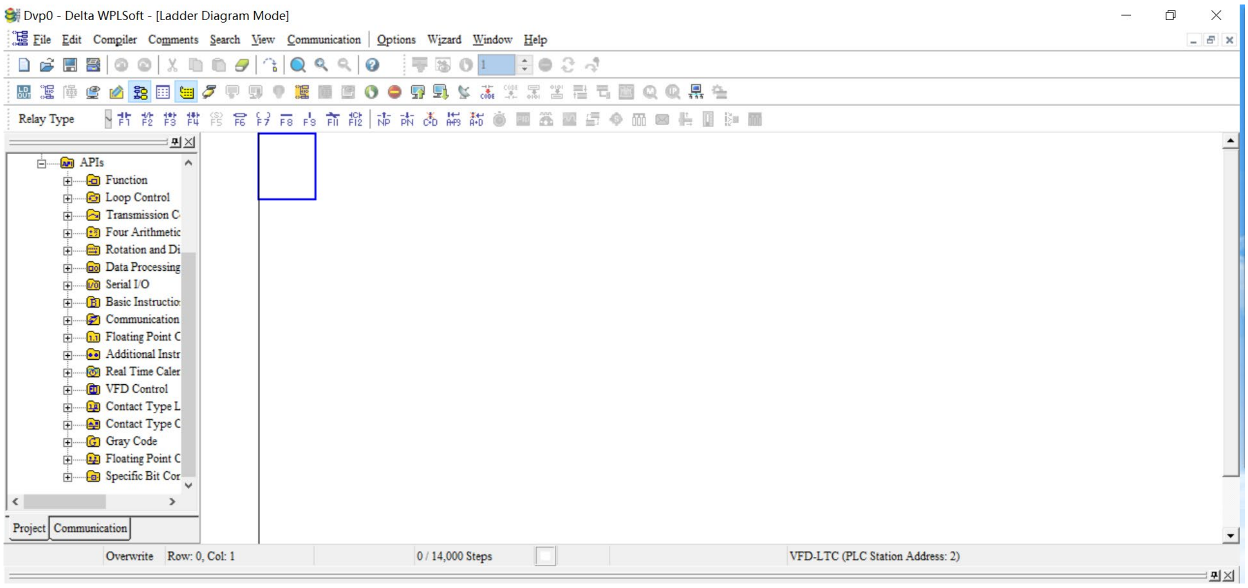


Figure 13-3-4-11

Step 2. Click  **Normally Open Contact** button or press function key F1. **Input Device Instruction** window appears. Select **Device Name** (e.g. M), **Device Number** (e.g. 10), and type **Comment** (e.g. Auxiliary coil). Then, click **OK** to finish settings, as Figure 13-3-4-12, 13-3-4-13 shows.

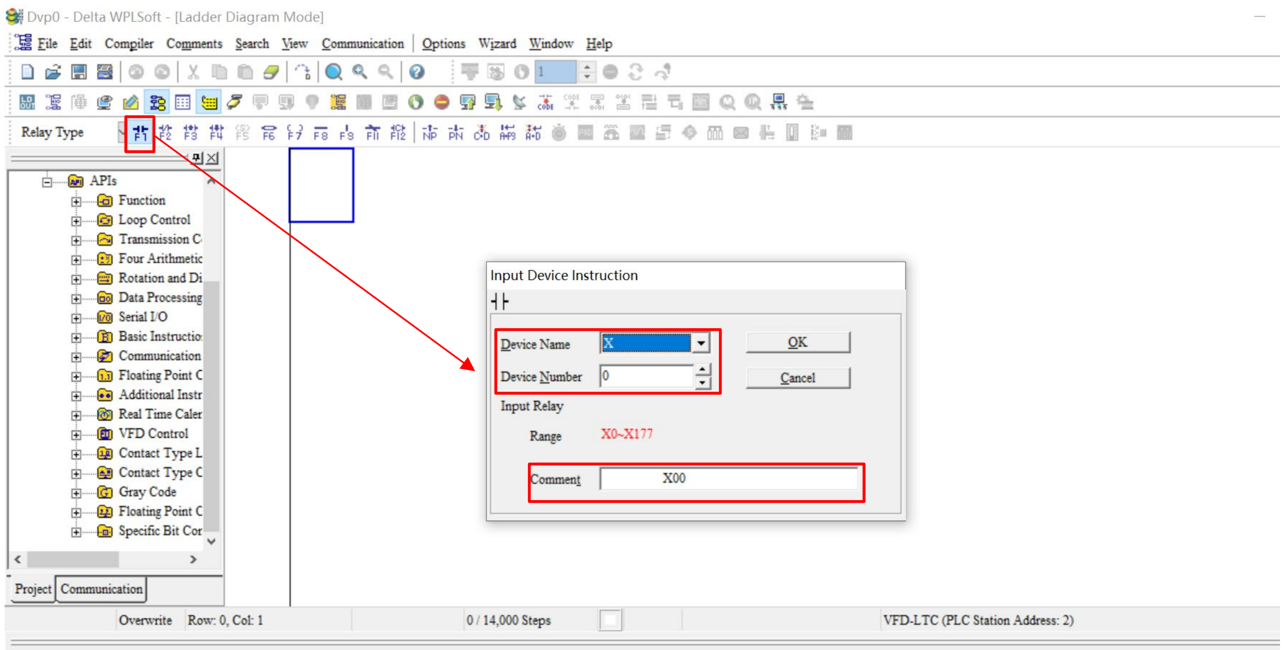


Figure 13-3-4-12

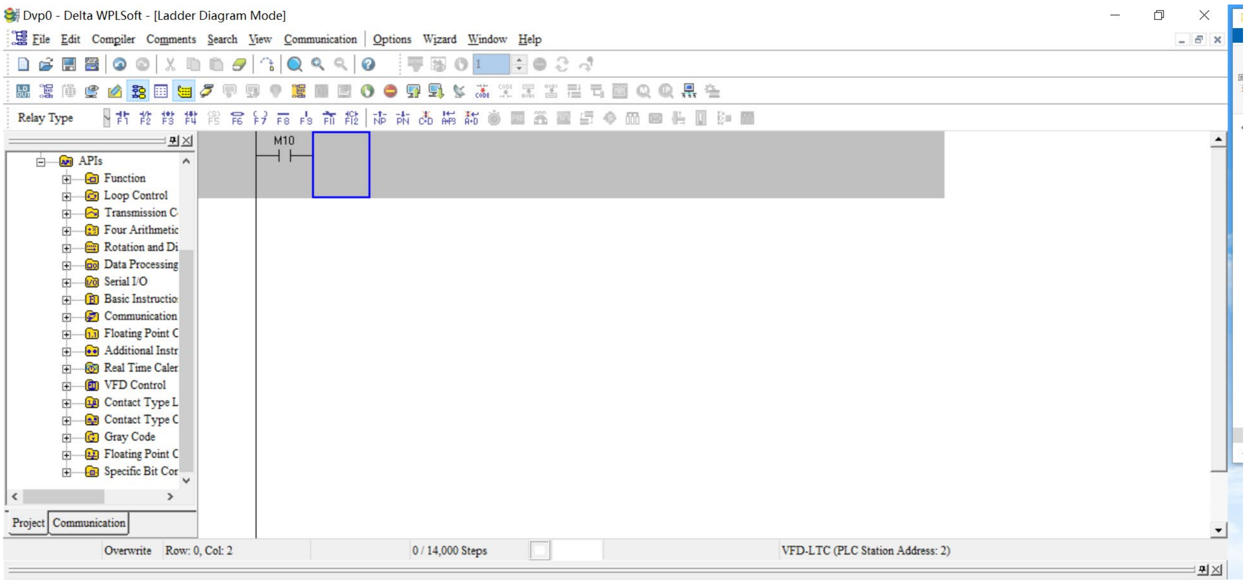


Figure 13-3-4-13

Step 3. Click **Output Coils** button or press function key F7. **Input Device Instruction** window appears. Select **Device Name** (e.g. Y), **Device Number** (e.g. 0), and type **Comment** (e.g. Output coil). Then, click **OK** to finish settings, as Figure 13-3-4-14, 13-3-4-15 shows.

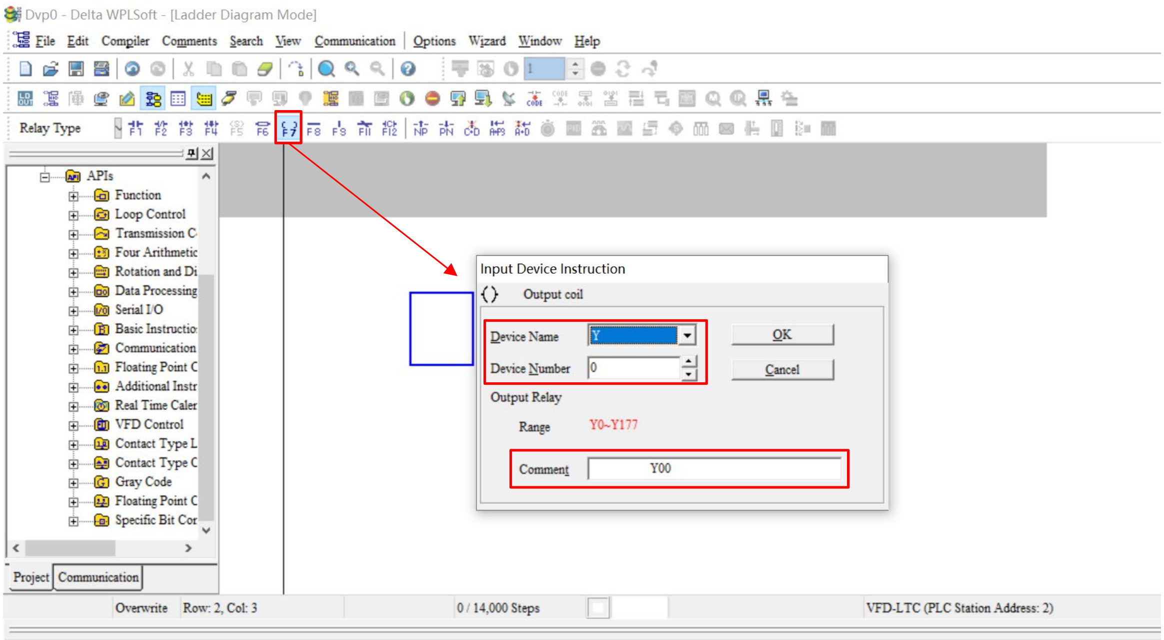


Figure 13-3-4-14

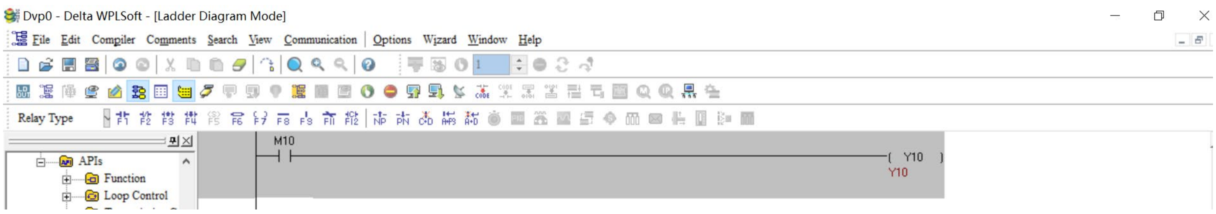


Figure 13-3-4-15

Step 4. Press ENTER key, and then an **Input Instruction** window appears. Type “END” in the field, and then click **OK**, as Figure 13-3-4-16, 13-3-4-17 shows.

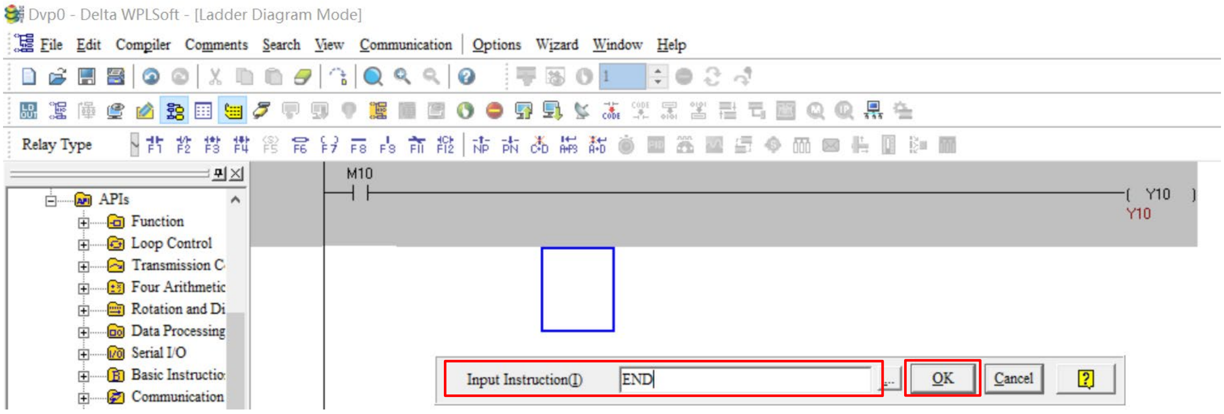


Figure 13-3-4-16

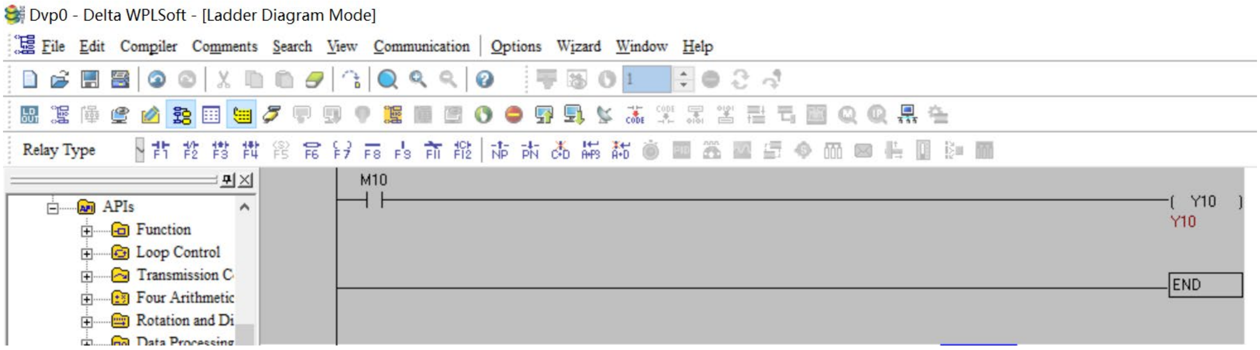
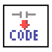


Figure 13-3-4-17

Step 5. Click  **Ladder Diagram=>Command** button to convert the edited ladder diagram to the commands. After compiling is finished, the number of rungs (steps) appear on the left side of the busbar, as Figure 13-3-4-18 shows.

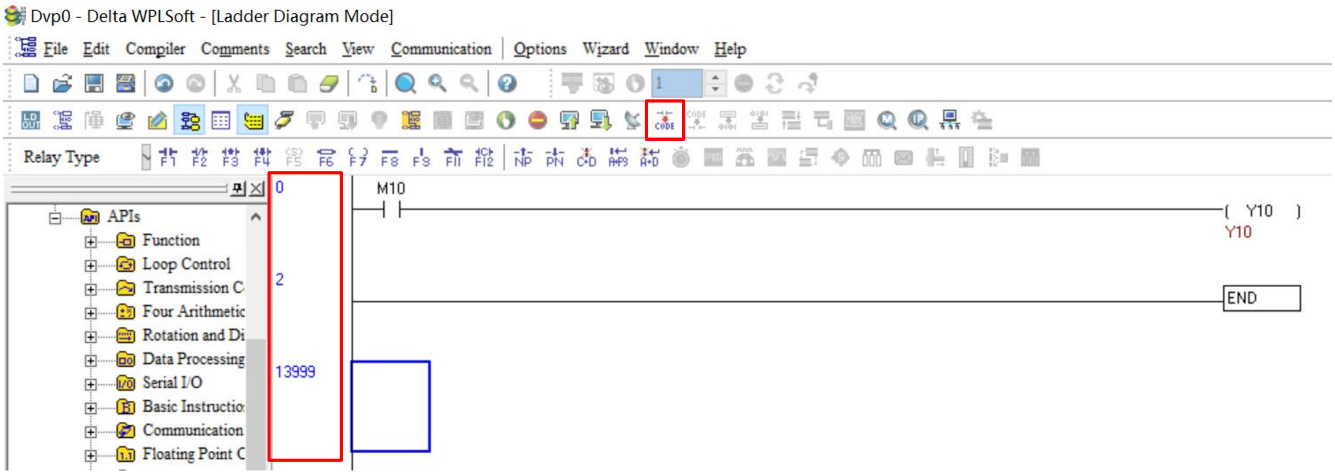


Figure 13-3-4-18

13-3-5 Program Downloading

After a program was input using WPLSoft, click **Compile** button. After compiling is finished, click Download button to download the programs. WPLSoft downloads the program to the online PLC in the communication format that you specified for the communication settings.

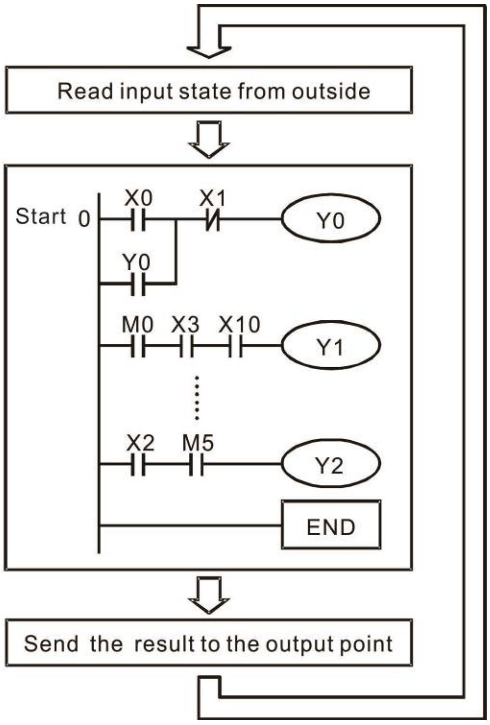
13-3-6 Program Monitoring

After downloading the program, make sure that the PLC is in Run mode. On the **Communications** menu, click **Online Mode** button, and then click **Start Ladder Diagram Control**, as the figure below shows. This allows you to monitor and operate the ladder diagram while online.

13-4 Basic Principles of PLC Ladder Diagrams

13-4-1 Schematic Diagram of PLC Ladder Diagram Program Scanning

Output results are calculated on the basis of the ladder diagram configuration (internal devices will have real-time output before results are sent to an external output point)



Repeated implementation

13-4-2 Introduction to Ladder Diagrams

Ladder diagrams comprise a graphic language widely applied in automatic control, and employs common electrical control circuit symbols. After a ladder diagram editor has been used to create a ladder pattern, PLC program designed is completed. The use of a graphic format to control processes is very intuitive, and is readily accepted by personnel who are familiar with electrical control circuit technology. Many of the basic symbols and actions in a ladder diagram comprise commonly seen electrical devices in conventional automatic control power distribution panels, such as buttons, switches, relays, timers, and counters.

Internal PLC devices: The types and quantities of internal PLC devices vary in different brands of products. Although these internal devices use the same names as conventional electrical control circuit elements such as relays, coils, and contacts, a PLC does not actually contain these physical devices, and they instead correspond to basic elements in the PLCs internal memory (bits). For instance, if a bit is 1, this may indicate that a coil is electrified, and if that bit is 0, it will indicate that the coil is not electrified. An N.O. contact (Normal Open, or contact a) can be used to directly read the value of the corresponding bit, and an N.C. contact (Normal Close, or contact b) can be used to obtain the inverse of the bits value. Multiple relays occupy multiple bits, and 8 bits comprise one byte; two bytes comprise one word, and two words comprise a double word. When multiple relays are processing at the same time (such as addition/ subtraction or displacement, etc.), a byte, word, or double word can be used. Furthermore, a PLC contains two types of internal devices: a timer and a counter. It not only has a coil, but can count time and numerical values. Because of this, when it is necessary to process some numerical values, these values are usually in the form of bytes, words, or double words.

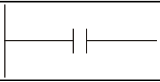
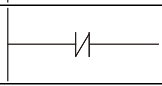
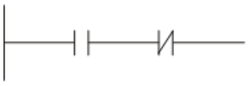
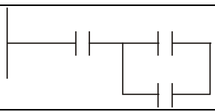
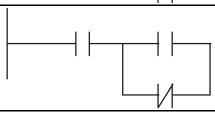
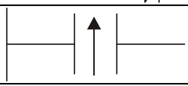
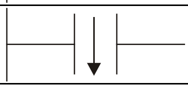
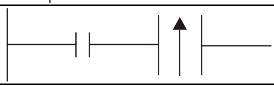
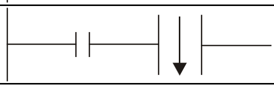
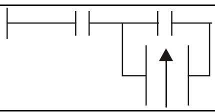
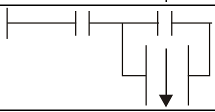
The various internal devices in a PLC all account for a certain quantity of storage units in the PLCs storage area. When these devices are used, the content of the corresponding storage area is read in the form of bits, bytes, or words.

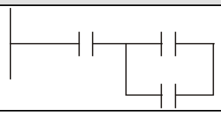
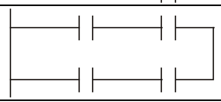
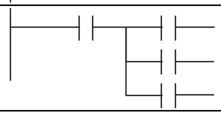
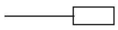
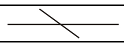
Introduction to the basic internal devices in a PLC

Device type	Description of Function
Input Relay	An input relay constitutes the basic unit of storage in a PLCs internal memory corresponding to an external input point (which serves as a terminal connecting with an external input switch and receiving external input signals). It is driven by external input signals, to which it assigns values of 0 or 1. A program design method cannot change the input relay status, and therefore cannot rewrite the corresponding basic units of an input relay, and WPLSoft cannot be used to perform compulsory On/Off actions. A relays contacts (contacts a and b) can be used an unlimited number of times. An input relay with no input signal must be left idle and cannot be used for some other purpose. ● Device indicated as: X0, X1, X7, X10, X11, etc. This device is expressed with the symbol "X", and a devices order is indicated with an octal number. Please refer to Section 13-3-2 I/O Device Correspondence for input point numbers.
Output Relay	An output relay constitutes the basic unit of storage in a PLCs internal memory corresponding to an external output point (which connects with an external load). It may be driven by an input relay contact, a contact on another internal device, or its own contacts. It uses one NO contact to connect with external loads or other contacts, and, like input contacts, can use the contact an unlimited number of times. An output relay with no input signal will be idle, but may be used an internal relay if needed. ● Device indicated as: Y0, Y1,…Y7, Y10, Y11,…etc. This device is expressed with the symbol "Y", and a devices order is indicated with an octal number. Please refer to Section 13-3-2 I/O Device Correspondence for output point numbers.
Internal Relay	Internal relays have no direct connection with the outside. These relays are auxiliary relays inside a PLC. Their function is the same as that of an auxiliary (central) relay in an electrical control circuit: Each auxiliary relay corresponding to a basic unit of internal storage; they can be driven by input relay contacts, output relay contacts, and the contacts of other internal devices. An internal auxiliary relays contact can also be used an unlimited number of times. Internal relays have no outputs to outside, and must output via an output point. ● Device indicated as: M0, M1 to M799, etc. This device is expressed as the symbol "M", and its order is expressed as a decimal number.
Counter	A counter is used to perform counting operations. A count setting value (such as the number of pulses to be counted) must be assigned when a counter is used. A counter contains a coil, contact, and a counting storage device. When the coil goes from Off to On, this indicates that the counter has an input pulse, and one is added to its count. There are 16 bits that can be employed by the user. ● Device indicated as: C0, C1 to C79, etc. This device is expressed as the symbol "C", and its order is expressed as a decimal number.
Timer	A timer is used to complete control of timing. The timer contains a coil, contact, and a time value register. When the coil is electrified, if the preset time is

Device type	Description of Function
	reached, the contact will be actuated (contact a will close, contact b will open), and the timers fixed value will be given by the set value. Timer has a regulated clock cycle (timing units: 100 ms). As soon as power to the coil is cut off, the contact will no longer be actuated (contact a will open, contact b will close), and the original timing value will return to zero. ● Device indicated as: T0, T1 to T159, etc. The device is expressed as the symbol "T", and its order is expressed as a decimal number.
Data register	When a PLC is used to perform various types of sequence control and set time value and count value control, it most commonly performs data processing and numerical operations, and data registers are used exclusively for storage of data and various parameters. Each data register contains 16 bits of binary data, which means that it can store one word. Two data registers with adjacent numbers can be used to process double words. ● Device indicated as: D0, D1 to D399, etc. The device is expressed as the symbol "D", and its order is expressed as a decimal number.

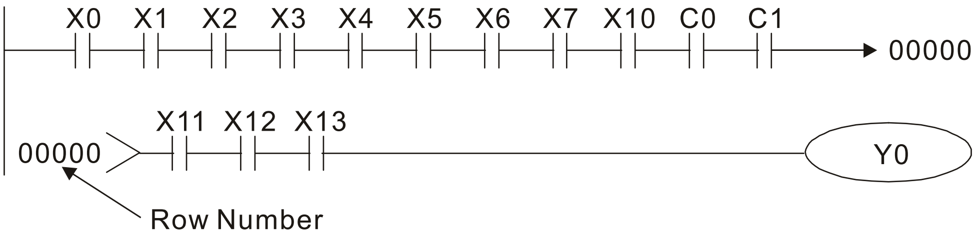
Ladder diagram images and their explanation

Ladder Diagram Structures	Explanation of Commands	Command	Using Device
	NO switch, contact a	LD	X, Y, M, T, C
	NC switch, contact b	LDI	X, Y, M, T, C
	Series NO	AND	X, Y, M, T, C
	Series NC	ANI	X, Y, M, T, C
	Parallel NO	OR	X, Y, M, T, C
	Parallel NC	ORI	X, Y, M, T, C
	Positive edge-triggered switch	LDP	X, Y, M, T, C
	Negative edge-triggered switch	LDF	X, Y, M, T, C
	Positive edge-triggered series	ANDP	X, Y, M, T, C
	Negative edge-triggered series	ANDF	X, Y, M, T, C
	Positive edge-triggered parallel	ORP	X, Y, M, T, C
	Negative edge-triggered parallel	ORF	X, Y, M, T, C

Ladder Diagram Structures	Explanation of Commands	Command	Using Device
	Block series	ANB	N/A
	Block parallel	ORB	N/A
	Multiple outputs	MPS MRD MPP	N/A
	Coil driven output commands	OUT	Y, M
	Some basic commands, applications commands	Some basic commands Applications commands	
	Inverted logic	INV	N/A

13-4-3 Overview of PLC Ladder Diagram Editing

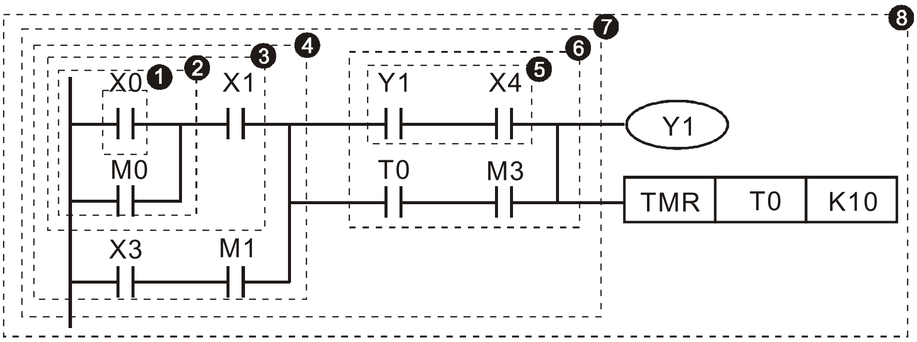
The program editing method begins from the left busbar and proceeds to the right busbar (the right busbar is omitted when editing using WPLSoft). Continue to the next row after completing each row; there is a maximum of 11 contacts on each row. If this is not sufficient, a continuous line will be generated to indicate the continued connection and more devices can be added. A continuous series of numbers will be generated automatically and identical input points can be used repeatedly. See figure below:



The ladder diagram programming method involves scanning from the upper left corner to the lower right corner. The coils and applications command-computing box are handled in the output, and the ladder diagram is placed on the farthest right. Taking the figure below as an example, we can gradually analyze the procedural sequence of the ladder diagram. The number in the upper right corner gives the sequential order.

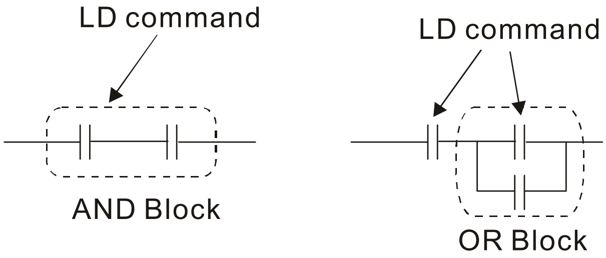
Explanation of command sequence

1	LD	X0	
2	OR	M0	
3	AND	X1	
4	LD	X3	
	AND	M1	
	ORB		
5	LD	Y1	
	AND	X4	
6	LD	T0	
	AND	M3	
	ORB		
7	ANB		
8	OUT	Y1	
	TMR	T0	K10

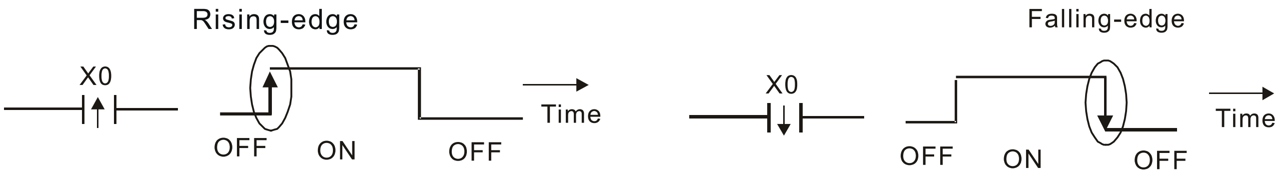


Explanation of basic structure of ladder diagrams

1. **LD (LDI) command:** An LD or LDI command is given at the start of a block.



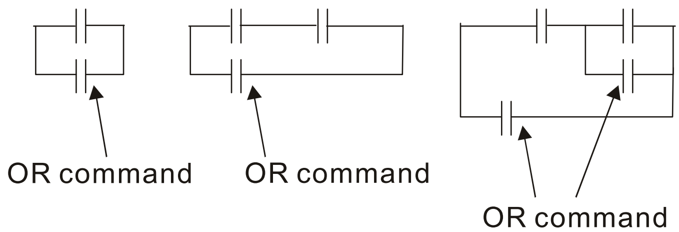
LDP and LDF have this command structure, but there are differences in their action state. LDP, LDF only act at the rising or falling edge of a conducting contact. (see figure below):



2. **AND (ANI) command:** A series configuration in which a single device is connected with one device or a block.

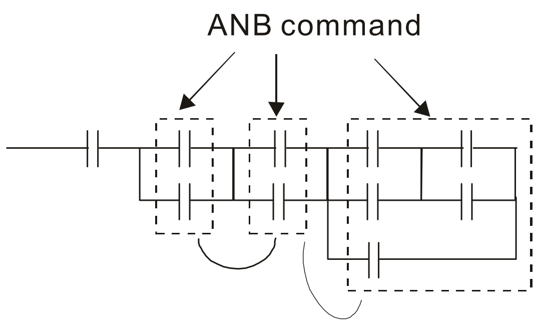
ANDP, ANDF also have structures like this, but their action occurs at the rising and falling edge.

3. **OR (ORI) command:** A single device is connected with one device or a block.

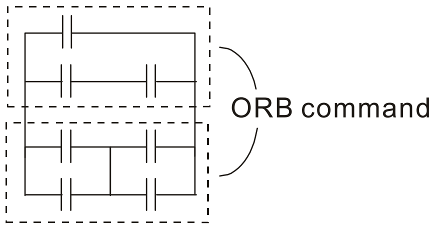


ORP, ORF also have identical structures, but their action occurs at the rising and falling edge.

4. **ANB command:** A configuration in which one block is in series with one device or block.

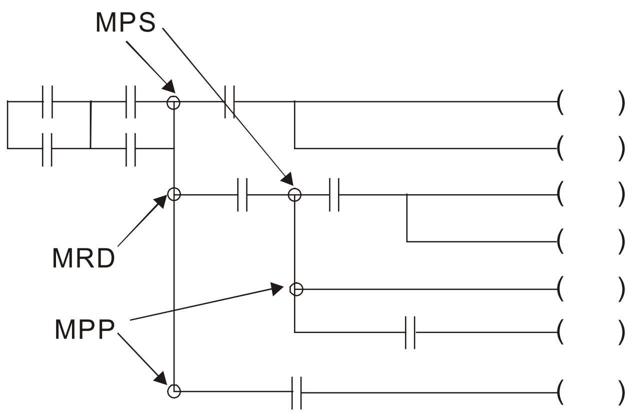


5. **ORB command:** A configuration in which one block is in parallel with one device or block.



In the case of ANB and ORB operations, if a number of blocks are connected, they should be combined to form a block or network from the top down or from left to right.

6. **MPS, MRD, MPP commands:** Branching point memory for multiple outputs, enabling multiple, different outputs. The MPS command begins at a branching point, where the so-called branching point refers to the intersection of horizontal and vertical lines. We have to rely on the contact status along a single vertical line to determine whether the next contact can give a memory command. While each contact is basically able to give memory commands, in view of convenience and the PLCs capacity restrictions, this can be omitted from some places when converting a ladder diagram. The structure of the ladder diagram can be used to judge what kinds of contact memory commands are used.
   - MPS can be distinguished by use of the "┬" symbol; this command can be used consecutively for up to 8 times. The MRD command is read from branching point memory; because logic states along any one vertical line must be the same, in order to continue analysis of other ladder diagrams, the original contact status must be read.
   - MRD can be distinguished by use of the " ├" symbol. The MPP command is read from the starting state of the uppermost branching point, and it is read from the stack (pop); because it is the final command along a vertical line, it indicates that the state of the vertical line can be concluded.
   - MPP can be distinguished by use of the " └" symbol. Although there should basically be no errors when using the foregoing analytical approach, the compiling program may sometimes omit identical state output, as shown in the following figure:



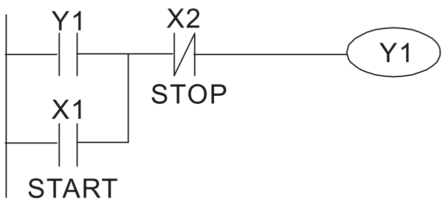
13-4-4 Commonly Used Basic Program Design Examples

Start, stop, and protection

Some applications may require a brief close or brief break using the buttons to start and stop equipment. A protective circuit must therefore be designed to maintain continued operation in these situations; this protective circuit may employ one of the following methods:

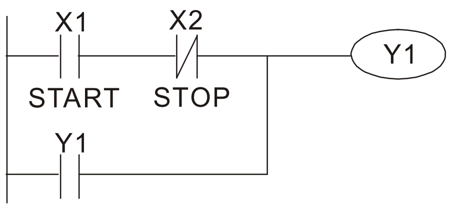
Example 1: Priority stop protective circuit

When the start NO contact X1=On, and the stop NC contact X2＝Off, Y1=On; if X2=On at this time, coil Y1 will no longer be electrified, and this is therefore referred to as priority stop.



Example 2: Priority start protective circuit

When start NO contact X1=On, and the stop NC contact X2＝Off, Y1=On, and coil Y1 will be electrified and protected. At this time, if X2=On, coil Y1 will still protect the contact and continue to be electrified, and this is therefore priority start.

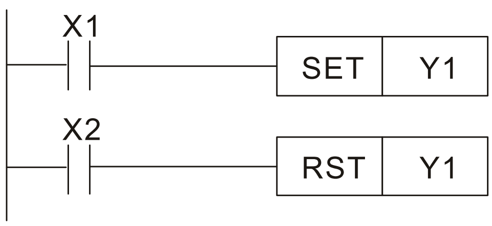


Example 3: Setting (SET) and reset (RST) command protective circuit

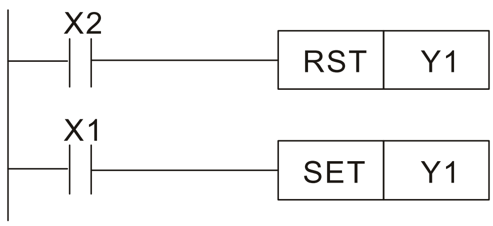
The following figure shows a protective circuit composed of RST and SET commands. Priority stop occurs when the RST command is placed after the SET command. Because the PLC executes programs from the top down, at the end of the program, the state of Y1 will indicate whether coil Y1 is electrified. When X1 and X2 are both actuated, Y1 will lose power, and this is therefore priority stop.

Priority start occurs when the SET command is placed after the RST command. When X1 and X2 are both actuated, Y1 will be electrified, and this is therefore priority start.

Top priority of stop



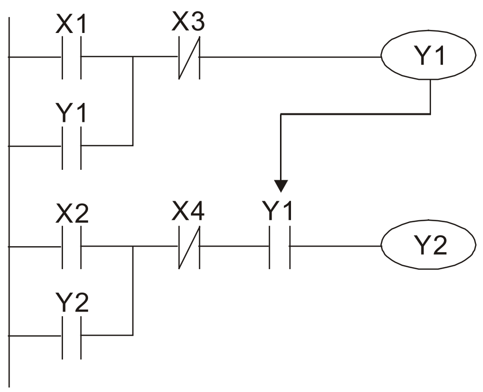
Top priority of start

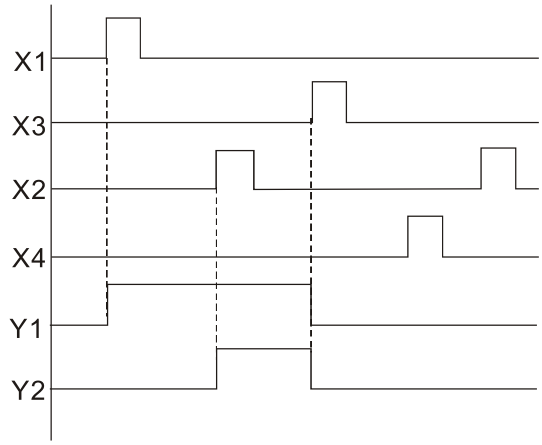


Commonly used control circuits

Example 4: Conditional control

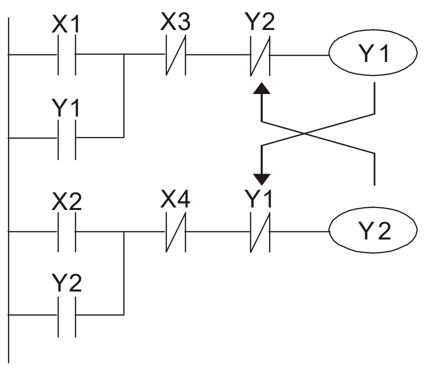
X1, X3 are respectively start/ stop Y1, and X2 & X4 are respectively start/ stop Y2; all have protective circuits. Because Y1s NO contact is in series with Y2s circuit, it becomes an AND condition for the actuation of Y2. The action of Y1 is therefore a condition for the action of Y2, and Y1 must be actuated before Y2 can be actuated.

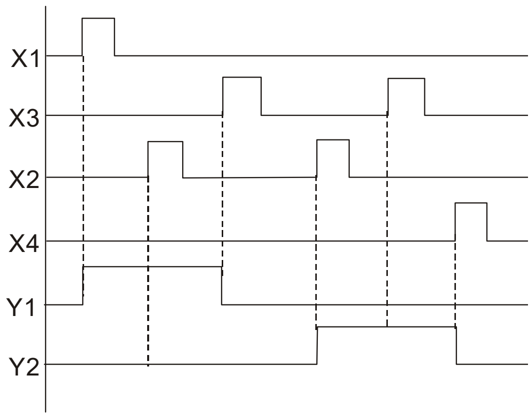




Example 5: Interlocking control

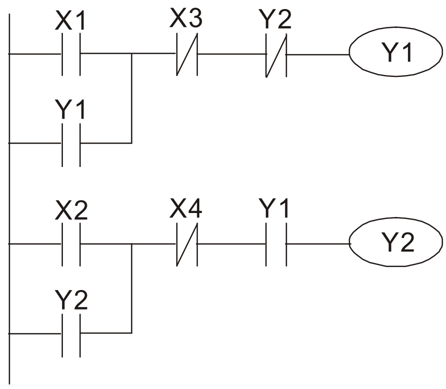
The figure below shows an interlocking control circuit. Depending on which of the start contacts X1, X2 is valid first, the corresponding output Y1 or Y2 will be actuated, and when one is actuated, the other will not be actuated. This implies that Y1 and Y2 cannot be actuated at the same time (interlocking effect). Even if both X1 and X2 are valid at the same time, because the ladder diagram program is scanned from the top down, it is impossible for Y1 and Y2 to be actuated at same time. This ladder diagram assigns priority only to Y1.





Example 6: Sequence control

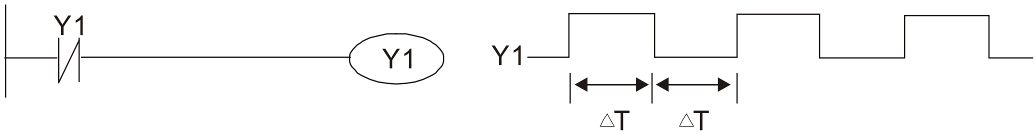
If the NC contact of Y2 in the interlocking control configuration of example 5 is put in series with the Y1 circuit, so that it is an AND condition for actuation of Y1 (see figure below), not only is Y1 a condition for the actuation of Y2 in this circuit, the actuation of Y2 will also stop the actuation of Y1. This configuration confirms the actuation order of Y1 and Y2.



Example 7: Oscillating circuit

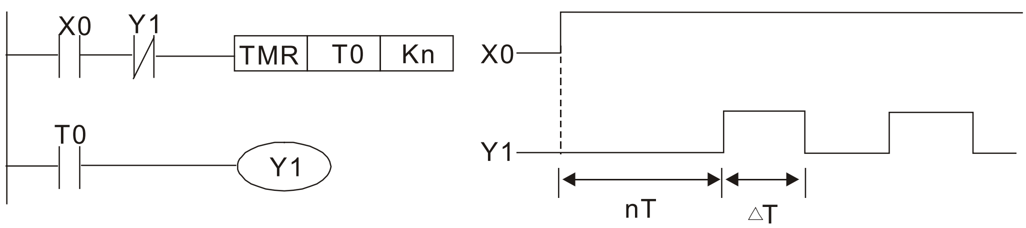
Oscillating circuit with a period of ΔT+ΔT

The figure below shows a very simple ladder diagram. When starting to scan the Y1 NC contact, because the Y1 coil has lost power, the Y1 NC contact will be closed. When the Y1 coil is then scanned, it will be electrified, and the output will be 1. When the Y1 NC contact is scanned in the scanning cycle, because Y1 coil is electrified, the Y1 NC contact will be opened, the Y1 coil will then lose power, and the output will be 0. Following repeated scanning, the output of Y1 coil will have an oscillating waveform with a period of ΔT (On) +ΔT (Off).



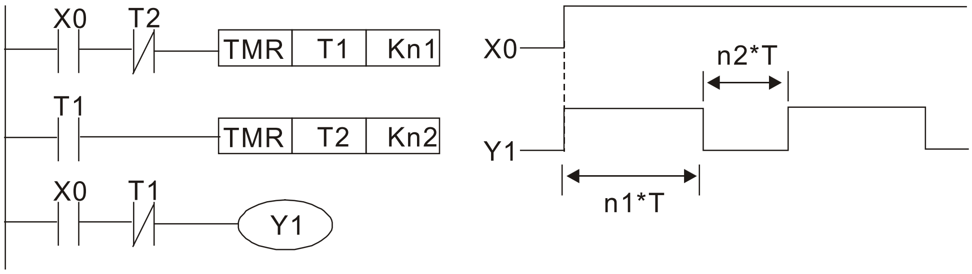
Oscillating circuit with a period of nT+ΔT

The program of the ladder diagram shown below uses timer T0 to control coil Y1s electri fied time. After Y1 is electrified, it causes timer T0 to close during the next scanning cycle, which will cause the output from Y1 to have the oscillating waveform shown in the figure below. Here n is the timers decimal setting value, and T is the clock cycle of the timer.



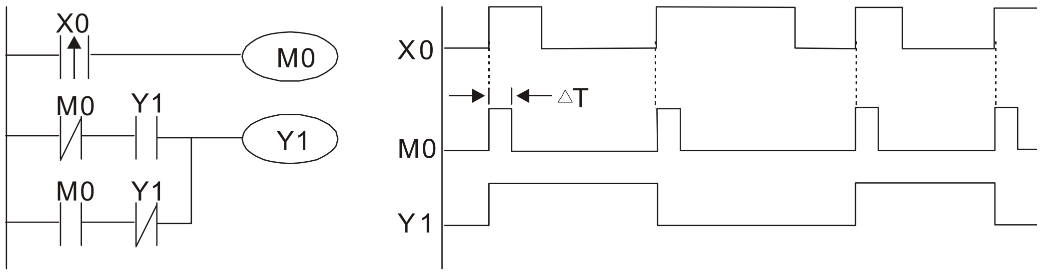
Example 8: Flashing circuit

The following figure shows an oscillating circuit of a type commonly used to cause an indicator light to flash or a buzzer to buzz. It uses two timers to control the On and Off time of Y1 coil. Here n1, n2 are the timing set values of T1 and T2, and T is the clock cycle of the timer.



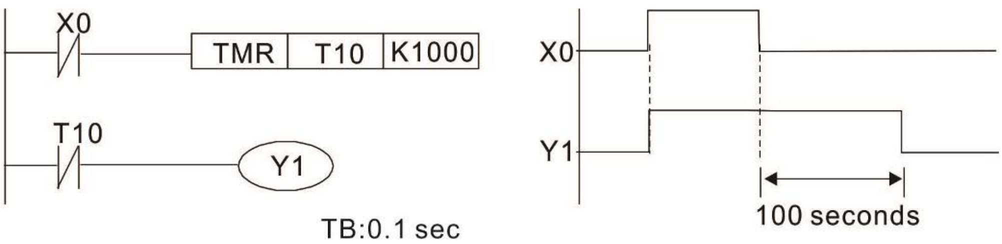
Example 9: Triggering circuit

In the figure below, a command consisting of the differential of the rising edge of X0 causes coil M0 to generate a single pulse for ΔT (length of one scanning cycle), and coil Y1 is electrified during this scanning cycle. Coil M0 loses power during the next scanning cycle, and NC contact M0 and NC contact Y1 are both closed. This causes coil Y1 to stay in an electrified state until there is another rising edge in input X0, which again causes the electrification of coil M0 and the start of another scanning cycle, while also causing coil Y1 to lose power, etc. The sequence of these actions can be seen in the figure below. This type of circuit is commonly used to enable one input to perform two actions in alternation. It can be seen from the time sequence in the figure below that when input X0 is a square wave signal with a period of T, the output of coil Y1 will be a square wave signal with a period of 2T.

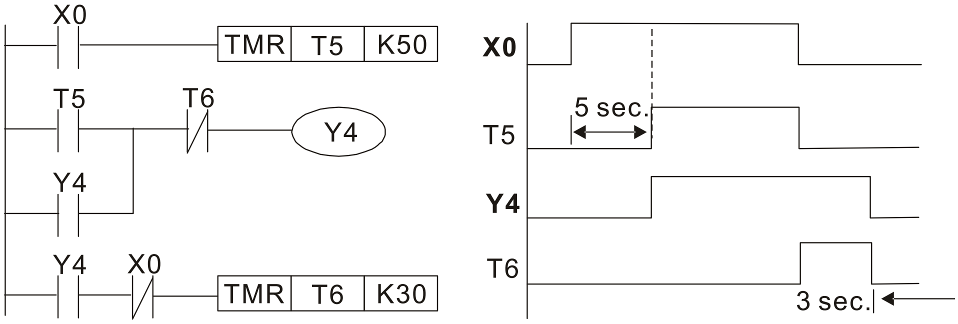


Example 10: Delay circuit

When input X0 is On, because the corresponding NC contact will be Off, the timer T10 will be in no power status, and output coil Y1 will be electrified. T10 will receive power and begin timing only after input X0 is Off, and output coil Y1 will be delayed for 100 sec. (K1000*0.1 sec. =100 sec.) before losing power; please refer to the sequence of actions in the figure below.

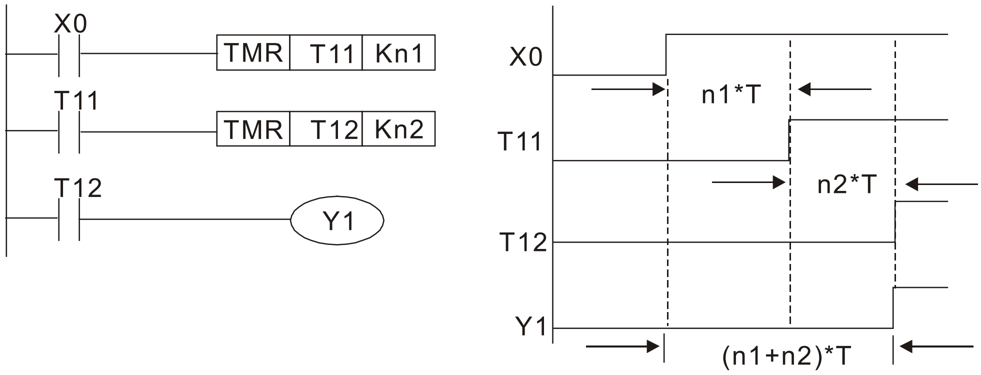


Example 11: The open / close delay circuit is composed of two timers; output Y4 will have a delay whether input X0 is On or Off.



Example 12: Extended timing circuit

In the circuit in the figure on the left, the total delay time from the moment input X0 closes to the time output Y1 is electrified is (n1+n2) * T, where T is the clock cycle. Timers: T11, T12; clock cycle: T.



13-5 Various PLC Device Functions

Item	Specifications	Notes
Control Mode	Alternating back-and-forth scanning method	
Inputs/Outputs Control Mode	Cyclic refresh mode	
Execution speed	Basic commands (several μs)	Application commands (1–dozens of μs)
Programming Language	Commands and ladder diagrams	
Program Capacity	14000 steps	
Inputs/Outputs Points	Digital inputs (X): 17 + 4 = 21 Digital outputs (Y): 8 + 5 = 13	X: 17 points for user-defined, and 4 for internal pre-defined Y: 8 points for user-defined, and 5 for internal pre-defined

<table>
<tr><th>Type</th><th>Device</th><th colspan="2">Item</th><th colspan="2">Range</th><th>Function</th></tr>
<tr><td rowspan="8">Relay (bit)</td><td>X</td><td colspan="2">External input relay</td><td>X0–X20, 17 points, octal</td><td rowspan="4">Total 34 points</td><td>Corresponds to external input points</td></tr>
<tr><td>X</td><td colspan="2">Internal input relay</td><td>X21–X24, 4 points, octal</td><td>Corresponds to internal input points</td></tr>
<tr><td>Y</td><td colspan="2">External output relay</td><td>Y0–Y7, 8 points, octal</td><td>Corresponds to external output points</td></tr>
<tr><td>Y</td><td colspan="2">Internal output relay</td><td>Y10–Y14, 5 points, octal</td><td>Corresponds to internal output points</td></tr>
<tr><td rowspan="2">M</td><td rowspan="2">Auxiliary relay</td><td>General purpose</td><td>M0–M999, 1000 points</td><td rowspan="2">Total 1280 points</td><td rowspan="2">Contacts can be used as ON/OFF switch in the program</td></tr>
<tr><td>Special purpose</td><td>M1000–M1279, 280 points</td></tr>
<tr><td>T</td><td>Timer</td><td>100 ms timer</td><td>T0–T159, 160 points</td><td>Total 160 points</td><td>Timer indicated by TMR instruction. If timing reaches its target, the T contact of the same number will be ON.</td></tr>
<tr><td>C</td><td>Counter</td><td>16-bit counting up (general purpose)</td><td>C0–C79, 80 points</td><td>Total 80 points</td><td>Counter indicated by CNT (DCNT) instruction. If counting reaches its target, the C contact of the same number will be ON.</td></tr>
<tr><td rowspan="4">Register word data (2 byte)</td><td>T</td><td colspan="2">Current value of timer</td><td colspan="2">T0–T159, 160 points</td><td>When the timing reaches the target, the contact of the timer will be ON.</td></tr>
<tr><td>C</td><td colspan="2">Current value of counter</td><td colspan="2">C0–C79, 16-bit counter, 80 points</td><td>When the counting reaches the target, the contact of the counter will be ON.</td></tr>
<tr><td rowspan="2">D</td><td rowspan="2">Data register</td><td>Latched</td><td>D0–D999, 1000 points</td><td rowspan="2">Total 1620 points</td><td rowspan="2">Memory area for data storage</td></tr>
<tr><td>Special purpose</td><td>D1000–D1619，620 points</td></tr>
<tr><td rowspan="4">Constant</td><td rowspan="2">K</td><td rowspan="2">Decimal</td><td>Single byte</td><td colspan="3">Available setting range: K-32,768 to K32,767</td></tr>
<tr><td>Double byte</td><td colspan="3">Available setting range: K-2,147,483,648 to K2,147,483,647</td></tr>
<tr><td rowspan="2">H</td><td rowspan="2">Hexadecimal</td><td>Single byte</td><td colspan="3">Available setting range: H0000 to HFFFF</td></tr>
<tr><td>Double byte</td><td colspan="3">Available setting range: H00000000 to HFFFFFFFF</td></tr>
<tr><td colspan="4">Serial communication port (program write/read)</td><td colspan="3">RS-485 USB Port</td></tr>
</table>

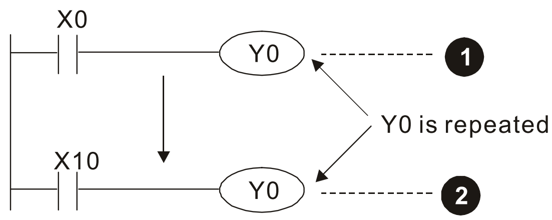
13-5-1 Introduction to Device Functions

Input / output contact functions

Input contact X functions: Input contact X is connected with an input device, and reads input signals entering the PLC. The number of times that contact a or b of input contact X is used in the program is not subject to restrictions. The On/ Off state of input contact X will change as the input device switches On and Off; a peripheral device (WPLSoft) cannot be used to force contact X On or Off.

Output contact Y functions

The job of output contact Y is to send an On/Off signal to drive the load connected with output contact Y. Output contacts consist of two types: relays and transistors. While number of times that contact a or b of each output contact Y is used in the program is not subject to restrictions, it is recommended that the number of output coil Y be used only once in a program, otherwise the right to determine the output state when the PLC performs program scanning will be assigned to the programs final output Y circuit.



The output of Y0 will be decided by circuit ❷, i.e. decided by ON/OFF of X10.

Numerical value, constant [K]/ [H]

Constant	Single-byte	K	Decimal	K-32,768–K32,767
	Double-byte			K-2,147,483,648–K2,147,483,647
	Single-byte	H	Hexadecimal	H0000–HFFFF
	Double-byte			H00000000–HFFFFFFFF

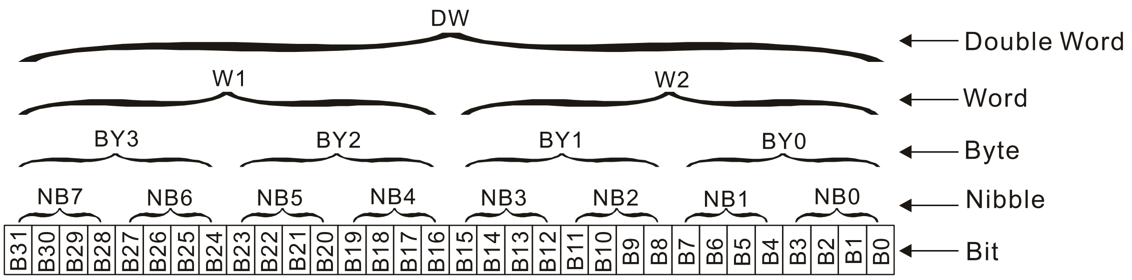
The PLC can use five types of numerical values to implement calculations based on its control tasks; the following is an explanation of the missions and functions of different numerical values.

Binary Number, BIN

The PLCs numerical operations and memory employ binary numbers. Binary nibbles and relevant terms are explained as follows:

bit	Bits are the fundamental units of binary values, and have a state of either 1 or 0
Nibble	Comprised of a series of 4 bits (such as b3–b0); can be used to express a one-nibble decimal number 0–9 or hexadecimal number: 0–F.
Byte	Comprised of a series of two nibbles (i.e. 8 bits, b7–b0); can express a hexadecimal number: 00–FF.
Word	Comprised of a series of two bytes (i.e. 16 bits, b15–b0); can express a hexadecimal number with four nibbles: 0000–FFFF.
Double Word	Comprised of a series of two words (i.e. 32 bits, b31–b0); can express a hexadecimal number with eight nibbles: 00000000–FFFFFFFF

Relationship between bits, digits, nibbles, words, and double words in a binary system (see figure below):



Octal Number, OCT

The external input and output terminals of a DVP-PLC are numbered using octal numbers
Example: External input: X0–X7, X10–X17 (Device number table);
External output: Y0–Y7, Y10–Y17 (Device number table)

Decimal Number, DEC

Decimal numbers are used for the following purposes in a PLC system:

- The setting values of timer T or counter C, such as TMR C0 K50. (K constant)
- The numbers of devices including M, T, C, or D, such as M10 or T30. (device number)
- Used as an operand in an application command, such as MOV K123 D0. (K constant)

Binary Code Decimal, BCD

Uses one nibble or 4 bits to express the data in a decimal number; a series of 16 bits can therefore express a decimal number with 4 nibbles. Chiefly used to read the input value of a fingerwheel numerical switch input or output a numerical value to a seven-segment display drive.

Hexadecimal Number, HEX

Applications of hexadecimal numbers in a PLC system: Used as operands in application commands, such as MOV H1A2B D0. (H constant)

Constant K

Decimal numbers are usually prefixed with a "K" in a PLC system, such as K100. This indicates that it is a decimal number with a numerical value of 100.

Example: K can be combined with bit device X, Y, M, or S to produce data in the form of a nibble, byte, word, or double word, such as in the case of K2Y10 or K4M100. Here K1 represents a 4-bit combination, and K2–K4 variously represent 8, 12, and 16-bit combinations.

Constant H

Hexadecimal numbers are usually prefixed with the letter "H" in a PLC system, such as in the case of H100, which indicates a hexadecimal number with a numerical value of 100.

Functions of auxiliary relays

Like an output relay Y, an auxiliary relay M has an output coil and contacts a and b, and the number of times they can be used in a program is unrestricted. Users can use an auxiliary relay M to configure the control circuit, but cannot use it to directly drive an external load. Auxiliary relays have the following two types of characteristics:

- Ordinary auxiliary relays: Ordinary auxiliary relays will all revert to the Off state if a power outage occurs while the PLC is running, and will remain in the Off state if power is again turned down.
- Special purpose auxiliary relays: Each special purpose auxiliary relay has its own specific use. Do not use any undefined special purpose auxiliary relays.

Timer functions

Timers take 100 ms as their timing units. When the timing method is an upper time limit, when the current timer value = set value, power will be sent to the output coil. Timer setting values consist of decimal K values, and the data register D can also serve as a setting value.

Actual timer setting time = timing units * set value

Counter features

Item	16-bit counter
Type	General Type
CT Direction:	Score
Setting	0–32,767
Designation of set value	Constant K or data register D
Change in current value	When the count reaches the set value, there is no longer a count
Output contact	When the count reaches the set value, the contact comes On and stays On
Reset	The current value reverts to 0 when an RST command is executed, and the contact reverts to Off
Contact actuation	All are actuated after the end of scanning

Counter functions

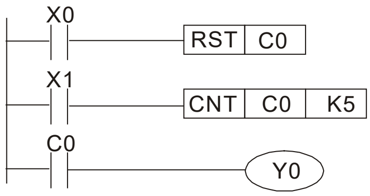
When a counters counting pulse input signal goes Off →On, if the counters current value is equal to the set value, the output coil will come On. The setting value will be a decimal K values, and the data register D can also serve as a setting value.

16-bit counter C0–C79:

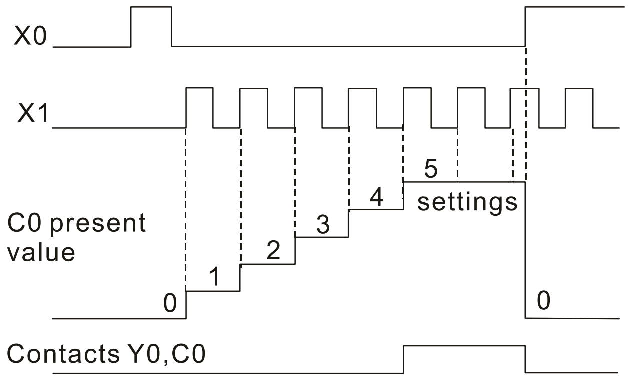
- 16-bit counter setting range: K0–K32,767. (when K0 and K1 are identical, the output contact will immediately be On during the first count.)
- The current counter value will be cleared from an ordinary counter when power is shut off to the PLC.
- If the MOV command or WPLSoft is used to transmit a value greater than the set value to the C0 current value register, when the next X1 goes from Off→On, the C0 counter contact will change to On, and the current value will change to the set value.
- A counters setting value may be directly set using a con stant K or indirectly set using the value in register D (not including special data registers D1000–D1199 or D2000–D2799).
- If the set value employs a constant K, it may only be a positive number; the set value may be either a positive or a negative number if the value in data register D is used. The current counter value will change from 32,767 to -32,768 as the count continues to accumulate.

Example

LD	X0	
RST	C0	
LD	X1	
CNT	C0	K5
LD	C0	
OUT	Y0	



1. When X0=On and the RST command is executed, the current value of C0 will revert to 0, and the output contact will revert to Off.
2. When X1 changes from Off→On, the current value of the counter will execute an increase (add one).
3. When the count of counter C0 reaches the set value K5, the contact C0 will come On, and the current value of C0＝ set value =K5. Afterwards, signal C0 triggered by X1 cannot be received, and the current value of C0 will remain K5.
4.



13-5-2 Introduction to Special Relay Functions (Special M)

R/W items: RO: read only function; RW: read and write function

Special M	Description of Function	R/W *
M1000	Operates monitor NO contact (contact a). NO while RUN, contact a. This contact is On while in the RUN state.	RO
M1001	Operates monitor NC contact (contact b). NC while RUN, contact b. This contact is Off while in the RUN state.	RO
M1002	Initiates a forward (the instant RUN is On) pulse. Initial pulse, contact a. Produces a forward pulse the moment RUN begins; its width = scan cycle	RO
M1003	Initiates a reverse (the instant RUN is Off) pulse. Initial pulse, contact a. Produces a reverse pulse the moment RUN ends; the pulse width = scan cycle	RO
M1004	Reserved	RO
M1005	Drive malfunction instructions	RO
M1006	Converter has no output (1 = no output, 0 = output)	RO
M1007	Drive direction FWD(0)/REV(1)	RO
M1008 – M1010	--	--
M1011	10 ms clock pulse, 5ms On / 5ms Off	RO
M1012	100 ms clock pulse, 50ms On / 50ms Off	RO
M1013	1 sec. clock pulse, 0.5s On / 0.5s Off	RO
M1014	1 min. clock pulse, 30s On / 30s Off	RO
M1015	Frequency attained (when used together with M1025)	RO
M1016	Parameter read/write error	RO
M1017	Parameter write successful	RO
M1018	--	--
M1019	--	--
M1020	Zero flag	RO
M1021	Borrow flag	RO
M1022	Carry flag	RO
M1023	Divisor is 0	RO
M1024	--	--
M1025	Target drive frequency = set frequency (ON) Target drive frequency =0 (OFF)	RW
M1026	Drive operating direction FWD(OFF) / REV(ON)	RW
M1027	Drive Reset	RW
M1028	--	--
M1029	--	--
M1030	--	--
M1031	Compulsory setting of the current PID integral value equal to D1019 (0 change, 1 valid)	RW
M1032	Compulsory definition of FREQ command after PID control	RW
M1033	--	--
M1034	Initiates CANopen real-time control	RW
M1035	Initiates internal communications control	RW
M1036	Ignore calendar error	RW
M1037	--	--
M1038	MI8 count begins	RW
M1039	Reset MI8 count value	RW
M1040	Excitation (Servo On)	RW
M1041	--	--
M1042	Quick stop	RW
M1043	--	--
M1044	Pause (Halt)	RW

Special M	Description of Function	R/W *
M1045 – M1047	--	--
M1048	Move to new position	RW
M1049	--	--
M1050	Absolute position / relative position (0: relative/1: absolute)	RW
M1051	--	--
M1052	Lock frequency (lock, frequency locked at the current operating frequency)	RW
M1053	--	--
M1054	Compulsory reset of absolute position	RW
M1055	Search Origin	RW
M1056	Excitation ready (Servo On Ready)	RO
M1057	--	--
M1058	On Quick Stopping	RO
M1059	CANopen Master setting complete	RO
M1060	CANopen Currently initializing slave station	RO
M1061	CANopen Slave station initialization failure	RO
M1062	--	--
M1063	Torque attained	RO
M1064	Target reached	RO
M1065	Read/write CANopen data time out	RO
M1066	Read/write CANopen data complete	RO
M1067	Read/write CANopen data successful	RO
M1068	Calendar calculation error	RO
M1069	--	--
M1070	Return home complete	RO
M1071	Homing error	RO
M1072 – M1075	--	--
M1076	Calendar time error or refresh time out	RO
M1077	485 Read/write complete	RO
M1078	485 Read-write error	RO
M1079	485 Communications time out	RO
M1090	OFF (Refer to Pr.00-29 for more information)	RO
M1091	HAND (Refer to Pr.00-29 for more information)	RO
M1092	AUTO (Refer to Pr.00-29 for more information)	RO
M1100	LOCAL (Refer to Pr.00-29 for more information)	RO
M1101	REMOTE (Refer to Pr.00-29 for more information)	RO
M1168	SMOV BCD and BIN mode switch	RW
M1260	PLC PID1 Enable	RW
M1262	PLC PID1 integral positive value limit	RW
M1270	PLC PID2 Enable	RW
M1272	PLC PID2 integral positive value limit	RW

13-5-3 Introduction to Special Register Functions (Special D)

Special D	Description of Function	R/W *
D1000	--	--
D1001	Device system program version	RO
D1002	Program capacity	RO
D1003	Total program memory content	RO
D1004 – D1009	--	--
D1010	Current scan time (units: 0.1 ms)	RO
D1011	Minimum scan time (units: 0.1 ms)	RO
D1012	Maximum scan time (units: 0.1 ms)	RO
D1013 – D1017	--	--
D1018	Current integral value	RO
D1019	Compulsory setting of PID I integral	RW
D1020	Output frequency (0.000–600.00Hz)	RO
D1021	Output current (####.#A)	RO
D1022	AI AO DI DO Expansion card number 0: No expansion card 4: AC input card (6 in) (EMC-D611A) 5: Digital I/O Card (4 in 2 out) (EMC-D42A) 6: Relay card (6 out) (EMC-R6AA) 11: Analog I/O Card (2 in 2 out) (EMC-A22A)	RO
D1023	Communication expansion card number 0: No expansion card 1: DeviceNet Slave (CMC-DN01) 2: Profibus-DP Slave (CMC-PD01) 3: CANopen Slave (EMC-COP01) 5: EtherNet/IP Slave (CMC-EIP01) 12: PROFINET Slave (CMC-PN01)	RO
D1024 – D1026	--	--
D1027	PID calculation frequency command (frequency command after PID calculation)	RO
D1028	AVI value (0.00–100.00%)	RO
D1029	ACI value (0.0–100.00%)	RO
D1030	AUI value (-100.0–100.00%)	RO
D1031	C series: extension card AI10 (0.0–100.0%)	RO
D1032	C series: extension card AI11 (0.0–100.0%)	RO
D1033 – D1035	--	--
D1036	Servo error bit	RO
D1037	Drive output frequency	RO
D1038	DCBUS voltage	RO
D1039	Output voltage	RO
D1040	Analog output value AFM1 (-100.00–100.00%)	RW
D1041	C series: extension card AO10 (0.0–100.0%)	RW
D1042	C series: extension card AO11 (0.0–100.0%)	RW
D1043	Can be user-defined (will be displayed on panel when Pr. 00-04 is set as 28; display method is C xxx)	RW
D1044	--	-
D1045	Analog output value AFM2 (-100.00–100.00%)	RW

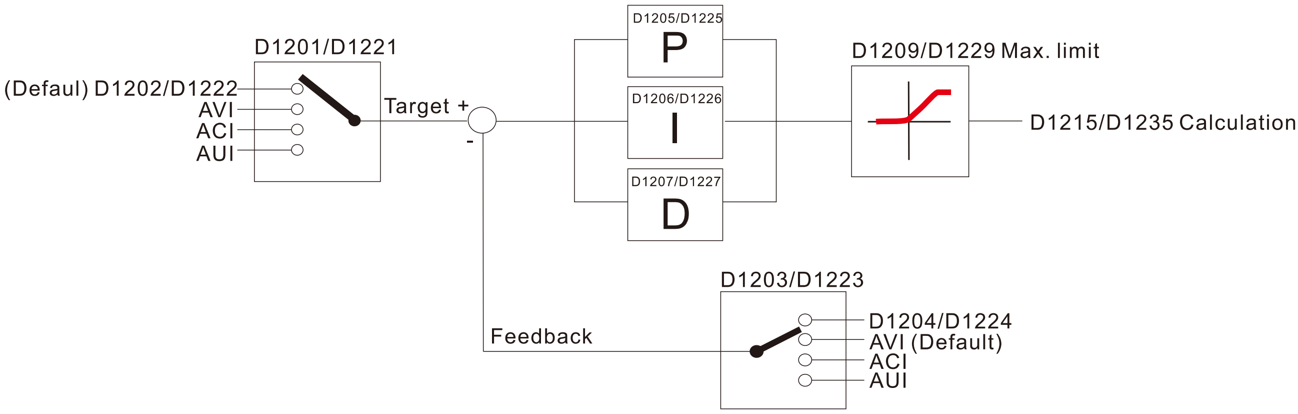
Special D	Description of Function	R/W *
D1046 – D1049	--	--
D1050	Actual Operation Mode 0: Speed 1: Position 2: Torque 3: Homing Origin	RO
D1051	Encoder Pulses L	RO
D1052	Encoder Pulses H	RO
D1053	Actual torque	RO
D1054	MI8 current calculated count value (Low Word)	RO
D1055	MI8 current calculated count value (High Word)	RO
D1056	Rotational speed corresponding to MI8	RO
D1057	MI8s rotational speed ratio	RW
D1058	MI8 refresh rate (ms) corresponding to rotational speed	RW
D1059	Number of nibbles of rotational speed corresponding to MI8 (0–3)	RW
D1060	Operation Mode setting 0: Speed 1: Position 2: Torque 3: Homing Origin	RW
D1061	485 COM1 communications time out time (ms)	RW
D1062	Torque command (torque limit in speed mode)	RW
D1063	Year (Western calendar) (display range 2000–2099) (must use KPC-CC01)	RO
D1064	Week (display range 1–7) (must use KPC-CC01)	RO
D1065	Month (display range 1–12) (must use KPC-CC01)	RO
D1066	Day (display range 1–31) (must use KPC-CC01)	RO
D1067	Hour (display range 0–23) (must use KPC-CC01)	RO
D1068	Minute (display range 0–59) (must use KPC-CC01)	RO
D1069	Second (display range 0–59) (must use KPC-CC01)	RO
D1100	Target frequency	RO
D1101	Target frequency (must be operating)	RO
D1102	Reference frequency	RO
D1103	Target L	RO
D1104	Target H	RO
D1105	Target torque	RO
D1106	--	--
D1107	π(Pi) Low word	RO
D1108	π(Pi) High word	RO
D1109	Random number	RO
D1110	Internal node communications number (set number of slave stations to be controlled)	RW
D1111	Actual position (Low word)	RO
D1112	Actual position (High word)	RO
D1113	--	RO
D1114	--	--
D1115	Internal node synchronizing cycle (ms)	RO
D1116	Internal node error (bit0 = Node 0, bit1 = Node 1,…bit7 = Node 7)	RO
D1117	Internal node online correspondence (bit0 = Node 0, bit1 = Node 1,…bit7 = Node 7)	RO
D1118	--	--
D1119	--	--
D1120	Internal node 0 control command	RW
D1121	Internal node 0 mode	RW
D1122	Internal node 0 reference command L	RW

Special D	Description of Function	R/W *
D1123	Internal node 0 reference command H	RW
D1124	--	--
D1125	--	--
D1126	Internal node 0 status	RO
D1127	Internal node 0 reference status L	RO
D1128	Internal node 0 reference status H	RO
D1129	--	--
D1130	Internal node 1 control command	RW
D1131	Internal node 1 mode	RW
D1132	Internal node 1 reference command L	RW
D1133	Internal node 1 reference command H	RW
D1134	--	--
D1135	--	--
D1136	Internal node 1 status	RO
D1137	Internal node 1 reference status L	RO
D1138	Internal node 1 reference status H	RO
D1139	--	--
D1140	Internal node 2 control command	RW
D1141	Internal node 2 mode	RW
D1142	Internal node 2 reference command L	RW
D1143	Internal node 2 reference command H	RW
D1144	--	--
D1145	--	--
D1146	Internal node 2 status	RO
D1147	Internal node 2 reference status L	RO
D1148	Internal node 2 reference status H	RO
D1149	--	--
D1150	Internal node 3 control command	RW
D1151	Internal node 3 mode	RW
D1152	Internal node 3 reference command L	RW
D1153	Internal node 3 reference command H	RW
D1154	--	--
D1155	--	--
D1156	Internal node 3 status	RO
D1157	Internal node 3 reference status L	RO
D1158	Internal node 3 reference status H	RO
D1159	--	--
D1160	Internal node 4 control command	RW
D1161	Internal node 4 mode	RW
D1162	Internal node 4 reference command L	RW
D1163	Internal node 4 reference command H	RW
D1164	--	--
D1165	--	--
D1166	Internal node 4 status	RO
D1167	Internal node 4 reference status L	RO
D1168	Internal node 4 reference status H	RO
D1169	--	--
D1170	Internal node 5 control command	RW
D1171	Internal node 5 mode	RW
D1172	Internal node 5 reference command L	RW
D1173	Internal node 5 reference command H	RW
D1174	--	RW
D1175	--	--
D1176	Internal node 5 status	--
D1177	Internal node 5 reference status L	RO

Special D	Description of Function	R/W *
D1178	Internal node 5 reference status H	RO
D1179	--	--
D1180	Internal node 6 control command	RW
D1181	Internal node 6 mode	RW
D1182	Internal node 6 reference command L	RW
D1183	Internal node 6 reference command H	RW
D1184	--	--
D1185	--	--
D1186	Internal node 6 status	RO
D1187	Internal node 6 reference status L	RO
D1188	Internal node 6 reference status H	RO
D1189	--	--
D1190	Internal node 7 control command	RW
D1191	Internal node 7 mode	RW
D1192	Internal node 7 reference command L	RW
D1193	Internal node 7 reference command H	RW
D1194	--	--
D1195	--	--
D1196	Internal node 7 status	RO
D1197	Internal node 7 reference status L	RO
D1198	Internal node 7 reference status H	RO
D1199	--	--

Special D	Description of Function	Default	R/W *
D1200	PID 1 Mode: 0: Basic mode	0	RW
D1201	PID 1 Target selection: 0: Refer to D1202 1: AVI 2: ACI 3: AUI	0	RW
D1202	PID 1 Target value (0.00%–100.00%)	5000	RW
D1203	PID 1 Feedback selection: 0: Refer to D1204 1: AVI 2: ACI 3: AUI	1	RW
D1204	PID 1 Feedback value (0.00%–100.00%)	0	RW
D1205	PID 1 P value (decimal 2 points)	10	RW
D1206	PID 1 I value (decimal 2 points)	1000	RW
D1207	PID 1 D value (decimal 2 points)	0	RW
D1209	PID 1 Max. limit	10000	RW
D1215	PID 1 Calculation (decimal 2 points)	0	RO
D1220	PID2 Mode: 0: Basic mode	0	RW
D1221	PID 2 Target selection: 0: Refer to D1202 1: AVI 2: ACI 3: AUI	0	RW
D1222	PID 2 Target value (0.00%–100.00%)	5000	RW
D1223	PID 2 Feedback selection: 0: Refer to D1204 1: AVI 2: ACI	1	RW

Special D	Description of Function	Default	R/W *
	3: AUI		
D1224	PID 2 Feedback value (0.00%–100.00%)	0	RW
D1225	PID 2 P value (decimal 2 points)	10	RW
D1226	PID 2 I value (decimal 2 points)	1000	RW
D1227	PID 2 D value (decimal 2 points)	0	RW
D1229	PID 2 Max. limit	10000	RW
D1235	PID 2 Calculation (decimal 2 points)	0	RO



The following is CANopen Masters special D (Allow writing only when PLC is in STOP state)

n = 0–7

Special D	Description of Function	PDO Map	Power off Memory	Default	R/W
D1070	Channel opened by CANopen initialization (bit0=Machine code0 …)	NO	NO	0	R
D1071	Error channel occurring in CANopen initialization process (bit0=Machine code0 …)	NO	NO	0	R
D1072	Reserved	-	-		-
D1073	CANopen break channel (bit0=Machine code0 …)	NO	NO		R
D1074	Error code of master error 0: No error 1: Slave station setting error 2: Synchronizing cycle setting error (too small)	NO	NO	0	R
D1075	Reserved	-	-		-
D1076	SDO error message (main index value)	NO	NO		R
D1077	SDO error message (secondary index value)	NO	NO		R
D1078	SDO error message (error code)	NO	NO		R
D1079	SDO error message (error code)	NO	NO		R
D1080	Reserved	-	-		-
D1081 – D1086	Reserved	-	-		-
D1087 – D1089	Reserved	-	-		-
D1090	Synchronizing cycle setting	NO	YES	4	RW
D1091	Sets slave station On or Off (bit 0–bit 7 correspond to slave stations number 0–7)	NO	YES	FFFFH	RW
D1092	Delay before start of initialization	NO	YES	0	RW
D1093	Break time detection	NO	YES	1000ms	RW
D1094	Break number detection	NO	YES	3	RW

Special D	Description of Function	PDO Map	Power off Memory	Default	R/W
D1095 – D1096	Reserved	-	-		-
D1097	Corresponding real-time transmission type (PDO) Setting range: 1–240	NO	YES	1	RW
D1098	Corresponding real-time receiving type (PDO) Setting range: 1–240	NO	YES	1	RW
D1099	Initialization completion delay time Setting range: 1–60000 sec.	NO	YES	15 sec.	RW
D2000+100*n	Station number n of slave station Setting range: 0–127 0: No CANopen function	NO	YES	0	RW

The LTC supports 8 slave stations under the CANopen protocol; each slave station occupies 100 special D locations; stations are numbered 1–8, total of 8 stations.

Explanation of slave station number

Slave station no. 1	D2000 D2001 – D2099	Node ID Slave station no. 1 torque restrictions – Address 4(H) corresponding to receiving channel 4
Slave station no. 2	D2100 D2101 – D2199	Node ID Slave station no. 2 torque restrictions – Address 4(H) corresponding to receiving channel 4
Slave station no. 3	D2200 D2201 – D2299	Node ID Slave station no. 3 torque restrictions – Address 4(H) corresponding to receiving channel 4
	⇩	
Slave station no. 8	D2700 D2701 – D2799	Node ID Slave station no. 8 torque restrictions – Address 4(H) corresponding to receiving channel 4

1. The range of n is 0–7
2. ● Indicates PDOTX, ▲Indicates PDORX; unmarked special D can be refreshed using the CANFLS command

Special D	Description of Function	Default:	R/W
D2000+100*n	Station number n of slave station Setting range: 0–127 0: No CANopen function	0	RW
D2002+100*n	Manufacturer code of slave station number n (L)	0	R
D2003+100*n	Manufacturer code of slave station number n (H)	0	R
D2004+100*n	Manufacturers product code of slave station number n (L)	0	R
D2005+100*n	Manufacturers product code of slave station number n (H)	0	R

Basic definitions

Special D	Description of Function	Default:	PDO Mapping	PDO Default: 1	2	3	4	R/W
D2006+100*n	Communications break handling method of slave station number n	0	6007H–0010H					RW
D2007+100*n	Error code of slave station number n error	0	603FH–0010H					R
D2008+100*n	Control word of slave station number n	0	6040H–0010H	●		●	●	RW
D2009+100*n	Status word of slave station number n	0	6041H–0010H	▲		▲	▲	R
D2010+100*n	Control mode of slave station number n	2	6060H–0008H					RW
D2011+100*n	Actual mode of slave station number n	2	6061H–0008H					R

Velocity Control

Slave station number n=0–7

Special D	Description of Function	Default:	PDO Mapping	PDO Default: 1	2	3	4	R/W
D2001+100*n	Torque restriction on slave station number n	0	6072H–0010H					RW
D2012+100*n	Target speed of slave station number n	0	6042H–0010H	●				RW
D2013+100*n	Actual speed of slave station number n	0	6043H–0010H	▲				R
D2014+100*n	Error speed of slave station number n	0	6044H–0010H					R
D2015+100*n	Acceleration time of slave station number n	1000	604FH–0020H					R
D2016+100*n	Deceleration time of slave station number n	1000	6050H–0020H					RW

Torque control

Slave station number n=0–7

Special D	Description of Function	Default:	PDO Mapping	PDO Default: 1	2	3	4	R/W
D2017+100*n	Target torque of slave station number n	0	6071H–0010H				●	RW
D2018+100*n	Actual torque of slave station number n	0	6077H–0010H				▲	R
D2019+100*n	Actual current of slave station number n	0	6078H–0010H					R

Position control

Slave station number n=0–7

Special D	Description of Function	Default:	PDO Mapping	PDO Default: 1	2	3	4	R/W
D2020+100*n	Target of slave station number n (L)	0	607AH–0020H			●		RW
D2021+100*n	Target of slave station number n (H)	0						RW
D2022+100*n	Actual position of slave station number n (L)	0	6064H–0020H			▲		R
D2023+100*n	Actual position of slave station number n (H)	0						R
D2024+100*n	Speed chart of slave station number n (L)	10000	6081H–0020H					RW
D2025+100*n	Speed chart of slave station number n (H)	0						RW

20XXH correspondences: MI MO AI AO

Slave station number n=0–7

Special D	Description of Function	Default:	PDO Mapping	PDO Default: 1	2	3	4	R/W
D2026+100*n	MI status of slave station number n	0	2026H–0110H		▲			RW
D2027+100*n	MO setting of slave station number n	0	2026H–4110H		●			RW
D2028+100*n	AI1 status of slave station number n	0	2026H–6110H		▲			RW
D2029+100*n	AI2 status of slave station number n	0	2026H–6210H		▲			RW
D2030+100*n	AI3 status of slave station number n	0	2026H–6310H		▲			RW
D2031+100*n	AO1 status of slave station number n	0	2026H–A110H		●			RW
D2032+100*n	AO2 status of slave station number n	0	2026H–A210H		●			RW
D2033+100*n	AO3 status of slave station number n	0	2026H–A310H		●			RW

PDO reflection length setting:

Special D	Description of Function	Default:	R/W
D2034+100*n	Real-time transmission setting of slave station number n	000AH	RW
D2067+100*n	Real-time reception setting of slave station number n	0000H	RW

13-5-4 PLC Communication Address

Device	Range	Type	Address (Hex)
X	00–37 (Octal)	bit	0400–041F
Y	00–37 (Octal)	bit	0500–051F
T	00–159	bit/word	0600–069F
M	000–799	bit	0800–0B1F
M	1000–1079	bit	0BE8–0C37
C	0–79	bit/word	0E00–0E47
D	00–399	word	1000–118F
D	1000–1099	word	13E8–144B
D	2000–2799	word	17D0–1AEF

Command code that can be used

Function Code	Description of Function	Function target
01	Coil status read	Y,M,T,C
02	Input status read	X,Y,M,T,C
03	Read single unit of data	T,C,D
05	Compulsory single coil status change	Y,M,T,C
06	Write single unit of data	T,C,D
0F	Compulsory multiple coil status change	Y,M,T,C
10	Write multiple units of data	T,C,D

NOTE: When PLC functions have been activated, LTC can match PLC and drive parameters; this method employs different addresses, drives (default station number is 1, PLC sets station number as 2)

13-6 Introduction to the Command Window

13-6-1 Overview of Basic Commands

Ordinary commands

Command Code	Function	OPERAND	Execution Speed (us)
LD	Load contact a	X, Y, M, T, C	0.8
LDI	Load contact b	X, Y, M, T, C	0.8
AND	Connect contact a in series	X, Y, M, T, C	0.8
ANI	Connect contact b in series	X, Y, M, T, C	0.8
OR	Connect contact a in parallel	X, Y, M, T, C	0.8
ORI	Connect contact b in parallel	X, Y, M, T, C	0.8
ANB	Series circuit block	N/A	0.3
ORB	Parallel circuit block	N/A	0.3
MPS	Save to stack	N/A	0.3
MRD	Stack read (pointer does not change)	N/A	0.3
MPP	Read stack	N/A	0.3

Output command

Command Code	Function	OPERAND	Execution Speed (us)
OUT	Drive coil	Y, M	1
SET	Action continues (ON)	Y, M	1
RST	Clear contact or register	Y, M, T, C, D	1.2

Timer, counter

Command Code	Function	OPERAND	Execution Speed (us)
TMR	16-bit timer	T-K or T-D commands	1.1
CNT	16-bit counter	C-K or C-D (16-bit)	0.5

Main control command

Command Code	Function	OPERAND	Execution Speed (us)
MC	Common series contact connection	N0–N7	0.4
MCR	Common series contact release	N0–N7	0.4

Contact rising edge / falling edge detection command

Command Code	Function	OPERAND	Execution Speed (us)
LDP	Start of forward edge detection action	X, Y, M, T, C	1.1
LDF	Start of reverse edge detection action	X, Y, M, T, C	1.1
ANDP	Forward edge detection series connection	X, Y, M, T, C	1.1
ANDF	Reverse edge detection series connection	X, Y, M, T, C	1.1
ORP	Forward edge detection parallel connection	X, Y, M, T, C	1.1
ORF	Reverse edge detection parallel connection	X, Y, M, T, C	1.1

Upper / lower differential output commands

Command Code	Function	OPERAND	Execution Speed (us)
PLS	Upper differential output	Y, M	1.2
PLF	Lower differential output	Y, M	1.2

Stop command

Command Code	Function	OPERAND	Execution Speed (us)
END	Program conclusion	N/A	0.2

Other commands

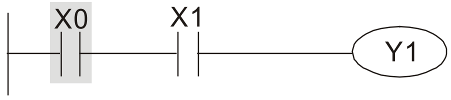
Command Code	Function	OPERAND	Execution Speed (us)
NOP	No action	N/A	0.2
INV	Inverse of operation results	N/A	0.2
P	Index	P	0.3

13-6-2 Detailed Explanation of Basic Commands

Command	Function					
LD	Load contact a					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The LD command is used for contact a starting at the left busbar or contact a starting at a contact circuit block; its function is to save current content and save the acquired contact status in the cumulative register.

Example: Ladder diagram:

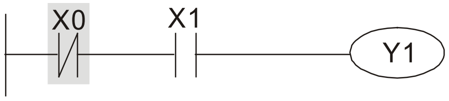


Command code:		Description:
LD	**X0**	Load Contact a of X0
AND	X1	Create series connection to contact a of X1
OUT	Y1	Drive Y1 coil

Command	Function					
LDI	Load contact b					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The LDI command is used for contact b starting at the left busbar or contact b starting at a contact circuit block; its function is to save current content and save the acquired contact status in the cumulative register.

Example: Ladder diagram:



Command code:		Description:
LDI	**X0**	Load Contact b of X0
AND	X1	Create series connection to contact a of X1
OUT	Y1	Drive Y1 coil

Command	Function					
AND	Connect contact a in series					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The AND command is used to create a series connection to contact a; first reads current status of the designated series contact and logical operation results before contact in order to perform "AND" operation; saves results in cumulative register.

Example: Ladder diagram:

Command code:		Description:
LDI	X1	Load Contact b of X1
AND	**X0**	Create series connection to contact a of X0
OUT	Y1	Drive Y1 coil

Command	Function					
ANI	Connect contact b in series					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The ANI command is used to create a series connection to contact b; its function is to first read current status of the designated series contact and logical operation results before contact in order to perform "AND" operation; saves results in cumulative register.

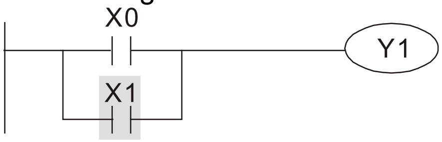
Example: Ladder diagram:

Command code:		Description:
LD	X1	Load Contact a of X1
ANI	**X0**	Create series connection to contact b of X0
OUT	Y1	Drive Y1 coil

Command	Function					
OR	Connect contact a in parallel					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The OR command is used to establish a parallel connection to contact a; its function is to first read current status of the designated series contact and logical operation results before contact in order to perform "OR" operation; saves results in cumulative register.

Example: Ladder diagram:

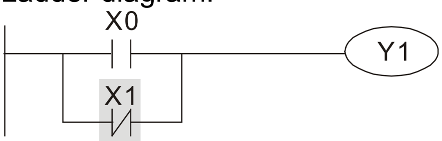


Command code:		Description:
LD	X0	Load Contact a of X0
OR	**X1**	Create series connection to contact a of X1
OUT	Y1	Drive Y1 coil

Command	Function					
ORI	Connect contact b in parallel					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The ORI command is used to establish a parallel connection to contact a; its function is to first read current status of the designated series contact and logical operation results before contact in order to perform "OR" operation; saves results in cumulative register.

Example: Ladder diagram:

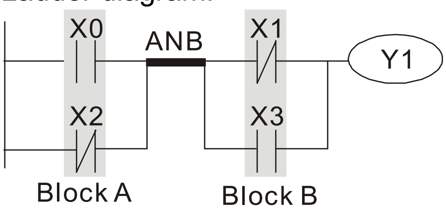


Command code:		Description:
LD	X0	Load Contact a of X0
ORI	**X1**	Create series connection to contact b of X1
OUT	Y1	Drive Y1 coil

Command	Function
ANB	Series circuit block
Operand	N/A

Explanation: ANB performs an "AND" operation on the previously saved logic results and the current cumulative register content.

Example: Ladder diagram:

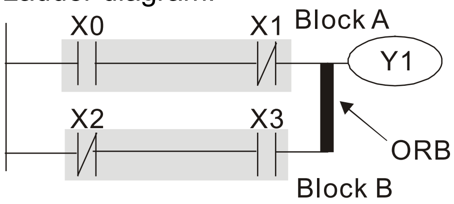


Command code:		Description:
LD	X0	Load Contact a of X0
ORI	X2	Establish parallel connection to contact b of X2
LDI	X1	Load Contact b of X1
OR	X3	Establish parallel connection to contact a of X3
ANB		Series circuit block
OUT	Y1	Drive Y1 coil

Command	Function
ORB	Parallel circuit block
Operand	N/A

Explanation: ORB performs an "OR" operation on the previously saved logic results and the current cumulative register content.

Example: Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
ANI	X1	Establish parallel connection to contact b of X1
LDI	X2	Load Contact b of X2
AND	X3	Establish parallel connection to contact a of X3
ORB		Parallel circuit block
OUT	Y1	Drive Y1 coil

Command	Function
MPS	Save to stack
Operand	N/A

Explanation: Save current content of cumulative register to the stack. (Add one to stack pointer)

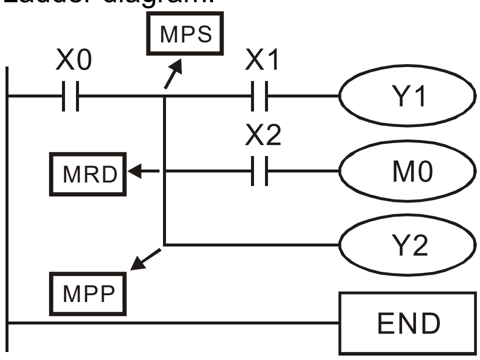
Command	Function
MRD	Read stack (pointer does not change)
Operand	N/A

Explanation: Reads stack content and saves to cumulative register. (Stack pointer does not change)

Command	Function
MPP	Read stack
Operand	N/A

Explanation: Retrieves result of previously-save logical operation from the stack, and saves to cumulative register. (Subtract one from stack pointer)

Example: Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
MPS		Save to stack
AND	X1	Create series connection to contact a of X1
OUT	Y1	Drive Y1 coil
MRD		Read stack (pointer does not change)
AND	X2	Create series connection to contact a of X2
OUT	M0	Drive M0 coil
MPP		Read stack
OUT	Y2	Drive Y2 coil
END		Program conclusion

Command	Function					
OUT	Drive coil					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	—	✓	✓	—	—	—

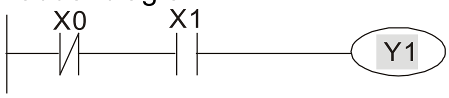
Explanation

Outputs result of logical operation before OUT command to the designated element.
Coil contact action:

Result:	Out command		
	Coil	Access Point:	
		Contact a (NO)	Contact b (NC)
FALSE	Off	Not conducting	Conducting
TRUE	On	Conducting	Not conducting

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact b of X0
AND	X1	Establish parallel connection to contact a of X1
OUT	**Y1**	Drive Y1 coil

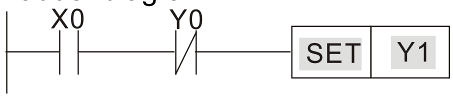
Command	Function					
SET	Action continues (ON)					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	—	✓	✓	—	—	—

Explanation

When the SET command is driven, the designated element will be set as On, and will be maintained in an On state, regardless of whether the SET command is still driven. The RST command can be used to set the element as Off.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
AN	Y0	Establish parallel connection to contact b of Y0
SET	**Y1**	Action continues (ON)

Command	Function					
RST	Clear contact or register					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	—	✓	✓	✓	✓	✓

Explanation

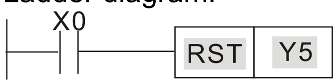
When the RST command is driven, the action of the designated element will be as follows:

Element	Mode
Y, M	Both coil and contact will be set as Off.
T, C	The current timing or count value will be set as 0, and both the coil and contact will be set as Off.
D	The content value will be set as 0.

If the RST command has not been executed, the status of the designated element will remain unchanged.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
RST	**Y5**	Clear contact or register

Command	Function	
TMR	16-bit timer	
Operand	T-K	T0–T159, K0–K32,767
	T-D	T0–T159, D0–D399

Explanation

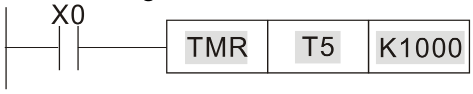
When the TMR command is executed, the designated timer coil will be electrified, and the timer will begin timing. The contacts action will be as follows when the timing value reaches the designated set value (timing value >= set value):

NO (Normally Open) contact	Closed
NC (Normally Close) contact	Open

If the RST command has not been executed, the status of the designated element will remain unchanged.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
TMR	T5 K1000	T5 timer Set value as K1000

Command	Function	
CNT	16-bit counter	
Operand	C-K	C0–C79, K0–K32,767
	C-D	C0–C79, D0–D399

Explanation

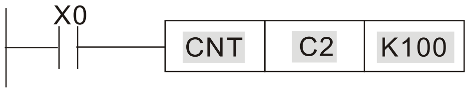
When the CNT command is executed from Off→On, this indicates that the designated counter coil goes from no power → electrified, and 1 will be added to the counters count value; when the count reaches the designated value (count value = set value), the contact will have the following action:

NO (Normally Open) contact	Closed
NC (Normally Close) contact	Open

After the count value has been reached, the contact and count value will both remain unchanged even if there is continued count pulse input. Please use the RST command if you wish to restart or clear the count.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
CNT	**C2 K100**	C2counter Set value as K100

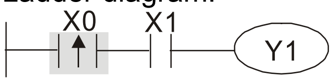
Command	Function					
LDP	Start of forward edge detection action					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation

The LDP command has the same usage as LD, but its action is different; its function is to save current content, while also saving the detected state of the rising edge of the contact to the cumulative register.

Example

Ladder diagram:



Command code:		Description:
LDP	**X0**	Start of X0 forward edge detection action
AND	X1	Create series connection to contact a of X1
OUT	Y1	Drive Y1 coil

Remark

Please refer to the function specifications table for each device in series for the scope of usage of each operand.

A rising edge contact will be TRUE after power is turned on if the rising edge contact is On before power is turned on to the PLC.

Command	Function
MC/MCR	Connect/release a common series contact
Operand	N0–N7

Explanation

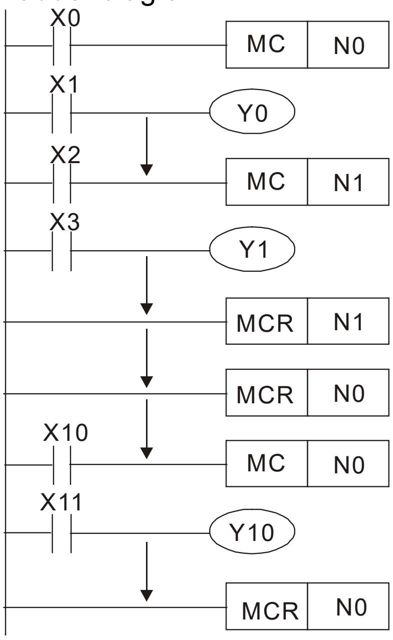
MC is the main control initiation command, and any commands between MC and MCR will be executed normally. When the MC command is Off, any commands between MC and MCR will act as follows:

Determination of commands	Description
Ordinary timer	The timing value will revert to 0, the coil will lose power, and the contact will not operate
Counter	The coil will lose power, and the count value and contact will stay in their current state
Coil driven by OUT command	None receive power
Elements driven by SET, RST commands	Will remain in their current state
Applications commands	None are actuated

MCR is the main control stop command, and is placed at the end of the main control program. There may not be any contact commands before the MCR command.
The MC-MCR main control program commands support a nested program structure with a maximum only 8 levels; use in the order N0–N7, please refer to the following program:

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
MC	**N0**	Connection of N0 common series contact
LD	X1	Load Contact a of X1
OUT	Y0	Drive Y0 coil
:		
LD	X2	Load Contact a of X2
MC	**N1**	Connection of N1 common series contact
LD	X3	Load Contact a of X3
OUT	Y1	Drive Y1 coil
:		
MCR	**N1**	Release N1 common series contact
:		
MCR	**N0**	Release N0 common series contact
:		
LD	X10	Load Contact a of X10
MC	**N0**	Connection of N0 common series contact
LD	X11	Load Contact a of X11
OUT	Y10	Drive Y10 coil
:		
MCR	**N0**	Release N0 common series contact

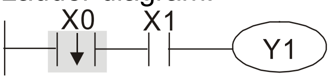
Command	Function					
LDF	Start of reverse edge detection action					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation

The LDF command has the same usage as LD, but its action is different; its function is to save current content while also saving the detected state of the falling edge of the contact to the cumulative register.

Example

Ladder diagram:

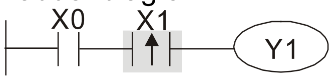


Command code:		Description:
LDF	**X0**	Start of X0 reverse edge detection action
AND	X1	Create series connection to contact a of X1
OUT	Y1	Drive Y1 coil

Command	Function					
ANDP	Forward edge detection series connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The ANDP command used for a contact rising edge detection series connection.

Example: Ladder diagram:

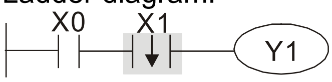


Command code:		Description:
LD	X0	Load Contact a of X0
ANDP	**X1**	X1 Forward edge detection series connection
OUT	Y1	Drive Y1 coil

Command	Function					
ANDF	Reverse edge detection series connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The ANDF command is used for a contact falling edge detection series connection.

Example: Ladder diagram:

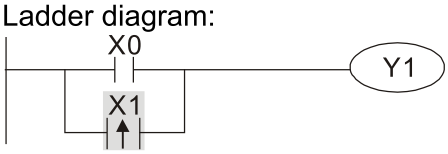


Command code:		Description:
LD	X0	Load Contact a of X0
ANDF	**X1**	X1 Reverse edge detection series connection
OUT	Y1	Drive Y1 coil

Command	Function					
ORP	Forward edge detection parallel connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The ORP command is used for a contact rising edge detection parallel connection.

Example: Ladder diagram:

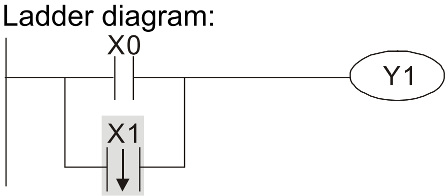


Command code:		Description:
LD	X0	Load Contact a of X0
ORP	**X1**	X1 Forward edge detection parallel connection
OUT	Y1	Drive Y1 coil

Command	Function					
ORF	Reverse edge detection parallel connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	—

Explanation: The ORF command is used for contact falling edge detection parallel connection.

Example: Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
ORF	**X1**	X1 Reverse edge detection parallel connection
OUT	Y1	Drive Y1 coil

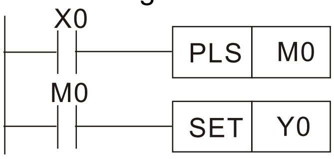
Command	Function					
PLS	Upper differential output					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	—	✓	✓	—	—	—

Explanation

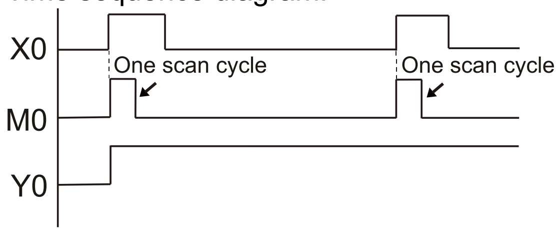
Upper differential output commands. When X0=Off→On (positive edge-triggered), the PLS command will be executed, and M0 will send one pulse, with a pulse length consisting of one scanning period.

Example

Ladder diagram:



Time sequence diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
PLS	**M0**	M0 Upper differential output
LD	M0	Load Contact a of M0
SET	Y0	Y0 Action continues (ON)

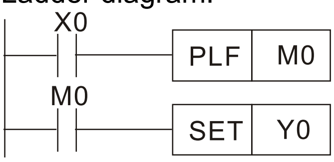
Command	Function					
PLF	Lower differential output					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	—	✓	✓	—	—	—

Explanation

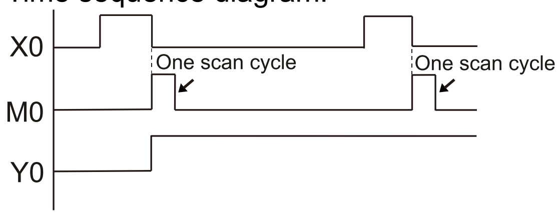
Lower differential output command. When X0= On→Off (negative edge-triggered), the PLF command will be executed, and M0 will send one pulse, with pulse length consisting of one scanning period.

Example

Ladder diagram:



Time sequence diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
PLF	**M0**	M0 Lower differential output
LD	M0	Load Contact a of M0
SET	Y0	Y0 Action continues (ON)

Command	Function
END	Program conclusion
Operand	N/A

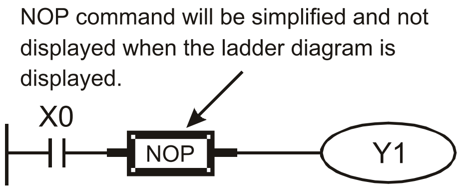
Explanation

An END command must be added to the end of a ladder diagram program or command program. The PLC will scan from address 0 to the END command, and will return to address 0 and begins scanning again after execution.

Command	Function
NOP	No action
Operand	N/A

Explanation
The command NOP does not perform any operation in the program. Because execution of this command will retain the original logical operation results, it can be used in the following situation: the NOP command can be used instead of a command that is deleted without changing the program length.

Example
Ladder diagram:

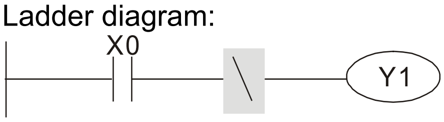


Command code:		Description:
LD	X0	Load Contact b of X0
NOP		No action
OUT	Y1	Drive Y1 coil

Command	Function
INV	Inverse of operation results
Operand	N/A

Explanation
Saves the result of the logic inversion operation prior to the INV command in the cumulative register.

Example
Ladder diagram:

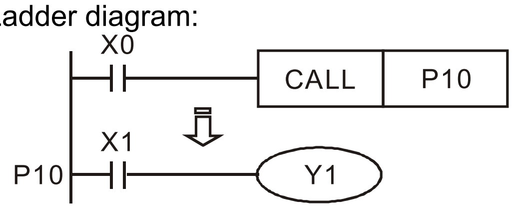


Command code:		Description:
LD	X0	Load Contact a of X0
INV		Inverse of operation results
OUT	Y1	Drive Y1 coil

Command	Function
P	Index
Operand	P0–P255

Explanation
Pointer P is used to subprogram call command API 01 CALL. User does not require starting from zero, but the number cannot be used repeatedly, otherwise an unpredictable error will occur.

Example
Ladder diagram:



Command code:		Description:
LD	X0	Load Contact a of X0
CALL	P10	Call command CALL to P10
:		
P10		Pointer P10
LD	X1	Load Contact a of X1
OUT	Y1	Drive Y1 coil

13-6-3 Overview of Application Commands

Classification	API	Command Code		P command	Function	STEPS	
		16 bit	32 bit			16 bit	32 bit
Circuit control	01	CALL	-	✓	Call subprogram	3	-
	2	SRET	-	-	Conclusion of subprogram	1	-
	06	FEND	-	-	Conclusion a main program	1	-
Send comparison	10	CMP	DCMP	✓	Compares set output	7	13
	11	ZCP	DZCP	✓	Range comparison	9	17
	12	MOV	DMOV	✓	Data movement	5	9
	13	SMOV	DSMOV	✓	Nibble movement	11	21
	15	BMOV	–	✓	Send all	7	–
Four logical operations	18	BCD	DBCD	✓	BIN to BCD transformation	5	9
	19	BIN	DBIN	✓	BCD to BIN transformation	5	9
	20	ADD	DADD	✓	BIN addition	7	13
	21	SUB	DSUB	✓	BIN subtraction	7	13
	22	MUL	DMUL	✓	BIN multiplication	7	13
	23	DIV	DDIV	✓	BIN division	7	13
	24	INC	DINC	✓	BIN add one	3	5
	25	DEC	DDEC	✓	BIN subtract one	3	5
Rotational displacement	30	ROR	DROR	✓	Right rotation	5	–
	31	ROL	DROL	✓	Left rotation	5	–
Data Process	40	ZRST	–	✓	Clear range	5	-
	41	DECO	DDECO	✓	Decoder	7	13
	42	ENCO	DENCO	✓	Encoder	7	13
	43	SUM	DSUM	✓	ON bit number	5	9
	44	BON	DBON	✓	ON bit judgement	7	13
	49	FLT	DFLT	✓	BIN whole number → binary floating point number transformation	5	9
Floating point operation	110	–	DECMP	✓	Comparison of binary floating point numbers	–	13
	111	–	DEZCP	✓	Comparison of binary floating point number range	–	17
	116	–	DRAD	✓	Angle → Diameter	–	9
	117	–	DDEG	✓	Diameter → angle	–	9
	120	–	DEADD	✓	Binary floating point number addition	–	13
	121	–	DESUB	✓	Binary floating point number subtraction	–	13
	122	–	DEMUL	✓	Binary floating point number multiplication	–	13
	123	–	DEDIV	✓	Binary floating point number division	–	13
	124	–	DEXP	✓	Binary floating point number obtain exponent	–	9
	125	–	DLN	✓	Binary floating point number obtain logarithm	–	9
	127	–	DESQR	✓	Binary floating point number find square root	–	9
	129	INT	DINT	✓	Binary floating point number → BIN whole number transformation	5	9
	130	–	DSIN	✓	Binary floating point number SIN operation	–	9
	131	–	DCOS	✓	Binary floating point number COS operation	–	9
	132	–	DTAN	✓	Binary floating point number TAN operation	–	9
	133	–	DASIN	✓	Binary floating point number ASIN operation	–	9

Classification	API	Command Code		P command	Function	STEPS	
		16 bit	32 bit			16 bit	32 bit
	134	–	DACOS	✓	Binary floating point number ACOS operation	–	9
	135	–	DATAN	✓	Binary floating point number ATAN operation	–	9
	136	–	DSINH	✓	Binary floating point number SINH operation	–	9
	137	–	DCOSH	✓	Binary floating point number COSH operation	–	9
	138	–	DTANH	✓	Binary floating point number TANH operation	–	9
Other	147	SWAP	DSWAP	✓	Exchange the up/down 8 bits	3	5
communication	150	MODRW	–	✓	MODBUS read/write	7	–
Calendar	160	TCMP	–	✓	Compare calendar data	11	–
	161	TZCP	–	✓	Compare calendar data range	9	–
	162	TADD	–	✓	Calendar data addition	7	–
	163	TSUB	–	✓	Calendar data subtraction	7	–
	166	TRD	–	✓	Calendar data read	3	–
GRAY code	170	GRY	DGRY	✓	BIN→GRY code transformation	5	9
	171	GBIN	DGBIN	✓	GRY code →BIN transformation	5	9
Contact form logical operation	215	LD&	DLD&	-	Contact form logical operation LD#	5	9
	216	LD|	DLD|	-	Contact form logical operation LD#	5	9
	217	LD^	DLD^	-	Contact form logical operation LD#	5	9
	218	AND&	DAND&	-	Contact form logical operation AND#	5	9
	219	ANDI	DANDI	-	Contact form logical operation AND#	5	9
	220	AND^	DAND^	-	Contact form logical operation AND#	5	9
	221	OR&	DOR&	-	Contact form logical operation OR#	5	9
	222	OR|	DOR|	-	Contact form logical operation OR#	5	9
	223	OR^	DOR^	-	Contact form logical operation OR#	5	9
Contact form compare command	224	LD =	DLD =	-	Contact form compare LD*	5	9
	225	LD >	DLD >	-	Contact form compare LD*	5	9
	226	LD <	DLD <	-	Contact form compare LD*	5	9
	228	LD < >	DLD < >	-	Contact form compare LD*	5	9
	229	LD < =	DLD < =	-	Contact form compare LD*	5	9
	230	LD > =	DLD > =	-	Contact form compare LD*	5	9
	232	AND =	DAND =	-	Contact form compare AND*	5	9
	233	AND >	DAND >	-	Contact form compare AND*	5	9
	234	AND <	DAND <	-	Contact form compare AND*	5	9
	236	AND < >	DAND < >	-	Contact form compare AND*	5	9
	237	AND < =	DAND < =	-	Contact form compare AND*	5	9
	238	AND > =	DAND > =	-	Contact form compare AND*	5	9
	240	OR =	DOR =	-	Contact form compare OR*	5	9
	241	OR >	DOR >	-	Contact form compare OR*	5	9
	242	OR <	DOR <	-	Contact form compare OR*	5	9

Classification	API	Command Code		P command	Function	STEPS	
		16 bit	32 bit			16 bit	32 bit
	244	OR < >	DOR < >	-	Contact form compare OR*	5	9
	245	OR < =	DOR < =	-	Contact form compare OR*	5	9
	246	OR > =	DOR > =	-	Contact form compare OR*	5	9
Floating point contact form	275	-	FLD =	-	Floating point number contact form compare LD*	-	9
	276	-	FLD >	-	Floating point number contact form compare LD*	-	9
	277	-	FLD <	-	Floating point number contact form compare LD*	-	9
Compare command	278	-	FLD < >	-	Floating point number contact form compare LD*	-	9
	279	-	FLD < =	-	Floating point number contact form compare LD*	-	9
	280	-	FLD > =	-	Floating point number contact form compare LD*	-	9
	281	-	FAND =	-	Floating point number contact form compare AND*	-	9
	282	-	FAND >	-	Floating point number contact form compare AND*	-	9
	283	-	FAND <	-	Floating point number contact form compare AND*	-	9
	284	-	FAND < >	-	Floating point number contact form compare AND*	-	9
	285	-	FAND < =	-	Floating point number contact form compare AND*	-	9
	286	-	FAND > =	-	Floating point number contact form compare AND*	-	9
	287	-	FOR =	-	Floating point number contact form compare OR*	-	9
	288	-	FOR >	-	Floating point number contact form compare OR*	-	9
	289	-	FOR <	-	Floating point number contact form compare OR*	-	9
	290	-	FOR < >	-	Floating point number contact form compare OR*	-	9
	291	-	FOR < =	-	Floating point number contact form compare OR*	-	9
	292	-	FOR > =	-	Floating point number contact form compare OR*	-	9
Drive special command	139	RPR	–	✓	Read servo parameter	5	–
	140	WPR	–	✓	Write servo parameter	5	–
	141	FPID	–	✓	Drive PID control mode	9	–
	142	FREQ	–	✓	Drive torque control mode	7	–
	262	–	DPOS	✓	Set target	-	5
	263	TORQ	–	✓	Set target torque	5	-
	261	CANRX	–	✓	Read CANopen slave station data	9	-
	264	CANTX	–	✓	Write CANopen slave station data	9	-
	265	CANFLS	–	✓	Refresh special D corresponding to CANopen	3	-
	320	ICOMR	DICOMR	✓	Internal communications read	9	17
	321	ICOMW	DICOMW	✓	Internal communications write	9	17
	323	WPRA	–	-	RAM write in drive parameters	5	-

13-6-4 Detailed Explanation of Applications Commands

API				
01	CALL	P	(S)	Call subprogram

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D

Notes on operand usage:
The S operand can designate P
LTC series device: The S operand can designate P0-P63

16-bit command (3 STEP)

CALL	Continuous execution type	CALLP	Pulse execution type

32-bit command

—	—	—	—

Flag signal: none

Explanation

- **S**：Call subprogram pointer.
- Write the subprogram after the FEND command.
- The subprogram must end after the SRET command.
- Refer to the FEND command explanation and sample content for detailed command functions.

API		SRET		–	Conclusion of subprogram
02			P		

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D

Notes on operand usage:
No operand
A contact-driven command is not needed

16-bit command (1 STEP)			
FEND	Continuous execution type	—	—

32-bit command			
—	—	—	—

Flag signal: none

Explanation

- A contact-driven command is not needed. Automatically returns next command after CALL command
- Indicates end of subprogram. After end of subprogram, SRET returns to main program, and executes next command after the original call subprogram CALL command.
- Refer to the FEND command explanation and sample content for detailed command functions.

API 06		FEND		–	Conclusion a main program

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D

Notes on operand usage:
No operand
A contact-driven command is not needed

16-bit command (1 STEP)			
FEND	Continuous execution type	–	–

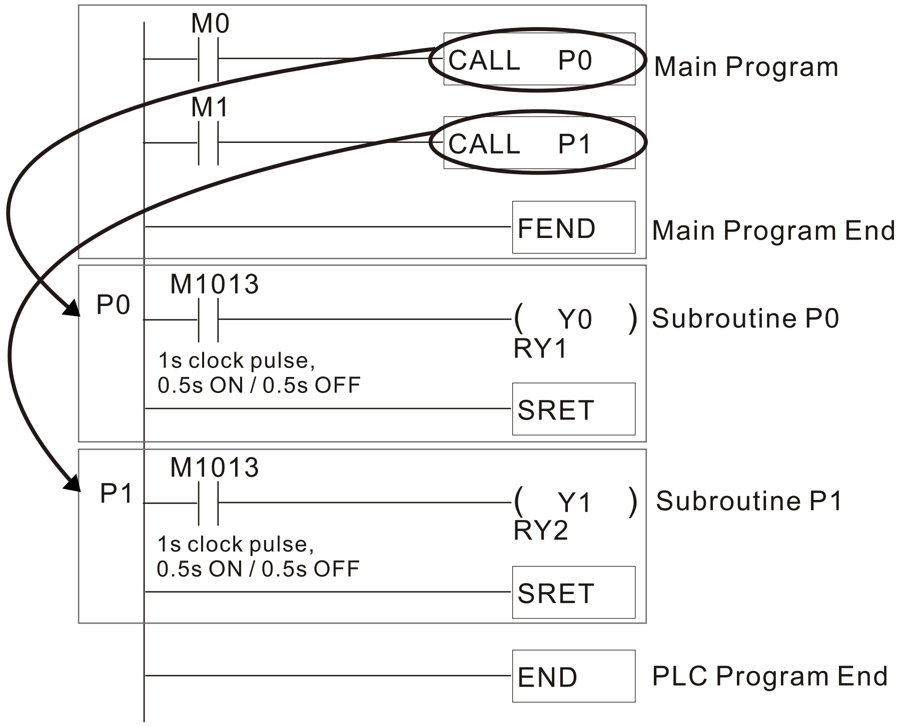
32-bit command			
–	–	–	–

Flag signal: none

Explanation

- This command indicates the end of the main program. It is the same as the END command when the PLC executes this command.
- The CALL command program must be written after the FEND command, and the SRET command added to the end of the subprogram.
- When using the FEND command, an END command is also needed. However, the END command must be placed at the end, after the main program and subprogram.

CALL command process



API				
10	D	CMP	P	(S1) (S2) (D)	Compares set output

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D		*	*								

Notes on operand usage:
The operand D occupies three consecutive points

16-bit command (7 STEP)			
CMP	Continuous execution type	CMPP	Pulse execution type

32-bit command (13 STEP)			
DCMP	Continuous execution type	DCMPP	Pulse execution type

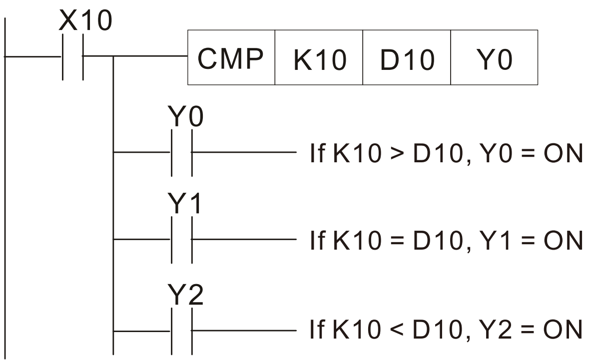
Flag signal: none

Explanation

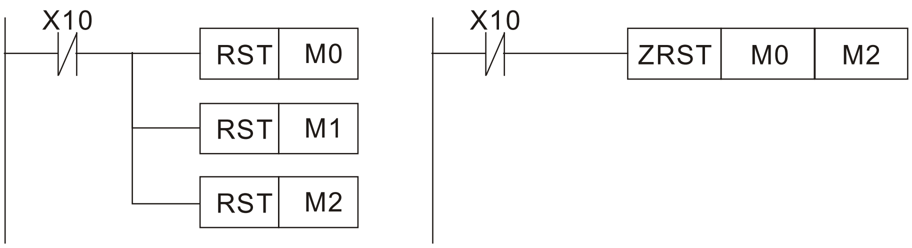
- (S1): Compare value 1. (S2): Compare value 2. (D): Results of comparison.
- Compares the size of the content of operand (S1) and (S2); the results of comparison are expressed in (D).
- Size comparison is performed algebraically. All data is compared in the form of numerical binary values. Because this is a 16-bit command, when b15 is 1, this indicates a negative number.

Example

- When the designated device is Y0, it automatically occupies Y0, Y1 and Y2.
- When X10=On, the CMP command executes, and Y0, Y1 or Y2 will be On. When X10=Off, the CMP command will not execute, and the state of Y0, Y1 and Y2 will remain in the state prior to X10=Off.
- If ≥, ≤, or ≠ results are needed, they can be obtained via series/parallel connections of Y0–Y2.



- To clear results of comparison, use the RST or ZRST command.



API					
11	D	ZCP	P	S1 S2 S D	Range comparison

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
S				*	*	*	*	*	*	*	*
D		*	*								

Notes on operand usage:
The content value of operand S1 is less than the content value of S2 operand
The operand D occupies three consecutive points

16-bit command (9 STEP)			
ZCP	Continuous execution type	ZCPP	Pulse execution type

32-bit command (17 STEP)			
DZCP	Continuous execution type	DZCPP	Pulse execution type

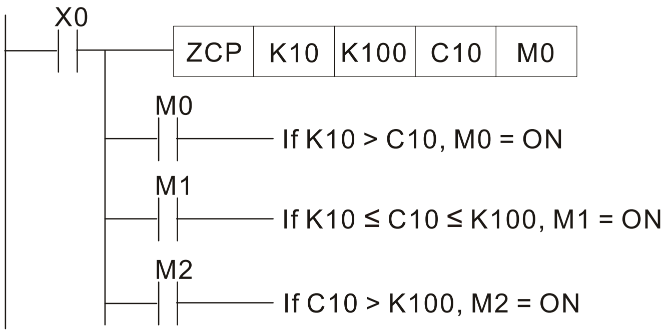
Flag signal: none

Explanation

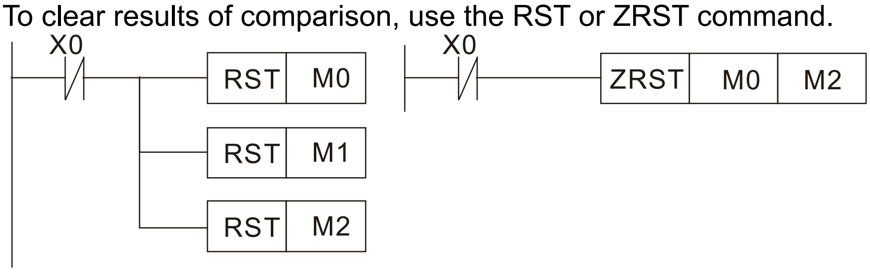
- S1: Lower limit of range comparison. S2: Upper limit of range comparison. S: Comparative value. D: Results of comparison.
- When the comparative value S is compared with the lower limit S1 and upper limit S2, the results of comparison are expressed in D.
- When lower limit S1 > upper limit S2, the command will use the lower limit S1 to perform comparison with the upper and lower limit.
- Size comparison is performed algebraically. All data is compared in the form of numerical binary values. Because this is a 16-bit command, when b15 is 1, this indicates a negative number.

Example

- When the designated device is M0, it automatically occupies M0, M1 and M2.
- When X0=On, the ZCP command executes, and M0, M1 or M2 will be On. When X0=Off, the ZCP command will not execute, and the state of M0, M1 or M2 will remain in the state prior to X0=Off.
- If ≥, ≤, or ≠ results are needed, they can be obtained via series/parallel connections of M0–M2.



- To clear results of comparison, use the RST or ZRST command.



API					
12	D	MOV	P	S D	Data movement

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (5 STEP)			
MOV	Continuous execution type	MOVP	Pulse execution type

32-bit command (9 STEP)			
DMOV	Continuous execution type	DMOVP	Pulse execution type

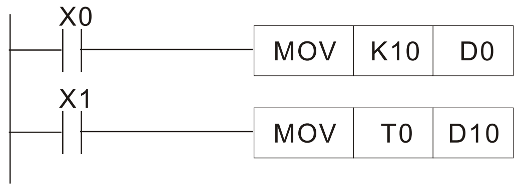
Flag signal:

Explanation

- S: Data source. D: Destination of data movement.
- When this command is executed, the content of S will be directly moved to D. When the command is not executed, the content of D will not change.

Example

- When X0=Off, the content of D10 will not change; if X0=On, the value K10 will be sent to data register D10.
- When X1=Off, the content of D10 will not change; if X1=On, the current value of T0 will be sent to data register D10.



API	D	SMOV	P	S m1 m2 D n	Nibble movement
13					

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (11 STEP)			
MOV	Continuous execution type	SMOVP	Pulse execution type

32-bit command (21 STEP)			
DSMOV	Continuous execution type	DSMOVP	Pulse execution type

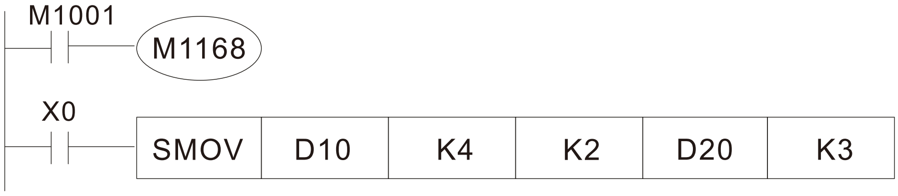
Flag signal: M1168

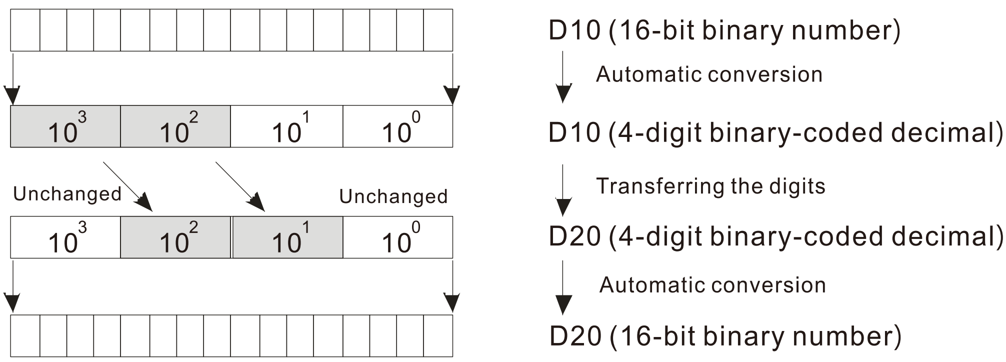
Explanation

- S: Data source. m1: The data source transfers starting bit number. m2 : The data source transfers individual bit number. D: Transfer destination. n Transferring starting bit number of the destination.
- BCD mode (M1168 = Off):
  SMOV enables and operates BCD under this mode, the operation is similar to the way SMOV operates decimal numbers. The command copies specific bit number of arithmetic element S (S is a 4-figure decimal number), and sends the bit number to arithmetic element D (D is also a 4-figure decimal number). The current data on the target register will be covered.
- m_1 range: 1–4
- m_2 range: 1–m_1 (m_2 cannot be larger than m_1)
- n range: m_2–4 (n cannot be smaller than m_2)

Example 1

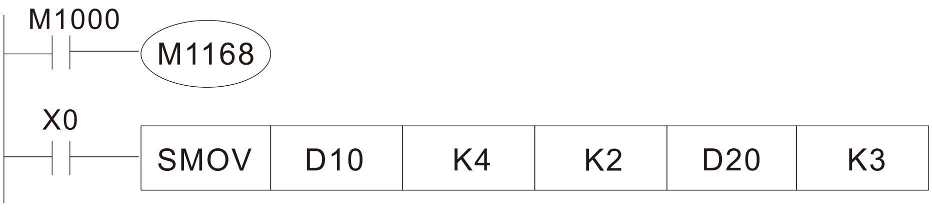
- When M1168 = Off (BCD mode), X0 is ON, the instruction transfers two digits of the decimal number starting from the fourth digit of the decimal number (the digit in the thousands place of the decimal number) in D10 to the two digits of the decimal number starting from the third digit of the decimal number (the digit in the hundreds place of the decimal number) in D20. After the instruction is executed, the digits in the thousands place of the decimal number (10^3) and the ones place of the decimal number (10^0) in D20 are unchanged.

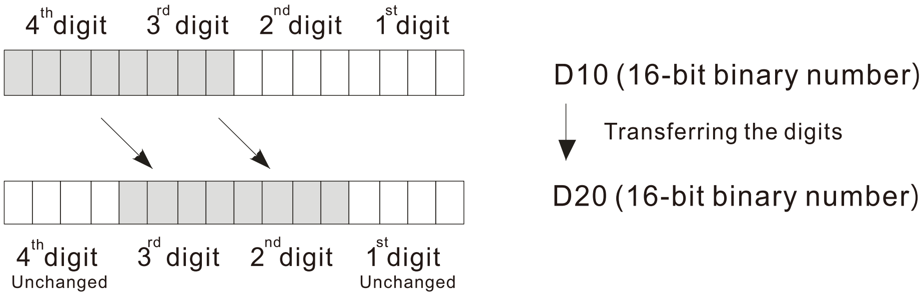




Example 2

- When M1168 is On (BIN mode), and the SMOV command is executed, D10 and D20 do not change in BCD mode, but send 4 digits as a unit in BIN mode.





API				
15	BMOV	P	(S) (D) (n)	Send all

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S						*	*	*	*	*	*
D							*	*	*	*	*
n				*	*				*	*	

Notes on operand usage:
n operand scope n ＝ 1 to 512

16-bit command (7 STEP)			
BMOV	Continuous execution type	BMOVP	Pulse execution type

32-bit command			
—	—	—	—

Flag signal: none

Explanation

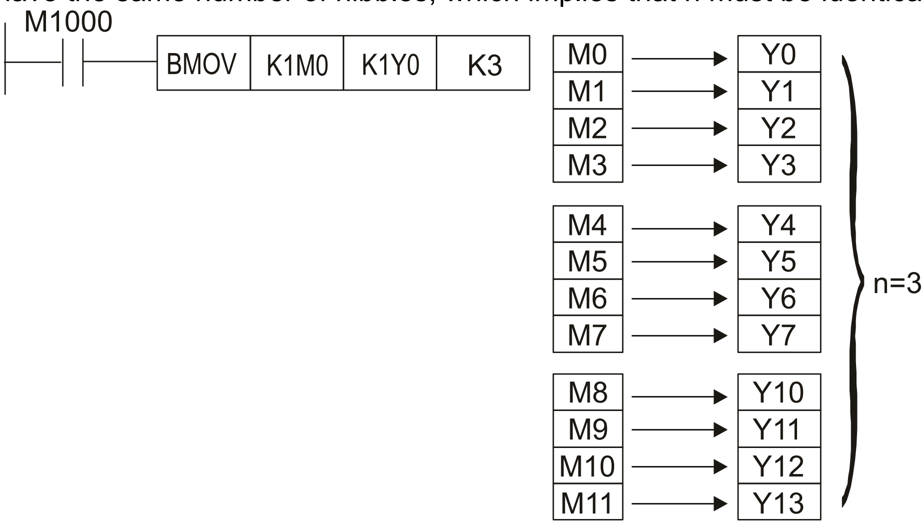
- (S): Initiate source device. (D): Initiate destination device. (n): Send block length.
- The content of n registers starting from the initial number of the device designated by (S) will be sent to the n registers starting from the initial number of the device designated by (n); if the number of points referred to by n exceeds the range used by that device, only points within the valid range will be sent.

Example 1

- When X10=On, the content of registers D0–D3 will be sent to the four registers D20 to D23.

Example 2

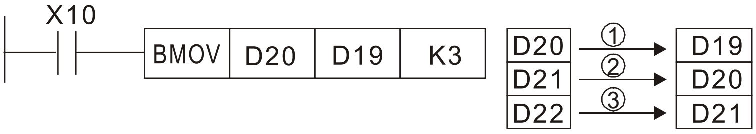
- If the designated bit devices KnX, KnY, and KnM are sent, (S) and (D) must have the same number of nibbles, which implies that n must be identical.



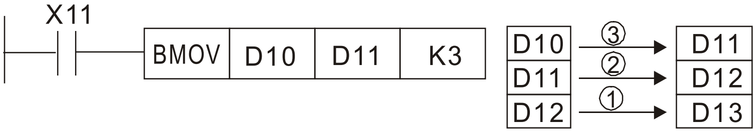
Example 3

- In order to prevent overlap between the transmission addresses of two operands, which would cause confusion, make sure that the addresses designated by the two operands have different sizes, as shown below:

When (S) > (D), send in the order ①→② →③.



When (S) < (D), send in the order ③→② →①.



API					
18	D	BCD	P	(S) (D)	BIN to BCD transformation

	Bit device			Word device						
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S						*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (5 STEP)			
BCD	Continuous execution type	BCDP	Pulse execution type

32-bit command (9 STEP)			
DBCD	Continuous execution type	DBCDP	Pulse execution type

Flag signal: none

Explanation

- (S): Data source. (D): Destination of data movement.
- The content of data source (S) (BIN value, 0–9999) executes BCD transformation and saves in (D).
- Arithmetic elements S and D use the F device, it can only use 16-bit command.

Example

- When X0 is ON, and the BIN value of D10 is transformed to BCD value, the digit is saved in 4-bit element of K1Y0 (Y0–Y3).

- If D10 = 001E (Hex) = 0030 (Decimal), the executed result will be Y0–Y3=0000 (BIN).

API					
19	D	BIN	P	(S) (D)	BCD to BIN transformation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S						*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (5 STEP)			
BIN	Continuous execution type	BINP	Pulse execution type

32-bit command (9 STEP)			
DBIN	Continuous execution type	DBINP	Pulse execution type

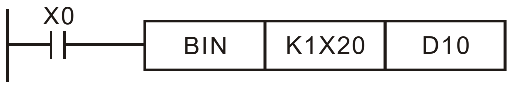
Flag signal: none

Explanation

- (S): Data source. (D): Transformation result.
- The content of data source (S) (BCD: 0–9,999) executes BIN transformation and saves in (D).
- Valid number range of the data source S: BCD (0–9,999), DBCD (0–99,999,999).

Example

- When X0 is ON, and the BCD value of K1X20 is transformed to BIN value, the result saves in D10.



Remark

- When PLC reads a BCD type switch-off from the outside, it has to use the BIN command to transform the read data to BIN value, then saves the value into PLC.

API					
20	D	ADD	P	(S1) (S2) (D)	BIN addition

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (7 STEP)

ADD	Continuous execution type	ADDP	Pulse execution type

32-bit command (13 STEP)

DADD	Continuous execution type	DADDP	Pulse execution type

Flag signal: M1020 Zero flag
M1021 Borrow flag
M1022 Carry flag
Please refer to the following supplementary explanation

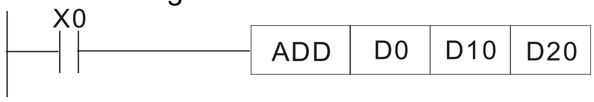
Explanation

- (S1): Augend. (S2): Addend. (D): Sum.
- Using two data sources: The result of adding (S1) and (S2) using the BIN method will be stored in (D).
- The highest bit of any data is symbolized as bit 0 indicating (positive) 1 indicating (negative), enabling the use of algebraic addition operations. (for instance: 3+(-9) =-6)
- Flag changes connected with the addition.

  1. When calculation results are 0, the zero flag M1020 will be On.
  2. When calculation results are less than –32,768, the borrow flag M1021 will be On.
  3. When calculation results are greater than 32,767, the carry flag M1022 will be On.

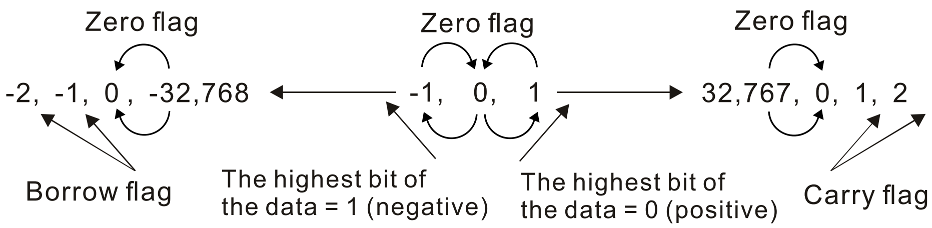
Example

- 16-bit BIN addition: When X0=On, the result of the content of addend D0 plus the content of augend D10 will exist in the content of D20.

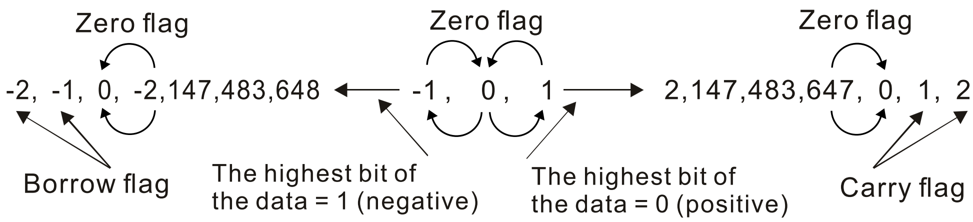


Remark

- Relationship between flag actions and negative/positive numbers:
  16-bit:



32-bit:



API 21	D	SUB	P	(S1) (S2) (D)	BIN subtraction

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (7 STEP)

SUB	Continuous execution type	SUBP	Pulse execution type

32-bit command (13 STEP)

DSUB	Continuous execution type	DSUBP	Pulse execution type

Flag signal: M1020 Zero flag
M1021 Borrow flag
M1022 Carry flag
Please refer to the following supplementary explanation

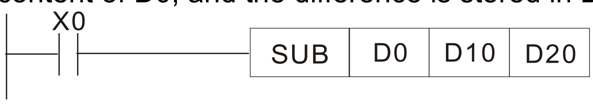
Explanation

- (S1): Minuend. (S2): Subtrahend. (D): Difference.
- Using two data sources: The result of subtraction of (S1) and (S2) using the BIN method is stored in (D).
- The highest bit of any data is symbolized as bit 0 indicating (positive) 1 indicating (negative), enabling the use of algebraic subtraction operations.
- Flag changes connected with subtraction.

1. When calculation results are 0, the zero flag M1020 will be On.
2. When calculation results are less than –32,768, the borrow flag M1021 will be On.
3. When calculation results are greater than 32,767, the carry flag M1022 will be On.

Example

- 16-bit BIN subtraction: When X0=On, the content of D10 is subtracted from the content of D0, and the difference is stored in D20.



API					
22	D	MUL	P	S1 S2 D	BIN multiplication

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
The 16-bit command operand D will occupy 2 consecutive points

16-bit command (7 STEP)			
MUL	Continuous execution type	MULP	Pulse execution type

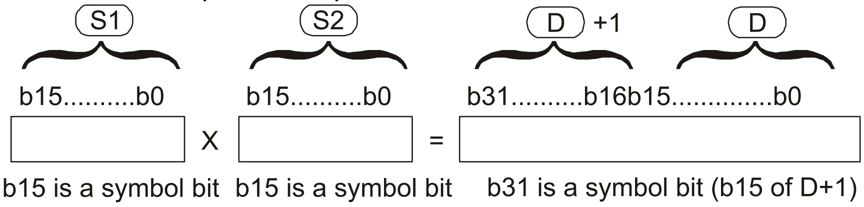
32-bit command (13 STEP)			
DMUL	Continuous execution type	DMULP	Pulse execution type

Flag signal: none

Explanation

- S1: Multiplicand. S2: Multiplier. D: Product.
- Using two data sources: When S1 and S2 are multiplied using the BIN method, the product is stored in D.

16-bit BIN multiplication operation:

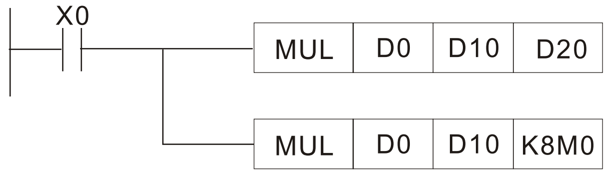


Symbol bit = 0 refers to a positive value
Symbol bit = 1 refers to a negative vlalue

When D is a bit device, K1–K4 can be designated as a hexadecimal number, which will occupy 2 consecutive units.

Example

- When 16-bit DO is multiplied by 16-bit D10, the result will be a 32-bit product; the upper 16 bits will be stored in D21, and the lower 16 bits will be stored in D20. Whether the bit at the farthest left is Off or On will indicate the sign of the result.



API 23	D	DIV	P	(S1) (S2) (D)	BIN division

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
The 16-bit command operand D will occupy 2 consecutive points

16-bit command (7 STEP)

DIV	Continuous execution type	DIVP	Pulse execution type

32-bit command (13 STEP)

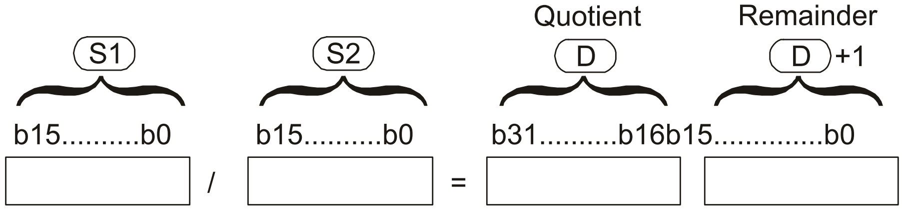
DDIV	Continuous execution type	DDIVP	Pulse execution type

Flag signal: none

Explanation

- (S1): Dividend. (S2): Divisor. (D): Quotient and remainder.
- Using two data sources: The quotient and remainder will be stored in (D) when (S1) and (S2) are subjected to division using the BIN method. The sign bit for (S1), (S2) and (D) must be kept in mind when performing a 16-bit operation.

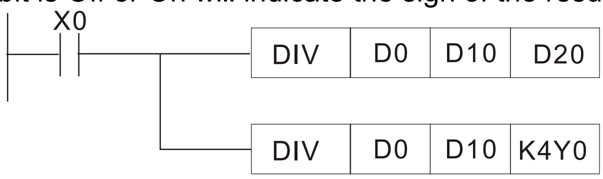
16-bit BIN division:



If (D) is a bit device, K1–K4 can be designated 16 bits, which will occupy 2 consecutive units and yield the quotient and remainder.

Example

- When X0=On, the quotient resulting from division of dividend D0 by divisor D10 will be placed in D20, and the remainder will be placed in D21. Whether the highest bit is Off or On will indicate the sign of the result.



API					
24	D	INC	P	(D)	BIN add one

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (3 STEP)			
INC	Continuous execution type	INCP	Pulse execution type

32-bit command (5 STEP)			
DINC	Continuous execution type	DINCP	Pulse execution type

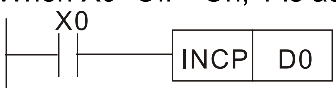
Flag signal: none

Explanation

- (D): Destination device.
- If a command is not the pulse execution type, when the command is executed, the program will add 1 to the content of device (D) for each scanning cycle.
- This command is ordinarily used as a pulse execution type command (INCP).
- During 16-bit operation, 32,767 +1 will change the value to -32,768. During 32 bit operation, 2,147,483,647 +1 will change the value to -2,147,483,648.

Example

- When X0=Off→On, 1 is automatically added to the content of D0.



API 25	D	DEC	P	(D)	BIN subtract one

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D				*	*	*	*	*			

Notes on operand usage: none

16-bit command (3 STEP)

DEC	Continuous execution type	DECP	Pulse execution type

32-bit command (5 STEP)

DDEC	Continuous execution type	DDECP	Pulse execution type

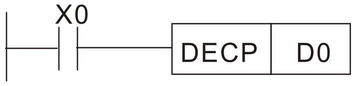
Flag signal: none

Explanation

- (D): Destination device.
- If a command is not the pulse execution type, when the command is executed, the program will add 1 to the content of device (D) for each scanning cycle.
- This command is ordinarily used as a pulse execution type command (DECP).
- During 16-bit operation, -32,768 minus 1 will change the value to 32,767. During 32 bit operation, -2,147,483,648 minus 1 will change the value to -2,147,483,647.

Example

- When X0=Off→On, 1 is automatically subtracted from the content of D0.



API	D	ROR	P	(D) (n)	Right rotation
30					

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D							*	*	*	*	*
n				*	*						

Notes on operand usage:
Only K4 (16-bit) will be valid if the operand D is designated as KnY or KnM.
n operand n=K1-K16 (16-bit)

16-bit command (5 STEP)			
ROR	Continuous execution type	RORP	Pulse execution type

32-bit command (9 STEP)			
DROR	Continuous execution type	DRORP	Pulse execution type

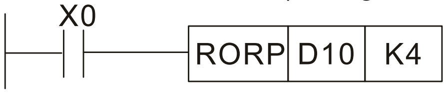
Flag signal: M1022 Carry flag

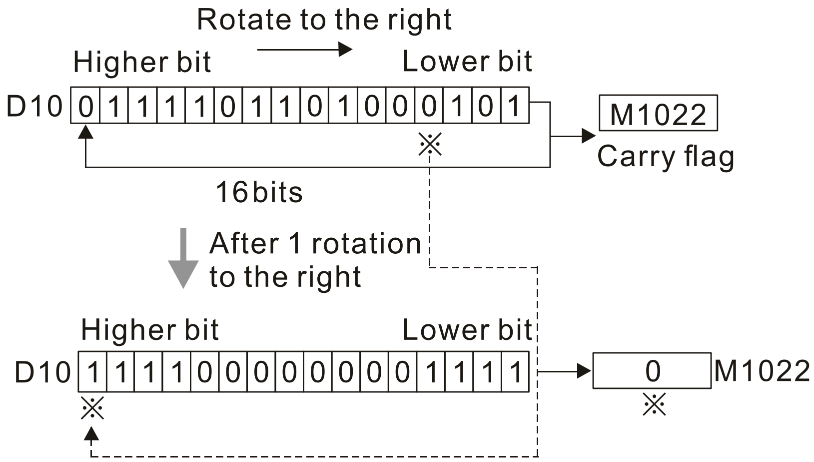
Explanation

- (D): Device to be rotated. (n): Number of bits for one rotation.
- Rotates the device designated by (D) to the right (n) bits.
- This command is ordinarily used as a pulse execution type command (RORP).

Example

- When X0=Off→On, 4 of the 16 bits in D10 specify a right rotation; the content of the bit indicated with * (see figure below) will be sent to the carry flag signal M1022.





API					
31	D	ROL	P	(D) (n)	Left rotation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D							*	*	*	*	*
n				*	*						

Notes on operand usage:
Only K4 (16-bit) will be valid if the operand D is designated as KnY or KnM.
n operand n=1 to 16 (16-bit)

16-bit command (5 STEP)

ROL	Continuous execution type	ROLP	Pulse execution type

32-bit command (9 STEP)

DROL	Continuous execution type	DROLP	Pulse execution type

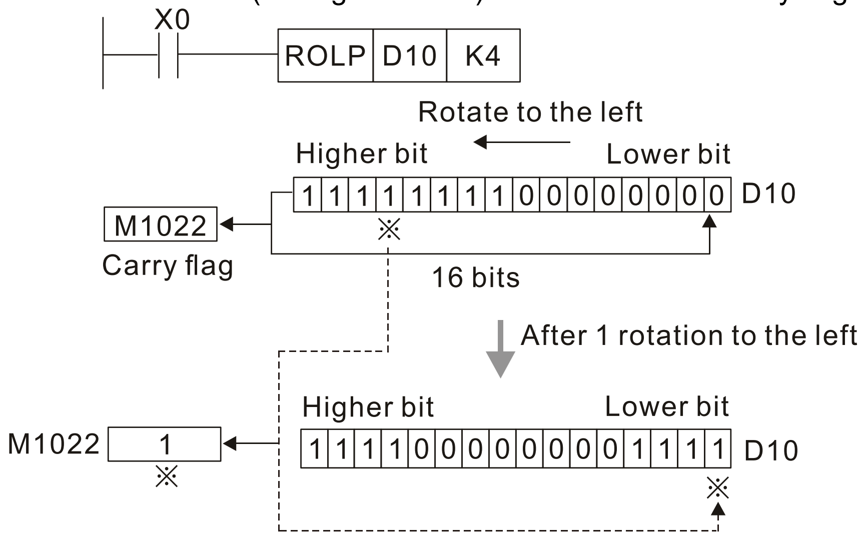
Flag signal: M1022 Carry flag

Explanation

- (D): Device to be rotated. (n): Number of bits for one rotation.
- Rotates the device designated by (D) to the left (n) bits.
- This command is ordinarily used as a pulse execution type command (ROLP).

Example

- When X0=Off→On, 4 of the 16 bits in D10 specify a left rotation; the content of the bit indicated with * (see figure below) will be sent to the carry flag signal M1022.



API				
40	ZRST	P	(D1) (D2)	Clear range

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D1		*	*						*	*	*
D2		*	*						*	*	*

Notes on operand usage:
Number of operand D_1 operand ≤ number of operand D_2
Operands D_1, D_2 must designate the same type of device
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)			
ZRST	Continuous execution type	ZRSTP	Pulse execution type

32-bit command			
—	—	—	—

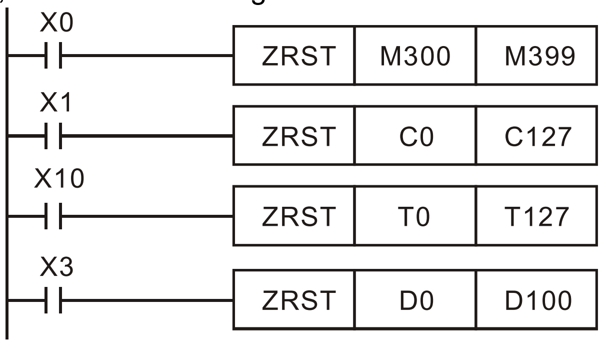
Flag signal: none

Explanation

- $\mathbf{D_1}$: Clear ranges initial device. $\mathbf{D_2}$: Clear ranges final device.
- When the number of operand D_1 > number of operand D_2, only the operand designated by D_2 will be cleared.

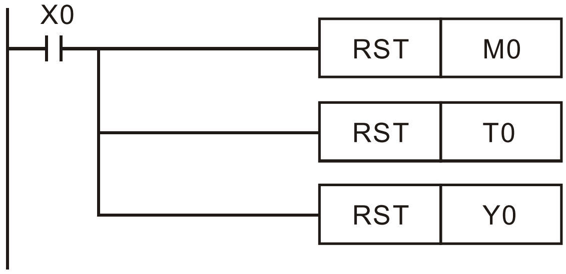
Example

- When X0 is On, auxiliary relays M300–M399 will be cleared and changed to Off.
- When X1 is On, 16-bit counters C0–C127 will all be cleared. (Writes 0, and clears and changes contact and coil to Off).
- When X10 is On, timer T0–T127 will all be cleared. (Writes 0, and clears and changes contact and coil to Off).
- When X3 is On, the data in data registers D0–D100 will be cleared and set as 0.



Remark

- Devices can independently use the clear command (RST), such as bit device Y, M and word device T, C, D.



API 41	D	DECO	P	S D n	Decoder

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S	*	*	*	*	*				*	*	*
D		*	*				*	*	*	*	*
n				*	*						

Notes on operand usage: none

16-bit command (7 STEP)			
DECO	Continuous execution type	DECOP	Pulse execution type

32-bit command (13 STEP)			
DDECO	Continuous execution type	DDECOP	Pulse execution type

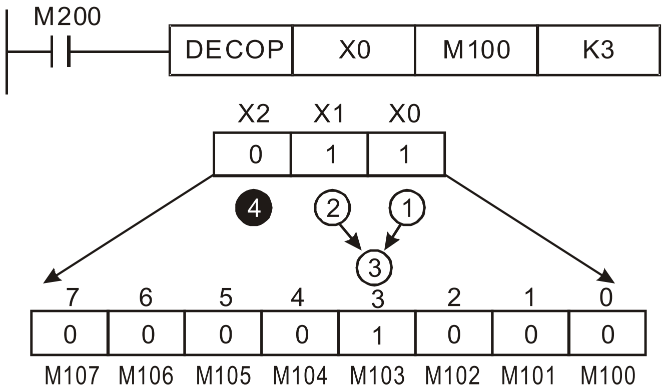
Flag signal: none

Explanation

- S: Decoding source device. D: Device that saves the decoding result. n: Length of decoding bit.
- Decodes with the lower "n" bit, and saves the length of "2^n" bit in D.
- This command usually uses pulse execution type command (DECOP).
- When D is the bit device, n = 1–8, when D is the word device, n = 1–4.

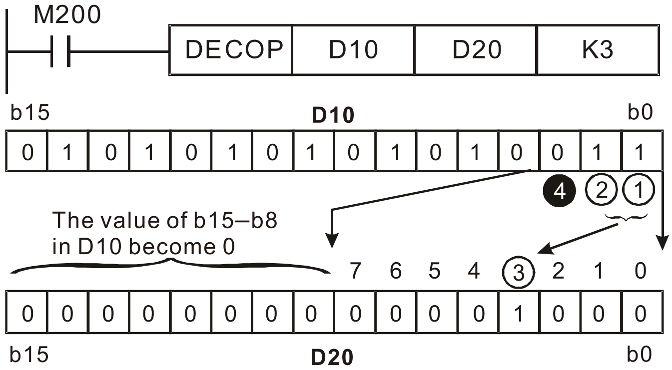
Example 1

- When Dis the bit device, the valid range of n is 0< **n** ≦8. If n = 0 or n > 8, a fault will occur.
- When n = 8, the maximum decoding will be 2^8 = 256 points.
- When M200 switches from Off to On, the content of X0–X2 is decoded to M100–M107.
- If S = 3, M103 (the third digit starting from M100) = On.
- When the command is executed, M200 turns to Off. The ones that are decoded and outputted act as usual.



Example 2

- When D is word device, the valid range of n is 0< **n** ≦4. If n = 0 or n > 4, the fault occurs.
- When n = 4, the maximum decoding will be 2^4 = 16 points.
- When M200 switches from Off to On, the content of D10 (b2–b0) is decoded to D20 (b7–b0). The unused digits (b15–b8) of D20 become 0.
- The lower 3 digits of D10 are decoded and saved in the lower 8 digits of D20, the upper 8 digits are 0.
- When the command is executed, M200 turns to Off. The ones that are decoded and outputted act as usual.



API				
42	D ENCO P	S D n		Encoder

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S	*	*	*						*	*	*
D							*	*	*	*	*
n				*	*						

Notes on operand usage: none

16-bit command (7 STEP)			
ENCO	Continuous execution type	ENCOP	Pulse execution type

32-bit command (13 STEP)			
DENCO	Continuous execution type	DENCOP	Pulse execution type

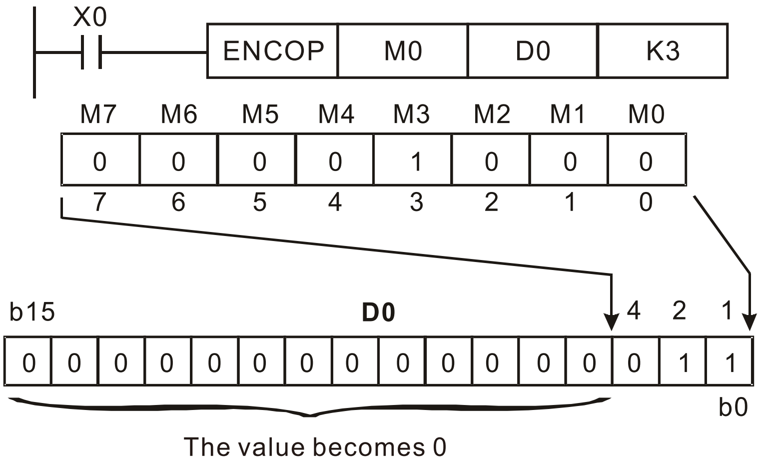
Flag signal: none

Explanation

- S: Encoding source device. D: Device that saves the encoding result. n: Length of encoding bit.
- Encodes the data of lower "2^n" bit length from encoding source device S, and saves the encoding result in D.
- If multiple digits of encoding source device are 1, the command will process the first digit starting from high digit.
- This command usually uses pulse execution type command (ENCOP).
- When S is the bit device, n = 1–8, when S is the word device, n = 1–4.

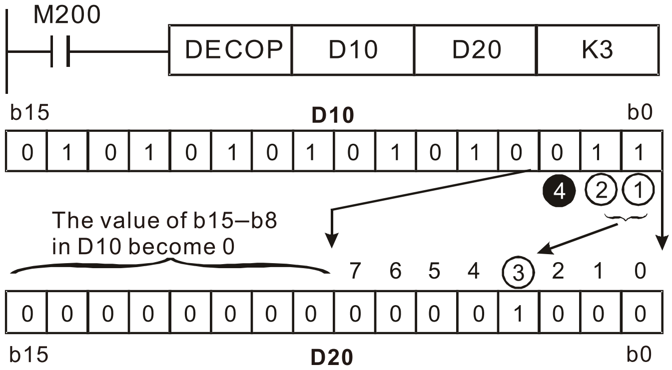
Example 1

- When S is the bit device, the valid range of n is 0< **n** ≦8. If n = 0 or n > 8, a fault will occur.
- When n = 8, the maximum decoding will be 2^8 = 256 points.
- When X0 switches from Off to On, the content of 2^3 digit (M0–M7) is encoded and saved in the lower 3 digits (b2–b0). The unused digits (b15–b3) in D0 become 0.
- When the command is executed, X0 turns to Off. The data in D is unchanged.



Example 2

- When S is word device, the valid range of n is 0< **n** ≦4. If n = 0 or n > 4, the fault occurs.
- When n = 4, the maximum decoding will be 2^4 = 16 points.
- When X0 switches from Off to On, 2^3 digit data of D10 (b0–b7) is encoded and saved in the lower 3 digits (b2–b0) of D20. The unused digits (b15–b3) of D20 become 0. (b8–b15 in D10 are invalid data)
- When the command is executed, X0 turns to Off. The data in D is unchanged.



API 43	D	SUM	P	(S) (D)	ON bit number

	Bit device			Word device						
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D									*	*	*

Notes on operand usage: none

16-bit command (5 STEP)

SUM	Continuous execution type	SUMP	Pulse execution type

32-bit command (9 STEP)

DSUM	Continuous execution type	DSUMP	Pulse execution type

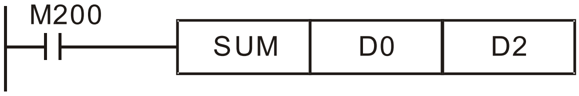
Flag signal: M1020

Explanation

- (S): Source device. (D): Destination of saving counter values.
- The total amount of all digits that is “1” in S will be saved in D.
- D will use 2 registers when use the 32-bit command.
- Arithmetic elements S and D use F device, and can only use 16-bit command.
- If there is no bit is ON, the flag signal M1020 will be ON.

Example

- When M200 = On, the total amount of content “1” digit in D0’s 16-bit command will be saved in D2.



0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0

D0

3

D2

API 44	D	BON	P	(S) (D) (n)	ON bit judgement

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D		*	*						*	*	*
n				*	*						

Notes on operand usage: none

16-bit command (7 STEP)			
BON	Continuous execution type	BONP	Pulse execution type

32-bit command (9 STEP)			
DBON	Continuous execution type	DBONP	Pulse execution type

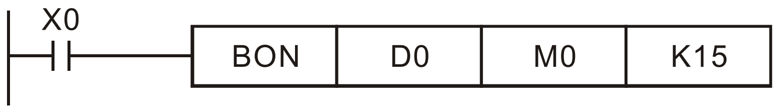
Flag signal: none

Explanation

- (S): Source device. (D): Destination of saving judging result. (n): assign judged digit (numbering from 0)
- The status of specific digit from source device is shown on target position.
- Arithmetic element S uses F device, and can only use the 16-bit command.
- The valid range of arithmetic element n: n = 0–15 (16-bit), n = 0–31 (32-bit).

Example

- When X0 = On, if the 15th digit of D0 is “1”, M0 is On. If it is “0”, M0 is Off.
- When X0 turns to Off, M0 remains previous status.



b15 … b0

0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0

D0 — M0=Off

b15 … b0

1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0

D0 — M0=On

API					
49	D	FLT	P	(S) (D)	BIN whole number → binary decimal transformation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S		*	*						*	*	*
D		*	*						*	*	*

Notes on operand usage: Please refer to the function specifications table for each device in series for the scope of device usage
The operand D will occupy 2 consecutive points

16-bit command (5 STEP)

FLT	Continuous execution type	FLTP	Pulse execution type

32-bit command (9 STEP)

DFLT	Continuous execution type	DFLTP	Pulse execution type

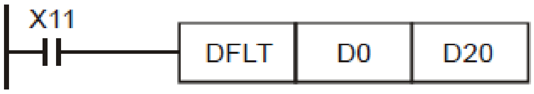
Flag signal: none

Explanation

- **S**: Transformation source device. **D**: Device storing transformation results.
- Transforms BIN whole number into a binary decimal value.

Example

- When M200 is On, converts the whole number of values corresponding to D0 and D1 into floating point numbers, which are placed in D20 and D21.



API				
110	D	ECMP	P	(S1) (S2) (D) Comparison of binary floating point numbers

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D				*	*						*

Notes on operand usage:
The operand D occupies three consecutive points
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (13 STEP)

DECMP	Continuous execution type	DECMPP	Pulse execution type

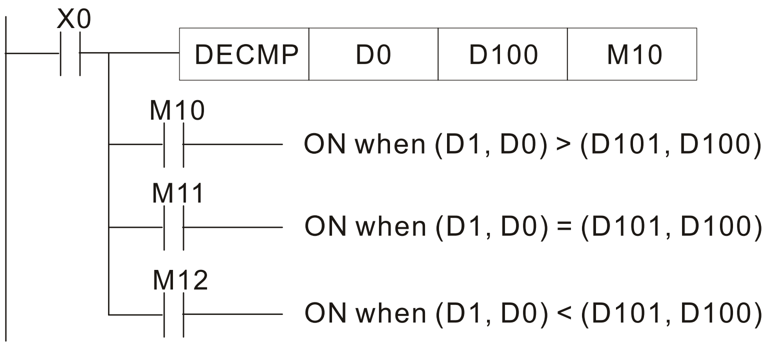
Flag signal: none

Explanation

- **S_1**: Comparison of binary floating point numbers value 1. **S_2**: Comparison of binary floating point numbers value 2. **D**: Results of comparison, occupies 3 consecutive points.
- When binary floating point number 1 is compared with comparative binary floating point number 2, the result of comparison (>, =, <) will be expressed in **D**.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command will transform the constant to a binary floating-point number for the purpose of comparison.

Example

- When the designated device is M10, it will automatically occupy M10–M12.
- When X0=On, the DECMP command executes, and one of M10–M12 will be On. When X0=Off, the DECMP command will not execute, and M10–M12 will remain in the X0=Off state.
- If results in the form of ≥, ≤, or ≠ are needed, they can be obtained by series and parallel connection of M10–M12.
- Please use the RST or ZRST command to clear the result.



API 111	D	EZCP	P	S1 S2 S D	Comparison of binary floating point number range

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
S				*	*						*
D		*	*								

Notes on operand usage:
The operand D occupies three consecutive points
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (17 STEP)

DEZCP	Continuous execution type	DEZCPP	Pulse execution type

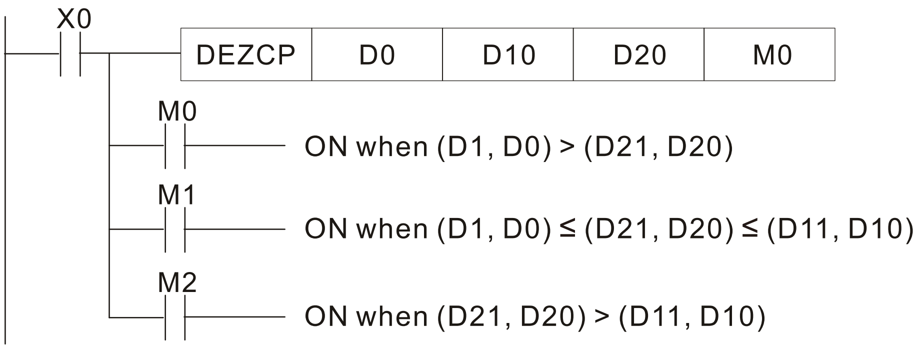
Flag signal: none

Explanation

- **S_1**: Lower limit of binary floating point number in range comparison. **S_2**: Upper limit of binary floating point number in range comparison. **S**: Comparison of binary floating point numerical values. **D**: Results of comparison, occupies 3 consecutive points.
- Comparison of binary floating point numerical value **S** with binary floating point number lower limit value **S_1** and binary floating point number upper limit value **S_2**; the results of comparison are expressed in **D**.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command will transform the constant to a binary floating-point number for the purpose of comparison.
- When the lower limit binary floating point number **S_1** is greater than the upper limit binary floating point number **S_2**, a command will be issued to perform comparison with the upper and lower limits using the binary floating point number lower limit value **S_1**.

Example

- When the designated device is M0, it will automatically occupy M0–M2.
- When X0=On, the DEZCP command will be executed, and one of M0–M2 will be On. When X0=Off, the EZCP command will not execute, and M0–M2 will continue in the X0=Off state.
- Please use the RST or ZRST command to clear the result.



API					
116	D	RAD	P	(S) (D)	Angle → Diameter

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

DRAD	Continuous execution type	DRADP	Pulse execution type

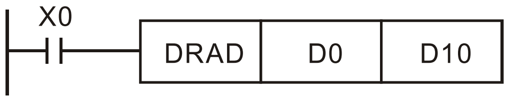
Flag signal: none

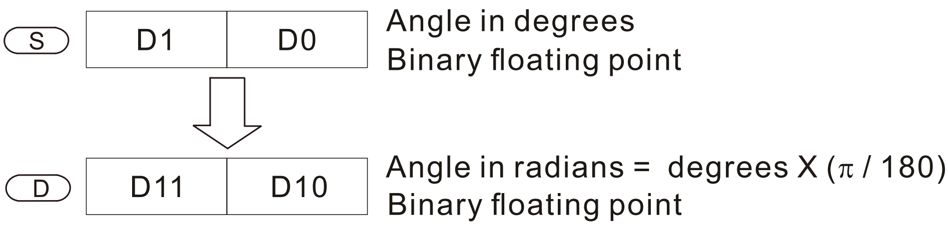
Explanation

- **S**: data source (angle). **D**: result of transformation (diameter).
- Uses the following formula to convert angles to radians.
- Diameter ＝Angle × (π/180)

Example

- When X0=On, the angle of the designated binary floating point number (D1, D0) will be converted to radians and stored in (D11, D10), with the content consisting of a binary floating point number.





API					
117	D	DEG	P	S D	Diameter → angle

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

DDEG	Continuous execution type	DDEGP	Pulse execution type

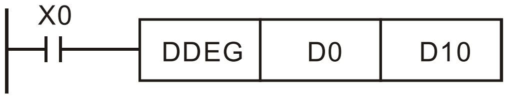
Flag signal: none

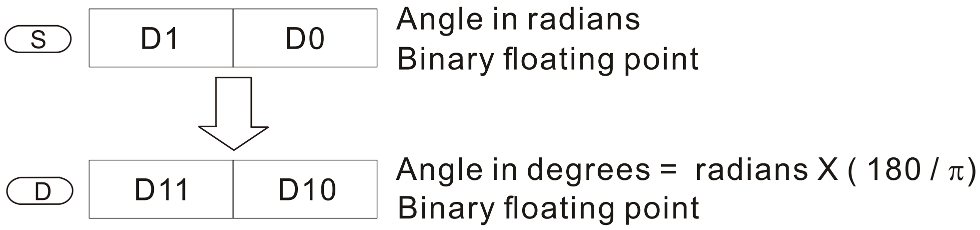
Explanation

- **S**: data source (diameter). **D**: results of transformation (angle).
- Uses the following formula to convert radians to an angle.
- Angle ＝Diameter × (180/π)

Example

- When X0=On, angle of the designated binary floating point number (D1, D0) in radians will be converted to an angle and stored in (D11, D10), with the content consisting of a binary floating point number.





API					
120	D	EADD	P	S1 S2 D	Adding binary floating point numbers

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

DEADD	Continuous execution type	DEADDP	Pulse execution type

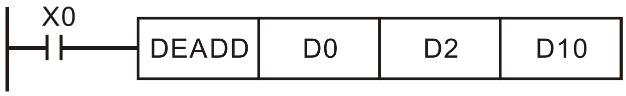
Flag signal: none

Explanation

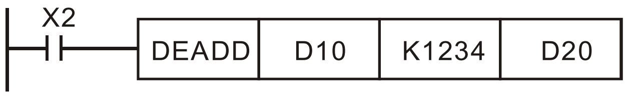
- S_1: addend. S_2: augend. **D**: sum.
- When the content of the register designated by S_2 is added to the content of the register designated by S_1, and the result is stored in the register designated by **D**. Addition is performed entirely using binary floating-point numbers.
- **If the source operand S_1** or S_2 designates a constant K or H, the command will transform that constant into a binary floating point number for use in addition.
- **In the situation when S_1** and S_2 designate identical register numbers, if a "continuous execution" command is employed, when conditional contact is On, the register will perform addition once during each scan. Pulse execution type commands (DEADDP) are generally used under ordinary circumstances.

Example

- When X0=On, a binary floating point number (D1, D0) will be added to a binary floating point number (D3, D2), and the results stored in (D11, D10).



- When X2 =On, a binary floating point number (D11, D10) will be added to K1234 (which has been automatically converted to a binary floating-point number), and the results stored in (D21, D20).



API					
121	D	ESUB	P	S1 S2 D	Subtraction of binary floating point numbers

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command			
—	—	—	—

32-bit command (13 STEP)			
DESUB	Continuous execution type	DESUBP	Pulse execution type

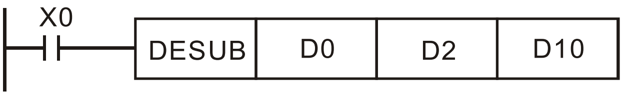
Flag signal: none

Explanation

- **S_1**: minuend. **S_2**: subtrahend. **D**: difference.
- When the content of the register designated by **S_2** is subtracted from the content of the register designated by **S_1**, the difference will be stored in the register designated by **D**; subtraction is performed entirely using binary floating-point numbers.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command will transform that constant into a binary floating point number for use in subtraction.
- **In the situation when S_1** and **S_2** designate identical register numbers, if a "continuous execution" command is employed, when conditional contact is On, the register will perform addition once during each scan. Pulse execution type commands (DESUBP) are generally used under ordinary circumstances.

Example

- When X0=On, a binary floating point number (D1, D0) will be subtracted to a binary floating point number (D3, D2), and the results stored in (D11, D10).



- When X2 =On, the binary floating point number (D1, D0) will be subtracted from K1234 (which has been automatically converted to a binary floating-point number), and the results stored in (D11, D10).

API					
122	D	EMUL	P	S1 S2 D	Multiplication of binary floating point numbers

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

–	–	–	–

32-bit command (13 STEP)

DEMUL	Continuous execution type	DEMULP	Pulse execution type

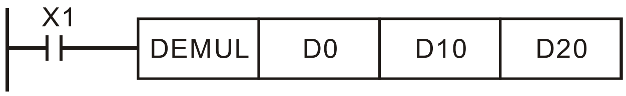
Flag signal: none

Explanation

- **S_1**: multiplicand. **S_2**: multiplier. **D**: product.
- When the content of the register designated by **S_1** is multiplied by the content of the register designated by **S_2**, the product will be stored in the register designated by **D**; multiplication is performed entirely using binary floating-point numbers.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command will transform that constant into a binary floating point number for use in multiplication.
- **In the situation when S_1** and **S_2** designate identical register numbers, if a "continuous execution" command is employed, when conditional contact is On, the register will perform multiplication once during each scan. Pulse execution type commands (DEMULP) are generally used under ordinary circumstances.

Example

- When X1=On, the binary floating point number (D1, D0) will be multiplied by the binary floating point number (D11, D10), and the product will be stored in the register designated by (D21, D20).



- When X2 =On, the binary floating point number (D1, D0) will be multiplied from K1234 (which has been automatically converted to a binary floating-point number), and the results stored in (D11, D10).

API 123	D	EDIV	P	S1 S2 D	Division of binary floating point numbers

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (13 STEP)

DEDIV	Continuous execution type	DEDIVP	Pulse execution type

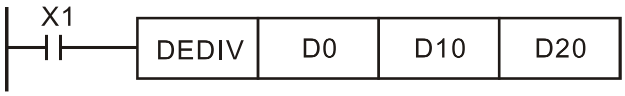
Flag signal: none

Explanation

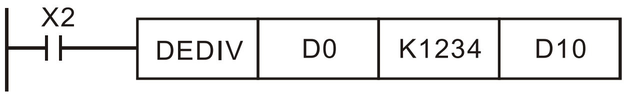
- **S_1**: dividend. **S_2**: divisor. **D**: quotient and remainder.
- When the content of the register designated by **S_1** is divided by the content of the register designated by **S_2**, the quotient will be stored in the register designated by **D**; division is performed entirely using binary floating-point numbers.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command will transform that constant into a binary floating point number for use in division.

Example

- When X1=On, the binary floating point number (D1, D0) will be divided by the binary floating point number (D11, D10), and the quotient stored in the register designated by (D21, D20).



- When X2=On, the binary floating point number (D1, D0) will be divided by K1,234 (which has been automatically converted to a binary floating-point number), and the results stored in (D11, D10).



API					
124	D	EXP	P	(S) (D)	Binary floating point number obtain exponent

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

–	–	–	–

32-bit command (9 STEP)

DEXP	Continuous execution type	DEXPP	Pulse execution type

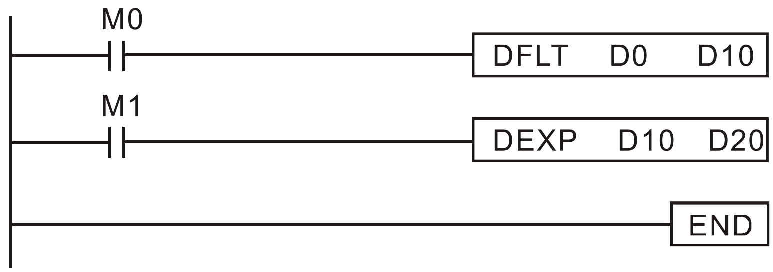
Flag signal: none

Explanation

- S: operation source device. D: operation results device.
- Taking e =2.71828 as a base, S is the exponent in the EXP operation.
- [D +1，D]=EXP [S +1, S]
- Valid regardless of whether the content of **S** has a positive or negative value. The designated register D must have a 32-bit data format. This operation is performed using floating-point numbers, and **S** must therefore be converted to a floating point number.
- Content of operand **D** =e ^{S} ; e=2.71828, **S** is the designated source data

Example

- When M0 is On, the value of (D1, D0) will be converted to a binary floating point number, which will be stored in register (D11, D10).
- When M1 is On, the EXP operation is performed on the exponent of (D11, D10); its value is a binary floating point number stored in register (D21, D20).



API 125	D	LN	P	(S) (D)	Binary floating point number obtain logarithm

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

DLN	Continuous execution type	DLNP	Pulse execution type

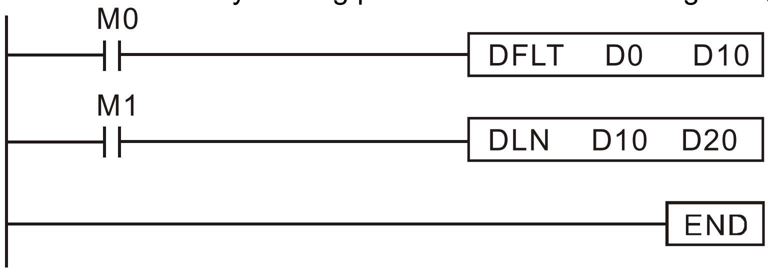
Flag signal: none

Explanation

- **S**: operation source device. **D**: operation results device.
- Taking e =2.71828 as a base, **S** is the exponent in the EXP operation.
- [**D** +1，**D**]=EXP［**S +1**，**S**］
- Valid regardless of whether the content of **S** has a positive or negative value. The designated register D must have a 32-bit data format. This operation is performed using floating-point numbers, and **S** must therefore be converted to a floating point number.
- Content of operand **D** $=e^{S}$; e=2.71828， **S** is the designated source data

Example

- When M0 is On, the value of (D1, D0) will be converted to a binary floating point number, which will be stored in register (D11, D10).
- When M1 is On, the EXP operation is performed on the exponent of (D11, D10); its value is a binary floating point number stored in register (D21, D20).



API 127	D	ESQR	P	(S) (D)	Binary floating point number find square root

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

–	–	–	–

32-bit command (9 STEP)

DESQR	Continuous execution type	DESQRP	Pulse execution type

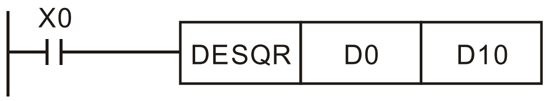
Flag signal: none

Explanation

- **S**: source device for which square root is desired **D**: result of finding square root.
- When the square root is taken of the content of the register designated by **S**, the result is temporarily stored in the register designated by **D**. Taking square roots is performed entirely using binary floating-point numbers.
- If the source operand **S** refers to a constant K or H, the command will transform that constant into a binary floating point number for use in the operation.

Example

- When X0=On, the square root is taken of the binary floating point number (D1, D0), and the result is stored in the register designated by (D11, D10).



$$\sqrt{(D1 \cdot D0)} \rightarrow (D11 \cdot D10)$$

Binary floating point   Binary floating point

- When X2 =On, the square root is taken of K1,234 (which has been automatically converted to a binary floating-point number), and the results stored in (D11, D10).

API					
129	D	INT	P	S D	Binary floating point number → BIN whole number transformation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S											*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)

INT	Continuous execution type	INTP	Pulse execution type

32-bit command (9 STEP)

DINT	Continuous execution type	DINTP	Pulse execution type

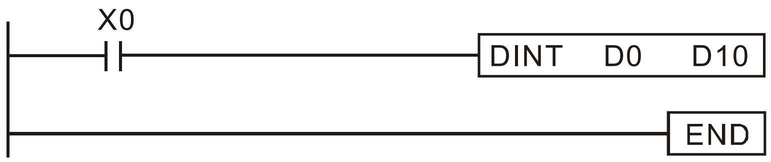
Flag signal: none

Explanation

- **S**: the source device to be transformed. **D**: results of transformation.
- The content of the register designated by **S** is transformed from a binary floating point number format into a BIN whole number, and is temporarily stored in **D**. The BIN whole number floating point number will be discarded.
- The action of this command is the opposite of that of command API 49 (FLT).

Example

- When X0=On, the binary floating point number (D1, D0) is transformed into a BIN whole number, and the result is stored in (D10); the BIN whole number floating point number will be discarded.



API					
130	D	SIN	P	S D	Binary floating point number SIN operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

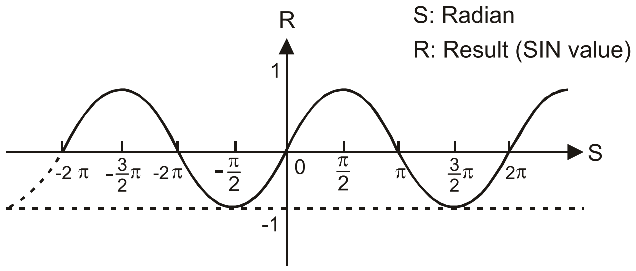
DSIN	Continuous execution type	DSINP	Pulse execution type

Flag signal: none

Explanation

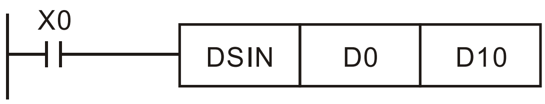
- **S**: the designated source value. **D**: the SIN value result.
- **S** is the designated source in radians.
- The value in radians (RAD) is equal to (angle ×π/180).
- The SIN obtained from the source value designated by **S** is stored in **D**.

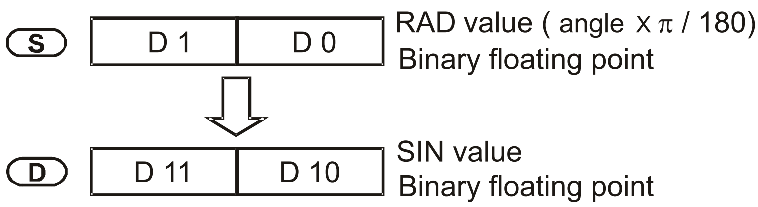
The following figure displays the relationship between the arc and SIN results:



Example

- When X0=On, the SIN value of the designated binary floating point number (D1, D0) in radians (RAD) will be stored in (D11, D10), with the content consisting of a binary floating point number.





API 131	D	COS	P	(S) (D)	Binary floating point number COS operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command			
—	—	—	—

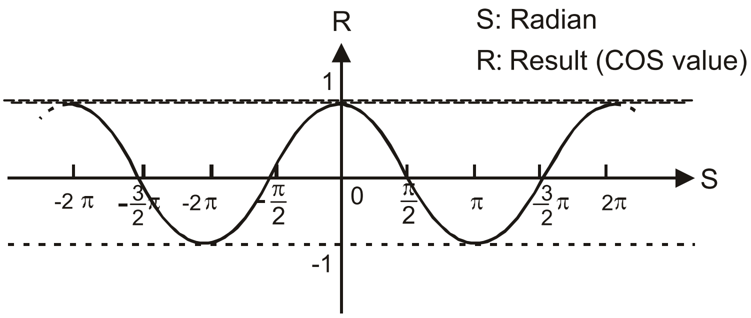
32-bit command (9 STEP)			
DCOS	Continuous execution type	DCOSP	Pulse execution type

Flag signal: none

Explanation

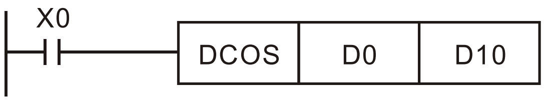
- **S**: the designated source value. **D**: the COS value result.
- The source designated by S can be given as radians or an angle; this is decided by flag M1018.
- When M1018=Off, the operation is in radians mode, where the radians (RAD) value is equal to (angle ×π/180).
- When M1018=On, the operation is in the angle mode, where the angular range is 0°≤ angle <360°.
- When calculation results yield 0, M1020=On.
- The COS obtained from the source value designated by **S** is stored in **D**.

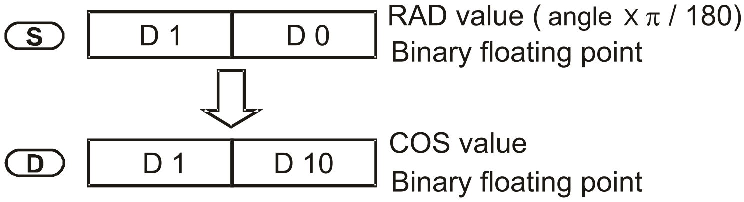
The following figure displays the relationship between the arc and SIN results:



Example

- When X0=On, the COS value of the designated binary floating point number (D1, D0) in radians will be stored in (D11, D10), with the content consisting of a binary floating point number.





API					
132	D	TAN	P	(S) (D)	Binary floating point number TAN operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

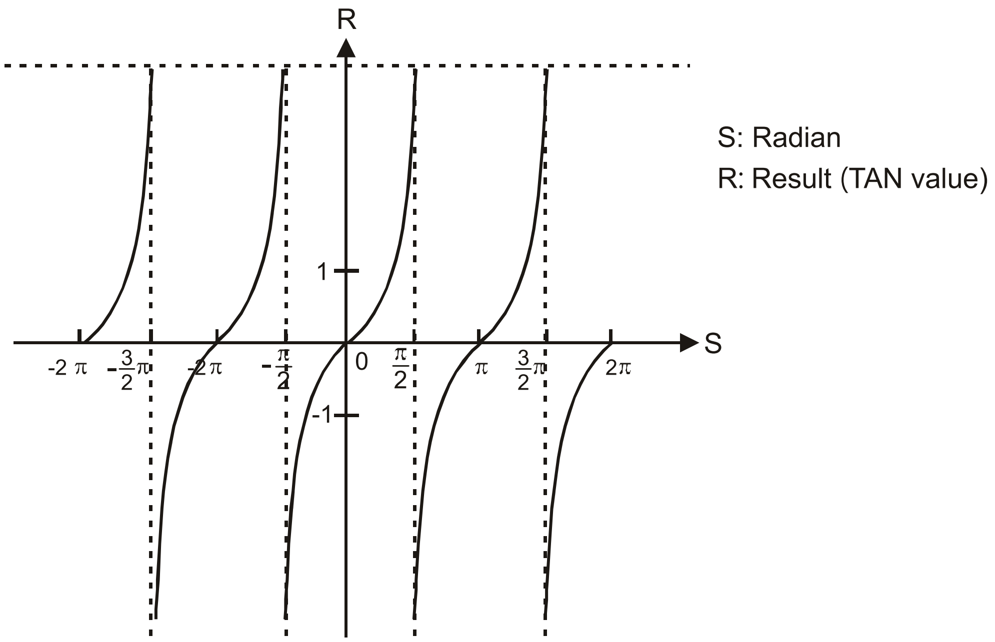
DTAN	Continuous execution type	DTANP	Pulse execution type

Flag signal: none

Explanation

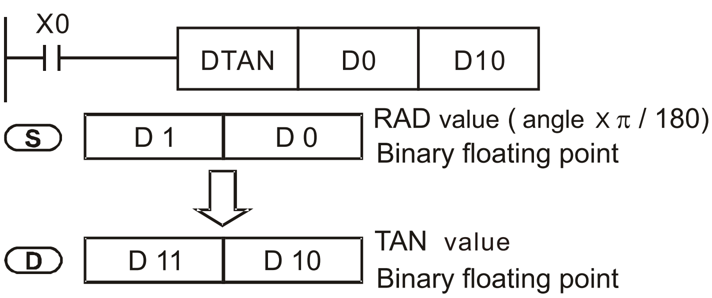
- **S**: the designated source value. **D**: the TAN value result.
- The source designated by **S** can be given as radians or an angle; this is decided by flag M1018.
- When M1018=Off, the operation is in radians mode, where the radians (RAD) value is equal to (angle ×π/180).
- When M1018=On, the operation is in the angle mode, where the angular range is 0°≤ angle <360°.
- When calculation results yield 0, M1020=On.
- The TAN obtained from the source value designated by **S** is stored in **D**.

The following figure displays the relationship between the arc and TAN results:



Example

- When X0=On, the TAN value of the designated binary floating point number (D1, D0) in radians (RAD) will be stored in (D11, D10), with the content consisting of a binary floating point number.



API					
133	D	ASIN	P	(S) (D)	Binary floating point number ASIN operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command			
—	—	—	—

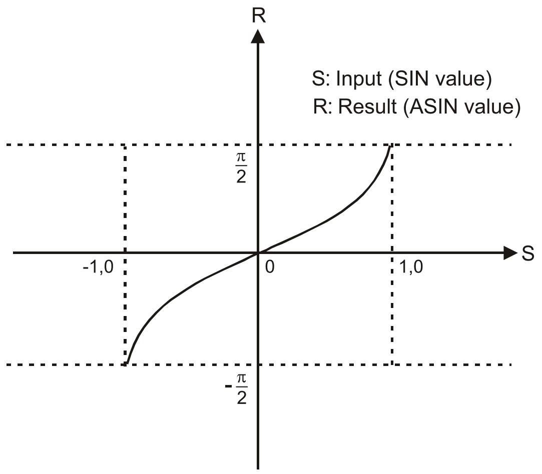
32-bit command (9 STEP)			
DASIN	Continuous execution type	DASINP	Pulse execution type

Flag signal: none

Explanation

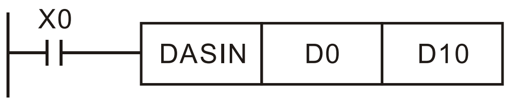
- **S**: the designated source (binary floating point number). **D**: the ASIN value result.
- ASIN value $=\sin^{-1}$

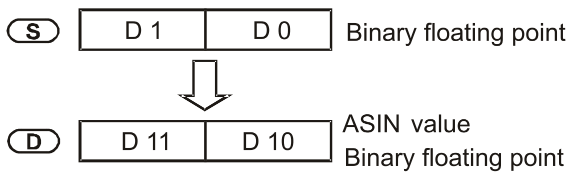
The figure below shows the relationship between input data and result:



Example

- When X0=On, the ASIN value obtained from the designated binary floating point number (D1, D0) will be stored in (D11, D10), with the content consisting of a binary floating point number.





API 134	D	ACOS	P	(S) (D)	Binary floating point number ACOS operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

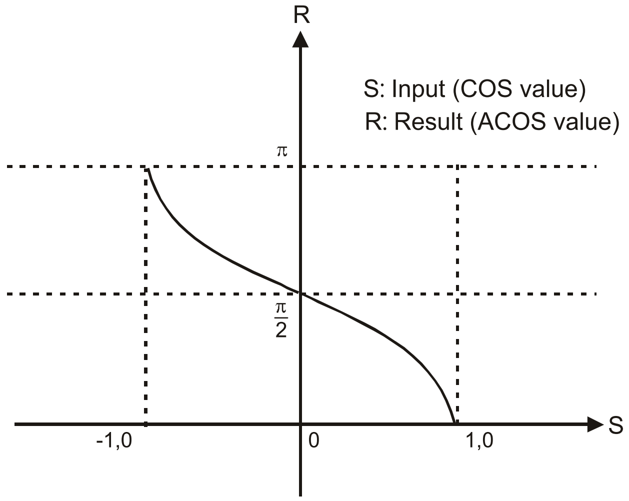
DACOS	Continuous execution type	DACOSP	Pulse execution type

Flag signal: none

Explanation

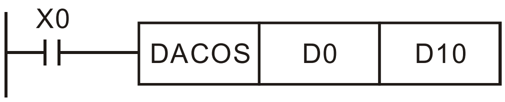
- **S**: the designated source (binary floating point number). **D**: the ACOS value result.
- ACOS value $=\cos^{-1}$

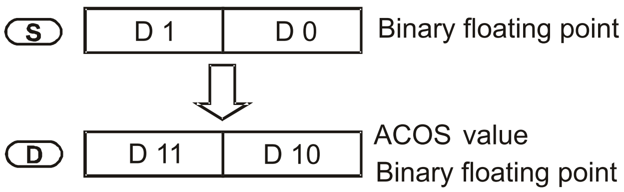
The figure below shows the relationship between input data and result:



Example

- When X0=On, the ACOS value obtained from the designated binary floating point number (D1, D0) will be stored in (D11, D10), with the content consisting of a binary floating point number.





API 135	D	ATAN	P	(S) (D)	Binary floating point number ATAN operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

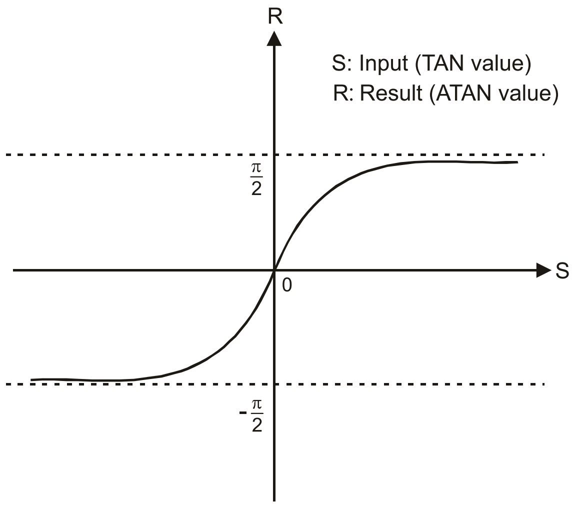
DATAN	Continuous execution type	DATANP	Pulse execution type

Flag signal: none

Explanation

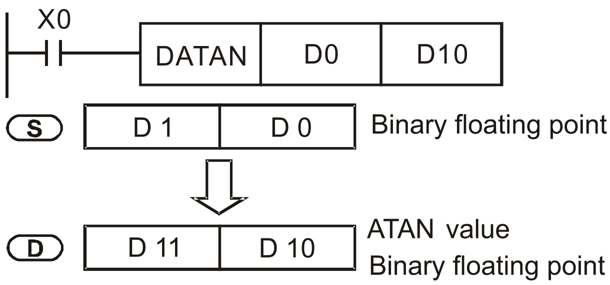
- **S**: the designated source (binary floating point number). **D**: the ATAN value result.
- ATAN value =$\tan^{-1}$

The figure below shows the relationship between input data and result:



Example

- When X0=On, the TAN value obtained from the designated binary floating point number (D1, D0) will be stored in (D11, D10), with the content consisting of a binary floating point number.



API 136	D	SINH	P	(S) (D)	Binary floating point number SINH operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

DSINH	Continuous execution type	DSINHP	Pulse execution type

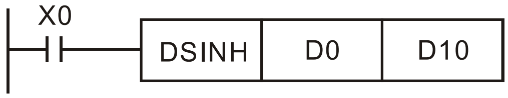
Flag signal: none

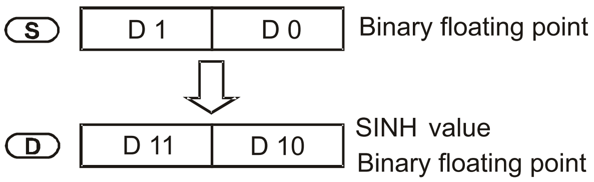
Explanation

- **S**: the designated source (binary floating point number). **D**: the SINH value result.
- SINH value $=(e^{s}-e^{-s})/2$

Example

- When X0=On, the SINH value obtained from the designated binary floating point number (D1, D0) will be stored in (D11, D10), with the content consisting of a binary floating point number.





API 137	D	COSH	P	(S) (D)	Binary floating point number COSH operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

—	—	—	—

32-bit command (9 STEP)

DCOSH	Continuous execution type	DCOSH P	Pulse execution type

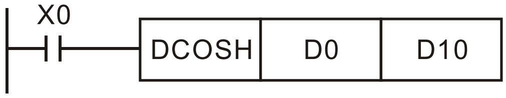
Flag signal: none

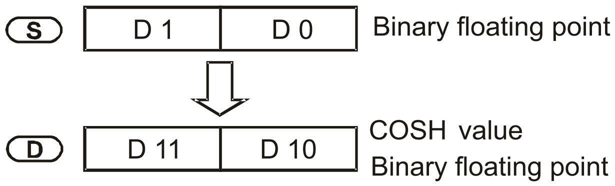
Explanation

- **S**: the designated source (binary floating point number). **D**: the COSH value result.
- COSH value =$(e^{s}+e^{-s})/2$

Example

- When X0=On, the COSH value obtained from the designated binary floating point number (D1, D0) will be stored in (D11, D10), with the content consisting of a binary floating point number.





API					
138	D	TANH	P	(S) (D)	Binary floating point number TANH operation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command

–	–	–	–

32-bit command (9 STEP)

DTANH	Continuous execution type	DTANH P	Pulse execution type

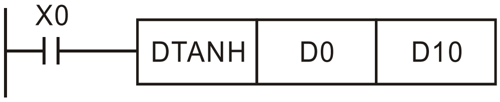
Flag signal: none

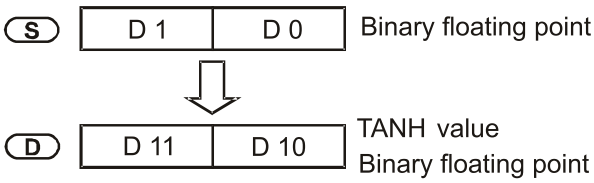
Explanation

- **S**: the designated source (binary floating point number). **D**: the TANH value result.
- TANH value $=(e^{s}-e^{-s})/(e^{s}+e^{-s})$

Example

- When X0=On, the TANH value obtained from the designated binary floating point number (D1, D0) will be stored in (D11, D10), with the content consisting of a binary floating point number.





API 147	D	SWAP	P	(S)	Exchange the up/down 8 bits

	Bit device			Word device						
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S						*	*	*	*	*	*

Notes on operand usage: none

16-bit command (3 STEP)
SWAP Continuous execution type
SWAPP Pulse execution type

32-bit command (5 STEP)
DSWAP Continuous execution type
DSWAPP Pulse execution type

Flag signal: none

Explanation

- (S): The device that going to exchange its up/down 8 bits.
- When using 16-bit command, the upper 8-bit and lower 8-bit exchange.
- When using 32-bit command, the contents of upper 8-bit and lower 8-bit of the 2 registers exchange.
- This command usually uses pulse execution type (SWAPP, DSWAPP)

API 150	MODRW P	S1 S2 S3 S n	MODBUS data read/write

	Bit device X	Y	M	Word device K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
S3				*	*						*
S											*
n				*	*						*

16-bit command (5 STEP)

MODRW	Continuous execution type	MODRWP	Pulse execution type

32-bit command

—	—	—	—

Flag signal: M1077 M1078 M1079

Explanation

- S1: online device address. S2: communications function code. S3: address of data to read/write. S: register for data to be read/written is stored. N: length of data to be read/written.
- COM1 must be defined as controlled by the PLC (set Pr.09-31 = -12) before using this command, and the corresponding communications speed and format must also be set (set Pr.09-01 and Pr.09-04). S2: communications function code. Currently only supports the following function code; the remaining function code cannot be executed.

Function	Description
H 02	Input read
H 03	Read word
H 06	Write single word
H 0F	Write multiple coils
H 10	Write single word

- After executing this command, M1077, M1078 and M1079 will be immediately changed to 0.
- As an example, when LTC must control another converter and PLC, if the converter has a station number of 10 and the PLC has a station number of 20, see the following example:

Control slave device converter

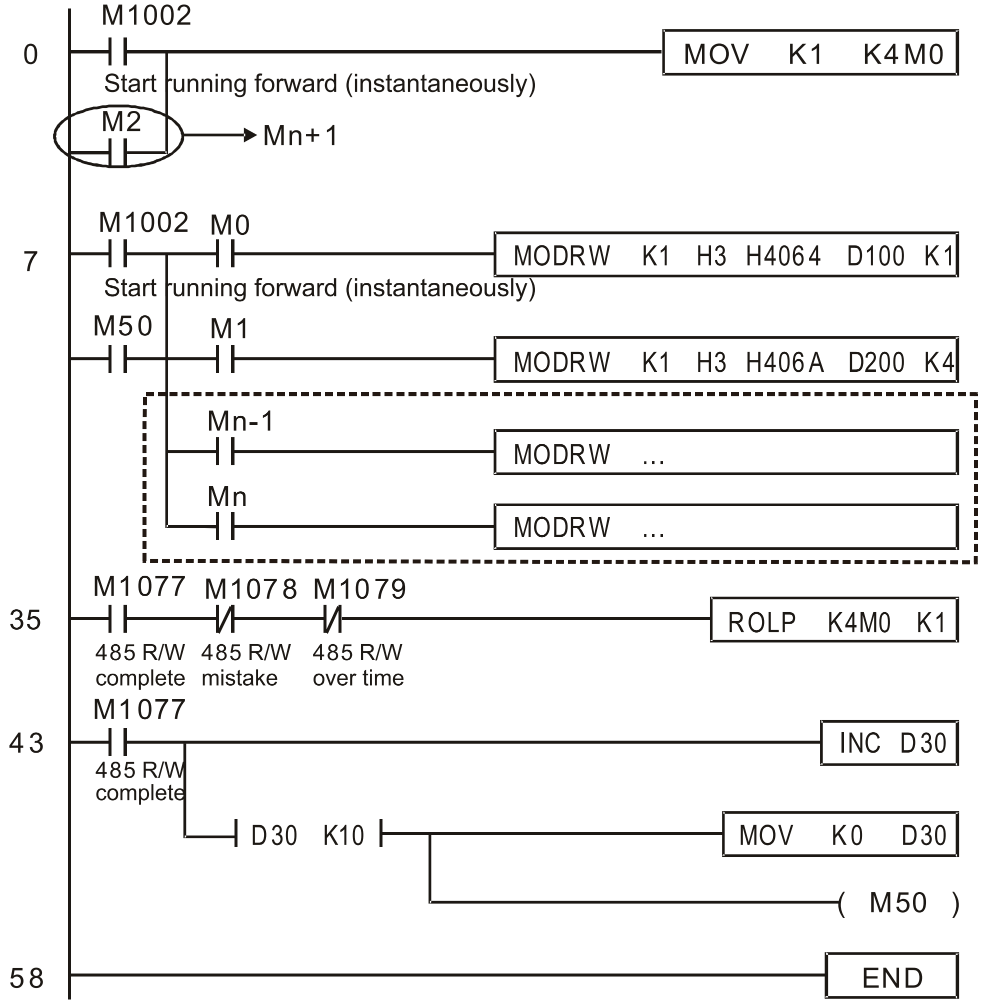
Serial No.	Example	MODRW command				
		S1	S2	S3	S4	n
		Node ID	Function code	Address	Register	Length:
1	Reads 4 sets of data comprising the converter slave device parameters Pr.01-00 to Pr.01-03, and saves the read data in D0 to D3	K10	H3	H100	D0	K4
2	Reads 3 sets of data comprising the converter slave device addresses H2100 to H2102, and saves the read data in D5 to D7	K10	H3	H2100	D5	K3
3	Writes 3 sets of data comprising the converter slave device parameters Pr.05-00 to Pr.05-03, and writes the values as D10 to D12	K10	H10	H500	D10	K3
4	Writes 2 sets of data comprising the converter slave device addresses H2000 to H2001, and writes the values as D15 to D16	K10	H10	H2000	D15	K2

PLC controlling slave device

Serial No.	Example	MODRW command				
		S1	S2	S3	S4	n
		Node ID	Function code	Address	Register	Length:
1	Reads 4 sets of data comprising the PLC slave device's X0 to X3 state, and saves the read data in bits 0 to 3 of D0	K20	H2	H400	D0	K4
2	Reads 4 sets of data comprising the PLC slave device's Y0 to Y3 state, and saves the read data in bits 0 to 3 of D1	K20	H2	H500	D1	K4
3	Reads 4 sets of data comprising the PLC slave device's M0 to M3 state, and saves the read data in bits 0 to 3 of D2	K20	H2	H800	D2	K4
4	Reads 4 sets of data comprising the PLC slave device's T0 to T3 state, and saves the read data in bits 0 to 3 of D3	K20	H2	H600	D3	K4
5	Reads 4 sets of data comprising the PLC slave device's C0 to C3 state, and saves the read data in bits 0 to 3 of D4	K20	H2	HE00	D4	K4
6	Reads 4 sets of data comprising the PLC slave device's T0 to T3 count value, and saves the read data of D10 to D13	K20	H3	H600	D10	K4
7	Reads 4 sets of data comprising the PLC slave device's C0 to C3 count value, and saves the read data of D20 to D23	K20	H3	HE00	D20	K4
8	Reads 4 sets of data comprising the PLC slave device's D0 to D3 count value, and saves the read data of D30 to D33	K20	H3	H1000	D30	K4
9	Writes 4 sets of the PLC slave device's Y0 to Y3 state, and writes the values as bits 0 to 3 of D1	K20	HF	H500	D1	K4
10	Writes 4 sets of the PLC slave device's M0 to M3 state, and writes the values as bits 0 to 3 of D2	K20	HF	H800	D2	K4
11	Writes 4 sets of the PLC slave device's T0 to T3 state, and writes the values as bits 0 to 3 of D3	K20	HF	H600	D3	K4
12	Writes 4 sets of the PLC slave device's C0 to C3 state, and writes the values as bits 0 to 3 of D4	K20	HF	HE00	D4	K4
13	Writes 4 sets of the PLC slave device's T0 to T3 state, and writes the values of D10 to D13	K20	H10	H600	D10	K4
14	Writes 4 sets of the PLC slave device's C0 to C3 state, and writes the values of D20 to D23	K20	H10	HE00	D20	K4
15	Writes 4 sets of the PLC slave device's D0 to D3 state, and writes the values of D30 to D33	K20	H10	H1000	D30	K4

Example

- Will trigger M0 On when the PLC begins to operate, and sends instruction to execute one MODRW command.
- After receiving the slave devices response, if the command is correct, it will execute one ROL command, which will cause M1 to be On.
- After receiving the slave devices response, will trigger M50 = 1 after a delay of 10 PLC scanning cycles, and then execute one MODRW command.
- After again receiving the slave devices response, if the command is correct, it will execute one ROL command, and M2 will change to On at this time (and M2 can be defined as a repeat of M); K4M0 will change to K1, and only M0 will remain 1. Transmission can proceed in a continuous cycle. If you wish to add a command, merely add the desired command in the empty frame, and change repeat M to Mn+1.



API				
160	TCMP	P	(S1) (S2) (S3) (S) (D)	Comparison of calendar data

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
S3				*	*	*	*	*	*	*	*
S									*	*	*
D		*	*								

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (11 STEP)

TCMP	Continuous execution type	TCMPP	Pulse execution type

32-bit command

—	—	—	—

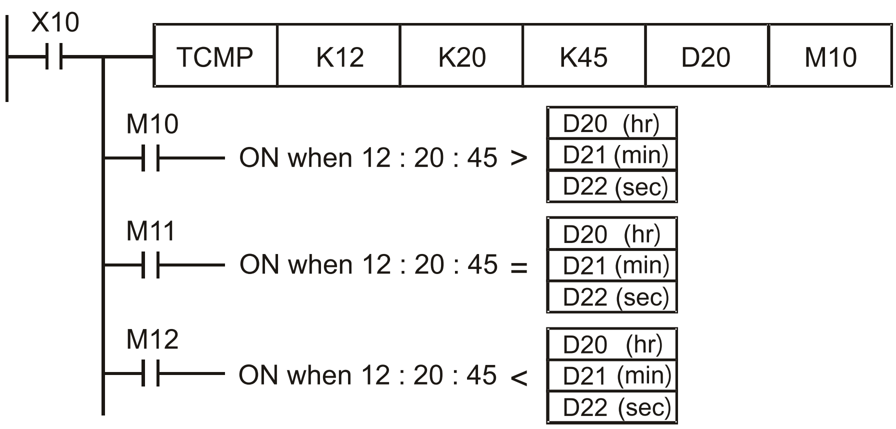
Flag signal: none

Explanation

- **S1**: Sets the hours of the comparison time, setting range is "K0–K23." **S2**: Sets the minutes of the comparison time, setting range is "K0–K59." **S3**: Sets the seconds of the comparison time, setting range is "K0–K59." **S**: current calendar time. **D**: Results of comparison.
- Compares the time in hours, minutes, and seconds set in **S1**–**S3** with the current calendar time in hours, minutes, and seconds, with the results of comparison expressed in **D**.
- **S** The hour content of the current calendar time is "K0–K23." **S** +1 comprises the minutes of the current calendar time, and consists of "K0–K59." **S** +2 comprises the seconds of the current calendar time, and consists of "K0–K59."
- The current calendar time designated by **S** is usually compared using the TCMP command after using the TRD command to read the current calendar time. If the content value of **S** exceeds the range, this is considered an operating error, the command will not execute, and M1068=On.

Example

- When X10=On, the command will execute, and the current calendar time in D20–D22 will be compared with the preset value of 12:20:45; the results will be displayed in M10–M12. When X10 On→Off, the command will not be executed, but the On/Off status prior to M10–M12 will be maintained.
- If results in the form of ≥, ≤, or ≠ are needed, they can be obtained by series and parallel connection of M10–M12.



API 161	TZCP P	(S1) (S2) (S) (D)	Comparison of calendar data

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*
S									*	*	*
D		*	*								

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (9 STEP)			
TZCP	Continuous execution type	TZCPP	Pulse execution type

32-bit command			
—	—	—	—

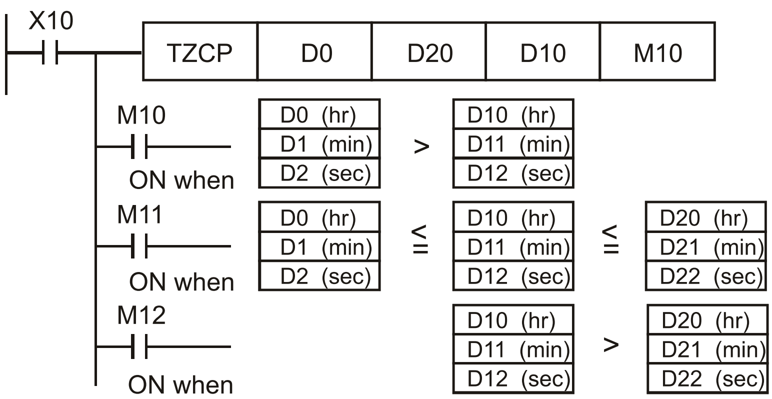
Flag signal: none

Explanation

- **S₁**: Sets the lower limit of the comparison time. **S₂**: Sets the upper limit of the comparison time. **S**: current calendar time. **D**: Results of comparison.
- Performs range comparison by comparing the hours, minutes, and seconds of the current calendar time designated by **S** with the lower limit of the comparison time set as $\mathbf{S_1}$ and the upper limit of the comparison time set as $\mathbf{S_2}$, and expresses the results of comparison in **D**.
- $\mathbf{S_1}$, $\mathbf{S_1}$ +1, $\mathbf{S_1}$ +2: Sets the hours, minutes, and seconds of the lower limit of the comparison time.
- $\mathbf{S_2}$, $\mathbf{S_2}$ +1, $\mathbf{S_2}$ +2: Sets the hours, minutes, and seconds of the upper limit of the comparison time.
- **S**, **S** +1, c2**S** +2: The hours, minutes, and seconds of the current calendar time
- The D0 designated by the **S** listed in this program is usually obtained by comparison using the TZCP command after using the TRD command in advance to read the current calendar time. If the value of $\mathbf{S_1}$, $\mathbf{S_2}$, or **S** exceeds the range, this is considered an operating error, the command will not execute, and M1068=On.
- When the current time **S** is less than the lower limit value $\mathbf{S_1}$ and **S** is less than the upper limit value $\mathbf{S_2}$, **D** will be On. When the current time **S** is greater than the lower limit value $\mathbf{S_1}$ and **S** is greater than the upper limit value $\mathbf{S_2}$, **D** +2 will be On; **D** +1 will be On under other conditions.

Example

- When X10=On, the TZCP command executes, and one of M10–M12 will be On. When X10=Off, the TZCP command will not execute, and M10–M12 will remain in the X10=Off state.



API				
162	TADD	P	S1 S2 D	Calendar data addition

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*
D									*	*	*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (7 STEP)

TADD	Continuous execution type	TADDP	Pulse execution type

32-bit command

—	—	—	—

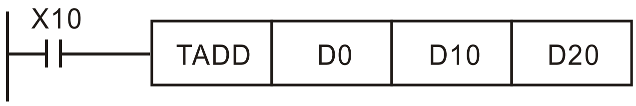
- Flag signal: M1020 Zero flag
  M1022 Carry flag
  M1068 Calendar error

Explanation

- **S₁**: time addend. **S₂**: time augend. **D**: time sum.
- The calendar data in hours, minutes, and seconds designated by **S_2** is added to the calendar data in hours, minutes, and seconds designated by **S_1**, and the result is stored as hours, minutes, and seconds in the register designated by **D**.
- If the value of **S_1** or **S_2** exceeds the range, this is considered an operating error, the command will not execute, M1067, M1068=On, and D1067 will record the error code 0E1A(HEX).
- If the results of addition are greater than or equal to 24 hours, carry flag M1022=On, and **D** will display the results of addition minus 24 hours.
- If the results of addition are equal to 0 (0 hours, 0 minutes, 0 seconds), zero flag M1020=On.

Example

- When X10=On, the TADD command will be executed, and the calendar data in hours, minutes, and seconds designated by D0 to D2 will be added to the calendar data in hours, minutes, and seconds designated by D10 to D12, and the results are stored as a total number of hours, minutes, and seconds in the registers designated by D20 to D22.



S1		+	S2		→	D	
D0	8(hr)		D10	6(hr)		D20	14(hr)
D1	10(min)		D11	40(min)		D21	50(min)
D2	20(sec)		D12	6(sec)		D22	26(sec)
8 : 10 : 20			6 : 40 : 6			14 : 50 : 26	

API					
163		TSUB	P	(S1) (S2) (D)	Calendar data subtraction

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*
D									*	*	*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (7 STEP)

TSUB	Continuous execution type	TSUBP	Pulse execution type

32-bit command

—	—	—	—

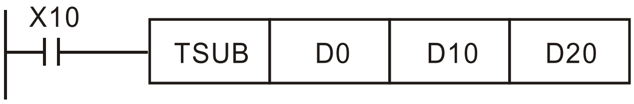
- Flag signal: M1020 Zero flag
  M1022 Carry flag
  M1068 Calendar error

Explanation

- S_1: time minuend. S_2: time augend. **D**: time sum.
- Subtracts the calendar data in hours, minutes, and seconds designated by S_2 from the calendar data in hours, minutes, and seconds designated by S_1, and the result is temporarily stored as hours, minutes, and seconds in the register designated by **D**.
- If the value of S_1 or S_2 exceeds the range, this is considered an operating error, the command will not execute, M1067, M1068=On, and D1067 will record the error code 0E1A(HEX).
- If subtraction results in a negative number, borrow flag M1021=On, and the result of that negative number plus 24 hours will be displayed in the register designated by **D**.
- If the results of subtraction are equal to 0 (0 hours, 0 minutes, 0 seconds), zero flag M1020=On.

Example

- When X10=On, the TADD command will be executed, and the calendar data in hours, minutes, and seconds designated by D10 to D12 will be subtracted from the calendar data in hours, minutes, and seconds designated by D0 to D2, and the results are stored as a total number of hours, minutes, and seconds in the registers designated by D20 to D22.



D0 20(hr)		D10 14(hr)		D20 5(hr)
D1 20(min)	–	D11 30(min)	→	D21 49(min)
D2 5(sec)		D12 8(sec)		D22 57(sec)
20 : 20 : 5		14 : 30 : 8		5 : 49 : 57

API				
166	TRD	P	(D)	Calendar data read

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D									*	*	*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (3 STEP)			
TRD	Continuous execution type	TRDP	Pulse execution type

32-bit command			
–	–	–	–

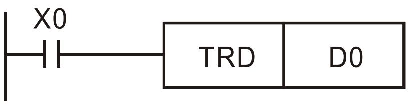
- Flag signal: none

Explanation

- **S**$_1$: time minuend. **S**$_2$: time augend. **D**: time sum.
- **D**: device used to store the current calendar time after reading.
- The EH/EH2/SV/EH3/SV2/SA/SX/SC main units have a built-in calendar clock, and the clock provides seven sets of data comprising year, week, month, day, hour, minute, and second stored in D1063 to D1069. The TRD command function allows program designers to directly read the current calendar time into the designated seven registers.
- D1063 only reads the two right digits of the Western calendar year.

Example

- When X0=On, the current calendar time is read into the designated registers D0 to D6.
- In D1064, 1 indicates Monday, 2 indicates Tuesday, and so on, with and 7 indicating Sunday.



Special D	Item	Content		General D	Item
D1063	Year (Western)	00–99	→	D0	Year (Western)
D1064	Weeks	1–7	→	D1	Weeks
D1065	Month	1–12	→	D2	Month
D1066	Day	1–31	→	D3	Day
D1067	Hour	0–23	→	D4	Hour
D1068	Minute	0–59	→	D5	Minute
D1069	Second	0–59	→	D6	Second

API					
170	D	GRY	P	(S) (D)	BIN→GRAY code transformation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)			
GRY	Continuous execution type	GRYP	Pulse execution type

32-bit command (9 STEP)			
DGRY	Continuous execution type	DGRYP	Pulse execution type

- Flag signal: none

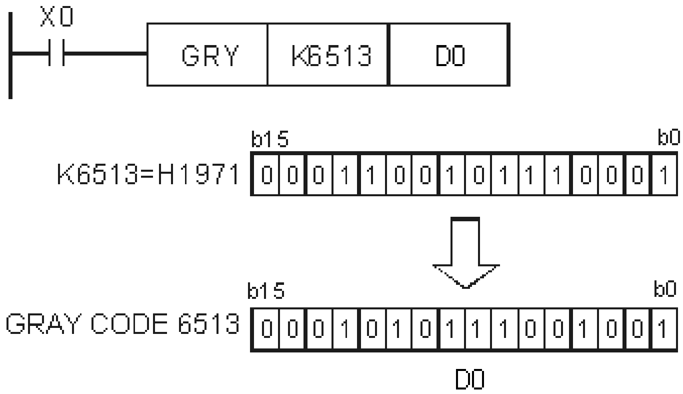
Explanation

- **S**: source device. **D**: device storing GRAY code.
- Transforms the content value (BIN value) of the device designated by **S** to GRAY code, which is stored in the device designated by **D**.
- The valid range of **S** is as shown below; if this range is exceeded, it will be considered an error, and the command will not execute.

  16-bit command: 0–32,767
- 32-bit command: 0–2,147,483,647

Example

- When X0=On, the constant K6513 will be transformed to GRAY code and stored in D0.



API 171	D	GBIN	P	(S) (D)	GRAY code →BIN transformation

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)

GBIN	Continuous execution type	GBINP	Pulse execution type

32-bit command (9 STEP)

DGBIN	Continuous execution type	DGBINP	Pulse execution type

- Flag signal: none

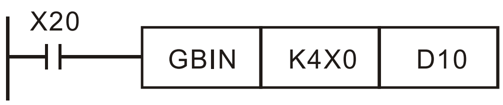
Explanation

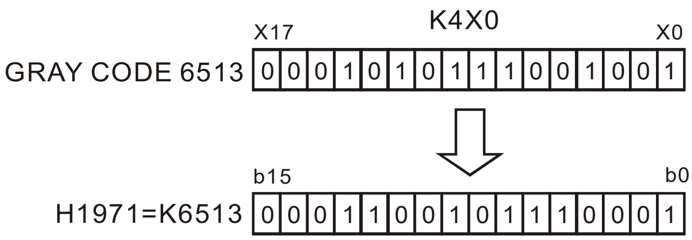
- **S**: source device used to store GRAY code. **D**: device used to store BIN value after transformation.
- The GRAY code corresponding to the value of the device designated by **S** is transformed into a BIN value, which is stored in the device designated by **D**.
- This command will transform the value of the absolute position encoder connected with the PLCs input and (this encoder usually has an output value in the form of GRAY code) into a BIN value, which is stored in the designated register.
- The valid range of **S** is as shown below; if this range is exceeded, it will be considered an error, and the command will not execute.

  16-bit command: 0–32,767
- 32-bit command: 0–2,147,483,647

Example

- When X20=On, the GRAY code of the absolute position encoder connected with input points X0 to X17 will be transformed into BIN value and stored in D10.





API				
215–217	D	LD#	(S1) (S2)	Contact form logical operation LD#

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: ＃：&, |, ^
Please refer to the function specifications table for each device in series for the range of device usage

16-bit command (5 STEP)			
LD#	Continuous execution type	—	—

32-bit command (9 STEP)			
DLD#	Continuous execution type	—	—

Flag signal: none

Explanation

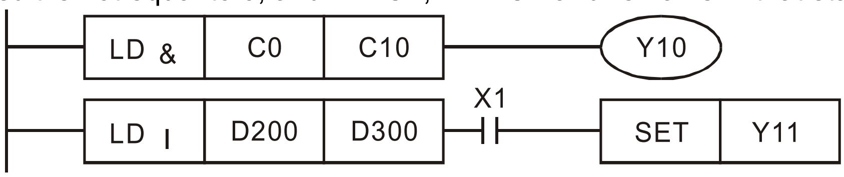
- **S_1**: data source device 1. **S_2**: data source device 2.
- This command performs comparison of the content of **S_1** and **S_2**; when the result of comparison is not 0, this command will be activated, but this command will not be activated when the result of comparison is 0.
- The LD#This command can be used while directly connected with the busbar

API No.	16-bit commands	32-bit commands	Conditions for activation				Conditions for inactivation			
215	LD&	**D**LD&	**S_1**	&	**S_2**	$\neq 0$	**S_1**	&	**S_2**	$=0$
216	LD|	**D**LD|	**S_1**	|	**S_2**	$\neq 0$	**S_1**	|	**S_2**	$=0$
217	LD^	**D**LD^	**S_1**	^	**S_2**	$\neq 0$	**S_1**	^	**S_2**	$=0$

- &: logical AND operation.
- |: logical OR operation.
- ^: logical XOR operation.

Example

- When the content of C0 and C10 is subjected to the logical AND operation, and the result is not equal to 0, Y10=On.
- When the content of D200 and D300 is subjected to the logical OR operation, and the result is not equal to 0, and X1=On, Y11=On and remains in that state.



API 218–220	D	AND#		(S1) (S2)	Contact form logical operation AND#

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: # : &, |, ^

Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)

AND#	Continuous execution type	–	–

32-bit command (9 STEP)

DAND#	Continuous execution type	–	–

Flag signal: none

Explanation

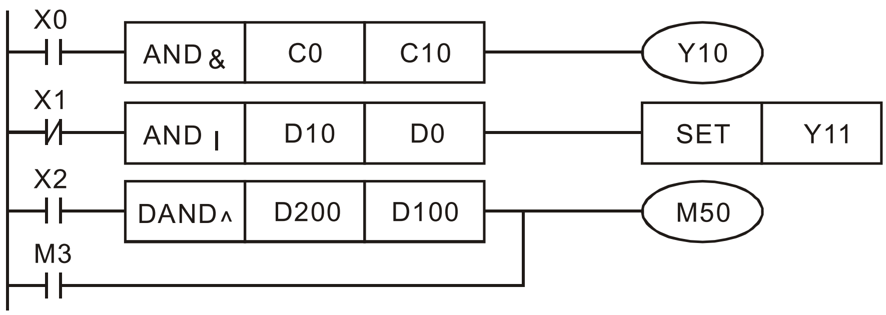
- S_1: data source device 1. S_2: data source device 2.
- This command performs comparison of the content of S_1 and S_2; when the result of comparison is not 0, this command will be activated, but this command will not be activated when the result of comparison is 0.
- The AND# command is an operation command in series with the contact.

API No.	16-bit commands	32-bit commands	Conditions for activation				Conditions for inactivation			
218	AND&	DAND&	S_1	&	S_2	$\neq 0$	S_1	&	S_2	=0
219	AND|	DAND|	S_1	|	S_2	$\neq 0$	S_1	|	S_2	=0
220	AND^	DAND^	S_1	^	S_2	$\neq 0$	S_1	^	S_2	=0

- &: logical AND operation.
- |: logical OR operation.
- ^: logical XOR operation.

Example

- When X0=On and the content of C0 and C10 is subjected to the logical AND operation, and the result is not equal to 0, Y10=On.
- When X1=Off and D10 and D0 is subjected to the logical OR operation, and the result is not equal to 0, Y11=On and remains in that state.
- When X2 =On and the content of the 32-bit register D200 (D201) and 32-bit register D100 (D101) is subjected to the logical XOR operation, and the result is not equal to 0 or M3=On, M50=On.



API				
221–223	D	OR#	(S1) (S2)	Contact form logical operation OR#

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: # : &, |, ^

Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)

OR#	Continuous execution type	–	–

32-bit command (9 STEP)

DOR#	Continuous execution type	–	–

Flag signal: none

Explanation

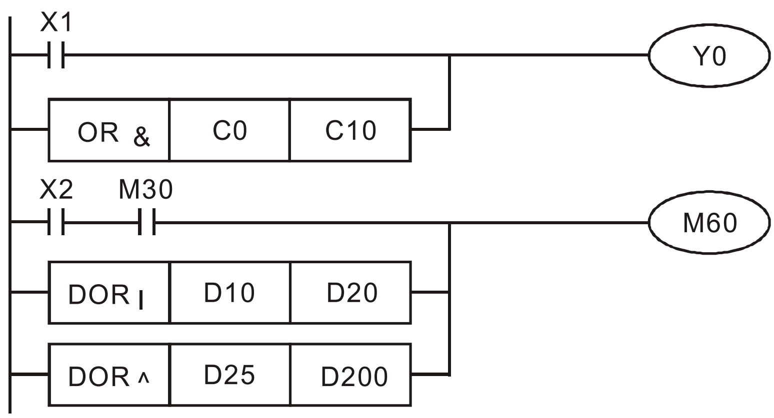
- **S₁**: data source device 1. **S₂**: data source device 2.
- This command performs comparison of the content of **S_1** and **S_2**; when the result of comparison is not 0, this command will be activated, but this command will not be activated when the result of comparison is 0.
- The OR# command is an operation command in series with the contact.

API No.	16-bit commands	32-bit commands	Conditions for activation				Conditions for inactivation			
221	OR&	**D**OR&	**S_1**	&	**S_2**	$\neq 0$	**S_1**	&	**S_2**	=0
222	OR|	**D**OR|	**S_1**	|	**S_2**	$\neq 0$	**S_1**	|	**S_2**	=0
223	OR^	**D**OR^	**S_1**	^	**S_2**	$\neq 0$	**S_1**	^	**S_2**	=0

- &: logical AND operation.
- |: logical OR operation.
- ^: logical XOR operation.

Example

- When X1=On or the content of C0 and C10 is subjected to the logical AND operation, and the result is not equal to 0, Y0=On.
- When X2 and M30 are both equal to On, or the content of 32-bit register D10 (D11) and 32-bit register D20 (D21) is subjected to the logical OR operation, and the result is not equal to 0, or the content of the 32-bit counter C235 and the 32-bit register D200 (D201) is subjected to the logical XOR operation, and the result is not equal to 0, M60=On.



API 224–230	D	LD※		(S1) (S2)	Contact form compare LD*

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: ※ : =, >, <, <>, ≦, ≧

Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)

LD※	Continuous execution type	–	–

32-bit command (9 STEP)

DLD※	Continuous execution type	–	–

Flag signal: none

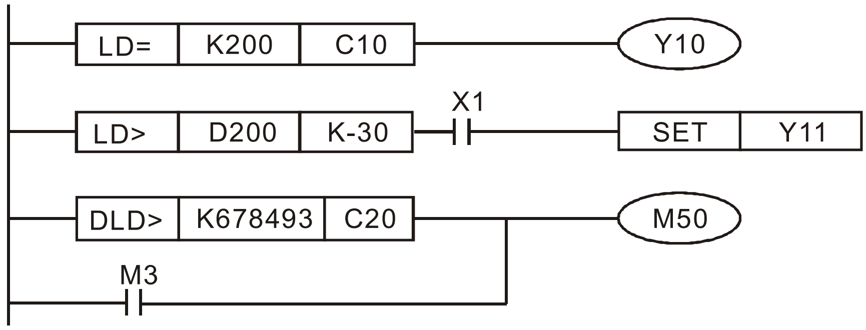
Explanation

- S_1: data source device 1. S_2: data source device 2.
- This command compares the content of S_1 and S_2. Taking API 224 (LD=) as an example, this command will be activated when the result of comparison is "equal," and will not be activated when the result is "unequal."
- The LD* can be used while directly connected with the busbar

API No.	16-bit commands	32-bit commands	Conditions for activation	Conditions for inactivation
224	LD=	DLD=	$S_1 = S_2$	$S_1 \neq S_2$
225	LD>	DLD>	$S_1 > S_2$	$S_1 \leqq S_2$
226	LD<	DLD<	$S_1 < S_2$	$S_1 \geqq S_2$
228	LD<>	DLD<>	$S_1 \neq S_2$	$S_1 = S_2$
229	LD<=	DLD<=	$S_1 \leqq S_2$	$S_1 > S_2$
230	LD>=	DLD>=	$S_1 \geqq S_2$	$S_1 < S_2$

Example

- When the content of C10 is equal to K200, Y10=On.
- When the content of D200 is greater than K-30, and X1=On, Y11=On and remains in that state.



API					
232–238	D	AND※		(S1) (S2)	Contact form compare AND*

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: ※ : =, >, <, <>, ≦, ≧

Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)			
AND※	Continuous execution type	–	–

32-bit command (9 STEP)			
DAND※	Continuous execution type	–	–

Flag signal: none

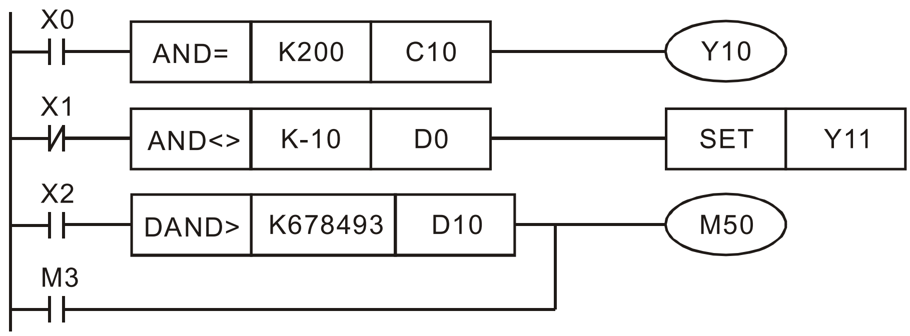
Explanation

- **S_1**: data source device 1. **S_2**: data source device 2.
- This command compares the content of **S_1** and **S_2**. Taking API 232 (AND=) as an example, when the result of comparison is equal, this command will be activated; when the result of comparison is unequal, this command will not be activated.
- The AND* command is a comparison command in series with a contact.

API No.	16-bit commands	32-bit commands	Conditions for activation	Conditions for inactivation
232	AND=	**D**AND=	**$S_1 = S_2$**	**$S_1 \neq S_2$**
233	AND>	**D**AND>	**$S_1 > S_2$**	**$S_1 \leqq S_2$**
234	AND<	**D**AND<	**$S_1 < S_2$**	**$S_1 \geqq S_2$**
236	AND<>	**D**AND<>	**$S_1 \neq S_2$**	**$S_1 = S_2$**
237	AND<=	**D**AND<=	**$S_1 \leqq S_2$**	**$S_1 > S_2$**
238	AND>=	**D**AND>=	**$S_1 \geqq S_2$**	**$S_1 < S_2$**

Example

- When X0=On and the current value of C10 is also equal to K200, Y10=On.
- When X1=Off and the content of register D0 is not equal to K-10, Y11=On and remains in that state.
- When X2 =On and the content of the 32-bit register D0 (D11) is less than 678,493, or M3=On, M50=On.



API 240–246	D	OR※		(S1) (S2)	Contact form compare OR*

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: ※ : =, >, <, <>, ≦, ≧

Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command (5 STEP)

OR※	Continuous execution type	—	—

32-bit command (9 STEP)

DOR※	Continuous execution type	—	—

Flag signal: none

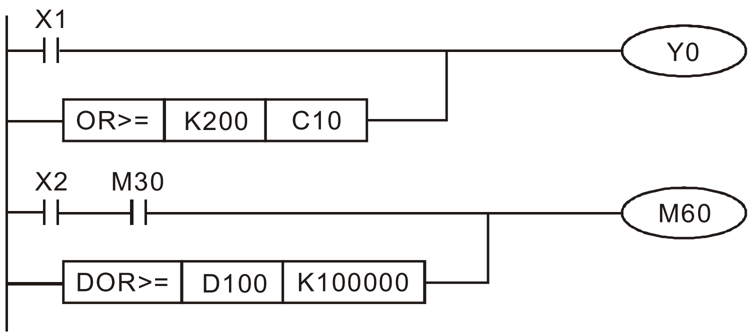
Explanation

- S_1: data source device 1. S_2: data source device 2.
- This command compares the content of S_1 and S_2. Taking API 240 (OR=) as an example, when the result of comparison is equal, this command will be activated; when the result of comparison is unequal, this command will not be activated.
- The OR* command is a compare command in parallel with a contact.

API No.	16-bit commands	32-bit commands	Conditions for activation	Conditions for inactivation
240	OR＝	DOR＝	$S_1 = S_2$	$S_1 \neq S_2$
241	OR＞	DOR＞	$S_1 > S_2$	$S_1 \leqq S_2$
242	OR＜	DOR＜	$S_1 < S_2$	$S_1 \geqq S_2$
244	OR＜＞	DOR＜＞	$S_1 \neq S_2$	$S_1 = S_2$
245	OR＜＝	DOR＜＝	$S_1 \leqq S_2$	$S_1 > S_2$
246	OR＞＝	DOR＞＝	$S_1 \geqq S_2$	$S_1 < S_2$

Example

- When X0=On and the current value of C10 is also equal to K200, Y10=On.
- When X1=Off and the content of register D0 is not equal to K-10, Y11=On and remains in that state.
- When X2 =On and the content of the 32-bit register D0 (D11) is less than 678,493, or M3=On, M50=On.



API 275–280		FLD※		(S1) (S2)	Floating point number contact form compare LD*

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*

Notes on operand usage: ＃：&, |, ^

Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command			
–	–	–	–

32-bit command (9 STEP)			
FLD※	Continuous execution type	–	–

Flag signal: none

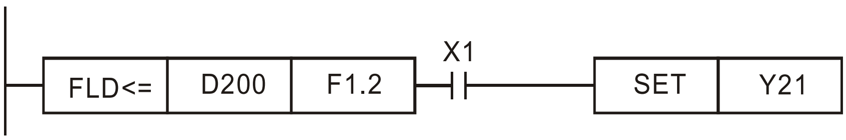
Explanation

- **S_1**: data source device 1. **S_2**: data source device 2.
- This command compares the content of **S_1** and **S_2**. Taking "FLD=" as an example, if the result of comparison is "equal," this command will be activated; but it will not be activated when the result is "unequal."
- The FLD* command can directly input floating point numerical values (for instance: F1.2) to the **S_1**, **S_2** operands, or store floating-point numbers in register D for use in operations.
- This command can be used while directly connected with the busbar

API No.	32-bit commands	Conditions for activation	Conditions for inactivation
275	FLD＝	**$S_1 = S_2$**	**$S_1 \neq S_2$**
276	FLD＞	**$S_1 > S_2$**	**$S_1 \leqq S_2$**
277	FLD＜	**$S_1 < S_2$**	**$S_1 \geqq S_2$**
278	FLD＜＞	**$S_1 \neq S_2$**	**$S_1 = S_2$**
279	FLD＜＝	**$S_1 \leqq S_2$**	**$S_1 > S_2$**
280	FLD＞＝	**$S_1 \geqq S_2$**	**$S_1 < S_2$**

Example

- When the floating point number of register D200 (D201) is less than or equal to F1.2, and X1 activated, contact Y21 will be activated and remain in that state.



API 281–286	FAND※	(S1) (S2)	Floating point number contact form compare AND*

	Bit device			Word device								16-bit command			
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	–	–	–	–
S1									*	*	*	32-bit command (9 STEP)			
S2									*	*	*	FAND※	Continuous execution type	–	–

Notes on operand usage: ＃：&, |, ^

Please refer to the function specifications table for each device in series for the scope of device usage

Flag signal: none

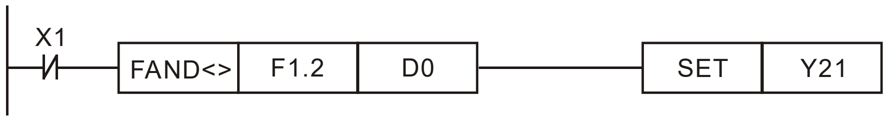
Explanation

- **S_1**: data source device 1. **S_2**: data source device 2.
- This command compares the content of **S_1** and **S_2**. Taking "FAND=" as an example, if the result of comparison is "equal," this command will be activated; but it will not be activated when the result is "unequal."
- The FAND* command can directly input floating point numerical values (for instance: F1.2) to the **S_1**, **S_2** operands, or store floating-point numbers in register D for use in operations.
- This command can be used while directly connected with the busbar

API No.	32-bit commands	Conditions for activation	Conditions for inactivation
281	FAND=	$S_1 = S_2$	$S_1 \neq S_2$
282	FAND＞	$S_1 > S_2$	$S_1 \leqq S_2$
283	FAND＜	$S_1 < S_2$	$S_1 \geqq S_2$
284	FAND＜＞	$S_1 \neq S_2$	$S_1 = S_2$
285	FAND＜＝	$S_1 \leqq S_2$	$S_1 > S_2$
286	FAND＞＝	$S_1 \geqq S_2$	$S_1 < S_2$

Example

- When X1=Off, and the floating point number in register D100 (D101) is not equal to F1.2, Y21=On and remains in that state.



API				
287–292	FOR※	S1 S2		Floating point number contact form compare OR*

	Bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*

Notes on operand usage: ＃：&, |, ^

Please refer to the function specifications table for each device in series for the scope of device usage

16-bit command			
–	–	–	–

32-bit command (9 STEP)			
FOR※	Continuous execution type	–	–

Flag signal: none

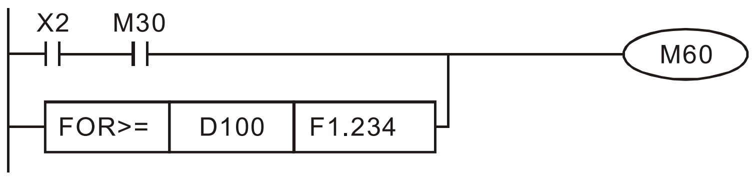
Explanation

- **S₁**: data source device 1. **S₂**: data source device 2.
- This command compares the content of S_1 and S_2. Taking "FOR=" as an example, if the result of comparison is "equal," this command will be activated; but it will not be activated when the result is "unequal."
- The FOR* command can directly input floating point numerical values (for instance: F1.2) to the S_1, S_2 operands, or store floating-point numbers in register D for use in operations.
- This command can be used while directly connected with the busbar

API No.	32-bit commands	Conditions for activation	Conditions for inactivation
287	FOR＝	$S_1 = S_2$	$S_1 \neq S_2$
288	FOR＞	$S_1 > S_2$	$S_1 \leqq S_2$
289	FOR＜	$S_1 < S_2$	$S_1 \geqq S_2$
290	FOR＜＞	$S_1 \neq S_2$	$S_1 = S_2$
291	FOR＜＝	$S_1 \leqq S_2$	$S_1 > S_2$
292	FOR＞＝	$S_1 \geqq S_2$	$S_1 < S_2$

Example

- When X2 and M30 are both equal to "On," or the floating point number in register D100 (D101) is greater than or equal to F1.234, M60=On.



13-7 Fault Display and Treatment

Code	ID	Descript	Recommended Treatment
PLod	50	Data writing memory error	Check if there is any error in the program and download the program again.
PLSv	51	Data writing memory error while executing programs	Cycle the power and download the program again.
PLdA	52	Error while uploading programs	Upload again. If error still exists, return to the factory for repair.
PLFn	53	Command error while downloading programs	Check if there is any error in the program and download the program again.
PLor	54	Program exceeds memory capacity or no program	Cycle the power and download the program again.
PLFF	55	Command error while executing programs	Check if there is any error in the program and download the program again.
PLSn	56	Check code error	Check if there is any error in the program and download the program again.
PLEd	57	No “END” command in the program	Check if there is any error in the program and download the program again.
PLCr	58	The MC command is continuously used for more than 9 times	Check if there is any error in the program and download the program again.
PLdF	59	Error while downloading programs	Check if there is any error in the program and download the program again.
PLSF	60	PLC scan time exceeds the maximum allowable time	Check if the source code is correct and download the program again.

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Appendix A. Revision History

Drive Firmware Version	Issued Edition	Revision History	Issued Date
V1.01	00	Newly established.	November, 2022

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