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MD520 Series General-Purpose AC Drive

Function Guide

Industrial Automation

Intelligent Elevator

New Energy Vehicle

Industrial Robot

Rail Transit

Data code 19011717B03

Preface

Introduction

The MD520 series is a general-purpose high-performance vector control AC drive for accurate speed and torque control in high-demand applications. It can drive asynchronous AC induction motors (IM), permanent magnet synchronous motors (PMSM), and synchronous reluctance motors (SynRM). It is also equipped with the STO, limp mode upon fault, position control, and tension control functions.

This guide describes function applications, and troubleshooting of the product. For complete information on parameters and fault codes, see *MD520 Series General-Purpose AC Drive Parameter Guide.*

More Data

Document Name	Data Code	Description
MD520 Series General-Purpose AC Drive Manual Package	PS00012134	This guide describes product selection, mechanical design, electrical design, installation, communication, commissioning, function application, troubleshooting, and standards.
MD520 Series General-Purpose AC Drive Parameter Guide	19012397	This guide describes parameters and fault codes.
MD520 Series General-Purpose AC Drive Quick Installation and Commissioning Guide	19011712	This guide describes the installation, wiring, commissioning, troubleshooting, and others.
MD520 Series General-Purpose AC Drive Hardware Guide	19011713	This guide describes the system composition, technical specifications, components, dimensions, options (including installation accessories, cables, and peripheral electrical components), expansion cards, routine inspection and maintenance, certifications, and standards of the AC drive.
MD520 Series General-Purpose AC Drive Installation Guide	19011714	This guide describes the installation dimensions, space design, specific installation steps, wiring requirements, routing requirements, option installation requirements, and common EMC troubleshooting suggestions.
MD520 Series General-Purpose AC Drive Commissioning Guide	19011715	This guide describes commissioning tools, commissioning flowchart, detailed commissioning steps, and troubleshooting.
MD520 Series General-Purpose AC Drive Communication Guide	19011716	This guide describes the communication mode, communication networking, and communication configuration of the product.
MD520 Series General-Purpose AC Drive Function Guide	19011717	This guide describes function applications, and troubleshooting of the product.
MD520 Series General-Purpose AC Drive Safety Function Guide	19011795	This guide describes the safety information, instructions for mechanical and electrical installation, commissioning and maintenance guidance, and safety-related parameters of the AC drive.

Revision History

Date	Document Version	Software Version	Revision
September 2024	B03	Version: A13 Version tag: F7-10= U60.07/F7-11=U61.11/F7-15=000.00/F7-16=000.00	**Modified the following content:** • Updated *"1.8 Monitoring" on page 211* • Updated *"2.6.3 Logic Operation" on page 249* • Made minor corrections.
August 2024	B02	Version: A13 Version tag: F7-10= U60.07/F7-11=U61.11/F7-15=000.00/F7-16=000.00	**Modified the following content:** • Updated *"1.1.1.4 Setting Operation Commands through Communication" on page 14*. • Updated *"1.1.2.2 Selecting Source for Main Frequency Reference" on page 18*. • Updated *"1.1.2.4 Setting Main Frequency Through AI" on page 20*. • Updated *"1.1.2.5 Setting Main Frequency Through Multi-reference" on page 23*. • Updated *"1.1.2.7 Setting Main Frequency Through PID" on page 29*. • Updated *"1.1.3.1 Start Mode" on page 47*. • Updated *" Motor Configuration" on page 54*. • Updated *"1.2.1 Asynchronous motor parameter auto-tuning" on page 60*. • Updated *"1.2.2 Asynchronous motor parameter auto-tuning" on page 64*. • Updated *"1.3.1 Digital Input Terminal (DI) Functions" on page 69*. • Updated *"1.3.3 Virtual Digital Input Terminal (VDI) Functions" on page 87*. • Updated *"1.4.4 Speed Loop" on page 124*. • Updated *"1.4.9 Torque Control" on page 140*. • Updated *"1.6.2 Undervoltage Threshold, Overvoltage Threshold, and Pulse-by-Pulse Current Limit Protection" on page 177*. • Updated *"1.6.7 Overspeed Protection" on page 184*. • Updated *"1.6.8 Protection Against Excessive Speed Deviation" on page 184*. • Updated *"1.6.9 Motor Stall Protection" on page 185*. • Updated *"1.6.13 Automatic Reset Upon Fault" on page 189*. • Updated *"2.4 Simple PLC Function" on page 227*. • Updated *"3.1.3 Common Troubleshooting" on page 289*. • Made minor corrections.
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Date	Document Version	Software Version	Revision
November 2023	B00	Version: A10 Version tag: F7-10= U60.07/F7-11=U61.08/F7-15=000.00/F7-16=000.00	**Modified the following content:** • Updated *" Motor Configuration" on page 54*. • Updated *"1.3.6 Analog Input Terminal (AI) Functions" on page 96*. • Updated 3.2 List of Fault Codes. • Updated Description of Parameters. • Updated Parameter List. • Updated parameters. **Added the following content:** • Added *" Brake Control" on page 272*.
January 2022	A00	–	First issue

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version by the following methods:

- Do keyword search under Service and Support at http://www.inovance.com.
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install the app, where you can search for and download manuals.

Warranty disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is caused by proper operation of the user. Maintenance will be charged after the warranty expires.

Within the warranty period, maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or unusual voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see Product Warranty Card.

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1 Function Applications

1.1 Drive Configuration

1.1.1 Operation Command Setting

1.1.1.1 Operation Command Setting Mode

Operation commands are used to control start, stop, forward run, reverse run, and jog of the AC drive. Commands can be given by the operating panel, terminal, communication, or self-defined method. Select the operation command setting mode through F0-02.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-02	Operation command source selection	0	0: Operating panel 1: Terminal 2: Communication 3: User-defined	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run and jog operation. 0: Operating panel Operation commands are input using the RUN, STOP/RES, and MF.K keys on the operating panel. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined The command source is defined by the user as needed for expansion.

1.1.1.2 Setting Operation Commands Through Operating Panel and Software

Setting operating commands through the operating panel

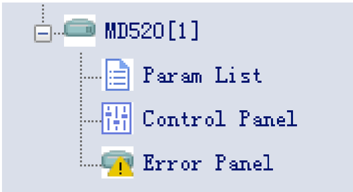
Set F0-02 to 0 and use the  and  keys on the operating panel to control the AC drive.

- Press  to start the AC drive. The RUN indicator becomes on.
- When the AC drive is running, press  to stop the AC drive. The RUN indicator becomes off.

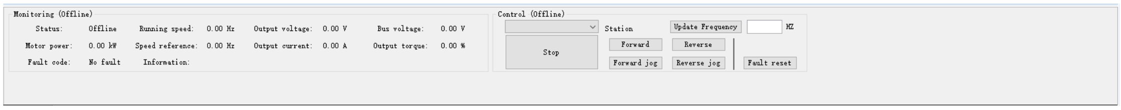
Setting operation commands through software

Set F0-02 to 0 to use the software to control the running command of the AC drive.

1. Open the InoDriverShop software and connect the AC drive to the software, as shown in the following figure.



2. Double-click the control panel menu under the AC drive to open the control panel of the software, as shown below.



- Enter the frequency in the text box Update Frequency HZ, and click **Update Frequency**. The value of F0-08 (Pre-set frequency) is changed.
- Click Forward on the control panel.The AC drive starts to run in the forward direction.
- Click Reverse on the control panel. The AC drive starts to run in the reverse direction.
- When the AC drive is running, click Stop on the control panel to stop the AC drive.
- Click and hold Forward jog on the control panel. The AC drive starts to jog in the forward direction. When you release the key, the AC drive stops jogging.
- Click and hold Reverse jog on the control panel. The AC drive starts to jog in the reverse direction. When you release the key, the AC drive stops jogging.
- When the AC drive encounters a fault, click Fault reset to reset the AC drive.

1.1.1.3 Setting Operation Commands Through Terminal

After setting F0-02 to 1, you can control the startup and stop of the AC drive through terminals.

F4-11 is used to set the terminal control mode. Four terminal control modes are available, including two-wire mode 1, two-wire mode 2, three-wire mode 1, and three-wire mode 2.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-11	Terminal command mode	0	0: Two-wire mode 1 1: Two-wire mode 2 2: Three-wire mode 1 3: Three-wire mode 2	0: Two-wire mode 1 Two DI terminals are connected. One is used to start/stop the AC drive in forward run mode, and the other is used to start/stop the AC drive in reverse run mode. 1: Two-wire mode 2 Two DI terminals are connected. One is used to start/stop the AC drive, and the other is used to control the running direction. 2: Three-wire mode 1 Three DI terminals are connected. One is used to start/stop the AC drive, and the other two are used to control the running direction. 3: Three-wire mode 2 Three DI terminals are connected. One is used to start the AC drive, one is used to stop the AC drive, and the last one is used to control the running direction.

You can use multi-functional input terminals DI1 to DI10 as external input terminals. That is, set parameters F4-00 to F4-09 to select functions of input terminals DI1 to DI10. For details about function definitions, see descriptions of F4-00 (DI1 function) to F4-09 (DI10 function).

Two-wire mode 1

Set F4-11 to 0 to select two-wire mode 1, which is the most commonly used mode.

For example, DI1 is allocated with the forward running function and DI2 is allocated with the reverse running function. Connect the forward running switch to DI1 and the reverse running switch to DI2.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	0	Two-wire mode 1
F4-00	DI1 function selection	1	Forward running (FWD)
F4-01	DI2 function selection	2	Reverse running (REV)

When SW1 is closed and SW2 is open, the motor rotates in the forward direction. When SW1 is open and SW2 is closed, the motor rotates in the reverse direction. When SW1 and SW2 are both open or closed, the motor stops. It is shown in the following figure.

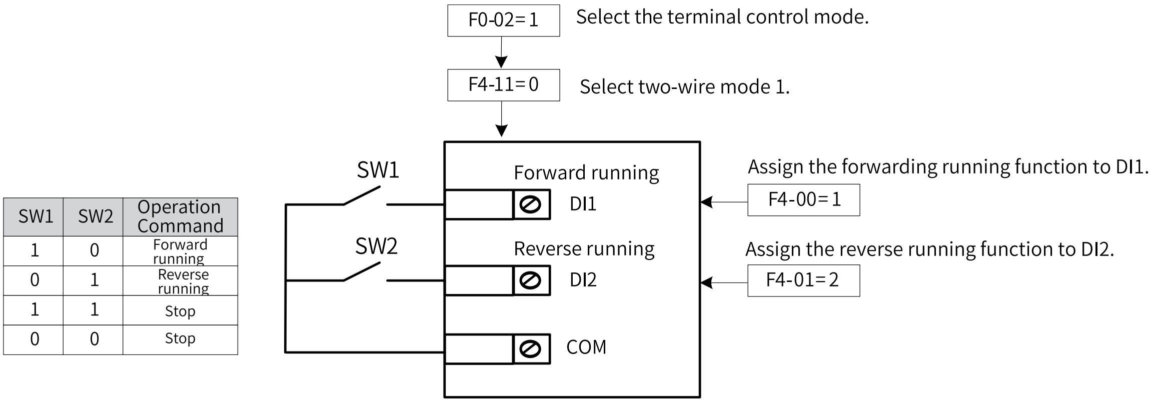


Figure 1-1 Wiring and parameter settings for two-wire mode 1

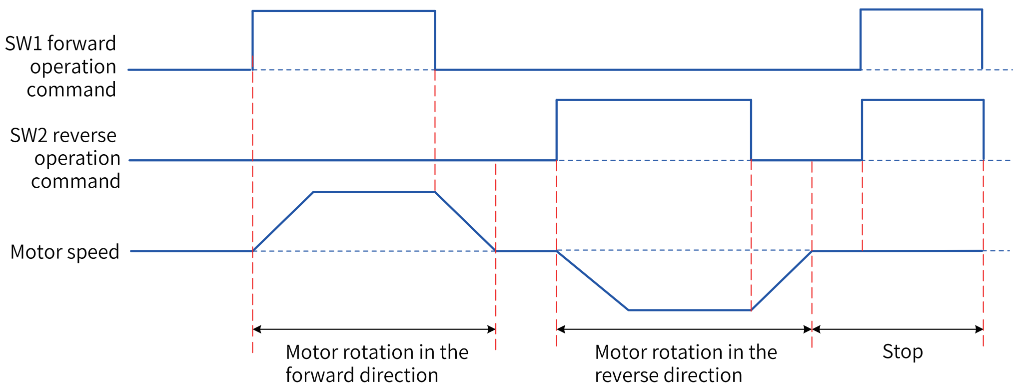


Figure 1-2 Time sequence (normal) for two-wire mode 1

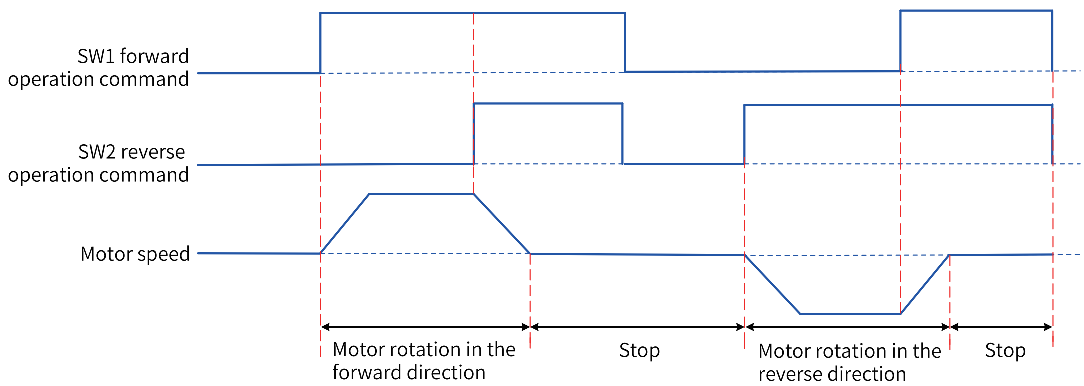


Figure 1-3 Time sequence (abnormal) for two-wire mode 1

Two-wire mode 2

For example, DI1 is allocated with the operation function, and DI2 is allocated with the forward and reverse running function. Set the parameters as follows.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	1	Two-wire mode 2
F4-00	DI1 function selection	1	Operation command
F4-01	DI2 function selection	2	Forward/reverse running direction

When SW1 is closed, the motor starts to run. When SW2 is open, the motor runs in the forward direction. When SW2 is closed, the motor runs in the reverse direction. When SW1 is open, the motor does not run regardless of the status of SW2. It is shown in the following figure.

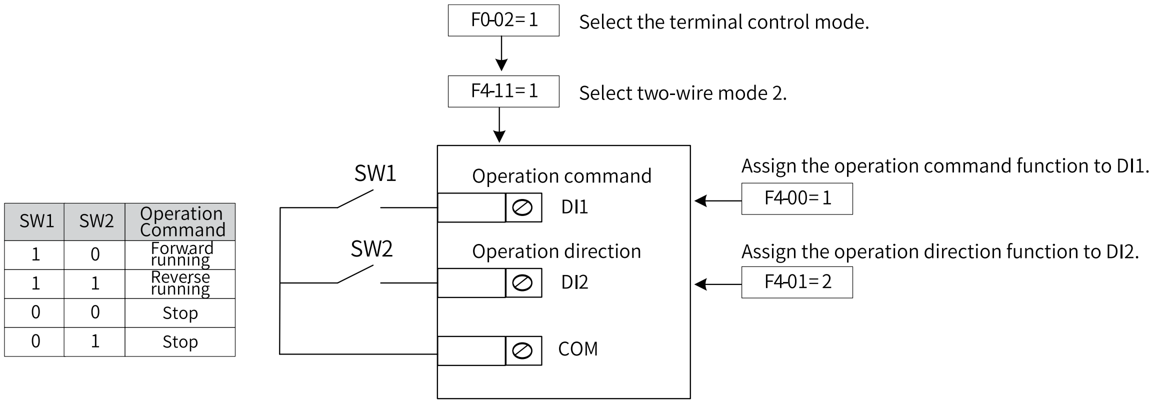


Figure 1-4 Wiring and parameter settings for two-wire mode 2

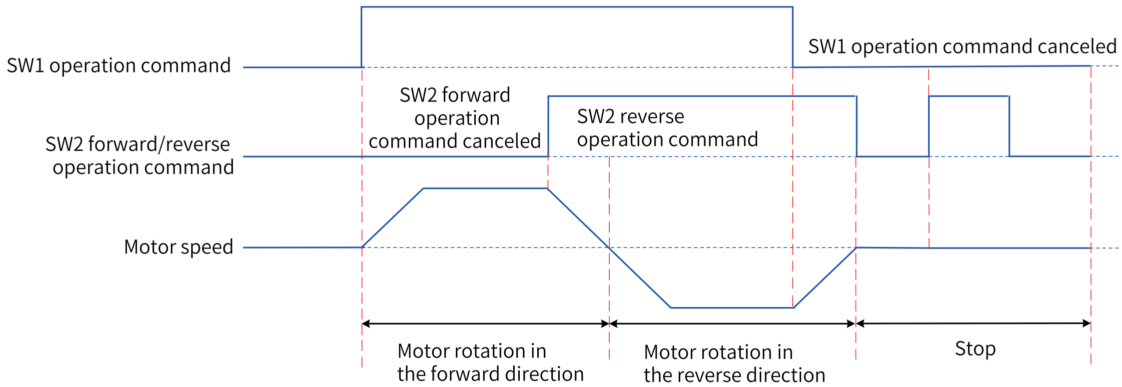


Figure 1-5 Two-wire mode 2 time sequence

Three-wire mode 1

For example, DI3 is allocated with the operation control function, DI1 is allocated with the forward running function, and DI2 is allocated with the reverse running function. In this mode, keys of the AC drive are used to start and stop it. Connect the start/stop key to DI3, the forward running key to DI1, and the reverse running key to DI2. The parameters are set as follows.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	2	Three-wire mode 1
F4-00	DI1 function selection	1	Forward running (FWD)
F4-01	DI2 function selection	2	Reverse running (REV)
F4-02	DI3 function selection	3	Three-wire control

SW3 is normally closed, and SW1 and SW2 are normally open. If SW3 is closed, the motor rotates in the forward direction when you press down SW1, and rotates in the reverse direction when you press down SW2. The motor stops immediately when SW3 opens. SW3 must remain closed during normal start and running. A signal from SW1 or SW2 takes effect once SW1 or SW2 is closed.

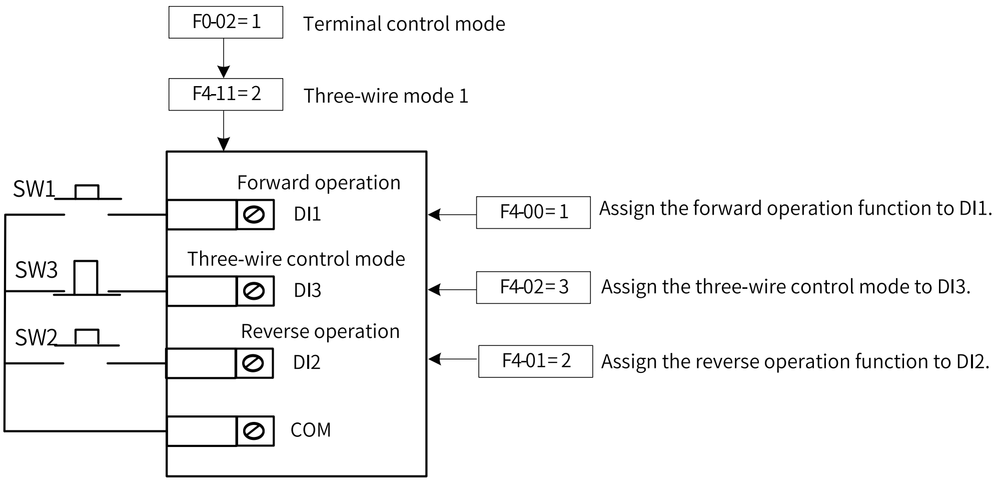


Figure 1-6 Wiring and parameter settings for three-wire mode 1

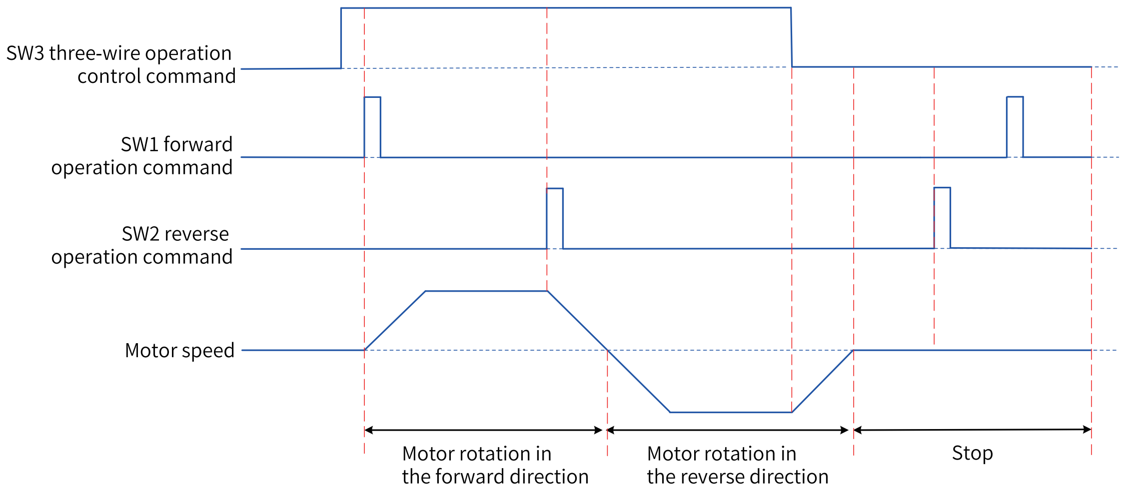


Figure 1-7 Three-wire mode 1 time sequence

Three-wire mode 2

For example, DI3 is allocated with the three-wire control function, DI1 is allocated with the operation function, and DI2 is allocated with the forward/reverse running function. Connect the start/stop key to DI3, the operation key to DI1, and the forward/reverse running key to the DI2. The parameters are set as follows.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	3	Three-wire mode 2
F4-00	DI1 function selection	1	Operation command
F4-01	DI2 function selection	2	Forward/reverse running direction
F4-02	DI3 function selection	3	Three-wire control

When SW3 is closed, the AC drive starts to run after you press SW1. If SW2 is open, the motor rotates in the forward direction. If SW2 is closed, the motor rotates in reverse direction. The drive stops immediately at the moment when SW3 becomes open. SW3 must remain closed during normal start and running. A signal from SW1 takes effect once SW1 is closed.

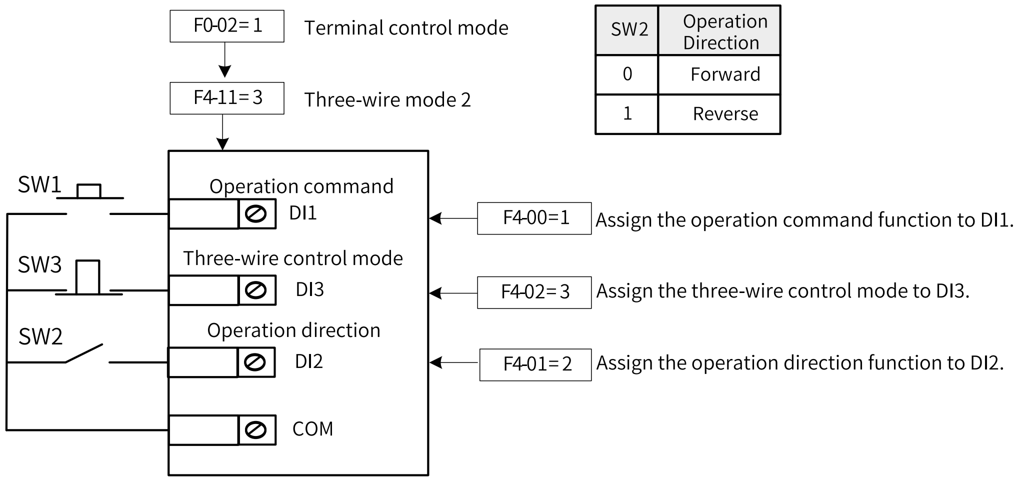


Figure 1-8 Wiring and parameter settings for three-wire mode 2

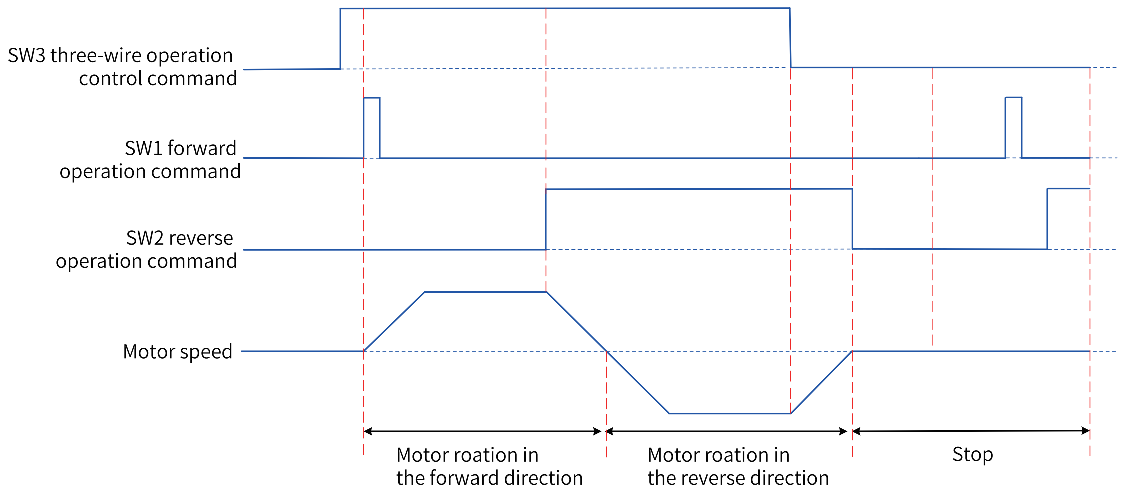


Figure 1-9 Three-wire mode 2 time sequence

1.1.1.4 Setting Operation Commands through Communication

You can set F0-02 to 2 to select communication as the command source for controlling start/stop of the AC drive.

The AC drive supports communication with the host controller through the following communication protocols: Modbus (Modbus RTU, Modbus ASCII, Modbus TCP), PROFIBUS DP, CANopen, CANlink, PROFINET, EtherCAT, and Ethernet/IP. Only one communication protocol is supported at a time. To enable the drive to communicate with the host controller through one of the previous protocol, you must install the related communication card. All the seven communication protocol is optional. If Modbus, PROFIBUS DP, CANopen, PROFINET, EtherCAT, or Ethernet/IP is used, set F0-28 (communication protocol selection) to select an applicable serial communication protocol. The CANlink protocol is valid all the time.

When running commands are given through communication, the host controller sends write commands to the AC drive. This part takes the Modbus protocol as an example to describe the process of giving running commands through communication.

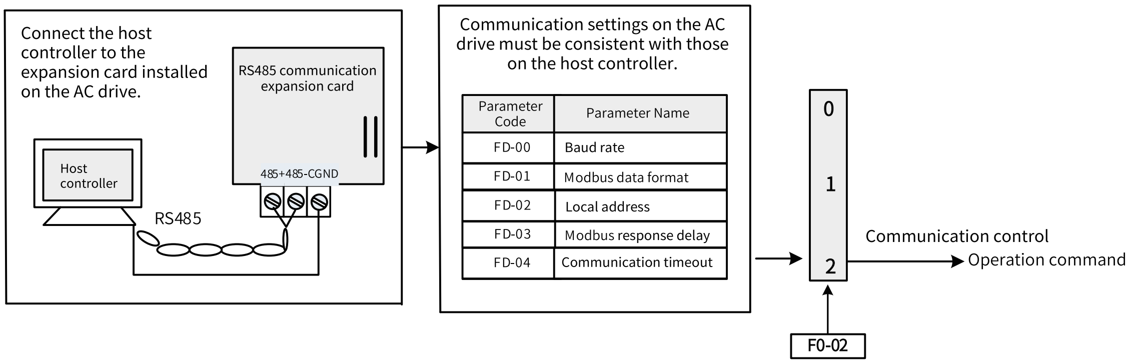


Figure 1-10 Sending running commands through communication

To make the AC drive run in the reverse direction, the host controller sends the write command 01 06 20 00 00 02 03 CB. The following table describes the definition of each byte. The command is in hexadecimal format. For other communication addresses and control commands, see "Appendix B: Communication Data Address Definition and Modbus Protocol".

Command	Definition
01H (settable)	Drive address
06H	Write command
2000H	Communication address of the control command
02H (reverse run)	Control command
03CBH	CRC check

The following table describes the relationship between master commands and slave responses.

Command from the Master		Response from the Slave	
ADDR	01H	ADDR	01H
CMD	06H	CMD	06H
High-order bit of the parameter address	20H	High-order bit of the parameter address	20H
Low-order bit of the parameter address	00H	Low-order bit of the parameter address	00H
High-order bit of the data content	00H	High-order bit of the data content	00H
Low-order bit of the data content	02H	Low-order bit of the data content	02H
CRC high-order bits	03H	CRC high-order bits	03H
CRC low-order bit	CBH	CRC low-order bit	CBH

1.1.1.5 Setting Operation Commands Through Customized Channel

Set F0-02 to 3 to configure the start and stop command source of the AC drive through a customized channel. Two groups of parameters for setting customized channels are provided.

Table 1–1

Parameter Code	Name	Default	Value Range	Description
A4-00	Control channel selection	0	0: Control channel 1 1: Control channel 2	This parameter is used to select a self-defined channel. When control channel 1 is selected, A4-01 to A4-18 are active. When control channel 2 is selected, A4-21 to A4-38 are active.
A4-01	Self-defined OFF1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of start/stop control command OFF1 for self-defined channel 1.
A4-02	Self-defined OFF2 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of coast to stop command OFF2 for self-defined channel 1. The coast to stop command OFF2 is valid if any of the three sources is active low.
A4-03	Self-defined OFF3 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of emergency stop command OFF3 for self-defined channel 1. The emergency stop command OFF3 is valid if any of the three sources is active low.
A4-04	Self-defined running permission command source	0	0: Operation inhibited 1: Operation allowed 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the running permission command source for self-defined channel 1.
A4-05	Self-defined fault reset command source 1	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of the fault reset command for self-defined channel 1. The fault reset command is valid if any of the three sources is active high.
A4-06	Self-defined JOG1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG1 command for self-defined channel 1.
A4-07	Self-defined JOG2 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG2 command for self-defined channel 1.
A4-08	Self-defined speed inversion source	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the command opposite to the command reference for self-defined channel 1.

Parameter Code	Name	Default	Value Range	Description
A4-21	Self-defined OFF1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of start/stop control command OFF1 for self-defined channel 2.
A4-22	Self-defined OFF2 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of coast to stop command OFF2 for self-defined channel 2. The coast to stop command OFF2 is valid if any of the three sources is active low.
A4-23	Self-defined OFF3 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of emergency stop command OFF3 for self-defined channel 2. The emergency stop command OFF3 is valid if any of the three sources is active low.
A4-24	Self-defined running permission command source	0	0: Operation inhibited 1: Operation allowed 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the running permission command source for self-defined channel 2.
A4-25	Self-defined fault reset command source 1	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of the fault reset command for self-defined channel 2. The fault reset command is valid if any of the three sources is active high.
A4-26	Self-defined JOG1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG1 command for self-defined channel 2.
A4-27	Self-defined JOG2 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG2 command for self-defined channel 2.
A4-28	Self-defined speed inversion source	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the command opposite to the command reference for self-defined channel 2.

1.1.2 Frequency Reference Setting

1.1.2.1 Frequency Reference Source Selection

The AC drive supports three frequency reference sources, including main frequency reference, auxiliary frequency reference, and main and auxiliary frequency superposition.

1.1.2.2 Selecting Source for Main Frequency Reference

There are ten main frequency reference sources in total, including digital setting (non-retentive at power failure), digital setting (retentive at power failure), AI1, AI2, AI3, pulse input, multi-reference, simple PLC, PID, communication setting, and F connector. You can set F0-03 to a value ranging from 0 to 9 to define the source.

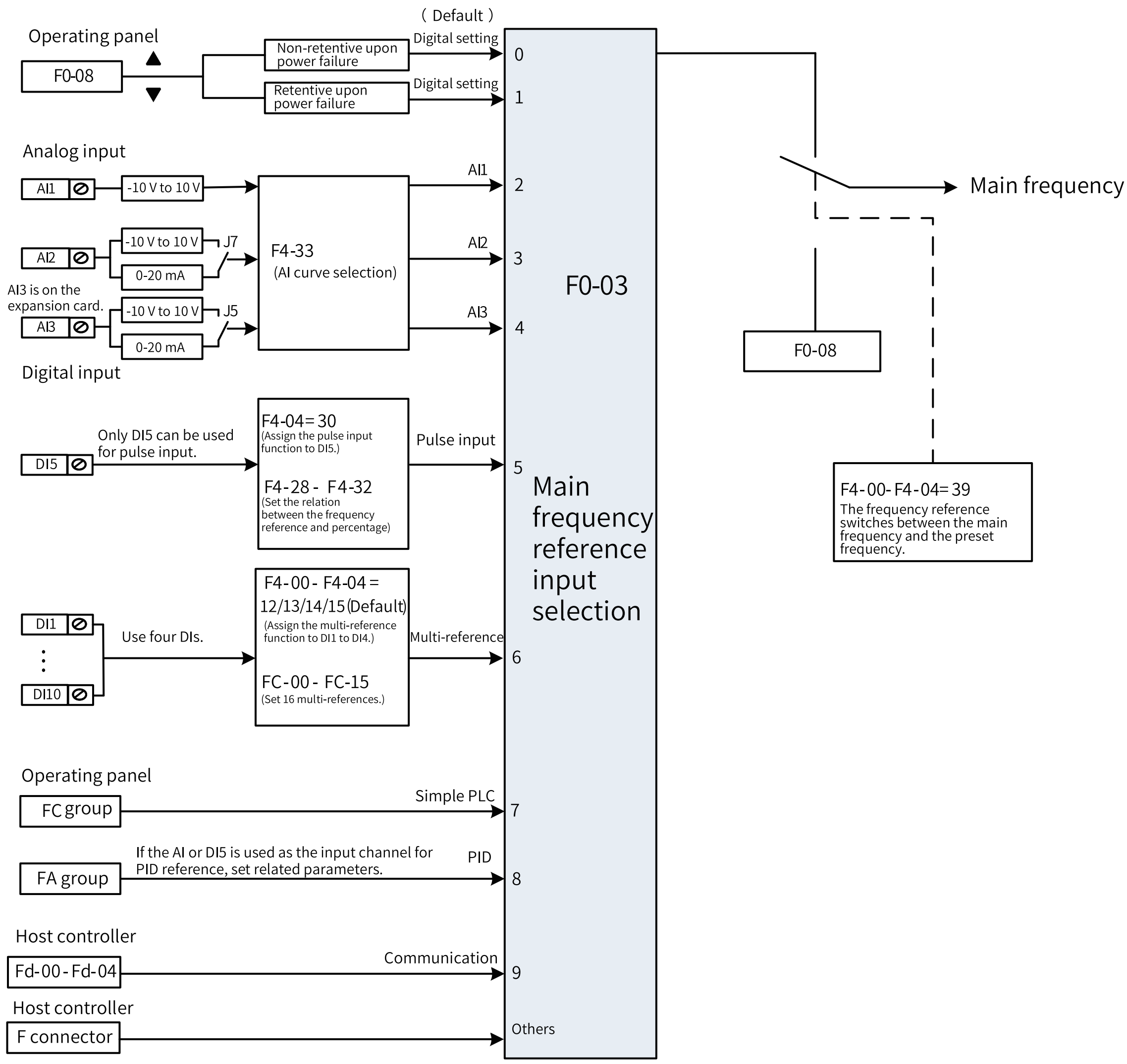
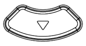
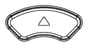
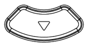


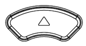
Figure 1-11 Main frequency source selection

Parameter Code	Parameter Name	Value Range	Default
F0-03	Main frequency source X selection	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	0

1.1.2.3 Setting Main Frequency Through Operating Panel

There are two ways to set the main frequency by using the operating panel:

- F0-03 = 0 (non-retentive at power failure): When the AC drive is powered on again after stop or power failure, the frequency reference is restored to the preset frequency (F0-08). The preset frequency (F0-08) can be changed by the  and  keys on the operating panel or by terminal functioning as the UP and DOWN keys. When the AC drive stops, the changed frequency will be reset.
- F0-03 = 1 (retentive at power failure): When the AC drive is powered on again after stop or power failure, the preset frequency is restored to the value memorized at the moment of the last power failure. The preset frequency (F0-08) can be changed by the  and  keys on the operating panel or by terminal functioning as the UP and DOWN keys. When the AC drive stops, the changed frequency will be retained.

  Example: The preset frequency (F0-08) is set to 40 Hz and then changed to 45 Hz by the  key on the operating panel. If F0-23 is set to 0 (non-retentive at power failure), the frequency is restored to 40 Hz (value of F0-08) after the AC drive stops. If F0-23 is set to 1 (retentive at power failure), the frequency is still 45 Hz after the AC drive stops.

Note

Note that F0-23 (Retention of digital-set frequency at stop) differs from F0-03. F0-23 determines whether the changed frequency is retained when the AC drive stops. F0-23 is related to the stop state, rather than power failures.

Related parameter

Parameter Code	Name	Default	Value Range
F0-08	Preset frequency	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)
F0-10	Maximum frequency	50.00 Hz	50.00 Hz to 600.00 Hz

Parameter Code	Name	Default	Value Range
F0-23	Retention of digital setting of frequency upon stop	0	0: Non-retentive at stop 1: Retentive at stop

1.1.2.4 Setting Main Frequency Through AI

When the main frequency is to be set through the AI, AI1, AI2, or AI3 can be selected.

- F0-03 = 2: AI1 is used to set the main frequency reference.
- F0-03 = 3: AI2 is used to set the main frequency reference.
- F0-03 = 4: AI3 is used to set the main frequency reference.

When the AI is used to as the frequency source, each AI supports five types of AI curves. The AI curve defines the relationship between the analog input voltage (or current) and the corresponding set values.

Procedure	Parameter	Description
Step 1: Set the AI curve. Set the relationship between AI voltage/current inputs and the set values.	F4-13 to F4-16	Curve 1 setting
	F4-18 to F4-21	Curve 2 setting
	F4-23 to F4-26	Curve 3 setting
	A6-00 to A6-07	Curve 4 setting
	A6-08 to A6-15	Curve 5 setting
	F4-34	This parameter is used to set the value when the AI value is lower than the minimum input. When the frequency is set through the AI, voltage/current input 100% corresponds to the maximum frequency F0-10.
Step 2: Select the AI curve for the AI. Select the AI curve and set the filter time.	F4-33	This parameter is used to select the AI curve. You can select any AI curve for an AI. The default value 0x321 of F4-33 is used. Select curve 1, curve 2, and curve 3 for AI1, AI2, and AI3, respectively.
	F4-17, F4-22, F4-27	Filter time of AI1 and AI3
Step 3: Set the AI as the frequency source. Select the AI for setting the frequency reference based on terminal characteristics.	F0-03 (Main frequency source)	F0-03 = 2 AI1 is used.
		F0-03 = 3 AI2 is used. DIP switches S1 to S3 on the control board are used to select voltage input or current input.
		F0-03 = 4 AI3 is used. Select the input mode (voltage or current) by setting S1 on the expansion card.

AI curve setting methods

There are five types of AI curves in total. Curves 1, 2, and 3 are 2-point curves, with relevant parameters being F4-13 to F4-27. Curves 4 and 5 are four-point curves. The related parameters are in group A6.

In the following example, AI curve 1 is set through F4-13 to F4-16.

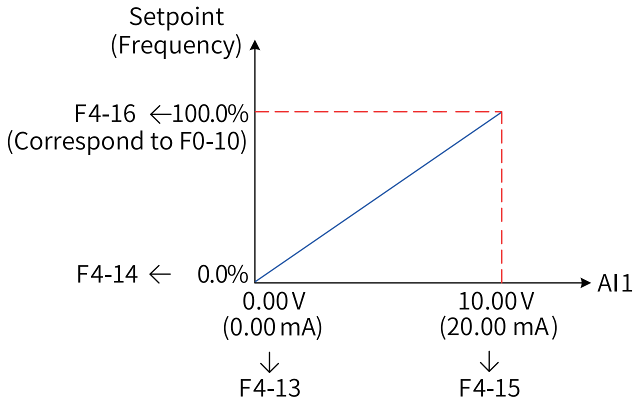


Figure 1-12 Setting AI curve 1

When the AI is used as the frequency setting source, the voltage/current input 100% corresponds to the value of F0-10 (maximum frequency).

When current mode 1 is selected for analog input, current of 1 mA corresponds to voltage of 0.5 V, and current of 0 mA to 20 mA corresponds to voltage of –10 V to +10 V.

When current mode 2 is selected for analog input, current of 1 mA corresponds to voltage of 0.25 V, and current of 0 mA to 40 mA corresponds to voltage of –10 V to +10 V.

Curve 2 and curve 3 are set in a similar way as curve 1. F4-18 to F4-21 are used to set curve 2. F4-23 to F4-26 are used to set curve 3.

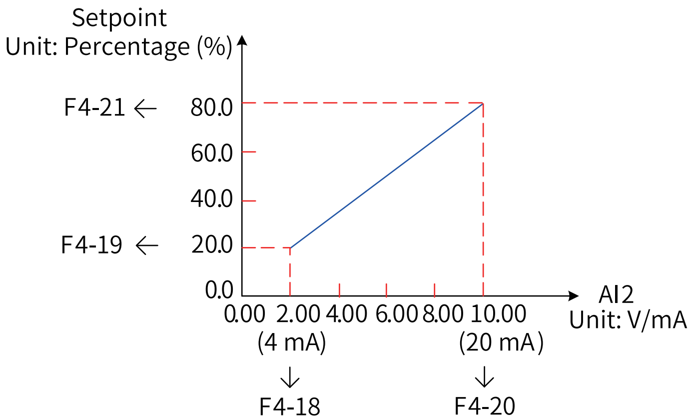


Figure 1-13 Setting AI curve 2

The function of curve 4 and curve 5 is similar to that of curve 1 to curve 3, but curve 1 to curve 3 are lines, and curve 4 and curve 5 are 4-point curves, implementing more flexible corresponding relationship. The x axis in AI curves 4 and 5 represents the analog input voltage (or current), and the y axis represents the set value corresponding to the analog input, that is, the percentage relative to the maximum frequency (F0-10). The four points on curves 4 and 5 are the minimum input point, inflection point 1, inflection point 2, and maximum input point. A6-00 corresponds to the minimum input point on the x axis, that is, the minimum analog input voltage (or current).

When setting curve 4 and curve 5, the minimum input voltage, inflection point 1 voltage, inflection point 2 voltage, and maximum input voltage must be increased in ascending order. A6-00 to A6-07 are used to set curve 4. A6-08 to A6-15 are used to set curve 5.

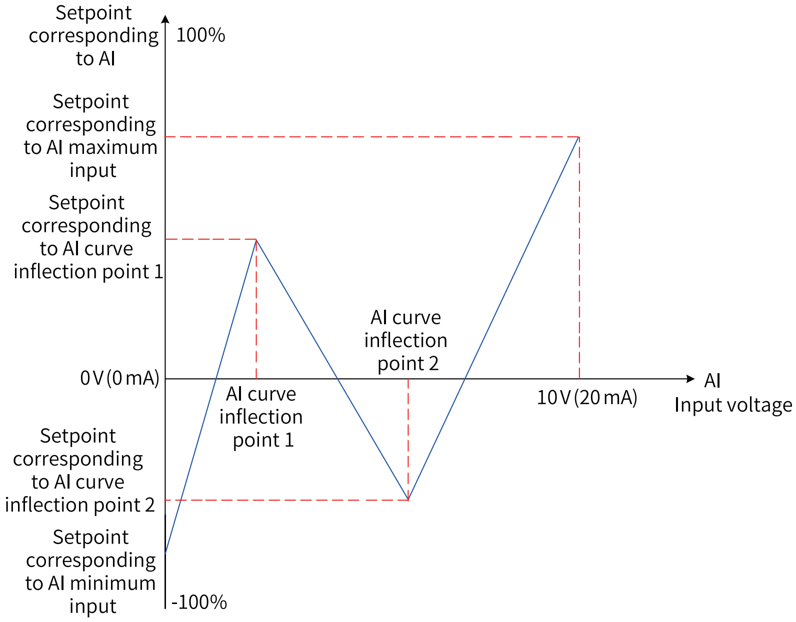


Figure 1-14 Schematic diagram for curve 4 and curve 5

AI curve selection

The ones and tens places of F4-33 are used to set the curve for AI1 and AI2, respectively. The two AIs can use any of the five curves.

The longer the AI input filter time, the stronger the anti-interference capability, but the slower the adjustment response. The shorter the filter time, the quicker the adjustment response, but the weaker the anti-interference capability. If the analog signal is prone to interference, increase the filter time to stabilize the detected analog signal. However, increasing the filter time will slow the response speed of analog detection. Set the filter time properly based on actual conditions.

AI as the main frequency reference source

The control board provides three AI terminals: AI1, AI2, and AI3. AI1 supports voltage input of –10 V to +10 V. AI2 and AI3 supports voltage input of –10 V to +10 V or current input of 0 mA to 20 mA/40 mA. DIP switches S1 to S3 on the control board are used to select voltage input, current input, or temperature input for AI2. DIP switch S1 on the expansion card is used to select voltage input or temperature input for AI3. The following describes the setting of each AI used as the main frequency reference source.

For example, assume that curve 1 is selected for AI1 (the ones place of F4-33 is set to 1) and voltage-type AI1 is used as the main frequency reference source. To make input voltage of 2 V to 10 V be mapped to frequency of 10 Hz to 40 Hz, set as follows.

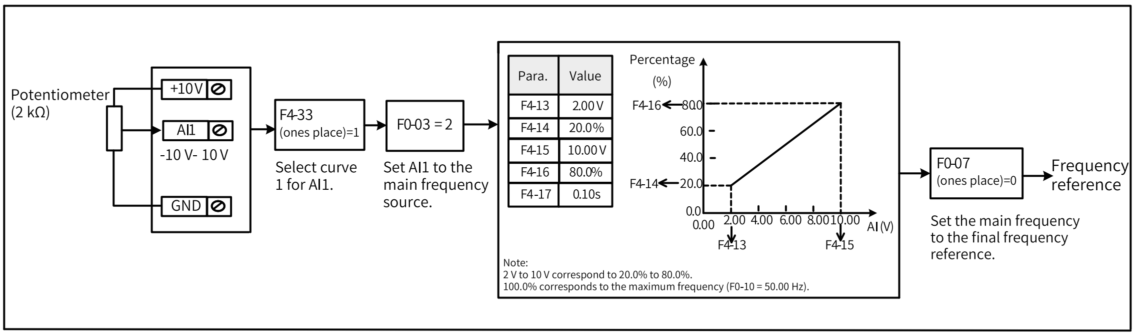


Figure 1-15 Parameter settings for voltage-type AI1 to be used as the main frequency reference source

AI2 supports analog voltage input (-10 V to 10 V) or analog current input (0 mA to 20 mA).

When AI2 is used for analog current input, input current of 0 mA to 20 mA corresponds to input voltage of 0 V to 10 V. If the input current ranges from 4 mA to 20 mA, current of 4 mA corresponds to voltage of 2 V, and current of 20 mA corresponds to voltage of 10 V.

For example, assume that curve 2 is selected for AI2 (the tens place of F4-33 is set to 2) and current-type AI2 is used as the main frequency reference source. To make input current of 4 mA to 20 mA be mapped to frequency of 0 Hz to 50 Hz, set as follows.

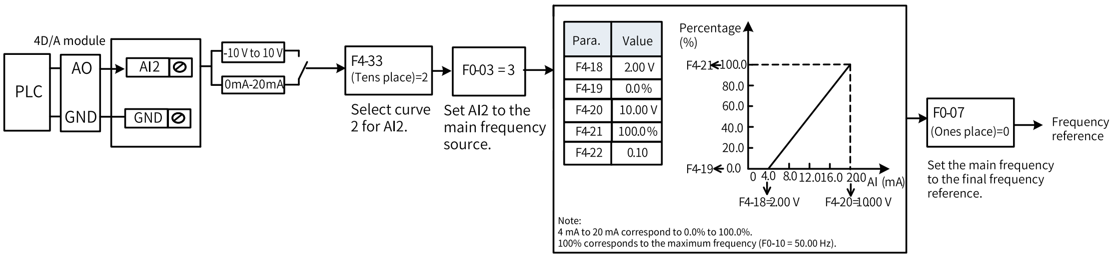


Figure 1-16 Parameter settings for current-type AI2 to be used as the main frequency reference source

1.1.2.5 Setting Main Frequency Through Multi-reference

When F0-03 is set to 6, multi-reference is selected as the main frequency reference source. This mode is suitable for applications where the operating frequency of the drive does not require continuous adjustment, and only several frequency values need to be used.

You can set a maximum of 16 operating frequencies through parameters FC-55 to FC-58 or through combinations of input signals of four DIs. The settings by terminal are preferred to those by parameters. For example, if DI1 is allocated with multi-reference terminal function 1, the setting of FC-55 is inactive. You can also use fewer than four DIs as the multi-reference source. In this case, missing digits are populated with 0.

The relationship between the reference quantity and DI quantity is as follows:

- Two multi-references: One DI K1; FC-55 to FC-58 set to 0
- Three to four multi-references: Two DIs K1 and K2; FC-57 to FC-58 set to 0
- Five to eight multi-references: Three DIs K1, K2, and K3; FC-58 set to 0
- Nine to sixteen multi-references: Four DIs K1, K2, K3, and K4

The multi-references are set through parameters in group FC, as listed in the following table.

Parameter Code	Parameter Name	Default	Value Range	Description
FC-00	Multi-reference 1	0.00%	-100.0% to 100.0%	This parameter indicates the frequency reference of each speed in the unit of %. The actual frequency is the percentage of the maximum frequency. The value 100% corresponds to F0-10 (Maximum frequency). FC-55 to FC-58 can provide 16 state combinations, corresponding to 16 frequency references. The DIs assigned with functions 12 to 15 can also be used to provide 16 frequency references. The source of multi-reference 1 is selected by FC-51, and the other multi-references are set by other parameters. When outputting to a floating-point connector, the multi-reference can be used not only as the frequency reference, but also as the torque, voltage, or other reference input. The multi-reference value is a percentage of the rated value.
FC-01	Multi-reference 2	0.00%	-100.0% to 100.0%	
FC-02	Multi-reference 3	0.00%	-100.0% to 100.0%	
FC-03	Multi-reference 4	0.00%	-100.0% to 100.0%	
FC-04	Multi-reference 5	0.00%	-100.0% to 100.0%	
FC-05	Multi-reference 6	0.00%	-100.0% to 100.0%	
FC-06	Multi-reference 7	0.00%	-100.0% to 100.0%	
FC-07	Multi-reference 8	0.00%	-100.0% to 100.0%	
FC-08	Multi-reference 9	0.00%	-100.0% to 100.0%	
FC-09	Multi-reference 10	0.00%	-100.0% to 100.0%	
FC-10	Multi-reference 11	0.00%	-100.0% to 100.0%	
FC-11	Multi-reference 12	0.00%	-100.0% to 100.0%	
FC-12	Multi-reference 13	0.00%	-100.0% to 100.0%	
FC-13	Multi-reference 14	0.00%	-100.0% to 100.0%	
FC-14	Multi-reference 15	0.00%	-100.0% to 100.0%	
FC-15	Multi-reference 16	0.00%	-100.0% to 100.0%	

Parameter Code	Parameter Name	Default	Value Range	Description
FC-51	Multi-reference 1 source	0	0 to 6	The frequency reference of multi-reference 1 can be selected through seven ways, including digital setting, analog input, pulse frequency, PID, and preset frequency. 0: FC-00 The frequency reference is set by FC-00. 1: AI1 The frequency reference is set by AI1. 2: AI2 The frequency reference is set by AI2. 3: AI3 The frequency reference is set by AI3. 4: Pulse reference The frequency reference is set by pulse frequency. 5: PID The frequency reference is set by PID. 6: Preset frequency (F0-08) The frequency reference is set by F0-08 Others: F connector The frequency reference is set by connector.

To set multi-reference as the main frequency reference source, assign functions 12 to 15 to the DIs.

Parameter Code	Parameter Name	Value Range	Description
F4-01	DI2 function selection	12	Multi-reference terminal 1
F4-03	DI4 function selection	13	Multi-reference terminal 2
F4-06	DI7 function selection	14	Multi-reference terminal 3
F4-07	DI8 function selection	15	Multi-reference terminal 4

Example

In the following figure, DI2, DI4, DI7, and DI8 are used as the multi-frequency input terminals, which form a four-bit binary number. The state combinations of these terminals represent different frequencies. When values of DI8, DI7, DI4, and DI2 are 0, 0, 1, and 0, the frequency set through FC-02 is selected. For details, see *"Table 1–2" on page 27*. The target operating frequency is automatically calculated from "FC-02 x F0-10". The following figure shows the frequency setting.

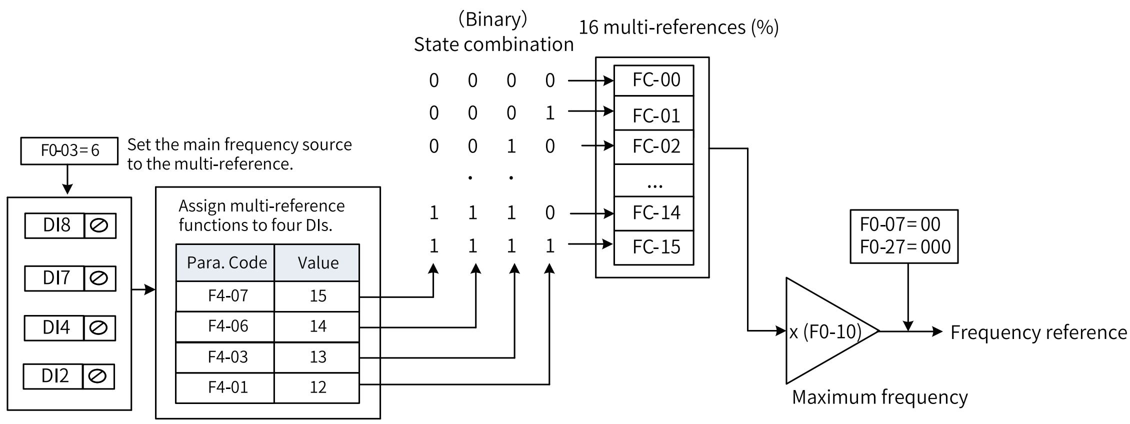


Figure 1-17 Multi-reference setting

The four multi-reference terminals can make up 16 state combinations, corresponding to 16 frequency reference values, as listed in the following table.

Table 1–2 Description of multi-reference function

K4	K3	K2	K1	Reference	Parameter
OFF	OFF	OFF	OFF	Multi-reference 1	FC-00 (FC-51 = 0)
OFF	OFF	OFF	ON	Multi-reference 2	FC-01
OFF	OFF	ON	OFF	Multi-reference 3	FC-02
OFF	OFF	ON	ON	Multi-reference 4	FC-03
OFF	ON	OFF	OFF	Multi-reference 5	FC-04
OFF	ON	OFF	ON	Multi-reference 6	FC-05
OFF	ON	ON	OFF	Multi-reference 7	FC-06
OFF	ON	ON	ON	Multi-reference 8	FC-07
ON	OFF	OFF	OFF	Multi-reference 9	FC-08
ON	OFF	OFF	ON	Multi-reference 10	FC-09
ON	OFF	ON	OFF	Multi-reference 11	FC-10
ON	OFF	ON	ON	Multi-reference 12	FC-11
ON	ON	OFF	OFF	Multi-reference 13	FC-12
ON	ON	OFF	ON	Multi-reference 14	FC-13
ON	ON	ON	OFF	Multi-reference 15	FC-14
ON	ON	ON	ON	Multi-reference 16	FC-15

In the preceding section, the multi-reference values are determined by assigning functions to terminals through parameters in group F4. You can also set the multi-reference values through parameters in group FC.

Parameter Code	Parameter Name	Value	Description
FC-51	Multi-reference 1 source	0: FC-00 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: PID 6: Preset frequency (F0-08) Others: F connector	The frequency reference of multi-reference 1 can be selected through seven ways, including digital setting, analog input, pulse frequency, PID, and preset frequency. 0: FC-00 The frequency reference is set by FC-00. 1: AI1 The frequency reference is set by AI1. 2: AI2 The frequency reference is set by AI2. 3: AI3 The frequency reference is set by AI3. 4: Pulse reference The frequency reference is set by pulse frequency. 5: PID The frequency reference is set by PID. 6: Preset frequency (F0-08) The frequency reference is set by F0-08 Others: F connector The frequency reference is set by connector.
FC-55	Multi-reference selection through K1	0: 0 1: 1 2: Terminal input function 3-18: DI1 to DI16 Others: B connector	This parameter is used to select K1 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "12: Multi-reference terminal 1".
FC-56	Multi-reference selection through K2		This parameter is used to select K2 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "13: Multi-reference terminal 2".
FC-57	Multi-reference selection through K3		This parameter is used to select K3 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "14: Multi-reference terminal 3".
FC-58	Multi-reference selection through K4		This parameter is used to select K4 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "15: Multi-reference terminal 4".

1.1.2.6 Setting Main Frequency Through Simple PLC

1: Set F0-03 to 7 to select simple PLC as the main frequency source.

2: Set parameters FC-00 to FC-15 and FC-18 to FC-49 to define the running time and acceleration/deceleration time for each multi-speed reference.

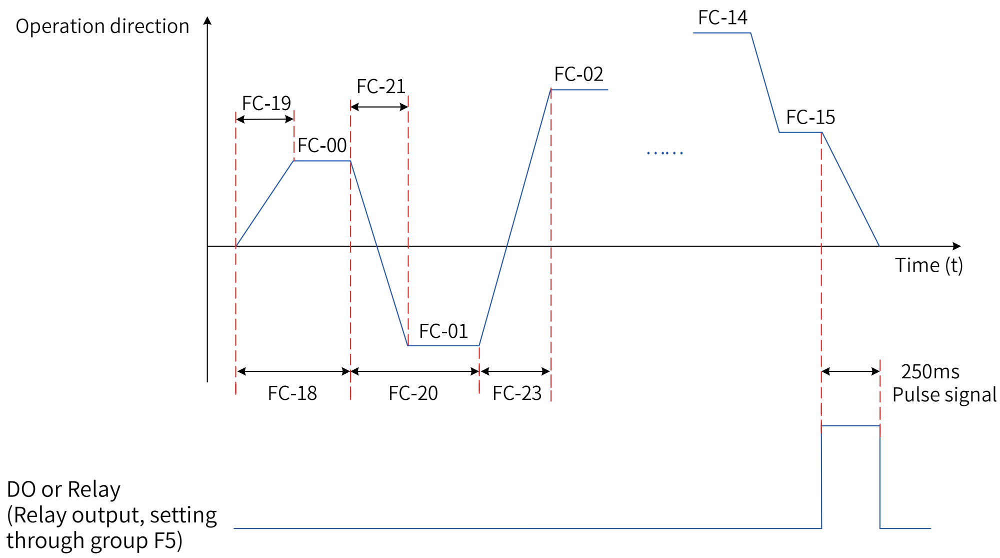


Figure 1-18 Use of simple PLC as the main frequency source

3: Set FC-16 to select the simple PLC running mode.

4: Set FC-17 to determine whether to retain the PLC running stage and running frequency upon a power failure or stop.

1.1.2.7 Setting Main Frequency Through PID

As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. The PID-controlled output is used as the running frequency. The PID control is generally used for field process closed-loop control, such as constant pressure closed-loop control and constant tension closed-loop control.

- Proportional gain Kp: When there is a deviation between the PID input and output, the PID regulator adjusts the output to reduce the deviation of the controlled variable. The deviation reduction speed depends on the proportionality coefficient Kp. A greater Kp value means faster deviation reduction but causes oscillation, especially in the case of long hysteresis. A smaller Kp value means lower probability of oscillation but leads to slow adjustment. (A proportional gain of 100.0 indicates that when the deviation between PID feedback and PID reference is 100.0%, the PID regulator regulates the output frequency reference at the amplitude of the maximum frequency.)
- Integral time Ti: Ti determines the integral regulation intensity of the PID regulator. The shorter the integral time, the greater the adjustment intensity. (When the deviation between PID feedback and PID reference is 100.0%, the integral regulator performs continuous regulation within the time. The regulation amount reaches the maximum frequency.)
- Differential time Td: Td determines the regulation intensity of the PID regulator on the deviation change. Longer differential time indicates greater adjustment intensity. (Differential time indicates the time within which the feedback change reaches 100.0%. The regulation amount reaches the maximum frequency.)

Example

Step 1: Set F0-03 or F0-04 to 8 to select PID as the main frequency reference input source and auxiliary frequency input source.

Step 2: Set FA-00 to select a source of PID target reference. If FA-00 is set to 0, set FA-01 (digital setting of PID). The value 100% of this parameter corresponds to the maximum value of PID feedback.

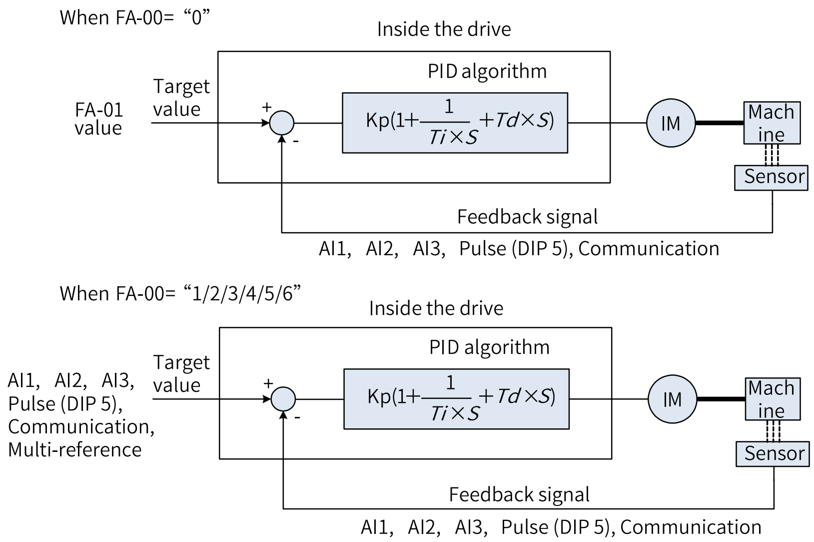


Figure 1-19 Principle of process PID control

Step 3: Set FA-02 to select a PID feedback source.

Step 4: Set FA-03 to select a PID action direction.

The following figure shows the logic of process PID control parameter configuration.

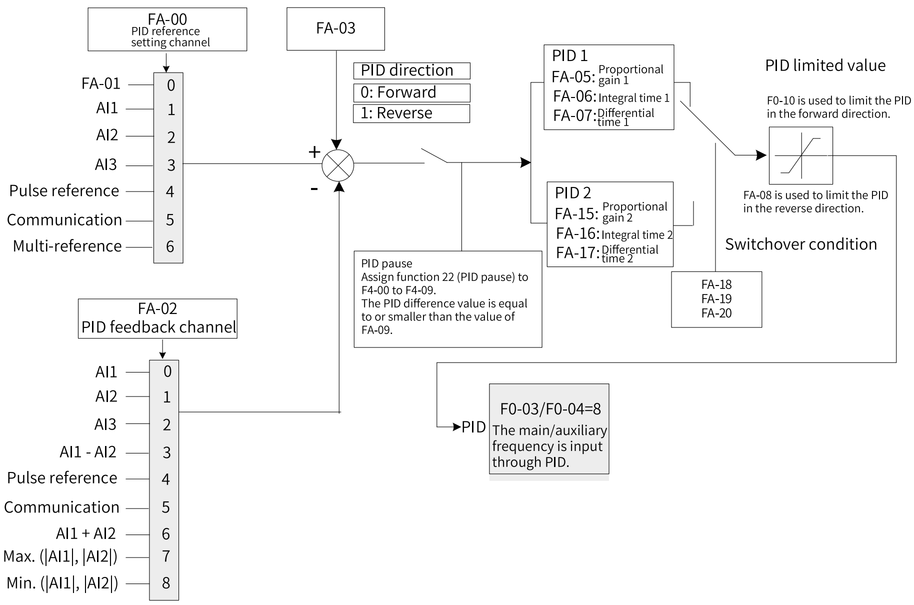


Figure 1-20 Parameter settings for process PID control

The upper and lower limits and range of the frequency output when the PID is used as the main frequency source are described as follows (for example, when the frequency source is only PID or main frequency + PID).

The reverse cut-off frequency is 0 or reverse running is prohibited (any one of the following three situations).

① FA-08 = 0, F8-13 = 0; ② FA-08 = 0, F8-13 = 1; ③ FA-08 ≠ 0, F8-13 = 1

Output upper limit = Frequency upper limit

Output lower limit = Frequency lower limit

Output range = Frequency lower limit to frequency upper limit (F0-14 to F0-12)

The reverse cut-off frequency is non-zero and reverse running is allowed (FA-08 ≠ 0, F8-13 = 0).

Output upper limit = +Frequency upper limit; Output lower limit = –Reverse cut-off frequency

Output range = –Reverse cut-off frequency to +Frequency upper limit (–FA-08 to +F0-12)

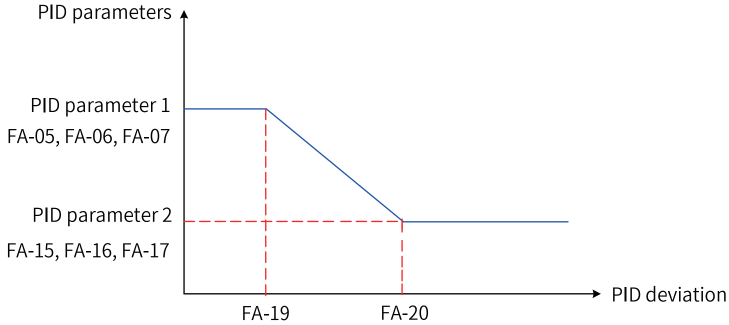


Figure 1-21 PID parameter switchover

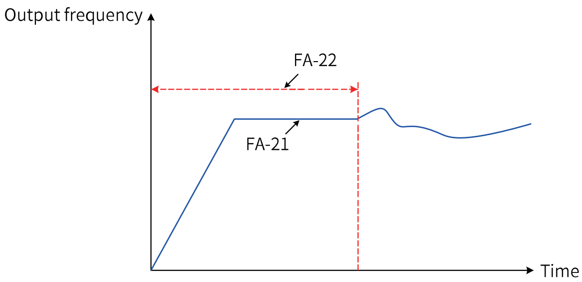


Figure 1-22 PID initial value

1.1.2.8 Setting Main Frequency Through Communication

The drive supports seven communication protocols, including Modbus, PROFIBUS DP, CANopen, CANlink, PROFINET, EtherCAT, and Ethernet/IP.

- When PROFIBUS DP, PROFINET, EtherCAT, Ethernet/IP, or CANopen (CANopen expansion card) is selected, set FD-00 to 9 and FD-01 to 3.
- When a CANlink card is used for CANopen communication, set FD-10 to 1. Set the CAN communication baud rate through FD-00 and CAN station No. through FD-02.
- When a CANlink card is used for CANlink communication, set FD-10 to 2. Set the CAN communication baud rate through FD-00 and CAN station No. through FD-02.

- When Modbus is used for communication, set the baud rate, data format, and station No. through FD-00, FD-01, and FD-02.

Example

Step 1: Set F0-03 to 9 to select communication as the main frequency source.

Step 2: Use the host controller to send a write command to the drive.

The following section describes how to set the main frequency through Modbus communication. For example, to set the frequency reference to 10000 through communication, send the write command 01 06 10 00 27 10 97 36.

The following table describes the definition of each byte.

Byte	Description
01H (settable)	Drive address
06H	Write command
1000H	Frequency reference address
2710H (10000 in decimal)	Target frequency
9736H	CRC check

Similarly, to set the frequency reference to –10000 through communication, send the write command 01 06 10 00 D8 F0 D7 4E. In the command, D8F0 is the low-order four bits of the hexadecimal number converted from -10000.

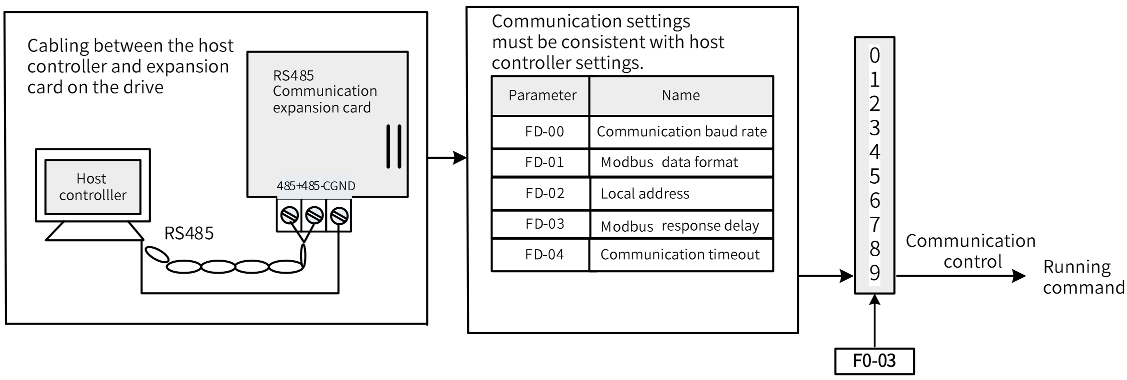


Figure 1-23 Parameters used to set the main frequency through communication

Table 1–3 Relationship between master commands and slave responses

Command from the Master		Response from the Slave	
ADDR	01H	ADDR	01H
CMD	06H	CMD	06H
High-order bit of the parameter address	10H	High-order bit of the parameter address	10H
Low-order bit of the parameter address	00H	Low-order bit of the parameter address	00H
High-order bit of the data content	27H	High-order bit of the data content	27H
Low-order bit of the data content	10H	Low-order bit of the data content	10H

Command from the Master		Response from the Slave	
CRC high-order bits	97H	CRC high-order bits	97H
CRC low-order Bit	36H	CRC low-order Bit	36H

The range of the frequency reference set through communication is -10000 to +10000 (decimal), corresponding to -100.00% (negative maximum frequency) to +100.00% (positive maximum frequency). Assume that F0-10 (maximum frequency) is set to 50 Hz. If the frequency reference in the write command is 2710H, which is equivalent to 10000 in the decimal format, the actual written frequency reference is 50 Hz (50 x 100%).

1.1.2.9 Selecting Source of Auxiliary Frequency Reference

There are ten auxiliary frequency sources in total, including digital setting (non-retentive at power failure), digital setting (retentive at power failure), AI1, AI2, AI3, pulse input, multi-reference, simple PLC, PID, and communication setting. You can set F0-04 to a value ranging from 0 to 9 to define the source.

When the auxiliary frequency reference is used as a separate frequency reference source, it is set in the same way as the main frequency reference. The following figure shows the logic block diagram. The auxiliary frequency reference can also be used together with the main frequency reference for frequency setting. For details, see *"1.1.2.10 Selecting Source of Main Frequency and Auxiliary Frequency Superposition" on page 36*.

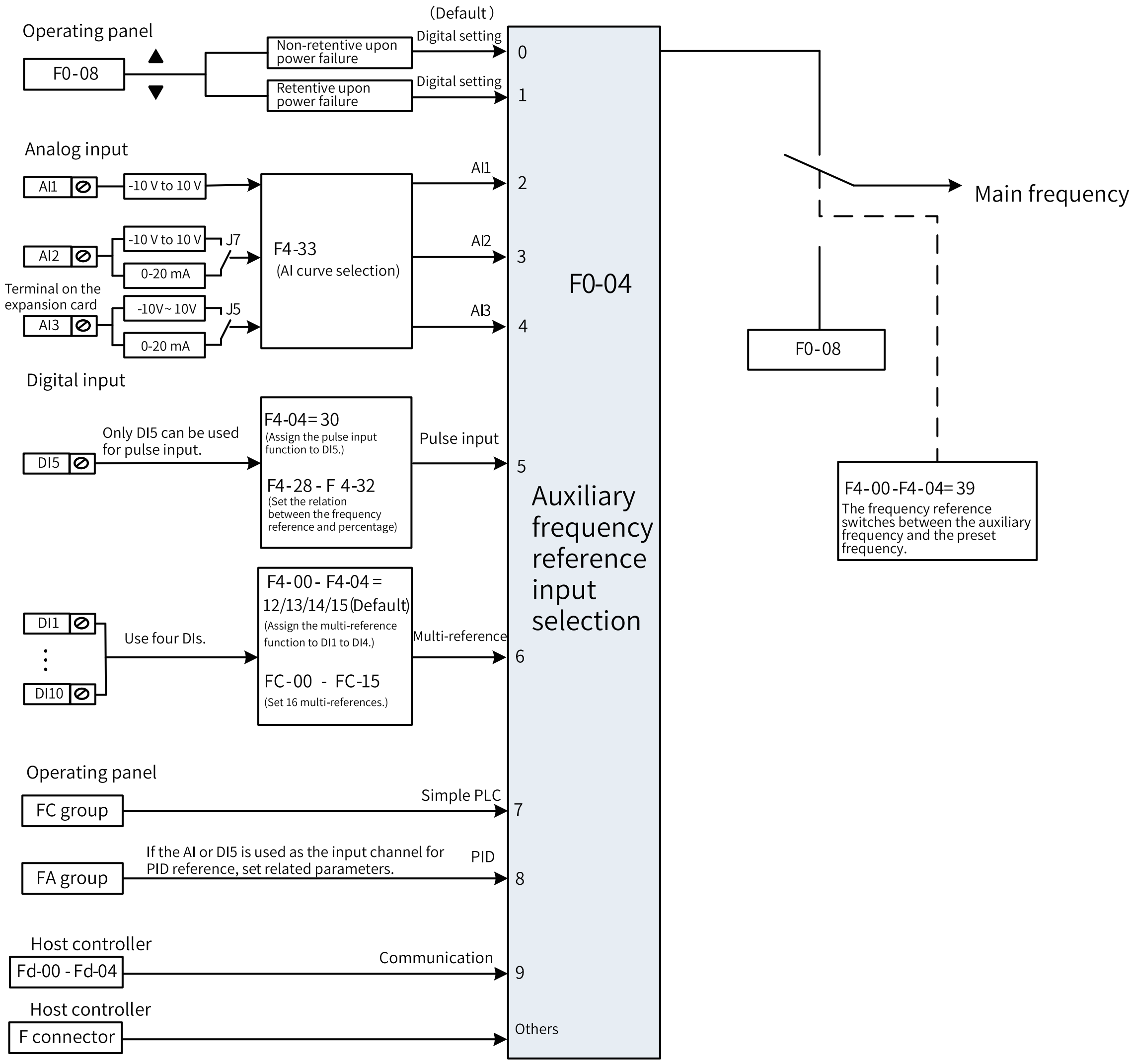


Figure 1-24 Auxiliary frequency reference source selection

Parameter Code	Parameter Name	Value Range	Default	Description
F0-04	Auxiliary frequency Y source	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication (To be continued)	0	This parameter is used to set the source of the auxiliary frequency Y, as shown below. 0: Digital setting (non-retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is restored to the value of F0-08. 1: Digital setting (retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is the same as that at the moment of the last power failure. Modifications made by using keys ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP and DOWN key remain effective. 2: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
F0-04	Auxiliary frequency Y source	Continued 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	0	Continued 7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. (To be continued)
F0-04	Auxiliary frequency Y source	Continued Others: F connector	0	Continued Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources. Note: If this parameter cannot be set to the desired value, check whether F0-03 is set repeatedly.

1.1.2.10 Selecting Source of Main Frequency and Auxiliary Frequency Superposition

Main and auxiliary frequency superposition is used to set the frequency reference by performing operations on the main frequency and auxiliary frequency. The relationship between the target frequency and the main and auxiliary frequencies is set in F0-07, which is described as follows.

Table 1–4 Relationship between target frequency and main and auxiliary frequencies

No.	Relationship Between Target Frequency and Main and Auxiliary Frequencies	
1	Main frequency	The main frequency reference is used as the target frequency source directly.
2	Auxiliary frequency source	The auxiliary frequency reference is used as the target frequency source directly.
3	Main and auxiliary frequency operation	Four operations are supported, including main frequency + auxiliary frequency, main frequency - auxiliary frequency, max. (main frequency, auxiliary frequency), and min. (main frequency, auxiliary frequency).
4	Frequency switchover	You can use the DI to select any of the preceding three frequency sources. In this case, allocate function 18 (frequency reference switchover) to the DI.

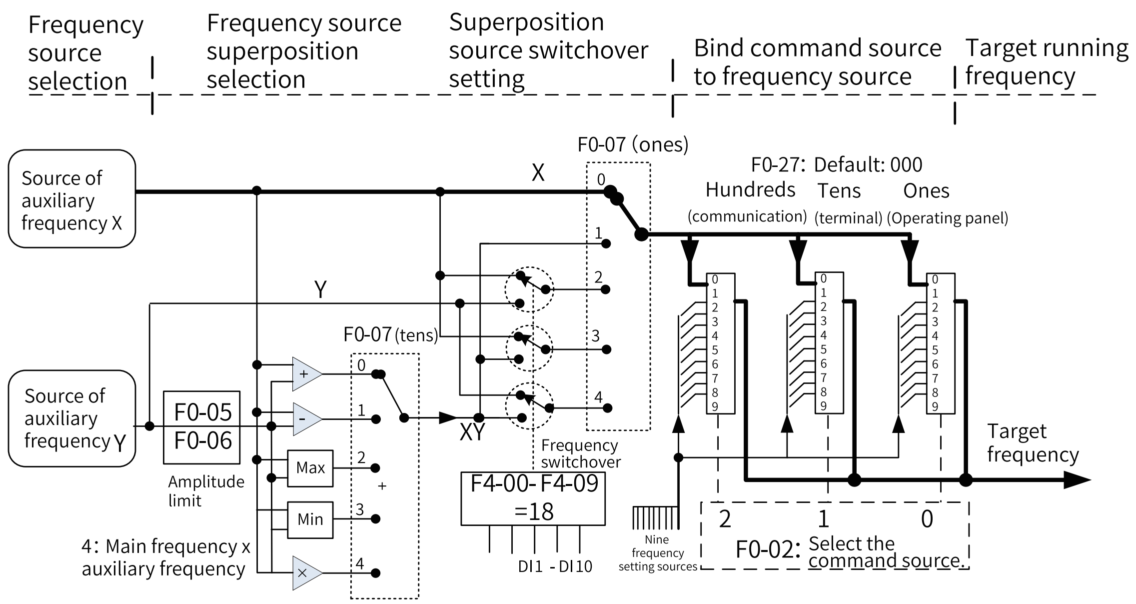


Figure 1-25 Main and auxiliary frequency superposition

Table 1–5 Main and auxiliary frequency superposition

Parameter Code	Parameter Name	Default	Value Range	Description
F0-05	Auxiliary frequency source Y at superposition	0	0: Relative to the maximum frequency 1: Relative to main frequency X	The auxiliary frequency source range is set as a percentage. This parameter is used to set the base value of the frequency source range percentage. 0: Relative to the maximum frequency The auxiliary frequency at superposition is equal to the auxiliary frequency source range (F0-06) multiplied by the maximum frequency (F0-10). 1: Relative to main frequency reference The auxiliary frequency at superposition is equal to the auxiliary frequency source range (F0-06) multiplied by the main frequency X.
F0-06	Range of auxiliary frequency Y upon superposition	100%	0% to 150%	This parameter defines the range of auxiliary frequency Y.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-07	Frequency superposition selection	0	Ones: Frequency reference selection 0: Main frequency X 1: Main and auxiliary frequency operation result (based on tens place) 2: Switchover between main frequency X and auxiliary frequency Y 3: Switchover between main frequency X and the main and auxiliary frequency operation result 4: Switchover between auxiliary frequency Y and the main and auxiliary frequency operation result	This parameter is used to set the superposition mode of the main frequency X and auxiliary frequency Y. The ones place is used to select the frequency reference, and the tens place is used to set the main and auxiliary frequency operation. Ones 0: Main frequency X The running frequency of the AC drive is determined by the main frequency X (F0-03). 1: Main and auxiliary frequency operation (based on tens place) The running frequency of the AC drive is the calculation result of the main and auxiliary frequencies, and the calculation method is determined by the tens place of F0-07 (Frequency source superposition). 2: Switchover between main frequency X and auxiliary frequency Y The operating frequency of the AC drive is selected or switched between the main frequency X and the auxiliary frequency Y through the DI. In this case, the corresponding DI must be assigned with the frequency source switching function. If the DI2 terminal is used for switchover, set F4-01 to 18. 3: Switchover between main frequency X and the main and auxiliary frequency operation result The operating frequency of the AC drive is selected or switched between the main frequency X and operation result of X and Y. If the DI2 terminal is used for switchover, set F4-01 to 18. 4: Switchover between auxiliary frequency Y and the main and auxiliary frequency operation result The operating frequency of the AC drive is selected or switched between the auxiliary frequency Y and operation result of X and Y. If the DI2 terminal is used for switchover, set F4-01 to 18.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-07	Frequency superposition selection	0	Continued Tens: Main and auxiliary frequency operation 0: Main frequency + auxiliary frequency 1: Main frequency - auxiliary frequency 2: Max. (main frequency, auxiliary frequency) 3: Min. (main frequency, auxiliary frequency)	Continued Tens: 0: Main frequency + auxiliary frequency The main and auxiliary operation result is the product of main frequency X plus the auxiliary frequency Y. 1: Main frequency - auxiliary frequency The main and auxiliary operation result is the product of main frequency X minus the auxiliary frequency Y. 2: Max. (main frequency, auxiliary frequency) The main and auxiliary operation result is the larger value between the main frequency X and the auxiliary frequency Y. 3: Min. (main frequency, auxiliary frequency) The main and auxiliary operation result is the smaller value between the main frequency X and the auxiliary frequency Y.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-27	Bind command source to frequency source	0	Ones: Bind operation panel to frequency source 0: No binding 1: Digital setting 2: AI1 3: AI2 4: AI3 5: Pulse reference 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	This parameter defines the binding relationship between the three operation command sources and nine frequency reference sources to facilitate synchronous switchover. For details on the frequency sources, see the description of F0-03 (Main frequency source X selection). Different command sources can be bound to the same frequency reference source. If a command source has a bound frequency source, the frequency sources set in F0-03 to F0-07 no longer take effect when the command source is effective. 0: No binding 1: Digital setting The initial value of the frequency reference is the value of F0-08 (Preset frequency). 2: AI1 The frequency reference is input through AI1, which inputs current or voltage signals. The frequency is calculated according to the AI curve, 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve. 4: AI3 The frequency reference is input through AI3, which inputs current or voltage signals. The frequency is calculated according to the AI curve. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated according to the relationship curve between the pulse frequency and the frequency reference.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-27	Bind command source to frequency source	0	Continued Tens: Bind terminal to frequency source Values 0 to 9 for the tens place are the same as those for the ones place. Hundreds: Bind communication to frequency source Values 0 to 9 for the tens place are the same as those for the ones place.	Continued 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals can provide 16 states, corresponding to 16 frequencies. 7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. 9: Communication The frequency is set through communication. The frequency can be input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment.

F0-05 and F0-06 are only valid in the main frequency + auxiliary frequency operation to limit the range of the auxiliary frequency.

The three command sources can be bound to different frequency sources through F0-27. When the specified command source (F0-02) is bound to a frequency source, the frequency is determined by the frequency setting channel set by F0-27. In this case, both main and auxiliary frequencies are invalid.

1.1.2.11 Setting Offset Frequency and Additional Frequency

Offset frequency: The offset frequency is set through F0-21 as the correction value that is superimposed on the main and auxiliary frequency. The offset frequency is superimposed directly on the original setting value before the ramp function generator acts.

Parameter Code	Parameter Name	Value Range	Default	Description
F0-21	Digital setting of offset frequency	0.00 Hz to F0-10	0.00	This parameter defines the offset frequency. It is used to adjust the frequency reference when the main/auxiliary frequency is set by an external analog signal (voltage or current). Output frequency = Current frequency reference+ F0-21 Note: The offset frequency is also valid when the main/auxiliary frequency is set by other sources.

Additional frequency: Set A4-61 to set the additional frequency, which is used for speed adjustment without acceleration/deceleration time. The additional frequency takes effect only during normal operation. The effective value is superimposed directly to the output of the ramp function generator.

Parameter Code	Parameter Name	Value Range	Default	Description
A4-61	Source of additional speed in speed control	0: 0 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference 7: Motorized potentiometer 8: PID Others: F connector	0	This parameter sets the source of the additional speed in the speed control mode. 0: 0 The additional speed in the speed control mode is set to 0. 1: AI1 The additional speed in the speed control mode is input through AI1, which inputs current or voltage signals. The speed is calculated according to the set AI curve. 2: AI2 The additional speed in the speed control mode is input through AI2, which inputs current or voltage signals. The speed is calculated according to the set AI curve. 3: AI3 The additional speed in the speed control mode is input through AI3, which inputs current or voltage signals. The speed is calculated according to the set AI curve. 4: Pulse reference The additional speed in the speed control mode is input through DI5 pulse frequency. 5: Communication The additional speed in the speed control mode is input through communication. The additional speed in the speed control mode is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals can be grouped in different ways to indicate 16 states, which correspond to 16 frequency references (percentage x maximum frequency) in group FC. 7: Motorized potentiometer The additional speed in the speed control mode is set by the motorized potentiometer module output. 8: PID The additional speed in the speed control mode is set by PID output. Others: F connector The additional speed in the speed control mode is input through the connector.

1.1.2.12 Setting Frequency Reference Limit

Frequency upper limit: Defines the maximum running frequency of the motor.

Frequency lower limit: Defines the minimum running frequency of the motor.

Maximum frequency: Defines the maximum output frequency.

Frequency upper limit source: Defines the source of the frequency upper limit.

Frequency upper limit offset: Defines the offset of the frequency upper limit. This parameter is valid only when the frequency upper limit source is set to the AI.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-10	Maximum frequency	50.00 Hz	5.00 Hz to 599.00 Hz	This parameter defines the maximum output frequency of the AC drive.
F0-11	Frequency upper limit source	0	0: F0-12 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication Others: F connector	This parameter defines the source of frequency upper limit, as described below. 0: F0-12 The frequency upper limit is set by F0-12. 1: AI1 The frequency upper limit is input through AI1, which inputs current or voltage signals. The frequency is calculated according to the set AI curve. 2: AI2 The frequency upper limit is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the set AI curve. 3: AI3 The frequency upper limit is through AI3, which inputs current or voltage signals. The frequency is calculated according to the set AI curve. 4: Pulse reference (DI5) The frequency upper limit is set through the DI5. The frequency is calculated based on the curve of the relationship between the pulse frequency and the maximum frequency. 5: Communication The frequency upper limit is set through communication. Others: F connector The frequency upper limit is set through the connector. Read the connector value through setting the parameter No. of a float connector. The value being read is used as the frequency upper limit. This mode is used for expansion besides the common sources.
F0-12	Frequency upper limit	50.00 Hz	F0-14 (frequency lower limit) to F0-10 (maximum frequency)	This parameter defines the maximum operating frequency of motors.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-13	Frequency upper limit offset	0.00 Hz	0.00 Hz to maximum frequency (F0-10)	This parameter defines the offset of the frequency upper limit. It is used to adjust the output frequency value upon the minimum frequency reference when the frequency is set by an external analog signal (voltage or current). Note: When the upper frequency source is selected to a value other than digital setting, the upper frequency offset is valid.
F0-14	Frequency lower limit	0.00 Hz	0.00 Hz to frequency upper limit (F0-12)	This parameter defines the minimum operating frequency of motors. If the frequency is lower than the lower limit, you can determine whether to stop, run at the lower limit, or run at zero speed by F8-14.

1.1.2.13 Setting Action When Frequency Is Below Lower Limit

The frequency lower limit defines the minimum running frequency for the motor.

If the frequency reference of the AC drive is lower than the frequency lower limit (F0-14), you need to set F8-14 to further specify the corresponding action of the AC drive, as described below.

- 0: Run at frequency lower limit
  If the running frequency is below the frequency lower limit, the AC drive will run at the frequency lower limit.
- 1: Stop
  If the running frequency is below the frequency lower limit, the AC drive stops.
- 2: Run at zero speed
  If the running frequency is below the frequency lower limit, the AC drive runs at zero speed.
- 3: Coast to stop
  If the running frequency is below the frequency lower limit, the AC drive coasts to stop.

Parameter Code	Parameter Name	Default	Value Range	Description
F8-14	Running mode when frequency reference is below lower limit	0	0: Run at frequency lower limit 1: Stop 2: Run at zero speed 3: Coast to stop	-

1.1.2.14 Setting Main Frequency Through Pulse

Select the input pulse as the main frequency source by setting F0-03 to 5. In this mode, the pulse reference must be input only from multi-functional input terminal DI5. The signal specifications set by pulse are 9 V to 30 V (voltage) and 0 Hz to 100 kHz (frequency).

The setting procedure is as follows.

Step 1: Set F0-03 to 5 to select "pulse reference" as the main frequency source. In this mode, the pulse reference must be input only from multi-functional input terminal DI5.

Step 2: Set F4-04 to 30 to assign DI5 with the "pulse frequency input" function.

Step 3: Set F0-07 to 00 to set frequency reference superposition to "main frequency reference".

Step 4: Set the pulse reference curve. Set F4-28 to F4-31 to set the two-point straight line relationship between the pulse frequency input from DI5 and the corresponding percentage.

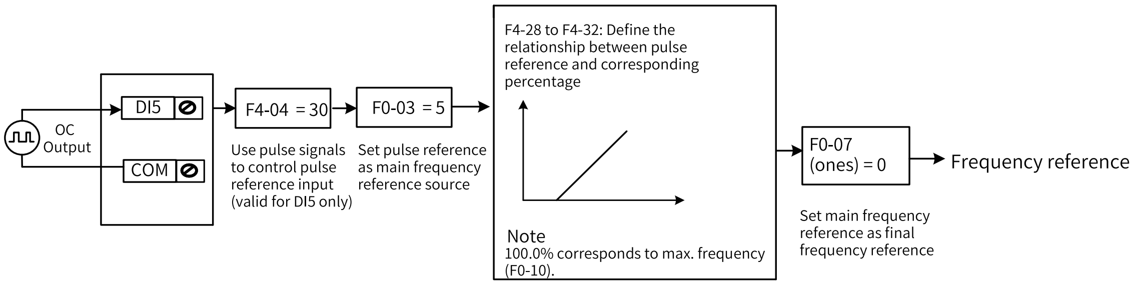


Figure 1-26 Parameters used to set the main frequency through pulse input

Step 5: Set F4-32 to select the filter time of pulse frequency.

Set this parameter to balance the response speed and anti-interference capability. If quick response is required, reduce the value of F4-32. If the interference on site is strong, increase the value of F4-32.

The longer the filter time, the stronger the anti-interference capability, but the slower the adjustment response speed. The shorter the filter time, the faster the adjustment response speed, but the weaker the anti-interference capability. When the pulse signal on site may easily be disturbed, increase the filter time to stabilize the detected pulse signals. However, long filter time slows down the response speed of the pulse signal detection. Therefore, set the filter time properly based on the actual application environment.

Parameter Code	Parameter Name	Default	Description
F4-29	Corresponding percentage of pulse minimum input	0.0%	F4-29 corresponds to the y axis of the minimum pulse input, that is, the set value corresponding to the minimum pulse input.
F4-30	Pulse maximum input	50.00 kHz	F4-30 corresponds to the x axis of the maximum pulse input, that is, the maximum input frequency of the pulse.
F4-31	Percentage corresponding to maximum pulse input frequency	100.0%	F4-31 corresponds to the y axis of the maximum pulse input, that is, the set value corresponding to the maximum pulse input.
F4-32	Pulse filter time	0.10s	Used to set the time coefficient for pulse curve filter processing.

1.1.3 Start/Stop Mode Setting

1.1.3.1 Start Mode

The drive supports four start modes: direct start, flying start, pre-excitation start, and SVC quick start. Set F6-00 to select a start mode of the drive.

Direct start

The direct start mode (F6-00 = 0) applies to most of loads.

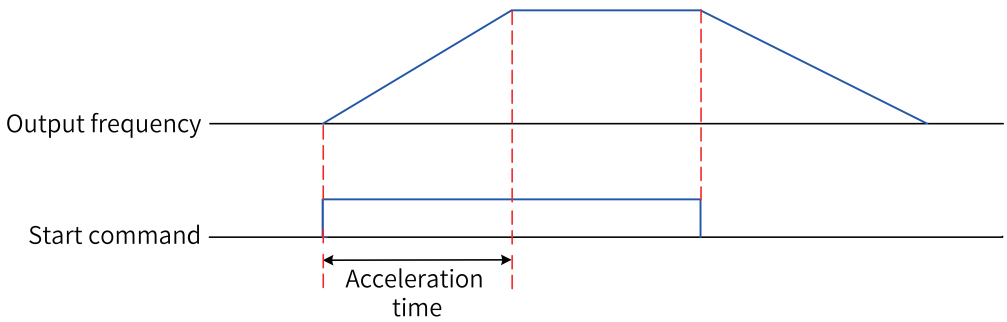


Figure 1-27 Direct start time sequence

The setting of starting frequency before start applies to lifting loads, such as elevators and cranes.

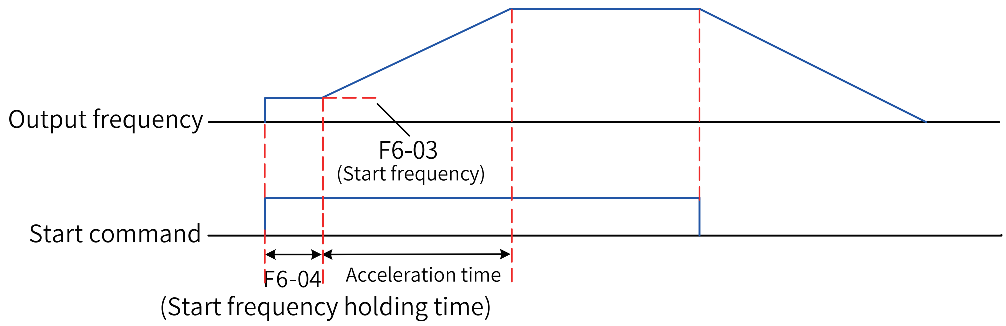


Figure 1-28 Time sequence for start with the starting frequency set

The setting of DC braking time at startup before start applies to applications where the motor may rotate at start.

If the DC braking time at startup is set to 0, the drive starts operating at the starting frequency. If the DC braking time at startup is not 0, the AC drive performs DC braking first and then running from the starting frequency. This method is applicable to most low-inertia loads. The motor may rotate during startup.

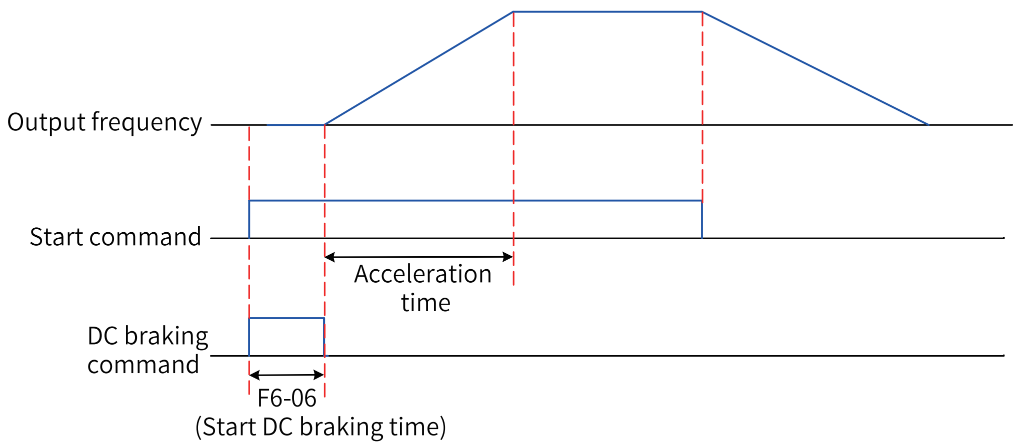


Figure 1-29 Time sequence for start with DC braking

Start with DC braking is suitable for driving loads such as elevators and lifting machines. Start with startup frequency is suitable for driving equipment that requires starting torque, such as cement mixers. The following figure describes the frequency curve during start.

The following figure shows the frequency change after F6-00 is set to direct start and the running command is executed.

After the running command is executed and the DC braking time (F6-06) elapses, the frequency starts from F6-03 and remains the time set by F6-04 (startup frequency holding time). Then the frequency changes to the value of F0-10 (maximum frequency) according to F6-07 (acceleration/deceleration mode) and F0-17 (acceleration time).

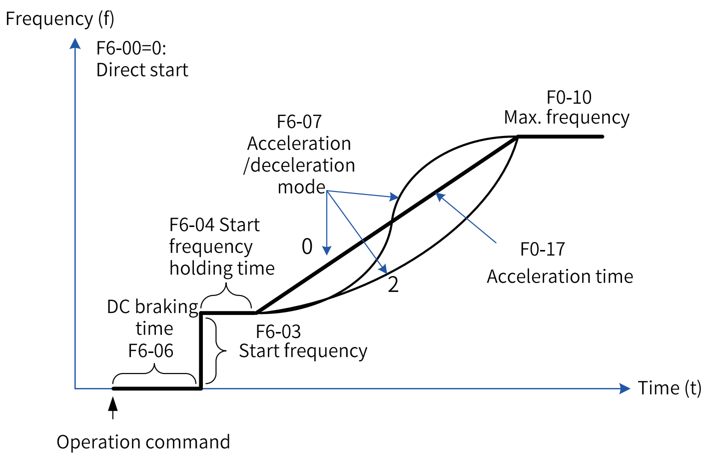


Figure 1-30 Direct start

The following figure describes the frequency curve during start when parameter default values are set. After the running command is executed, 0 Hz changes to the value of F0-10 (maximum frequency) linearly from 0s after the time set by F0-17.

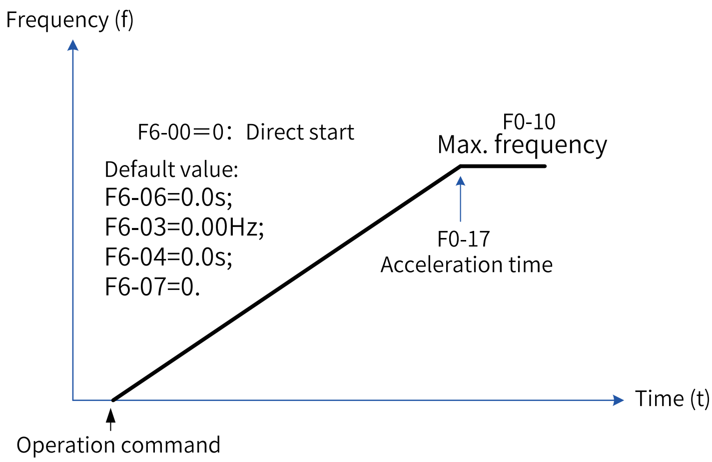


Figure 1-31 Frequency curve during start

Flying start

When F6-00 is set to 1, the drive uses the flying start mode. In this mode, the drive first determines the motor rotation speed and direction, and then starts at the detected frequency of the motor. This mode is applicable to applications where the drive is used to drive large-inertia machinery loads.

If the load motor is still rotating due to inertia when the drive needs a restart, using flying start can prevent overcurrent upon start. The following figure describes the frequency curve during start.

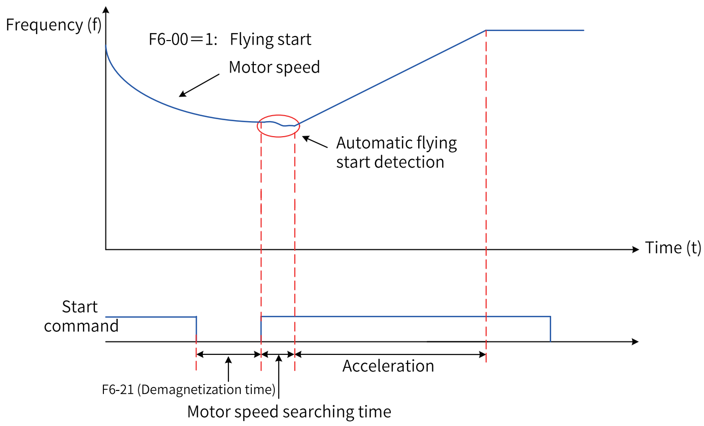


Figure 1-32 Flying start

Pre-excitation start

Set F6-00 to 0, 2, or 3, and F6-06 (DC braking time) to 0. The AC drive enters the pre-excitation startup mode. This mode is applicable to asynchronous motors only in the SVC and FVC modes. Before startup, the AC drive pre-excites the motor to speed up the motor response and reduce the startup current.

Changing bits 11 and 12 of the flux linkage control command word (AB-32 for the first motor and B9-32, BE-32, and CE-32 for the other motors) can modify the pre-excitation mode. By default, current pre-excitation is used. The value of AB-51, B9-51, BE-51, or CE-51 is the percentage of the pre-excitation current to the rated current. The higher the pre-excitation current, the shorter the pre-excitation time.

SVC quick start

This mode is the quick pre-excitation start mode.

Note

- Flying start is recommended if you need to start a motor that is rotating at a high speed.
- Pre-excitation start and SVC quick start apply only to AC asynchronous motors.

1.1.3.2 Stop Mode

The drive supports three stop modes, including decelerate to stop, coast to stop, and stop at the maximum capability.

You can set F6-10 to select a stop mode for the AC drive.

Parameter Code	Parameter Name	Default	Value Range	Description
F6-10	Stop mode	0	0: Decelerate to stop 1: Coast to stop 2: Stop at maximum capability	This parameter is used to select the stop mode of the AC drive. 0: Decelerate to stop After the stop command becomes active, the AC drive decreases the output frequency based on the deceleration time, and stops when the frequency is reduced to 0. 1: Coast to stop After the stop command becomes active, the drive stops output immediately and the motor coasts to stop based on the mechanical inertia. 2: Stop at maximum capability. The motor speed reference is set to 0 forcibly. The motor decelerates to 0 based on the maximum output capacity. The motor torque or current may reach the limit value during deceleration.
F6-11	Start frequency of DC braking for stop	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The AC drive starts DC braking when the running frequency decreases to the value of this parameter during deceleration to stop.
F6-12	Waiting time of DC braking for stop	0.0s	0.0s to 100.0s	When the operating frequency decreases to the start frequency of DC braking for stop, the drive stops output temporarily and then starts DC braking. This prevents faults such as overcurrent caused by DC braking at a high speed.
F6-13	DC braking current for stop	50%	0% to 100%	A greater DC braking current indicates greater braking force. The setpoint 100% corresponds to the rated motor current. The upper limit of the current is 80% of the rated current of the drive. The upper limit is set by F6-34. The maximum upper limit of the DC braking current for stop is 135% of the rated drive current.
F6-14	DC braking time for stop	0.0s	0.0s to 100.0s	This parameter specifies the holding time of DC braking. If this parameter is set to 0, DC braking is disabled.

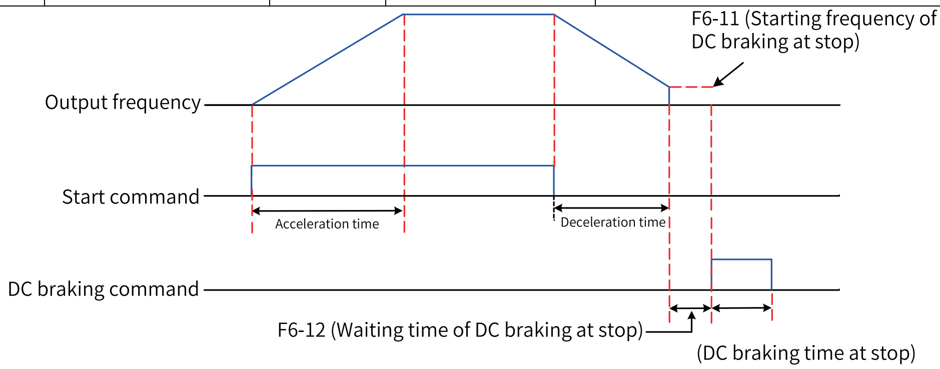


Figure 1-33 Time sequence of DC braking for stop

Decelerate to stop

When F6-10 is set to 0, the AC drive decelerates to stop. After the stop command is input, the drive decreases the output frequency based on the deceleration time and stops when the frequency declines to 0.

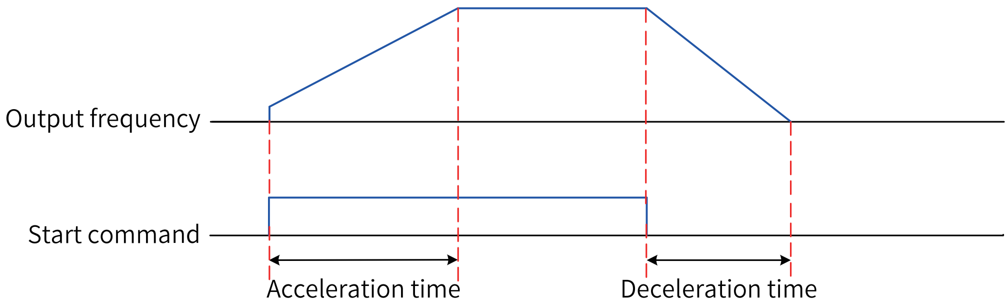


Figure 1-34 Sequence diagram for decelerate-to-stop

Coast to stop

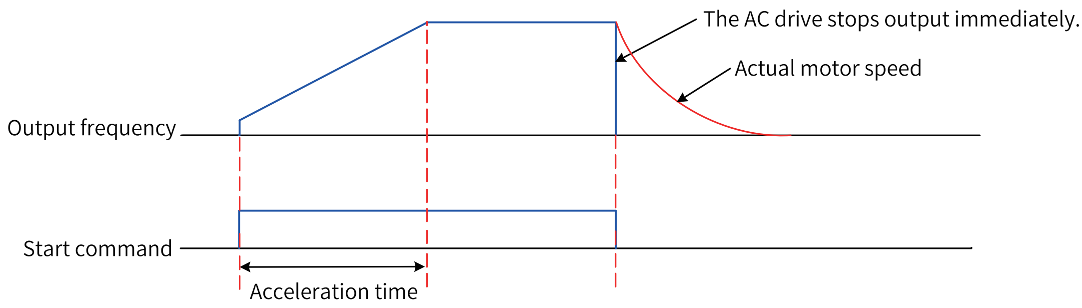


Figure 1-35 Sequence diagram for coast-to-stop

1.1.3.3 Acceleration/Deceleration Time Setting

The acceleration time indicates the time required for the AC drive to accelerate from 0 Hz to F0-25 (base frequency for acceleration/deceleration time). The deceleration time indicates the time required for the AC drive to decelerate from F0-25 (base frequency for acceleration/deceleration time) to 0 Hz.

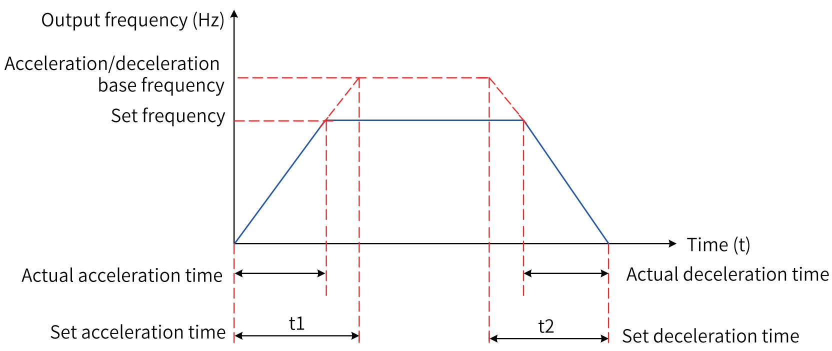


Figure 1-36 Acceleration/Deceleration time

The AC drive provides four groups of acceleration/deceleration time, which can be selected by using the DI assigned with functions 16 and 17. The acceleration/deceleration time is defined by the following parameters:

Group 1: F0-17, F0-18

Group 2: F8-03, F8-04

Group 3: F8-05, F8-06

Group 4: F8-07, F8-08

Example

The following example uses DI7 and DI8 as the input switchover terminals to describe how to set the acceleration/deceleration time.

1. Set F4-06 and F4-07 to select DI7 and DI8 for switchover.

Parameter Code	Parameter Name	Value Range	Description
F4-06	DI7 function selection	16	Acceleration/deceleration time selection terminal 1
F4-07	DI8 function selection	17	Acceleration/deceleration time selection terminal 2

2. Set the corresponding acceleration/deceleration time through parameters.

DI8 State	DI7 State	Acceleration/Deceleration Time
OFF	OFF	Group 1: F0-17, F0-18 (Acceleration time 1)
OFF	ON	Group 2: F8-03, F8-04 (Acceleration time 2. For details, see F0-17 and F0-18.)
ON	OFF	Group 3: F8-05, F8-06 (Acceleration time 3. For details, see F0-17 and F0-18.)
ON	ON	Group 4: F8-07, F8-08 (Acceleration time 4. For details, see F0-17 and F0-18.)

3. Set F0-19 (acceleration/deceleration time unit). Note that when this parameter is modified, the decimal places of the four groups of acceleration/deceleration time will change, and the corresponding acceleration/deceleration time will also change.
4. Set F6-07 (acceleration/deceleration mode) to select the frequency change mode during the start and stop process of the AC drive.
    - 0: The output frequency increases or decreases linearly.
    - 1: The output frequency increases or decreases according to the S-curve in real time when the target frequency changes. You must select the arc symmetric mode or the acceleration and deceleration segment setting through F6-20. This mode is applicable to applications requiring smooth running and quick response in real time.
5. Set F6-08 and F6-09 to select the time proportion of S-curve start segment and time proportion of S-curve end segment. The following condition must be met: F6-08 + F6-09 ⩽ 100.0%
6. Select the arc type.

In case of abrupt acceleration or deceleration, the output frequency of the ramp function generator is not smooth and the acceleration rate of the output frequency is discontinuous, which may cause motor torque oscillation and damage to mechanical gears.

A4-65 = 0 (incontinuous smoothing): The motor immediately decelerates in case of input value change.

A4-65 = 1 (continuous smoothing): During acceleration, even if the input value suddenly decreases, the motor will execute the end arc (causing overshoot) before deceleration. During deceleration, even if the input value suddenly increases, the motor will execute the end arc (causing overshoot) before acceleration.

The following description takes sudden deceleration during forward acceleration as an example. The target frequency at t0 is F3 and the motor accelerates to frequency F2 at t1. At this time, the target frequency is set to F1. The RFG output frequency will change according to curve 3 rather than curve 2 (decelerate to run after the acceleration rate is set to 0). Curve 3 indicates that acceleration v is reduced to 0 based on the jerk (time derivative of acceleration, standing for the acceleration change rate) of the end arc in the acceleration range and then the motor decelerates to run. This helps to solve abrupt change of acceleration v at t1 and reduces impact of the abrupt change response on the device.

1.2 Motor Configuration

The following figure describes quick commissioning of the AC drive.

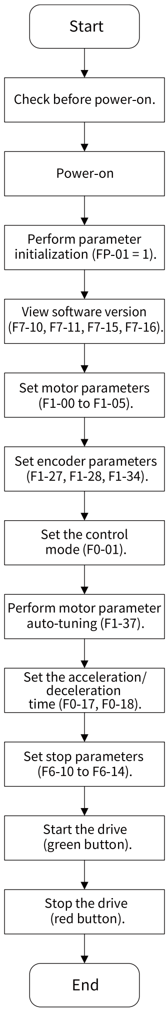


Figure 1-37 Basic commissioning flowchart

The following figure describes the overall commissioning procedure.

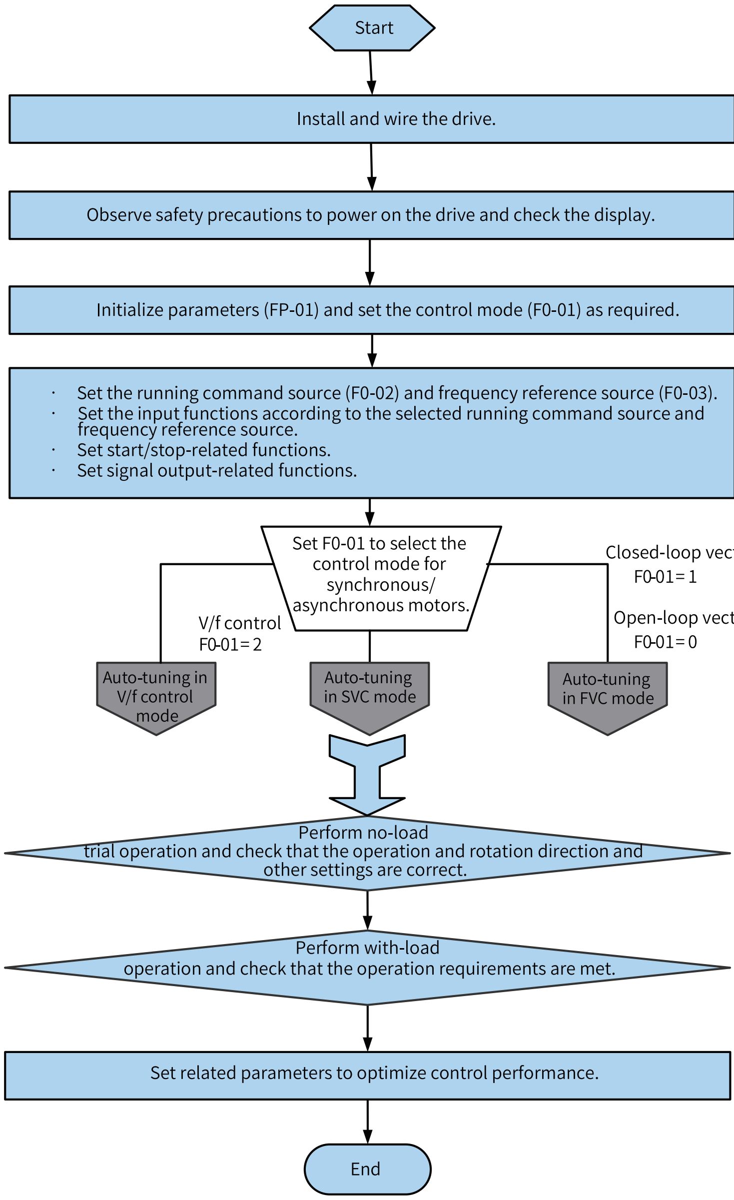


Figure 1-38 Overall commissioning flowchart

F1-37 can be used to select different tuning modes:

- 1: Static partial auto-tuning for asynchronous motor
- 2: Dynamic auto-tuning for asynchronous motor
- 3: Static complete auto-tuning for asynchronous motor
- 4: Inertia auto-tuning
- 5: Dead zone auto-tuning
- 11: With-load auto-tuning for synchronous motor
- 12: Dynamic no-load auto-tuning for synchronous motor
- 13: Complete static auto-tuning for synchronous motor

For permanent magnet synchronous motors and excited synchronous motors, select 11, 12, or 13.

Commissioning Flowchart in V/f Control Mode

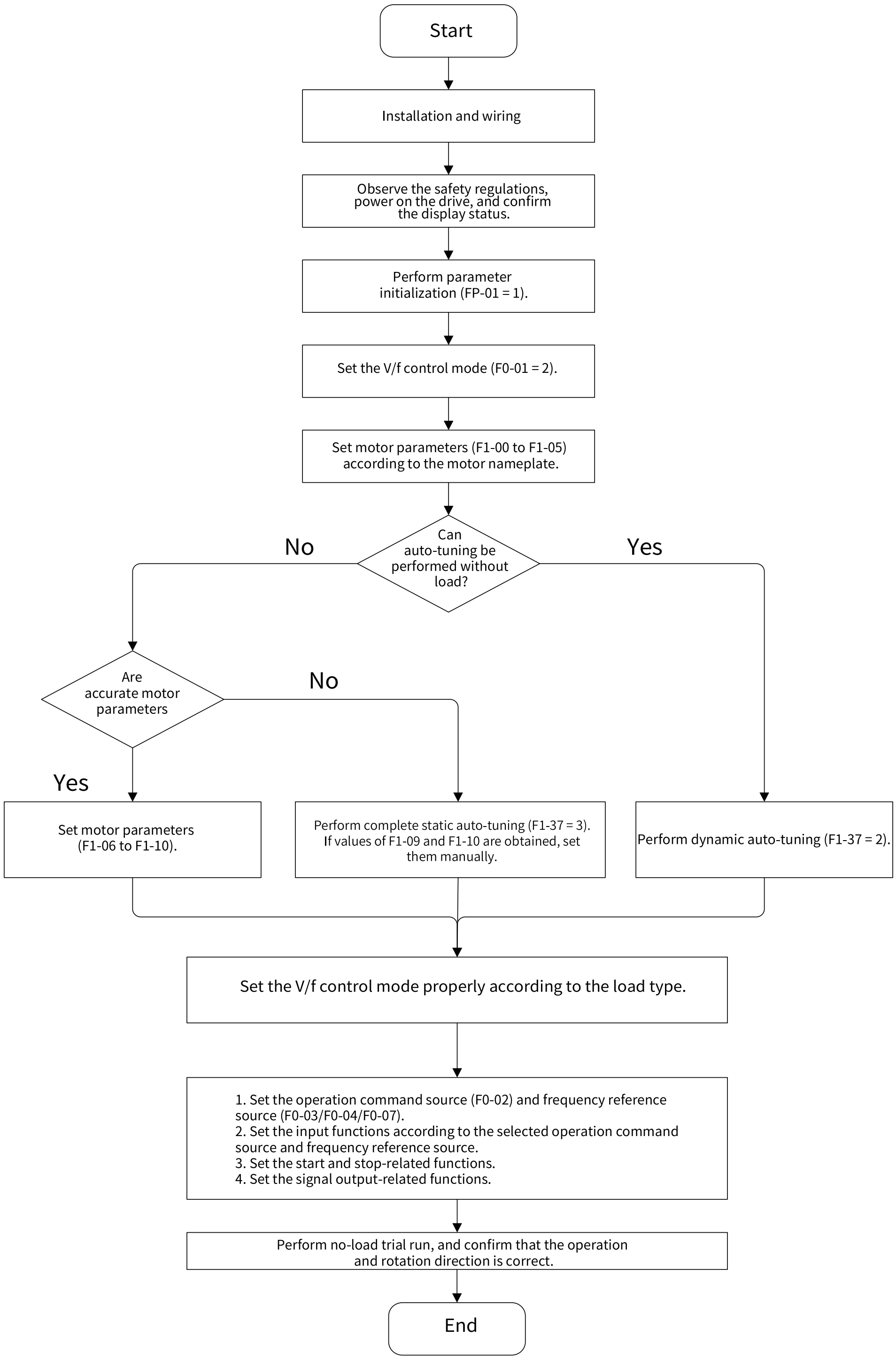


Figure 1-39 Commissioning flowchart in V/f control mode

Note

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

Commissioning Flowchart in SVC Mode

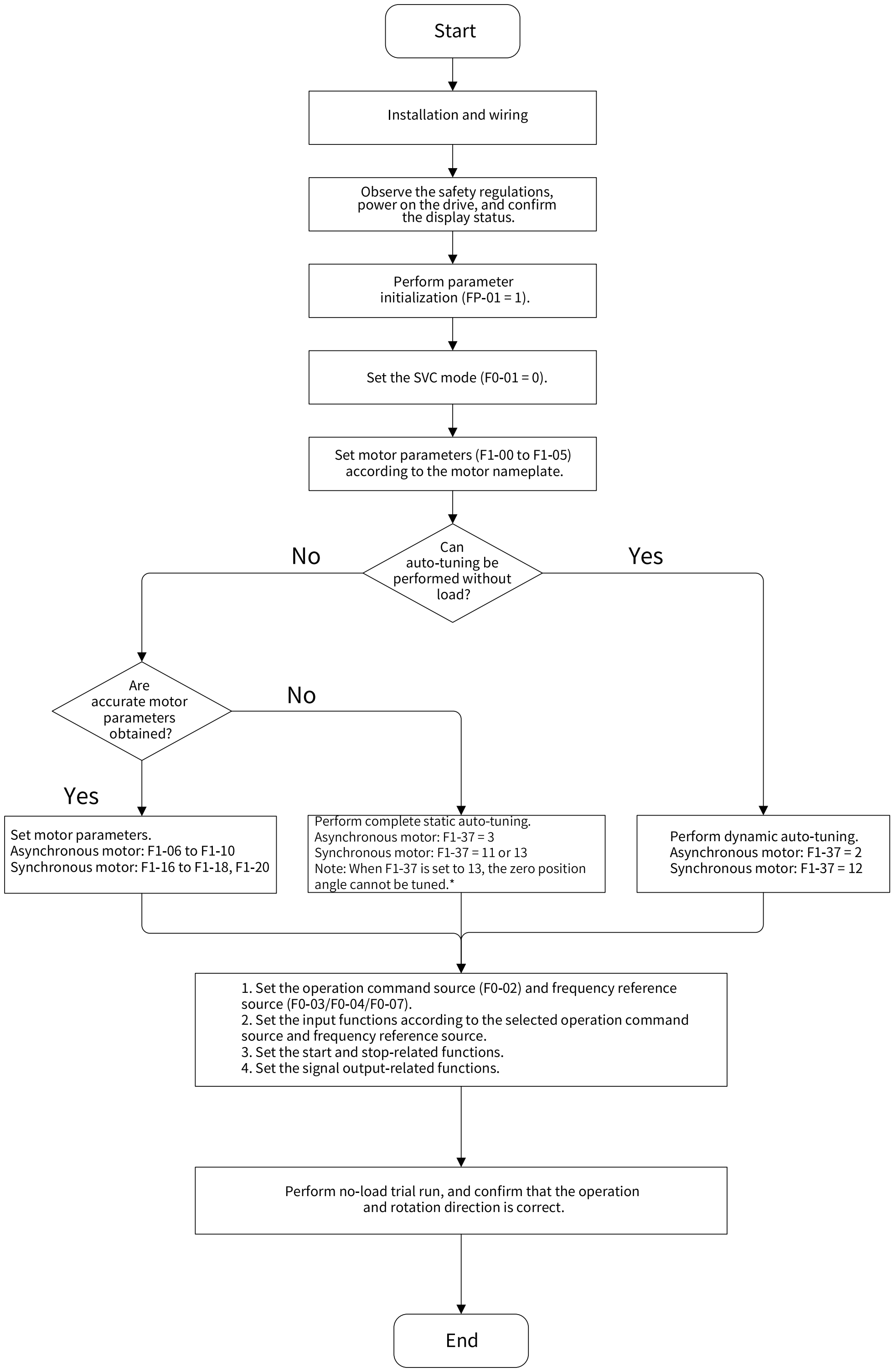


Figure 1-40 Commissioning flowchart in SVC mode

Note

* If bit 0 of A9-09 is enabled and F1-37 is set to 11, the encoder zero position angle will be tuned, but the encoder rotation direction will be not tuned. If F1-37 is set to 13, the encoder will not be tuned. If bit 0 of A9-09 is enabled and F1-37 is set to 11 or 13, the encoder will not be tuned.

During static auto-tuning, the motor will rotate slowly to a certain position when the encoder zero position angle is tuned.

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

Commissioning Flowchart in FVC Mode

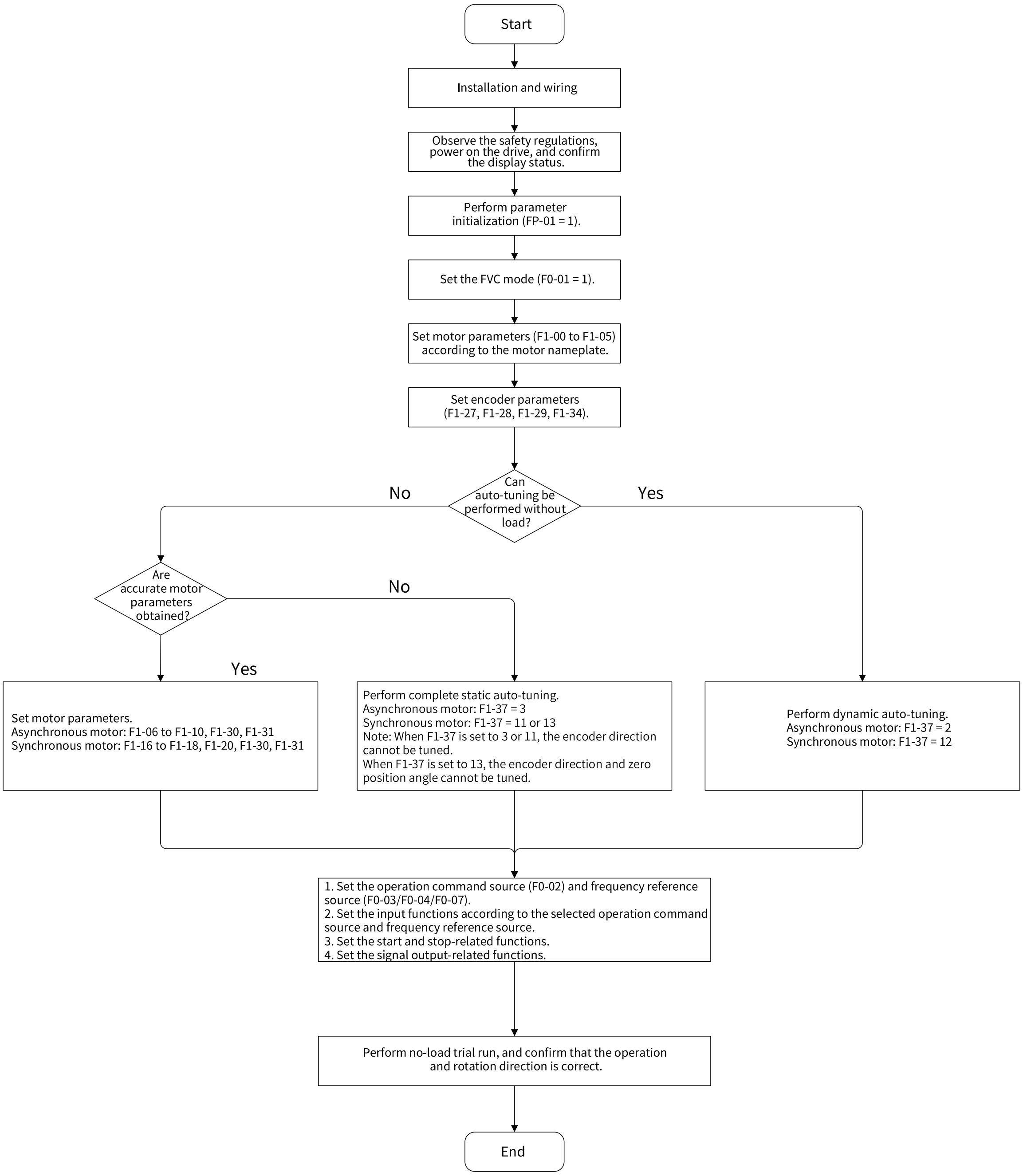


Figure 1-41 Commissioning flowchart in FVC mode

Note

Note:

1. During static auto-tuning, the motor will rotate slowly to a certain position when the encoder zero position angle is tuned.
2. Before static auto-tuning is performed (F1-37 = 11) to tune the zero position angle, check the encoder running direction (F1-30) and set it correctly. At the same time, the motor will rotate slightly static auto-tuning 11 rotates the motor slightly when the encoder zero position angle is tuned.

Encoder direction: The incorrect encoder direction can affect the precise control of the motor by the AC drive. For example, an incorrect direction may cause motor stall. The AC drive will report overload, overcurrent, overheat, and excessive speed deviation faults, which affects the safety and reliability of the system.

Zero position angle: The zero position angle of the motor indicates the position angle of the motor when the magnetic pole is aligned between the stator and the rotor. The following faults will occur when the zero position angle is incorrect:

1. **Positioning error:**An error will occur between the actual position of the motor and the set position. In this case, the position control system cannot locate the position accurately, affecting the operating accuracy of the equipment.
2. **Unstable motion:**Inaccurate zero point angle will cause unsuitability or vibration when the motor executes motion commands, affecting the stability and reliability of the system.
3. **Path deviation:**In applications requiring precise path control (such as manipulators and CNC machines), inaccurate zero position angle may cause path deviation, affecting the quality of processing or operation.
4. **Invalid system protection:**Some systems may rely on the zero position angle to set the safety boundary or limit position. If the zero position angle is not accurate, the system protection mechanism may fail, increasing the risk of mechanical collision or damage.

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

1.2.1 Asynchronous motor parameter auto-tuning

Auto-tuning must be performed in the vector control mode. Otherwise, overcurrent will occur. It is also recommended to perform parameter auto-tuning in the V/f control mode. If parameters are accurate, better control performance can be achieved for flying start (complete static auto-tuning of asynchronous motors), overcurrent stall suppression, and torque boost. The following table describes the range and performance of different auto-tuning modes.

Method	Application scenario	Effect
Partial static auto-tuning of asynchronous motor	This mode applies to scenarios where the motor cannot be disconnected from the load and dynamic auto-tuning is not allowed.	Normal
Asynchronous motor parameter auto-tuning	This mode applies to scenarios where the motor is easily disconnected from the application system. If the motor load is the roller type (pure inertia load), parameters can be directly tuned without the roller removed.	Optimal
No-load complete auto-tuning of asynchronous motors	It applies to scenarios where the motor cannot be disconnected from the load and dynamic complete auto-tuning is not allowed.	Good

Take motor parameter group 1 as an example. The following table lists parameters tuned in different auto-tuning modes of asynchronous motors.

Parameter Code	Parameter Name	F1-37 = 1	F1-37 = 2	F1-37 = 3	F1-37=4[2]
F1-06	Motor stator resistance	✓	✓	✓	-
F1-07	Asynchronous motor rotor resistance	✓	✓	✓	-
F1-08	Asynchronous motor leakage inductance	✓	✓	✓	-
F1-09	Asynchronous motor mutual inductance	√[4]	✓	√[3]	-
F1-10	No-load current of asynchronous motor	√[4]	✓	√[3]	-
F1-31	Phase sequence of encoder	-	√[1]	-	-
A9-19	Magnetic field saturation current coefficient 1 of asynchronous motor	-	✓	-	-
A9-20	Magnetic field saturation current coefficient 2 of asynchronous motor	-	✓	-	-
A9-21	Magnetic field saturation current coefficient 3 of asynchronous motor	-	✓	-	-
A9-22	Magnetic field saturation current coefficient 4 of asynchronous motor	-	✓	-	-
A9-23	Magnetic field saturation flux coefficient 1 of asynchronous motor	-	✓	-	-
A9-24	Magnetic field saturation flux coefficient 2 of asynchronous motor	-	✓	-	-
A9-25	Magnetic field saturation flux coefficient 3 of asynchronous motor	-	✓	-	-

Parameter Code	Parameter Name	F1-37 = 1	F1-37 = 2	F1-37 = 3	F1-37=4[2]
A9-26	Magnetic field saturation flux coefficient 4 of asynchronous motor	-	✓	-	-
F1-30	Input A/B phase sequence	-	✓	-	-
A9-16	Inertia ratio	-	✓	-	✓
A9-17	Inertia	-	✓	-	✓
A9-18	Friction torque	-	✓	-	✓
F2-00	Speed loop Kp in FVC mode	-	✓	-	✓
F2-01	Speed loop Ti in FVC mode	-	✓	-	✓
F2-03	Speed loop Kp in SVC mode	-	✓	-	✓
F2-04	Speed loop Ti in SVC mode	-	✓	-	✓

Note [1]: If the encoder detection function set by bit 1 of A9-09 is enabled or the motor control mode is set to the FVC mode, the corresponding encoder phase sequence will be detected and the result is written to F1-30.

Note [2]: If the motor control mode is set to V/f, FVC, or SVC, inertia auto-tuning is performed.

Note [3]: When conditions are allowed, set F1-37 to 2 to select no-load complete auto-tuning. After F1-37 is set to 2 for auto-tuning during rotation, more accurate motor mutual inductance and no-load current can be obtained. The magnetic field saturation coefficient of asynchronous motors can be auto-tuned to improve the torque control accuracy. When F1-37 is set to 3, the auto-tuning mode is applicable to scenarios where the motor cannot rotate during auto-tuning. In this mode, the saturation coefficient cannot be tuned. The motor mutual inductance and no-load current obtained when F1-37 is set to 3 are less accurate than those obtained when F1-37 is set to 2.

Note [4]: When F1-37 is set to 1, the static auto-tuning mode is selected. The calculated mutual inductance and no-load current are used and are less accurate than those obtained when F1-37 is set to 2 or 3.

Note [5]: You can tune project configurations and optimize the tuning project through AA-09.

Note [6]: In addition to the preceding auto-tuning modes, you can also enter motor parameters manually or download the parameter file.

Note [7]: You can perform motor auto-tuning either through commands from the operating panel or communication commands. Select the operation command source through F0-02. The PKW areas of the Modbus, PROFIBUS DP, and CANopen support auto-tuning through communication, whereas their PZD areas do not support auto-tuning through communication. To start auto-tuning through communication, write the auto-tuning parameter to F1-37/A2-37 and then write operation commands.

Note

When F1-37 is set to 2 (no-load complete auto-tuning), the motor will rotate at a high speed. Therefore, ensure that it is set under conditions allowed by mechanical safety. Besides, keep the load torque close to no-load torque as much as possible when the motor rotates at a constant speed. Lower load means more accurate auto-tuning results. Heavy load may cause drive overload or overcurrent.

Application example

Parameters of motor 1 (F0-24 = 0, motor parameter group 1) are used to describe the motor auto-tuning mode. If you need to perform auto-tuning on motor 2, set F0-24 to 1 (motor parameter group 2) first. The auto-tuning mode for motor 2 is similar to that for motor 1. Parameters of motor 2 are those in A2 group.

- Procedure of partial static auto-tuning of the asynchronous motor

Table 1–6 Procedure of partial static auto-tuning of the asynchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	Set F1-37 to 1 (partial static auto-tuning of asynchronous motor), and press **ENTER**. The following information is displayed on the operating panel: 
Step 4	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. During auto-tuning, the RUN indicator keeps on and the TUNE/TC indicator blinks. The drive energizes the motor but the motor does not rotate. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06 to F1-08 will be computed by the AC drive automatically.

- Procedure of dynamic complete auto-tuning of the asynchronous motor
  If the motor has constant output or is used for high-accuracy applications, perform complete dynamic auto-tuning after disconnecting the motor from the load for optimal auto-tuning effect.

Table 1–7 Procedure of dynamic complete auto-tuning of the asynchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	If F0-01 is set to 1 (FVC), input encoder parameters (F1-27, F1-28, and F1-30).

Procedure	Description
Step 4	Set F1-37 to 2 to select dynamic complete auto-tuning of the asynchronous motor. Press ENTER on the keypad. The following information is displayed on the keypad: 
Step 5	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. During auto-tuning, the RUN indicator is steady on and the TUNE/TC indicator blinks. The drive drives the motor to accelerate/decelerate and run in the forward/reverse direction. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06, F1-10, and F1-30 will be computed by the AC drive automatically.

Note

- If the encoder phase sequence is known, set F1-30 (Encoder A/B phase sequence) in step 3.
- If the encoder phase sequence is unknown, you do not need to set F1-30 in step 3. The value of F1-30 can be obtained through motor parameter auto-tuning.

- No-load complete auto-tuning of asynchronous motors
  If the motor cannot be disconnected from the load, perform with-load complete auto-tuning, namely, complete static auto-tuning.

Table 1–8 3: Static complete auto-tuning of asynchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 = 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	Set F1-37 to 3 (Complete static auto-tuning of asynchronous motor). Press ENTER on the operating panel. The following information is displayed on the operating panel: 
Step 4	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. During auto-tuning, the RUN indicator keeps on and the TUNE/TC indicator blinks. The drive energizes the motor but the motor does not rotate. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06 to F1-10 will be computed by the AC drive automatically.

1.2.2 Asynchronous motor parameter auto-tuning

Motor auto-tuning is the process by which the AC drive obtains the parameters of the controlled motor.

Auto-tuning modes of the synchronous motor include partial static auto-tuning (excluding back EMF), no-load complete dynamic auto-tuning, and complete static auto-tuning.

The following table describes differences among these auto-tuning modes.

Table 1–9 Motor Parameter Auto-tuning

Motor Parameter Auto-tuning	Application scenario	Motor Parameter Auto-tuning
13: Static partial auto-tuning of synchronous motor	Scenarios where the motor cannot be disconnected from the load and dynamic auto-tuning is not allowed Set the back EMF (SVC) and encoder phase sequence after auto-tuning is done.	Good
12: No-load dynamic complete auto-tuning of synchronous motor	It applies to scenarios where motors can be disconnected from the load easily.	Best
Static auto-tuning of synchronous motors	This mode applies to scenarios where the motor cannot be disconnected from the load and the motor rotation is not allowed. After auto-tuning, manually set the back EMF (SVC and PMVVC), encoder zero position angle (FVC), and encoder phase sequence (FVC).	Normal

The rated motor frequency is limited by the maximum frequency and frequency upper and lower limits. The default value of the maximum frequency is 50 Hz. Before tuning the synchronous motor, set F0-10 (maximum frequency), F0-12 (frequency upper limit), and F0-14 (frequency lower limit). If the rated motor frequency is greater than 50 Hz, set the maximum frequency and frequency upper and lower limits properly. Ensure that the maximum frequency is not lower than the frequency upper limit and that the rated motor frequency ranges from the frequency lower limit to the frequency upper limit.

Parameter Code	Parameter Name	F1-37 = 11	F1-37 = 12	F1-37 = 13	F1-37 = 4
F1-16	Synchronous motor stator resistance	✓	✓	✓	-
F1-17	D axis inductance of synchronous motor	✓	✓	✓	-
F1-18	Axis Q inductance of synchronous motor	✓	✓	✓	-
F1-20	Back EMF of synchronous motor	√[1]	✓	-	-
F1-30	A/B phase sequence of encoder	-	√[3]	-	-
F1-31	Encoder installation angle	√[2]	√[3]	-	-
A9-16	Electromechanical time constant	-	✓	-	✓
A9-17	Inertia ratio	-	✓	-	✓
A9-18	Friction torque	-	✓	-	✓
F2-00	Speed loop proportional gain 1	-	✓	-	✓
F2-01	Speed loop integral time 1	-	✓	-	✓

Parameter Code	Parameter Name	F1-37 = 11	F1-37 = 12	F1-37 = 13	F1-37 = 4
F2-03	Speed loop proportional gain 2	-	√	-	√
F2-04	Speed loop integral time 2	-	√	-	√

Note [1]: If F1-37 is set to 11 (with-load auto-tuning of synchronous motor), the back EMF is not tuned and is an estimated value, which is less accurate than that when F1-37 is set to 12 or 13.

Note [2]: If F1-37 is set to 11 (with-load auto-tuning of synchronous motor), the encoder phase sequence is not tuned. Before auto-tuning, check that the encoder direction is consistent with the motor rotation direction. System rotation inertia

Note [3]: In the SVC or V/f (SVC) control mode, if the encoder test (bit 1 of A9-09) is not enabled, the encoder zero position angle will not be tuned.

Note [4]: If a resolver or 23-bit encoder is used, the motor does not rotate during auto-tuning. If an ABZ encoder is used, the motor rotates for a short period of time during auto-tuning.

Note [5]: You can also manually enter motor parameters or download parameter files (accurate motor direction and encoder direction).

Note [6]: You can use the LED operating panel as the command source for motor auto-tuning. Besides, you can also use the LCD operating panel (F0-02 = 0), DI (F0-02 = 1), or communication channel (F0-02 = 2) as the command source for motor auto-tuning. The PKW areas of the Modbus, PROFIBUS DP, and CANopen support auto-tuning through communication, whereas their PZD areas do not support auto-tuning through communication. To perform auto-tuning through communication, write the value of F1-37 and then write operation commands.

When F1-37 is set to 12 (no-load complete auto-tuning), the motor will rotate at a high speed. Therefore, ensure that it is set under conditions allowed by mechanical safety. Besides, keep the load torque close to no-load torque as much as possible when the motor rotates at a constant speed. Lower load means more accurate auto-tuning results. Heavy load may cause drive overload or overcurrent.

Caution

In the FVC mode, before starting a synchronous motor, correctly set the installation position angle of the encoder or obtain it through auto-tuning. If no-load complete auto-tuning (F1-37 = 12) cannot be performed because the load cannot be disengaged, set F1-37 to 11 to select with-load auto-tuning for the synchronous motor.

Application example

- Procedure for partial static auto-tuning of synchronous motors

Table 1–10 Procedure for partial static auto-tuning of synchronous motors

Procedure	Description
Step 1	Power on the drive, and then set F0-02 = 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.

Procedure	Description
Step 3	Set F1-37 to 11 (static partial auto-tuning of the asynchronous motor), and press ENTER. The following information is displayed on the keypad: 
Step 4	Press the **RUN** key on the operating panel for more than 1 s to start motor auto-tuning. During this process, the Run indicator is steady ON, the secondary display area displays "TUNE", and the AC drive energizes the motor. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-16, F1-17, F1-18, and F1-31 (FVC) will be calculated by the AC drive automatically. F1-19 (SVC) needs to be set manually.

- 12: No-load dynamic complete auto-tuning of synchronous motor
  If the motor features constant output or high accuracy is required, perform dynamic complete auto-tuning after disconnecting the motor from the load for optimal auto-tuning effect.

Table 1–11 Procedure for complete dynamic auto-tuning of synchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	If F0-01 is set to 1 (FVC), enter encoder parameters (F1-27 and F1-28).
Step 4	Set F1-37 to 12 (no-load complete dynamic auto-tuning of synchronous motor), and press **Enter** on the operating panel. The following information is displayed. 
Step 5	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. The RUN indicator is steady on, the TUNE/TC indicator blinks, and the AC drive energizes the motor. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06, F1-17, F1-18, F1-20, F1-30 (FVC), and F1-31 (FVC) will be computed by the AC drive automatically.

- Complete static auto-tuning of synchronous motors
  The mode applies when motor rotation is not allowed.

Table 1–12 Procedure for complete static auto-tuning of synchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.

Procedure	Description
Step 3	Set F1-37 to 13 (complete static auto-tuning of synchronous motor), and press **Enter** on the operating panel. The following information is displayed. 
Step 4	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. The RUN indicator is steady on, the TUNE/TC indicator blinks, and the AC drive energizes the motor. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06, F1-17, and F1-18 will be computed by the AC drive automatically. Manually set F1-20 (SVC and PMVVC), F1-31 (FVC), and F1-30 (FVC).

1.2.3 Motor Parameter Group Switchover

The MD520 supports switchover of four groups of motor parameters. The following table describes four groups of motor parameters.

Parameter Group Number	Parameter Group
Motor parameter group 1	F0, F1, F2, F3, F6, F8, A9, AA, AB
Motor parameter group 2	A2, A3, B6, B7, B8, B9
Motor parameter group 3	BA, BB, BC, BD, BE
Motor parameter group 4	CA, CB, CC, CD, CE

You can select the required motor parameter group in the following two methods:

- Set F0-24 to select the motor parameter group. Set F0-24 to 0, 1, 2, or 3 to select motor parameter group 1, 2, 3, or 4, respectively.
- Select the currently valid motor parameter group through the DI. Assign any two of the DIs from DI1 to DI10 (F4-00 to F4-09) with function 41 (motor selection terminal 1) and function 76 (motor selection terminal 2). The following table describes the relationship between DI states and motor parameter groups.

State of DI with Function 41 Assigned	State of DI with Function 76 Assigned	Motor Parameter Group Selection
0	0	1
1	0	2
0	1	3
1	1	4

If any terminal (F4-00 to F4-09) is assigned with function 41 (motor selection terminal 1) or function 76 (motor selection terminal 2), the DI is used to determine which motor parameter group is selected. In this case, the setting of F0-24 is invalid. When no terminal (F4-00 to F4-09) is assigned with function 41 (motor selection terminal 1) or function 76 (motor selection terminal 2), the motor parameter group is determined by F0-24.

You can also view the selected motor parameter group by U2-00. When U2-00 is set 0, 1, 2, or 3, the motor parameter group 1, 2, 3, or 4 is selected, respectively.

Note

During running, the motor parameter group switchover command is invalid, and the motor parameter group cannot be switched. To switch parameter groups, stop the AC drive first.

1.3 Control Terminal

1.3.1 Digital Input Terminal (DI) Functions

The drive provides multiple multi-functional DIs, among which DI5 can be used as the pulse input terminal. Each DI can be assigned with a specific function.

Table 1–13 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
F4-00	DI1 function selection	1	0-86 (function 30 pulse frequency input is valid only for DI5)	See *"Table 1–14" on page 75*.
F4-01	DI2 function selection	4		
F4-02	DI3 function selection	9		
F4-03	DI4 function selection	12		
F4-04	DI5 function selection	13		
F4-05	DI6 function selection	0		
F4-06	DI7 function selection	0		
F4-07	DI8 function selection	0		
F4-08	DI9 function selection	0		
F4-09	DI10 function selection	0		
F4-10	DI filter time	0.010s	0.000s to 1.000s	This parameter defines the delay time for the DI status change.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-38	DI active mode selection 1	0	Ones: DI1 0: Active high 1: Active low Tens: DI2 0: Active high 1: Active low Hundreds: DI3 0: Active high 1: Active low Thousands: DI4 0: Active high 1: Active low Ten thousands: DI5 0: Active high 1: Active low	The active mode for terminals DI1 to DI5 are set through the ones, tens, hundreds, thousands, and ten thousands places of this parameter. 0: Active high The DI (DI1 to DI5) is active when connected to the COM terminal and inactive when disconnected from the COM terminal. 1: Active low The DI (DI1 to DI5) is inactive when connected to the COM terminal and active when disconnected from the COM terminal.
F4-39	DI active mode selection 2	0		
F4-41	DI1 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI1 function is turned on.
F4-42	DI1 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI1 function is turned off.
F4-43	DI2 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI2 function is turned on.
F4-44	DI2 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI2 function is turned off.
F4-45	DI3 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI3 function is turned on.
F4-46	DI3 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI3 function is turned off.
F4-47	DI4 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI4 function is turned on.
F4-48	DI4 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI4 function is turned off.
F4-49	DI forced data	0x0	Bit 0 to bit 9 correspond to DI1 to DI10 respectively. Bit 10 to bit 15 are reserved. 0: Inactive level; 1: Active level	This parameter is used to set the level state of DI1 to DI10 forcibly according to the bit sequence. 0: The level is forced to be inactive 1: The level is forced to be active

Parameter Code	Parameter Name	Default	Value Range	Description
F4-51	DI1 hardware source	0	0: Hardware 1: Forced value Others: B connector	Generally, the active state of the DI is obtained from hardware sampling. This function provides a software setting method to force the DIx to be active or inactive. 0: Hardware Whether the DIx input state is valid depends on whether the result of the DIx terminal sampling by hardware is valid. 1: Forced value Whether the DIx input state is valid depends on whether the bit x of F4-49 is valid. For example, if bit 0 is valid, the DI1 input state is valid. Others: B connector Whether the DIx terminal input state is valid depends on the state of the parameter connected to the connector.
F4-52	DI2 hardware source	0		
F4-53	DI3 hardware source	0		
F4-54	DI4 hardware source	0		
F4-55	DI5/HDI hardware source	0		

Parameter Code	Parameter Name	Default	Value Range	Description
F4-56	DI6 hardware source	0	0: Hardware 1: Forced value 2: Communication 4: AI1 5: AI2 6: AI3 11: DI1 12: DI2 13: DI3 14: DI4 (To be continued)	This parameter is used to select the DI6 input state source. 0: Hardware The DI input status is sourced from hardware sampling. 1: Forced value Software is used to set the forced status value of DI input (corresponding bit of F4-49). 2: Communication The DI input is sourced through communication. 4: AI1 AI1 is used as the DI input source. 5: AI2 AI2 is used as the DI input source. 6: AI3 AI3 is used as the DI input source. 11: DI1 DI1 is used as the DI input source. 12: DI2 DI2 is used as the DI input source. 13: DI3 DI3 is used as the DI input source. 14: DI4 DI3 is used as the DI input source. 15: DI5/HDI DI5/HDI is used as the DI input source. 17: DI7 DI7 is used as the DI input source. 18: DI8 DI8 is used as the DI input source. 19: DI9 DI9 is used as the DI input source. (To be continued)

Parameter Code	Parameter Name	Default	Value Range	Description
F4-56	DI6 hardware source	0	(Continued) 15: DI5/HDI 17: DI7 18: DI8 19: DI9 20: DI10 21: VDI1 22: VDI2 23: VDI3 24: VDI4 25: VDI5 (To be continued)	(Continued) 20: DI10 DI10 is used as the DI input source. 21: VDI1 VDI1 is used as the DI input source. 22: VDI2 VDI2 is used as the DI input source. 23: VDI3 VDI3 is used as the DI input source. 24: VDI4 VDI4 is used as the DI input source. 25: VDI5 VDI5 is used as the DI input source. (To be continued)

Parameter Code	Parameter Name	Default	Value Range	Description
F4-56	DI6 hardware source	0	(Continued) 26: VDI6 51: Relay 1 52: Relay 2 53: DO1 54: Relay on expansion card 55: DO2 on expansion card 56: VDO1 57: VDO2 58: VDO3 59: VDO4 60: VDO5 61: VDO6 62: VDO7 63: VDO8 64: VDO9 65: VDO10 66: VDO11 Others: B connector	(Continued) 26: VDI6 VDI6 is used as the DI input source. 51: Relay 1 Relay 1 is used as the DI input source. 52: Relay 2 Relay 2 is used as the DI input source. 53: DO1 DO1 is used as the DI input source. 54: Relay on expansion card The relay port of the expansion card is used as the DI input source. 55: DO2 on expansion card DO2 on the expansion card is used as the DI input source. 56: VDO1 VDO1 is used as the DI input source. 57: VDO2 VDO2 is used as the DI input source. 58: VDO3 VDO3 is used as the DI input source. 59: VDO4 VDO4 is used as the DI input source. 60: VDO5 VDO5 is used as the DI input source. 61: VDO6 VDO6 is used as the DI input source. 62: VDO7 VDO7 is used as the DI input source. 63: VDO8 VDO8 is used as the DI input source. 64: VDO9 VDO9 is used as the DI input source. 65: VDO10 VDO10 is used as the DI input source. 66: VDO11 VDO11 is used as the DI input source.
F4-57	DI7 hardware source	0	Same as F4-56	This parameter is used to select the DI7 input state source.
F4-58	DI8 hardware source	0	Same as F4-56	This parameter is used to select the DI8 input state source.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-59	DI9 hardware source	0	Same as F4-56	This parameter is used to select the DI9 input state source.
F4-60	DI10 hardware source	0	Same as F4-56	This parameter is used to select the DI10 input state source.
F4-61	DI5/HDI terminal type selection	1	0: Used as HDI 1: Used as DI	Set DI5 function as normal DI or HDI terminal.

Table 1–14 Descriptions of DI functions

Value	Function	Description
0	No function	No function is assigned to the DI.
1	Forward running (IN1)	The AC drive runs in the forward direction. FWD indicates forward running. In two-wire mode 1 (F4-11 = 0), activating DI function 1 triggers forward running. In two-wire mode 2 (F4-11 = 1), activating DI function 1 triggers a running command.
2	Reverse running (IN2)	The AC drive runs in the reverse direction. REV indicates reverse running. In three-wire mode 1 (F4-11 = 2), activating DI function 2 triggers reverse running. In three-wire mode 2 (F4-11 = 3), activating DI function 2 triggers forward/reverse running.
3	Three-wire mode (IN3)	The DI is used to set the three-wire mode for the AC drive. To set the running command source to the terminal, set F4-11 (terminal command mode) to 2 (three-wire mode 1) or 3 (three-wire mode 2), and set the DI to function 3. The three-wire control modes include three-wire mode 1 and three-wire mode 2.
4	Forward jog (FJOG)	The terminal is used to set the AC drive to jog forwardly. In the jogging mode, the drive runs at the frequency set by F8-00 (Jogging frequency), which is generally used for maintenance and commissioning of the equipment on site.
5	Reverse jog (RJOG)	The terminal is used to set the AC drive to jog reversely. In the jogging mode, the drive runs at the frequency set by F8-00 (Jogging frequency), which is generally used for maintenance and commissioning of the equipment on site.
6	Function as UP key for frequency adjustment	The terminal is used to increase the frequency. Activating the terminal is equivalent to pressing and holding the increment key. Deactivating the terminal is equivalent to releasing the increment key.
7	Function as DOWN key for frequency adjustment	The terminal is used to decrease the frequency. Activating the terminal is equivalent to pressing and holding the decrement key. Deactivating the terminal is equivalent to releasing the decrement key.
8	Coast to stop	Once the drive receives a stop command, it immediately stops output. The load then coasts to stop based on the mechanical inertia. The AC drive stops output to shut down. At this time, the power supply of the motor is cut off and the driving system is in the free braking state. This is also known as inertia stop because the stop time is determined by the inertia of the driving system.
9	Fault reset (RESET)	This function is used to reset the drive upon a fault, which is equivalent to the function of the STOP/RES key on the operating panel. This function allows you to perform a reset upon the fault remotely.

Value	Function	Description
10	Running pause	This function is valid only when F0-02 is set to 1 (terminal). After this function is assigned to the terminal, the drive decelerates to stop with all the operating parameters memorized (such as PLC parameters, wobble frequency, and PID parameters). When the terminal is inactive, the drive resumes to the status before decelerating to stop.
11	NO input of external fault	When an external signal is sent to the drive, the drive reports E015.1.
12	Multi-reference terminal 1	Multi-reference is selected as the main frequency source. Sixteen speeds or sixteen references can be set through combinations of sixteen states of these four terminals. It is suitable for applications where the operating frequency of the drive does not require continuous adjustment, and only several frequency values need to be used.
13	Multi-reference terminal 2	
14	Multi-reference terminal 3	
15	Multi-reference terminal 4	
16	Acceleration/deceleration time selection terminal 1	The acceleration time indicates the time required by the AC drive to accelerate from 0 Hz to the acceleration/deceleration base frequency (F0-25). The deceleration time indicates the time required by the AC drive to decelerate from the acceleration/deceleration base frequency (F0-25) to 0 Hz. Four groups of acceleration/deceleration time can be selected through combinations of four states of these two terminals. For example, if DI1 is assigned with function 16 and DI2 is assigned with function 17, the active states of DI2 and DI1 can be used to indicate the following groups acceleration/deceleration time: [0, 0]: Acceleration/deceleration time of group one [0, 1]: Acceleration/deceleration time of group two [1, 0]: Acceleration/deceleration time of group three [1, 1]: Acceleration/deceleration time of group four
17	Acceleration/deceleration time selection terminal 2	
18	Frequency source switchover	The terminal is used to select the frequency reference input modes. The frequency reference is set through F0-07 (Frequency reference superposition).
19	Clear data set by UP/DOWN key or by terminal functioning as UP/DOWN key	Activating the terminal clears the frequency that is set by the increment or decrement key on the operating panel or the terminal functioning as UP/DOWN keys and resumes the frequency reference to the value specified by F0-08.
20	Command source switchover terminal 1	When the running command is set through the terminal (F0-02 = 1) and the terminal is valid, you can switch between the terminal control mode and the operating panel control mode through the terminal. When the command is set through communication (F0-02 = 2) and the terminal is active, you can switch between the communication control mode and operating panel control mode through the terminal.
21	Acceleration/Deceleration inhibition	The drive runs at the current operating frequency without being affected by external input frequency except that a stop command is received.
22	PID invalid	The PID is deactivated temporarily. The drive maintains the current output frequency without PID adjustment of the frequency source.
23	Simple PLC status reset	The terminal is used to restore the AC drive to the initial state of the simple PLC.
24	Wobble frequency pause	In the wobble process, when the terminal is active, the wobble frequency function is paused and the drive outputs at the center frequency.
25	Counter input	In the counting process, the counted pulse is input when the terminal is active.

Value	Function	Description
26	Counter reset	In the counting process, the counter status is cleared when the terminal is active.
27	Length counting input	In the fixed length process, the counted length is input when the terminal is active.
28	Length reset	In the fixed length process, the length is set to zero when the terminal is active.
29	Torque control prohibited	When the terminal is active, the drive switches from the torque control mode to the speed control mode. When the terminal is inactive, the drive switches back to the torque control mode.
30	Pulse frequency input (valid only for DI5)	When DI5 is used as the pulse input terminal, DI5 must be assigned with this function.
32	Immediate DC braking	The terminal is used to switch the drive to the DC braking state. DC braking indicates that the drive outputs direct current to the stator winding of the asynchronous motor to form a static magnetic field, enabling the motor to brake with energy consumption. In this state, the rotor cuts the static magnetic field to generate braking torque, which stops the motor quickly.
33	NC of external fault	When an external signal is sent to the drive, the drive reports E015.2.
34	Frequency modification enable	When the terminal is active, the frequency can be modified. When the terminal is inactive, the frequency cannot be modified.
35	Opposite to PID action direction	The terminal is used to reverse the PID action direction defined by FA-03 (PID action direction).
36	External stop terminal 1	The terminal is used to stop the drive regardless of the value of F0-02, which functions the same as the STOP/RES key on the operating panel.
37	Control command switchover terminal 2	The terminal is used to switch the drive between the terminal control mode and communication control mode. If the command source is set to terminal control, activating the terminal switches the AC drive to communication control. If the command source is set to communication control, activating the terminal switches the AC drive to terminal control.
38	PID integral pause	After this function is active, the integral adjustment function pauses. However, the proportional and derivative adjustment functions are still valid.
39	Switchover between main frequency X and preset frequency	The terminal is used to switch from main frequency X to the preset frequency (F0-08).
40	Switchover between auxiliary frequency Y and preset frequency	The terminal is used to switch from auxiliary frequency Y to the preset frequency (F0-08).
41 and 76	Motor selection terminal 1/2	The terminal is used to select the motor. For example, when function 41 and function 76 are allocated to DI1 and DI2, respectively, motor 1 applies when DI1 and DI2 are inactive; motor 2 applies when DI1 is active and DI2 is inactive; motor 3 applies when DI1 is inactive and DI2 is active; motor 4 applies when DI1 and DI2 are active.
43	PID parameter switchover	If PID parameters are switched through the DI (FA-18 = 1), the PID parameters FA-05 (proportional gain Kp1), FA-06 (integral time Ti1), and FA-07 (derivative time Td1) are used when the terminal is inactive; the PID parameters FA-15 (proportional gain Kp2), FA-16 (integral time Ti2), and FA-17 (derivative time Td2) are used when the terminal is active.

Value	Function	Description
44	User-defined fault 1	The AC drive reports E027.1, and acts according to the value of F9-49 (Fault protection action selection).
45	User-defined fault 2	The AC drive reports E027.2, and acts according to the value of F9-49 (Fault protection action selection).
46	Speed control/Torque control selection	The terminal is used to switch the AC drive between the speed control mode and torque control mode. If A0-00 (speed/torque control mode) is set to 0, the torque control mode is used when the terminal is active, and the speed control mode is used when the terminal is inactive. If A0-00 (speed/torque control mode) is set to 1, the speed control mode is used when the terminal is active, and the torque control mode is used when the terminal is inactive.
47	Emergency stop	When the system is in the emergency state, the drive decelerates according to F8-55 (Deceleration time for emergency stop) or according to the minimum unit time when the deceleration time for emergency stop is 0s in the V/f control mode. The input terminal does not need to be in the closed state continuously. Even if it is closed only for a moment, an emergency stop will occur immediately. Different from general deceleration time, the emergency stop input terminal is opened after the deceleration time for emergency stop expires. In this case, if the operation signal is still active, the drive will not restart. To restart the drive, disconnect the operation terminal and input the operation command again.
48	External stop terminal 2	The terminal is used to make the drive decelerate to stop in any control mode (operating panel, terminal, or communication). In this case, the deceleration time is fixed to the value of F8-08 (deceleration time 4).
49	Decelerate to DC braking	The drive decelerates to the start frequency of DC braking for stop (F6-11) and then enters the DC braking state.
50	Clear current running time	The current running time of the drive (U0-26) is cleared. When the terminal is active, the current running time of the drive is not cleared.
51	Two-wire/Three-wire mode switchover	The terminal is used to switch the drive between the two-wire mode and the three-wire mode. When F4-11 is set to 0 (two-wire mode 1) and the terminal is active, the drive switches to three-wire mode 1. When the terminal is inactive, two-wire mode 1 is used. When F4-11 is set to 1 (two-wire mode 2) and the terminal is active, the drive switches to three-wire mode 2. When F4-11 is set to 2 (three-wire mode 1) and the terminal is active, the drive switches to two-wire mode 1. When F4-11 is set to 3 (three-wire mode 2) and the terminal is active, the drive switches to two-wire mode 2.
52	Reverse running prohibited	When the terminal is active, even if the reverse frequency is set, the actual frequency of the AC drive is fixed to 0. This function is the same as F8-13 (Reverse frequency inhibited).
64	Forward limit switch (NO signal)	-
65	Reverse limit switch (NO signal)	-
66	Water cooling fault input	When an external signal is sent to the drive and the terminal is active, E064.1 is reported.

Value	Function	Description
67	Low liquid level fault input	When an external signal is sent to the drive and the terminal is active, A066.1 (thousands place of F9-50 = 2) or E066.1 (thousands place of F9-50 = 0) is reported.
70	Control channel	The terminal is used to select a user-defined command channel. Value 0 represents channel 1, and value 1 represents channel 2.
72	Terminal module A/B selection	The terminal is used to select a terminal module. Value 0 represents module A, and value 1 represents module B.
73	Startup mode selection bit 0	The terminal is used to select a start mode. For example, if DI1 and DI2 are assigned with functions 73 and 74, respectively, direct start is selected when both DI1 and DI2 are inactive; flying start is selected when DI1 is active but DI2 is inactive; DC braking start is selected when DI1 is inactive but DI2 is active; and the last start mode is selected when both DI1 and DI2 are active.
74	Startup mode selection bit 1	
75	Control command switchover terminal 3	The terminal is used to switch the command source between the terminal/communication control mode and the user-defined operation command.
77	Running enabling	When the terminal is active at high level, running is allowed. Otherwise, running is not allowed or the AC drive must stop according to the setting of AA-09 (stop mode during running).
78	Forward operation permission	When the terminal is active at high level, the frequency reference is allowed to be a positive value. Otherwise, the positive frequency reference is reset to zero.
79	Reverse operation permission	When the terminal is active at high level, the frequency reference is allowed to be a negative value. Otherwise, the negative frequency reference is reset to zero.
80	RFG input clear	When the terminal is active at low level, the target reference is reset to zero. When the terminal is inactive at high level, the target reference is restored to its original setting.
86	Wire breakage detection (wire drawing machine)	After the AC drive is started and the time set by A7-32 (Breakage detection time for startup delay) expires, the DI starts detecting an active signal. If the DI detects an active signal, the AC drive reports E031.2 (breakage detection fault).

1.3.2 Digital Output Function (DO) Functions

Table 1–15 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
F5-01	FMR output function selection	0	0-44 (Others: B connector)	See "Table 1–16" on page 85.
F5-02	Output function selection of control panel relay (T/A-T/B-T/C)	2		
F5-03	Output function selection of DO4 on expansion card relay (P/A-P/B-P/C)	0		
F5-04	DO1 output function selection	1		
F5-05	Output function selection of DO2 on expansion card	4		
F5-22	DO valid status selection	0	Ones: FMR 0: Positive logic 1: Negative logic Tens: Relay 1 (DO3) 0: Positive logic 1: Negative logic Hundreds: Relay 2 (DO4) 0: Positive logic 1: Negative logic Thousands: DO1 0: Positive logic 1: Negative logic Ten thousands: DO2 0: Positive logic 1: Negative logic	The ones, tens, hundreds, thousands, and ten thousands places of this parameter are used to set the valid state of DOs to which F5-01 to F5-05 correspond. 0: Positive logic (equivalent to a NO contact) Valid state: The DO is connected to the COM/CME terminal internally. Invalid state: The DO is disconnected from the COM/CME terminal. 1: Negative logic (equivalent to a NC contact) Valid state: The DO is disconnected from the COM/CME terminal. Invalid state: The DO is connected to the COM/CME terminal internally.
F5-24	Control board relay (DO3) switch-on delay time	0.0s	0.0s to 3600.0s	It indicates the output delay of the control board relay. The output function set by F5-02 is active after the set delay time elapses.
F5-25	Control board relay (DO3) switch-off delay	0.0s	0.0s to 3600.0s	
F5-26	FMR output switch-on delay time	0.0	0.0s to 3600.0s	This parameter indicates the FMR output delay. The output function set by F5-01 is active after the set delay time elapses.
F5-27	FMR output switch-off delay time	0.0s	0.0s to 3600.0s	

Parameter Code	Parameter Name	Default	Value Range	Description
F5-28	DO1 output switch-on delay	0.0s	0.0s to 3600.0s	This parameter indicates the delay of DO1 output. The output function set by F5-04 is active after the set delay time elapses.
F5-29	DO1 output switch-off delay time	0.0s	0.0s to 3600.0s	
F5-30	Switch-on delay time of expansion card relay (DO4)	0.0s	0.0s to 3600.0s	This parameter indicates the output delay time of expansion card DO4. The output function set by F5-03 is active after the set delay time elapses.
F5-31	Switch-off delay time of expansion card relay (DO4)	0.0s	0.0s to 3600.0s	
F5-32	Switch-on delay time of expansion card DO2	0.0s	0.0s to 3600.0s	This parameter indicates the output delay time of expansion card DO2. The output function set by F5-05 is active after the set delay time elapses.
F5-33	Switch-off delay time of expansion card DO2	0.0s	0.0s to 3600.0s	

Parameter Code	Parameter Name	Default	Value Range	Description
F5-34	DO/RO output source	0x0	Bit 0: Relay 1 (DO3) output source 0: Output function 1: Communication Bit 1: FMR output source 0: Output function 1: Communication Bit 2: DO1 output source 0: Output function 1: Communication Bit 3: Relay 2 (DO4) output source 0: Output function 1: Communication Bit 4: DO2 output source 0: Output function 1: Communication Bit 5: VDO1 output source 0: Output function 1: Communication	Bit 0 to bit 16 of this parameter are used to set DO, VDO, and FMR output sources. 0: Output function The output source is determined based on the output functions of DO, VDO, and FMR. 1: Communication The output source is set through communication.

Parameter Code	Parameter Name	Default	Value Range	Description
Con-tinued	Continued	Con-tinued	Continued Bit 6: VDO2 output source 0: Output function 1: Communication Bit 7: VDO3 output source 0: Output function 1: Communication Bit 8: VDO4 output source 0: Output function 1: Communication (To be continued)	Continued

Parameter Code	Parameter Name	Default	Value Range	Description
Continued	Continued	Continued	(Continued) Bit 9: VDO5 output source 0: Output function 1: Communication Bit 10: VDO6 output source 0: Output function 1: Communication Bit 11: VDO7 output source 0: Output function 1: Communication Bit 12: VDO8 output source 0: Output function 1: Communication Bit 13: VDO9 output source 0: Output function 1: Communication Bit 14: VDO10 output source 0: Output function 1: Communication Bit 15: VDO11 output source 0: Output function 1: Communication	Continued

Parameter Code	Parameter Name	Default	Value Range	Description
F5-35	DO/RO output set through communication	0x0	Same as F5-34	After F5-34 (DO/RO output source) is set communication, bit 0 to bit 15 of this parameter are used to set written values of DO, VDO, and FMR terminals through communication. 0: Invalid level 1: Valid level The output source is set through communication.

Table 1–16 Descriptions of output terminal functions

Value	Function	Description
0	No output	The output terminal has no function.
1	AC drive running	The terminal outputs an active signal when the AC drive is running with output frequency (which can be 0).
2	Fault output	When the drive encounters a fault, the terminal outputs an active signal.
3	Frequency-level detection FDT1 output	When the running frequency exceeds the frequency detection value, the terminal outputs an active signal. When the running frequency falls below the result of the frequency detection value minus the FDT hysteresis (F8-19 x F8-20), the terminal stops outputting the active signal.
4	Frequency reach	When the running frequency of the AC drive is within a specific range (target frequency ± F8-21 x maximum frequency), the terminal outputs an active signal.
5	Running at zero speed (no output at stop)	When the drive is operating and the output frequency is 0, the terminal outputs an active signal. When the AC drive is in the stop state, the signal is inactive.
6	Motor overload warning	Before motor overload protection, the AC drive determines whether the motor load exceeds the overload warning threshold according to the overload warning coefficient (F9-02). If the threshold is exceeded, the terminal outputs an active signal. (For calculation of the alarm threshold, see the description of motor overload protection.)
7	Drive overload warning	The terminal outputs an active signal 10s before AC drive overload protection applies.
8	Counting value reach	The terminal outputs an active signal when the counting value reaches the value of FB-08.
9	Designated counting value reach	The terminal outputs an active signal when the counting value reaches the value of FB-09.
10	Length reach	The terminal outputs an active signal when the actual length detected exceeds the length defined by FB-05.
11	Simple PLC cycle completed	When the simple PLC completes one cycle, the terminal outputs a pulse signal with the width of 250 ms.
12	Cumulative running time reach	The AC drive compares the cumulative running time and the time set by F8-17 and F8-75. If the former is greater than or equal to the latter, the terminal outputs an active signal.
13	Wobble frequency limited	In a wobble process, the terminal outputs an active signal when the set frequency exceeds the upper or lower limit of frequency and the output frequency of AC drive reaches the upper or lower limit of frequency.
14	Torque limited	The terminal outputs an active signal when the output torque reaches the torque limit in the speed control mode.

Value	Function	Description
15	Ready for running	The terminal outputs an active signal if no exception occurs on the AC drive after power-on.
16	AI1 > AI2	The terminal outputs an active signal when the AI1 input value is higher than the AI2 input value.
17	Frequency upper limit reach	The terminal outputs an active signal when the operating frequency reaches the frequency upper limit (F0-12).
18	Frequency lower limit reach (no output at stop)	When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 1 (stop), the terminal outputs an inactive signal no matter whether the operating frequency reaches the lower limit. When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 0 (run at the frequency lower limit) or 2 (run at zero speed) and the running frequency reaches the lower limit, the terminal outputs an active signal.
19	Undervoltage state output	The terminal outputs an active signal when the drive is in the undervoltage state.
20	Communication control	The active or inactive state of the terminal is controlled by the setpoint of communication address 0x2001.
21	Brake output	The terminal outputs an active signal upon brake release, and outputs an inactive signal upon brake applying.
23	Running at zero speed 2 (output at stop)	The terminal outputs an active signal when the drive is operating and the output frequency is 0. The signal remains active when the drive is in the stop state.
24	Cumulative power-on time reached	The terminal outputs an active signal when the cumulative power-on time of the AC drive (F7–13) exceeds the time defined by F8–16.
25	Frequency-level detection FDT2 output	The terminal outputs an active signal when the running frequency exceeds the frequency detection value and stops outputting the active signal when the running frequency is lower than the result of the detection value minus the frequency detection hysteresis (F8-28 x F8-29).
26	Frequency 1 reached	The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-30 (Detection frequency 1). Frequency detection range: F8-30 - F8-31 x F0-10 (Maximum frequency) to F8-30 + F8-31 x F0-10
27	Frequency 2 reached	The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-32 (Detection frequency 2). Frequency detection range: F8-32 – F8-33 x F0-10 (Maximum frequency) to F8-32 + F8-33 x F0-10
28	Current 1 reached	The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-38 (Detection current 1). Current detection range = F8-38 - F8-39 x F1-03 (Rated motor current) to F8-38 + F8-39 x F1-03
29	Current 2 reached	The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-40 (Detection current 2). Current detection range = F8-40 - F8-41 x F1-03 (Rated motor current) to F8-40 + F8-41 x F1-03
30	Timing reached	When the timing function set by F8-42 is enabled and the operating time reaches the set timing duration, the terminal outputs an active signal. The timing duration is defined by F8-43 and F8-44.
31	AI1 input limit exceeded	If the value of AI1 input is larger than the value of F8-46 (AI1 input protection upper limit) or lower than the value of F8-45 (AI1 input protection lower limit), the terminal outputs an active signal.
32	Load loss	The terminal outputs an active signal when the drive is in the load loss state.
33	Reverse running	The terminal outputs an active signal when the drive is operating in the reverse direction.

Value	Function	Description
34	Zero current state	When the output current of the drive is within the zero current range for a duration longer than that defined by F8-35 (zero current detection delay), the terminal outputs an active signal. Zero current detection range = 0 to F8-34 x F1-03
35	Module temperature reached	The terminal outputs an active signal when F7-07 (drive unit heatsink temperature) reaches the value of F8-47 (module temperature threshold).
36	Output current overlimit	When the output current of the AC drive is higher than F8-36 (Output current threshold) for a period longer than F8-37 (Delay time for output current overlimit detection), the terminal outputs an active signal.
37	Frequency lower limit reached (output at stop)	The terminal outputs an active signal when the operating frequency reaches the lower limit (F0-14). The terminal still outputs the active signal when the drive is in the stop state.
38	Alarm (all faults)	The terminal outputs an active signal when a fault occurs and the drive continues operating. For details about the fault protection action, see F9-47 to F9-50.
39	Motor overtempera-ture	The terminal outputs an active signal when the motor temperature reaches the value of F9-58 (motor overtemperature warning threshold). You can check the motor temperature using U0-34.
40	Current operating time reached	When the current operating time of the drive exceeds the time defined by F8-53 (Current running time reach), the terminal outputs an active signal.
41	Fault output (excluding undervoltage)	The terminal outputs an active signal when a fault (other than the undervoltage fault) occurs on the AC drive.
42	STO output	The terminal outputs an active signal when the STO is triggered.
43	Operation restricted	When a minor fault that restricts the running of the AC drive occurs, the operating panel of the AC drive displays "Lxxx.y".
44	Brake output at stop (wire drawing machine)	When the AC drive stops and the running frequency is lower than the brake frequency set by A7-30, the terminal outputs an active signal. After the brake delay time set by A7-31 expires, the terminal outputs an active signal.
Others	B connector	When this option is selected, the output function is the signal or function state of the parameter to which the connector is connected.

1.3.3 Virtual Digital Input Terminal (VDI) Functions

The virtual digital input terminals (VDIs), which can be used for multi-functional digital inputs, have the similar functions as the DIs on the control board.

There are four VDI sources.

- The VDI is set by writing values to A1-06 and A1-42. This mode applies to communication scenarios, where physical DIs are not used. The relationship between A1-06 and VDIs are as follows: The ones to ten thousands places of A1-06 correspond to VDI1 to VDI5, respectively. A1-42 corresponds to VDI6.
- The VDI is set by VDO state. There are six VDOs from VDO1 to VDO6, corresponding to VDI1 to VDI6.
- VDI1 to VDI6 are set by DI1 to DI6, respectively.
- VDI1 to VDI3 are set by AI1 to AI3, respectively.

Example

The following examples show how to use VDIs.

- Example 1: When A1-05 (VDI state setting mode) is set to 00001 (determined by DO), the following function needs to be implemented: The AC drive reports an alarm and stops when AI1 input exceeds the upper limit or lower limit. Do as follows.

Step	Parameter Setting
1	Set the VDI1 function to "User-defined fault 1" (A1-00 = 44).
2	Set the DO1 function to "AI input limit exceeded" (F5-04 = 31).
3	Set the VDI1 state setting mode to the DO (A1-05 = 00000).

When AI1 input exceeds the upper/lower limit, DO1 output becomes ON. In this case, VDI1 is active. The drive reports E27.00 after receiving user-defined fault 1 through VDI1 and then stops.

- Example 2: In a communication scenario, implement emergency stop through the VDI without using the physical DI.

Step	Parameter Setting
1	Set the VDI1 function to "Emergency stop" (A1-00 = 47).
2	Set the VDI1 state to be determined by parameters (A1-05 = 00001).
3	Modify the ones place of A1-06 through communication.

After the preceding steps, set the ones place of A1-06 to 1 to implement the emergency stop function.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A1-00	VDI1 function selection	0	0 to 86	Same as F4-00
A1-01	VDI2 function selection	0		
A1-02	VDI3 function selection	0		
A1-03	VDI4 function selection	0		
A1-04	VDI5 function selection	0		
A1-05	VDI state setting source	0	Ones: VDI1 0: VDO1 state 1: A1-06 2: DI1 state 3: Communication value (bit 10 of F4-50) 4: AI1 5: Reserved Tens: VDI2 0: VDO2 state 1: A1-06 2: DI2 state 3: Communication value (bit 11 of F4-50) 4: AI2 5: Reserved (To be continued)	The VDIx (x ranges from 1 to 5) state is set by the ones to ten thousands places of this parameter. 0: VDOx state The VDIx state is determined by the VDOx state. VDIx is uniquely bound to VDOx. x in VDIx and VODx ranges from 1 to 5. 1: A1-06 The VDIx (x ranges from 1 to 5) state is set through the binary bits of A1-06. 2: DIx state The VDIx state is determined by the DIx state. VDIx is uniquely bound to DIx. x in VDIx and DIx ranges from 1 to 5. 3: Communication value (bit 10 to bit 14 of F4-50) 4: AIx state The VDIx state is determined by the AIx state. VDIx is uniquely bound to AIx. x in VDIx and AIx ranges from 1 to 3. 5: Reserved

Parameter Code	Parameter Name	Default	Value Range	Description
Contin-ued	Continued	Contin-ued	(Continued) Hundreds: VDI3 0: VDO3 state 1: A1-06 2: DI3 state 3: Communication value (bit 12 of F4-50) 4: AI3 5: Reserved Thousands: VDI4 0: VDO4 state 1: A1-06 2: DI4 state 3: Communication value (bit 13 of F4-50) 4-5: Reserved Ten thousands: VDI5 0: VDO5 state 1: A1-06 2: DI5 state 3: Communication value (bit 14 of F4-50) 4-5: Reserved	Continued
A1-06	VDI state setting	0	Ones: VDI1 0: Invalid 1: Valid Tens: VDI2 0: Invalid 1: Valid Hundreds: VDI3 0: Invalid 1: Valid Thousands: VDI4 0: Invalid 1: Valid Ten thousands: VDI5 0: Invalid 1: Valid	The VDIx (x ranges from 1 to 5) state is set by the ones to ten thousands places of this parameter.
A1-40	VDI6 function selection	0	0 to 80	Same as F4–00

Parameter Code	Parameter Name	Default	Value Range	Description
A1-41	VDI6 hardware source	0	Ones: VDI6 0: VDO6 state 1: A1-42 2: DI6 state 3: Communication value (bit 15 of F4-50) 4-5: Reserved	Same as A1-05
A1-42	VDI6 state setting	0	Ones: VDI6 0: Invalid 1: Valid	Same as A1-06
A1-43	VDI1 to VDI5 active mode	0	Ones position: VDI1 0: Active low 1: Active high Tens: VDI2 0: Active low 1: Active high Hundreds: VDI3 0: Active low 1: Active high Thousands: VDI4 0: Active low 1: Active high Ten thousands: VDI5 0: Active low 1: Active high	The VDIx (x ranging from 1 to 5) state is set by the ones to ten thousands places of this parameter.
A1-44	VDI6 active mode	0	Ones position: VDI6 0: Active low 1: Active high	Same as A1-43

1.3.4 Virtual Digital Output Terminal (VDO) Functions

The virtual digital output (VDO) functions are similar to the DO functions on the control board. The VDO can be used together with the virtual digital input (VDI) to implement some simple logic control.

VDO and VDI can be used together to achieve flexible control. For detailed examples, see the VDI section.

Parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A1-11	VDO1 output selection	0	0-44 (others: B connector)	Same as F5-01
A1-12	VDO2 output selection	0		
A1-13	VDO3 output selection	0		
A1-14	VDO4 output selection	0		
A1-15	VDO5 output selection	0		
A1-21	VDO valid status selection	0	Ones: VDO1 0: Positive logic 1: Negative logic Tens: VDO2 0: Positive logic 1: Negative logic Hundreds: VDO3 0: Positive logic 1: Negative logic Thousands: VDO4 0: Positive logic 1: Negative logic Ten thousands: VDO5 0: Positive logic 1: Negative logic	Positive logic: When the terminal is invalid, 0 is output. When the terminal is valid, 1 is output. Negative logic: When the terminal is invalid, 1 is output. When the terminal is valid, 0 is output.
A1-22	VDO1 output switch-on delay	0.0	0.0s to 3600.0s	-
A1-23	VDO2 output switch-on delay	0.0	0.0s to 3600.0s	
A1-24	VDO3 output switch-on delay	0.0	0.0s to 3600.0s	
A1-25	VDO4 output switch-on delay	0.0	0.0s to 3600.0s	
A1-26	VDO5 output switch-on delay	0.0	0.0s to 3600.0s	
A1-27	VDO1 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-28	VDO2 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-29	VDO3 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-30	VDO4 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-31	VDO5 output switch-off delay time	0.0	0.0s to 3600.0s	

Parameter Code	Parameter Name	Default	Value Range	Description
A1-32	VDO6 output function selection	0	0-44 (others: B connector)	Same as F5-01
A1-33	VDO7 output function selection	0		
A1-34	VDO8 output function selection	0		
A1-35	VDO9 output function selection	0		
A1-36	VDO10 output function selection	0		
A1-37	VDO11 output function selection	0		
A1-38	VDO6 to VDO10 active mode selection	0	Ones: VDO6 0: Positive logic 1: Negative logic Tens: VDO7 0: Positive logic 1: Negative logic Hundreds: VDO8 0: Positive logic 1: Negative logic Thousands: VDO9 0: Positive logic 1: Negative logic Ten thousands: VDO10 0: Positive logic 1: Negative logic	Positive logic: When the terminal is invalid, 0 is output. When the terminal is valid, 1 is output. Negative logic: When the terminal is invalid, 1 is output. When the terminal is valid, 0 is output.
A1-39	VDO11 active mode selection	0	0: Positive logic 1: Negative logic	

1.3.5 Digital Input and Output Terminal Counting Function

The DIO edge counting function helps you record the number of active edges of a signal (retentive upon power failure) to realize functions such as device life cycle measurement and warning of level jump times.

Example

The following examples show how to use the DIO edge counting function.

The product provides four counting modules, which can count simultaneously without affecting each other, and 32 counting channels (DI/VDI/DO/RO/VDO).

Step	Parameter Setting
1	1. Select one counting module from the four to be used and set A1-50 to 1 to reset the count module. 2. Set A1-50 to 0 to disable reset.
2	Set the number warning threshold of the counting module through A1-55/ A1-56/A1-57/A1-58.
3	Set the active level (positive logic or negative logic) through F4-38/F4-39/A1-43/A1-44/F5-22/A1-21/A1-38/A1-39.
4	Select a counting channel from the 32 channels through A1-51/A1-52/A1-53/ A1-54.
5	After the program runs for a certain period of time, you can view the counting value through A1-59/A1-60/A1-61/A1-62 and the comparison result through L1-03/L1-04/L1-05/L1-06.

Example 1: Assume that the first counting module is used to count the number of times that DO1 changes from active level to inactive level and the warning threshold is 100. Set parameters as follows:

Step	Parameter Setting
1	1. Set A1-50 to 1 to reset the first counting module. 2. Set A1-50 to 0 to disable reset after the historical parameter is cleared.
2	Set A1-55 to 100, which is the number warning threshold of the first counting module.
3	Set DO1 to "1: Negative logic" through F5-22.
4	Set A1-51 to 19, which is the counting channel DO1 of the first counting module.
5	After the program runs for a period of time, you can view the counting value through A1-59 and the comparison result through L1-03.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A1-50	DIO edge counting channel selection for reset	0	0: Disable 1: First counting module 2: Second counting module 3: Third counting module 4: Fourth counting module 5: All counting modules	When a counting module needs to be reset, you can clear it by selecting the corresponding value of this parameter. Note: After the reset, you need to set A1-50 to 0. 0: No counting module is reset. 1: The value calculated by the first counting module is reset. 2: The value calculated by the second counting module is reset. 3: The value calculated by the third counting module is reset. 4: The value calculated by the fourth counting module is reset. 5: The value calculated by the fifth counting module is reset.
A1-51	Channel selection for DIO edge counting module 1	0	0: Disable 1: DI1 2: DI2 3: DI3 4: DI4 5: DI5 6: DI6 7: DI7 8: DI8 9: DI9 10: DI10 11: VDI1 12: VDI2 13: VDI3 14: VDI4 15: VDI5 (To be continued)	This parameter is used to select the channel for the first counting module.
A1-52	DIO edge counting channel selection 2	0		This parameter is used to select the channel for the second counting module.
A1-53	DIO edge counting channel selection 3	0		This parameter is used to select the channel for the third counting module.
A1-54	DIO edge counting channel selection 4	0		This parameter is used to select the channel for the fourth counting module.

Parameter Code	Parameter Name	Default	Value Range	Description
A1-51	Channel selection for DIO edge counting module 1	0	Continued 16: VDI6 17: RELAY1 (DO3) 18: FMR 19: DO1 20: RELAY2 (DO4) 21: DO2 22: VDO1 23: VDO2 24: VDO3 25: VDO4 26: VDO5 27: VDO6 28: VDO7 29: VDO8 30: VDO9 31: VDO10 32: VDO11	This parameter is used to select the channel for the first counting module.
A1-52	DIO edge counting channel selection 2	0		This parameter is used to select the channel for the second counting module.
A1-53	DIO edge counting channel selection 3	0		This parameter is used to select the channel for the third counting module.
A1-54	DIO edge counting channel selection 4	0		This parameter is used to select the channel for the fourth counting module.
A1-55	Comparison value of DIO edge counting module 1	0	0 to 65535	This parameter is used to set the comparison value of the first counting module.
A1-56	DIO edge counting comparison value setting 2	0	0 to 65535	This parameter is used to set the comparison value of the second counting module.
A1-57	Comparison value of DIO edge counting module 3	0	0 to 65535	This parameter is used to set the comparison value of the third counting module.
A1-58	Comparison value of DIO edge counting module 4	0	0 to 65535	This parameter is used to set the comparison value of the fourth counting module.
A1-59	Counting value of DIO edge counting module 1	0	0 to 65535	This parameter indicates the counted value of the first counting module.
A1-60	Counting value of DIO edge counting module 2	0	0 to 65535	This parameter indicates the counted value of the second counting module.
A1-61	Counting value of DIO edge counting module 3	0	0 to 65535	This parameter indicates the counted value of the third counting module.
A1-62	Counting value of DIO edge counting module 4	0	0 to 65535	This parameter indicates the counted value of the fourth counting module.

1.3.6 Analog Input Terminal (AI) Functions

The AC drive provides two multi-functional AIs by default. If more AIs are required by field applications, an I/O expansion card can be selected. For the number of AIs on each expansion card, see "Expansion Card". For example, the expansion card MD38IO1 provides one analog input terminal AI3.

To use AIs as DIs, the following parameters need to be set. When an AI is used as an DI, the AI state is high level if the input voltage of the AI is higher than 7 V and is low level if the input voltage of the AI is lower than 3 V. The AI is in hysteresis state if the input voltage ranges from 3 V and 7 V. The following figure shows the relationship between AI input voltages and DI states.

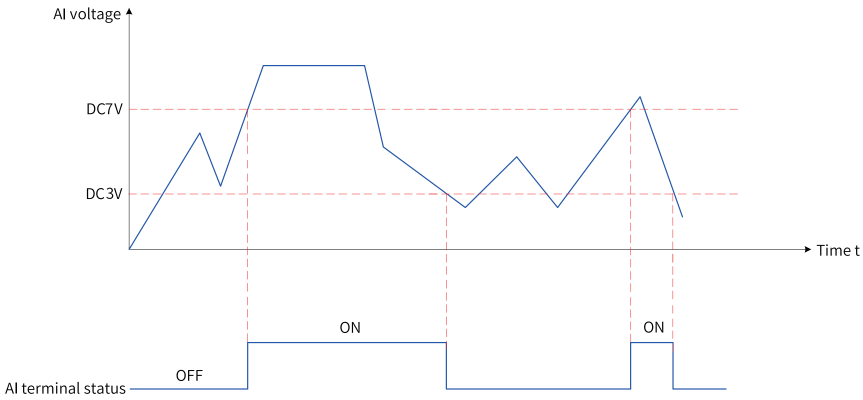


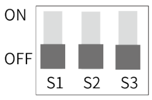
Figure 1-42 Relationship between AI input voltages and DI states

Table 1–17 Related parameter list

Terminal	Name	Type	Input Range
AI1-GND	Control board AI 1	Voltage type	0 VDC to 10 VDC
AI2-GND	Control board AI 2	Voltage type	0 VDC to 10 VDC
		Current type (500 Ω impedance)	0 mA to 20 mA
		Current type (250 Ω impedance)	0 mA to 40 mA
		Temperature	Select different input types and temperature sensor types based on the DIP switch on the main control board and F9-75. PT100: -25°C to +200°C PT1000: -25°C to +200°C KTY84-130: -40°C to +260°C PTC130: -20°C to +180°C
AI3-GND	I/O expansion card AI	Voltage type	0 VDC to 10 VDC
		Temperature	Select different input types and temperature sensor types based on the DIP switch on the expansion board and F9-56. PT100: 0°C to 200°C PT1000: 0°C to 200°C

Functions of the AI can be set by the DIP switches on the main control board, as summarized in the following table.

Table 1–18 Descriptions of DIP switches S1 to S3

DIP Switch Diagram	DIP Switch Status			Function Description
	S1	S2	S3	
	OFF	OFF	OFF	Voltage mode with the range of 0 VDC to 10 VDC for AI2
	ON	OFF	OFF	Temperature mode for AI2 Set the temperature sensor type through F9-75. 0: Temperature sensor not supported (AI used for analog input) 1: PT100, supporting the temperature range of -25°C to +200°C 2: PT1000, supporting the temperature range of -25°C to +200°C 3: KTY84-130, supporting the temperature range of -40°C to +260°C 4: PTC130, supporting the temperature range of -20°C to +180°C
	OFF	ON	OFF	Current mode for AI2; current range: 0 mA to 20 mA; input impedance: 500 Ω
	OFF	ON	ON	Current mode for AI2; current range: 0 mA to 40 mA; input impedance: 250 Ω

Note

S1, S2, and S3 are DIP switches used in combination. For details, see *"Table 1–18" on page 98*.

Use F9-56 and F9-75 to select a temperature sensor for the AI. Note that if AI2/AI3 is not used as temperature input, you need to set F9-56 and F9-75 to 0 (No temperature sensor).

Table 1–19 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
A1-07	AI1 (used as DI) function	0	0 to 86	Same as F4-00
A1-08	AI2 (used as DI) function	0		
A1-09	AI3 (used as DI) function	0		
A1-10	Active mode selection for AI used as DI	000	Ones: AI1 0: Active low 1: Active high Tens: AI2 0: Active low 1: Active high Hundreds: AI3 0: Active low 1: Active high	When the AI is active low, the AI is inactive if the corresponding digit of A1-10 is set to 0, and active if the corresponding digit of A1-10 is set to 1. When the AI is active low, the AI is active if the corresponding digit of A1-10 is set to 0, and inactive if the corresponding digit of A1-10 is set to 1.
F4-13	Minimum input of AI curve 1	0.00 V	-10.00 V to F4-15	When the main frequency is set by the AI, each AI supports five types of AI curves. The AI curve is used to set the relationship between the analog input voltage (or current) and the percentage corresponding to the maximum frequency (F0-10). The x axis of the AI curve represents the analog input voltage or current, and the y axis represents the set value corresponding to the analog input, which is the percentage of the maximum frequency (F0-10). Five AI curves are provided. Curves 1 to 3 are two-point curves, and their relevant parameters are F4-13 to F4-27. Curves 4 and 5 are four-point curves, and their relevant parameters are A6-00 to A6-15. The two points on curves 1 to 3 are the minimum input point and maximum input point, respectively. F4-13 corresponds to the x axis of the AI curve 1 minimum input, that is, the minimum analog input voltage or current.
F4-14	Percentage corresponding to minimum input of AI curve 1	0.0%	-100.0% to 100.0%	F4-14 corresponds to the y axis of AI curve 1 minimum input, that is, the set value corresponding to the minimum analog input.
F4-15	Maximum input of AI curve 1	10.00 V	F4-13 to 10.00 V	F4-15 corresponds to the x axis of AI curve 1 maximum input, that is, the maximum analog input voltage or current.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-16	Percentage corresponding to maximum input of AI curve 1	100.0%	-100.0% to 100.0%	F4-16 corresponds to the y axis of AI curve 1 maximum input, that is, the set value corresponding to the maximum analog input.
F4-17	AI1 filter time	0.10s	0.00s to 10.00s	This parameter indicates the software filter time of AI1. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-18	Minimum input of AI curve 2	0.00 V	-10.00 V to F4-20	F4-18 corresponds to the x axis of the AI curve 2 minimum input, that is, the minimum analog input voltage or current.
F4-19	Percentage corresponding to minimum input of AI curve 2	0.0%	-100.0% to 100.0%	F4-19 corresponds to the y axis of AI curve 2 minimum input, that is, the set value corresponding to the minimum analog input.
F4-20	Maximum input of AI curve 2	10.00 V	F4-18 to 10.00 V	F4-20 corresponds to the x axis of AI curve 2 maximum input, that is, the maximum analog input voltage or current.
F4-21	Percentage corresponding to maximum input of AI curve 2	100.0%	-100.0% to 100.0%	F4-21 corresponds to the y axis of AI curve 2 maximum input, that is, the set value corresponding to the maximum analog input.
F4-22	AI2 filter time	0.10s	0.00s to 10.00s	This parameter indicates the software filter time of AI2. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-23	Minimum input of AI curve 3	0.00 V	-10.00 V to F4-25	F4-23 corresponds to the x axis of the AI curve 3 minimum input, that is, the minimum analog input voltage or current.
F4-24	Percentage corresponding to minimum input of AI curve 3	0.0%	-100.0% to 100.0%	F4-24 corresponds to the y axis of AI curve 3 minimum input, that is, the set value corresponding to the minimum analog input.
F4-25	Maximum input of AI curve 3	10.00 V	F4-23 to 10.00 V	F4-25 corresponds to the x axis of AI curve 3 maximum input, that is, the maximum analog input voltage or current.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-26	Percentage corresponding to maximum input of AI curve 3	100.0%	-100.0% to 100.0%	F4-26 corresponds to the y axis of AI curve 3 maximum input, that is, the set value corresponding to the maximum analog input.
F4-27	AI3 filter time	0.10s	0.00s to 10.00s	This parameter indicates the software filter time of AI3. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-33	AI curve selection	0x321	Ones: AI1 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15) Tens: AI2 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15)	The ones to hundreds places of this parameter are used to select curves for AI1 to AI3. Each digit can be used to set a curve for an AI. Different AIs can be set with the same curve.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-33	AI curve selection	0x321	Continued Hundreds: AI3 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15)	Continued
F4-34	Selection when AI value < minimum input value	0x0	Ones place: Selection when AI1 value < minimum input value 0: Corresponding to the minimum input 1: 0.0% Tens: Selection when AI2 value < minimum input value 0: Corresponding to the minimum input 1: 0.0% Hundreds: Selection when AI3 value < minimum input value 0: Corresponding to the minimum input 1: 0.0%	The ones to hundreds places of this parameter are used to select curves for AI1 to AI3.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-56	AI3 temperature mode - motor temperature sensor type	0	0: Temperature sensor not supported (AI used for analog input) 1: PT100 2: PT1000	A motor temperature sensor needs to be connected to the AI3 and PGND terminals on the MD38IO1 expansion card. The AC drive supports PT100 and PT1000 motor temperature sensors. Set the sensor type properly. Set the DIP switch on the MD38IO1 expansion card. For details, see section MD38IO1 expansion card in the AC drive expansion card selection guide. You can view the motor temperature in U0-34.
F9-57	AI3 temperature mode - motor overheat protection threshold	110°C	F9-58 to 200°C	This parameter is used to set the motor overtemperature protection threshold. When the motor temperature exceeds the value of F9-57 (motor overtemperature protection threshold), the AC drive generates the motor overtemperature alarm (E045.1).
F9-58	AI3 temperature mode - motor overheat warning threshold	90°C	0°C to F9-57	When the motor temperature exceeds the motor overtemperature warning threshold (F9-58), the DO allocated with function 39 (Motor overtemperature warning) outputs a valid signal.
F9-75	AI2 temperature mode - motor temperature sensor type	0	0: Temperature sensor not supported (AI used for analog input) 1: PT100 2: PT1000 3: KTY84-130 4: Single-conductor PTC130 5: Three-conductor PTC130 6: Single-conductor PTC150 7: Three-conductor PTC150 8: Three PT100s connected in series	This parameter is used to select the temperature sensor type when AI2 is used for temperature input.
F9-76	AI2 temperature mode - motor overheat protection threshold	110°C	F9-77 to 200°C	This parameter is used to set the overheat protection threshold when AI2 is used for temperature sampling.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-77	AI2 temperature mode - motor overheat warning threshold	90°C	0°C to F9-76	This parameter is used to set the overheat warning threshold when AI2 is used for temperature sampling.
F9-78	AI2 temperature mode - motor temperature reach	75°C	0°C to 100°C	This parameter is used to set the temperature reach threshold when AI2 is used for temperature sampling.
F9-80	AI3 temperature mode - motor temperature reach	75°C	0°C to 100°C	This parameter is used to set the temperature reach threshold when AI3 is used for temperature sampling.
A6-00	Minimum input of AI curve 4	0.00 V	-10.00 V to A6-02	A6-00 corresponds to the x axis of the AI curve 4 minimum input, that is, the minimum analog input voltage or current.
A6-01	Percentage corresponding to minimum input of AI curve 4	0.0%	-100.0% to 100.0%	A6-01 corresponds to the y axis of AI curve 4 minimum input, that is, the set value corresponding to the minimum analog input.
A6-02	Inflection point 1 input of AI curve 4	3.00 V	A6-00 to A6-04	A6-02 corresponds to the x axis of the AI curve 4 inflection point 1, that is, the minimum analog input voltage.
A6-03	Percentage corresponding to inflection point 1 input of AI curve 4	30.0%	-100.0% to 100.0%	A6-03 corresponds to the y axis of the AI curve 4 inflection point 1, that is, the set value corresponding to the minimum analog input.
A6-04	Inflection point 2 input of AI curve 4	6.00 V	A6-02 to A6-06	A6-04 corresponds to the x axis of the AI curve 4 inflection point 2, that is, the minimum analog input voltage.
A6-05	Percentage corresponding to inflection point 2 input of AI curve 4	60.0%	-100.0% to 100.0%	A6-05 corresponds to the y axis of the AI curve 4 inflection point 2, that is, the set value corresponding to the minimum analog input.
A6-06	Maximum input of AI curve 4	10.00 V	A6-04 to 10.00 V	A6-06 corresponds to the x axis of AI curve 4 maximum input, that is, the maximum analog input voltage or current.
A6-07	Percentage corresponding to maximum input of AI curve 4	100.0%	-100.0% to 100.0%	A6-07 corresponds to the y axis of AI curve 4 maximum input, that is, the set value corresponding to the maximum analog input.
A6-08	Minimum input of AI curve 5	-10.00 V	-10.00 V to A6-10	A6-08 corresponds to the x axis of the AI curve 5 minimum input, that is, the minimum analog input voltage or current.

Parameter Code	Parameter Name	Default	Value Range	Description
A6-09	Percentage corresponding to minimum input of AI curve 5	-100.0%	-100.0% to 100.0%	A6-09 corresponds to the y axis of AI curve 5 minimum input, that is, the set value corresponding to the minimum analog input.
A6-10	Inflection point 1 input of AI curve 5	-3.00 V	A6-08 to A6-12	A6-10 corresponds to the x axis of the AI curve 5 inflection point 1, that is, the minimum analog input voltage.
A6-11	Percentage corresponding to inflection point 1 input of AI curve 5	-30.0%	-100.0% to 100.0%	A6-11 corresponds to the y axis of the AI curve 5 inflection point 1, that is, the set value corresponding to the minimum analog input.
A6-12	Inflection point 2 input of AI curve 5	3.00 V	A6-10 to A6-14	A6-12 corresponds to the x axis of the AI curve 5 inflection point 2, that is, the minimum analog input voltage.
A6-13	Percentage corresponding to inflection point 2 input of AI curve 5	30.0%	-100.0% to 100.0%	A6-13 corresponds to the y axis of the AI curve 5 inflection point 2, that is, the set value corresponding to the minimum analog input.
A6-14	Maximum input of AI curve 5	10.00 V	A6-12 to 10.00 V	A6-14 corresponds to the x axis of AI curve 5 maximum input, that is, the maximum analog input voltage or current.
A6-15	Percentage corresponding to maximum input of AI curve 5	100.0%	-100.0% to 100.0%	A6-15 corresponds to the y axis of AI curve 5 maximum input, that is, the set value corresponding to the maximum analog input.
A6-24	AI1 jump point	0.0%	-100.0% to 100.0%	This parameter is used to set the AI1 jump point. If the input value is within the range from A6-24 - A6-25 to A6-24 + A6-25, the value of the AI1 jump point (A6-24) will be output.
A6-25	AI1 jump amplitude	0.1%	0.0% to 100.0%	This parameter is used to set the AI1 jump amplitude. If the input value is within the range from A6-24 - A6-25 to A6-24 + A6-25, the value of the AI1 jump point (A6-24) will be output.
A6-26	AI2 jump point	0.0%	-100.0% to 100.0%	This parameter is used to set the AI2 jump point. If the input value is within the range from A6-26 - A6-27 to A6-26 + A6-27, the value of the AI2 jump point (A6-26) will be output.
A6-27	AI2 jump amplitude	0.1%	0.0% to 100.0%	This parameter is used to set the AI2 jump amplitude. If the input value is within the range from A6-26 - A6-27 to A6-26 + A6-27, the value of the AI2 jump point (A6-26) will be output.
A6-28	AI3 jump point	0.0%	-100.0% to 100.0%	This parameter is used to set the AI3 jump point. If the input value is within the range from A6-28 - A6-29 to A6-28 + A6-29, the value of the AI3 jump point (A6-28) will be output.

Parameter Code	Parameter Name	Default	Value Range	Description
A6-29	AI3 jump amplitude	0.1%	0.0% to 100.0%	This parameter is used to set the AI3 jump amplitude. If the input value is within the range from A6-28 - A6-29 to A6-28 + A6-29, the value of the AI3 jump point (A6-28) will be output.
A6-30	AI automatic adjustment curve	0	Ones: Point selection (for setting) 0: Disable 1: Point 1 2: Point 2 3: Point 3 4: Point 4 Tens: AI channel selection (for setting) 0: Disable 1: Corrected AI1 2: Corrected AI2 3: Corrected AI3 Hundreds: AI automatic adjustment curve (for setting) 0: Disable 1: Enable Thousands: X-point curve (for display) 0: Enabling or channel is not selected 2: 2-point curve 4: 4-point curve Ten thousands: Reserved	You can set different AI curves, control functions, and curve types (2-point curve or 4-point curve) through the ones, tens, hundreds, thousands, and ten thousands places of this parameter.
A6-31	AI1 input	0	0: Disable 1: Enable Other: B connector	-
A6-32	AI2 input	0	0: Disable 1: Enable Other: B connector	-

Parameter Code	Parameter Name	Default	Value Range	Description
A6-33	AI3 input	0	0: Disable 1: Enable Other: B connector	-
A6-34	AI polarity selection	0	Ones: AI1 polarity 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value Tens: AI2 polarity 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value Hundreds: AI3 polarity 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value	You can set AI1, AI2, and AI3 input polarities through the ones, tens, and hundreds places of this parameter. 0: Normal value 1: Absolute value 2: Opposite to the normal value 3: Opposite to absolute value
A6-35	AI hardware source selection	0	Ones: AI1 source 0: Hardware sampling 1: Forced value Tens: AI2 source 0: Hardware sampling 1: Forced value Hundreds: AI3 source 0: Hardware sampling 1: Forced value	You can set AI1, AI2, and AI3 hardware sources through the ones, tens, and hundreds places of this parameter. If the source is set to 0 (hardware sampling), the AI value is sourced from hardware sampling. If the source is set to 1 (forced value), the AI value can be forcibly set through parameters A6-36 to A6-38.
A6-36	AI1 forced value	0.00 V	-10.00 V to 10.00 V	If the ones place of A6-35 is set to 1 (forced value), you can set the AI1 value forcibly through A6-36.
A6-37	AI2 forced value	0.00 V	-10.00 V to 10.00 V	If the tens place of A6-35 is set to 1 (forced value), you can set the AI2 value forcibly through A6-37.

Parameter Code	Parameter Name	Default	Value Range	Description
A6-38	AI3 forced value	0.00 V	-10.00 V to 10.00 V	If the hundreds place of A6-35 is set to 1 (forced value), you can set the AI3 value forcibly through A6-38.
A6-39	High level judgment threshold when AI uses as DI	7.0 V	5.5 V to 9.0 V	This parameter defines the threshold for judging high level when the AI is used as the DI.
A6-40	Low level judgment threshold when AI uses as DI	3.0 V	1.0 V to 4.5 V	This parameter defines the threshold for judging low level when the AI is used as the DI.
A6-41	AI1 gain	1.00	-10.00 to 10.00	This parameter defines the gain multiple of AI1 analog sampling value.
A6-42	AI1 offset	0.00 V	-10.00 V to 10.00 V	This parameter defines the zero offset coefficient for AI1 correction voltage.
A6-43	AI1 denoising threshold	0.5%	0.0% to 100.0%	This parameter defines the AI1 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-44	AI1 dead zone width	0.5%	0.0% to 100.0%	This parameter defines the AI1 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.
A6-47	AI2 gain	1.00	-10.00 to 10.00	This parameter defines the gain multiple of AI2 analog sampling value.
A6-48	AI2 offset	0.00 V	-10.00 V to 10.00 V	This parameter defines the AI2 analog sampling offset.
A6-49	AI2 denoising threshold	0.5%	0.0% to 100.0%	This parameter defines the AI2 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-50	AI2 dead zone width	0.5%	0.0% to 100.0%	This parameter defines the AI2 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.
A6-53	AI3 gain	1.00	-10.00 to 10.00	This parameter defines the gain multiple of AI3 analog sampling value.
A6-54	AI3 offset	0.00 V	-10.00 V to 10.00 V	This parameter defines the AI3 analog sampling offset.
A6-55	AI3 denoising threshold	0.5%	0.0% to 100.0%	This parameter defines the AI3 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-56	AI3 dead zone width	0.5%	0.0% to 100.0%	This parameter defines the AI3 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.

Table 1–20 Procedure for setting the AI as the frequency reference

Procedure	Parameter	Description	
AI selection: Select the AI for setting the frequency reference based on terminal characteristics.	F0-03	F0-03 = 2	AI1 is used.
		F0-03 = 3	AI2 is used.
		F0-03 = 4	AI3 is used.
Curve between AI voltage[1] and frequency: Select any of the five curves.	F4-33	Generally, F4-33 is set to the default value 321. That is, AI1 uses curve 1, AI2 uses curve 2, and AI3 uses curve 3.	
Curve between AI voltage[1] and frequency: Set the relationship between AI voltage inputs and the set values.	F4-13 to F4-16 [2]	Curve 1 setting	Typical curve [3]
	F4-18 to F4-21	Curve 2 setting	Typical curve [4]
	F4-23 to F4-27	Curve 3 setting	Typical curve [5]
	A6-00 to A6-07	Curve 4 setting	
	A6-08 to A6-15	Curve 5 setting	
	F4-34	Selection when AI value < minimum input value[2]	
	F0-10	When the AI is used as the frequency reference source, the value 100% of the voltage/current input corresponds to the value of F0-10 (Maximum frequency).	
AI filter time	F4-17	The default value is 0.1s. Set this parameter to balance the response speed and anti-interference capability. If quick response is required, reduce the setpoint of F4-17. If the interference on site is strong, increase the setpoint of F4-17.	

[1] For the current-type AI curve, 1 mA current corresponds to 0.5 V voltage. That is, 20 mA corresponds to 10 V.

[2] When the analog input voltage exceeds the maximum value (F4-15), the maximum value is used as the analog input voltage. When the analog input voltage is less than the minimum value (F4-13), the value (minimum input value or 0.0%) of F4-34 (selection when AI value < minimum input value) is used as the analog input voltage.

[3] The typical curve of AI1 is shown in the following figure.

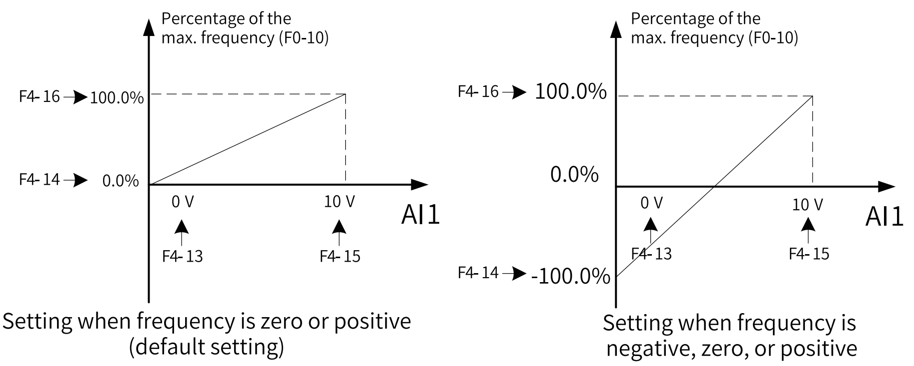


Figure 1-43 Typical curve of AI1

[4] The typical curve of AI2 for voltage input is consistent with that of AI1. When AI2 is used for current input, set 4 mA to 20 mA, which corresponds to 0 Hz to 50 Hz or -50 Hz to 50 Hz.

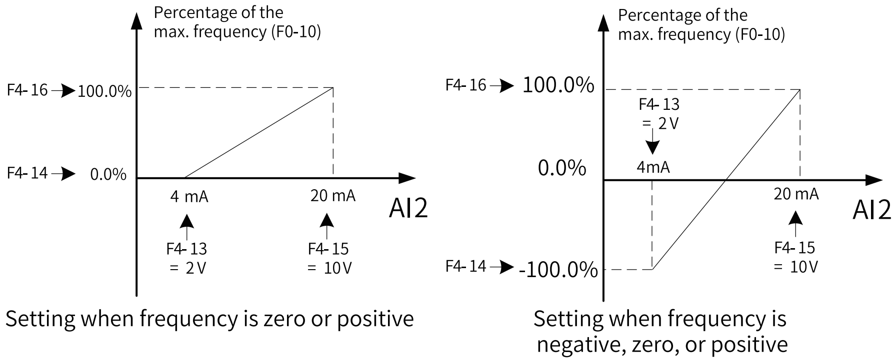


Figure 1-44 Typical curve of AI2

[5] The typical curve of AI3 is shown in the following figure. The corresponding relations in the following two setting methods are the same in the voltage range from 0 V to 10 V. However, when the negative voltage is input, the voltage will be limited to 0 V (F4-24) in the setting method shown in the left figure.

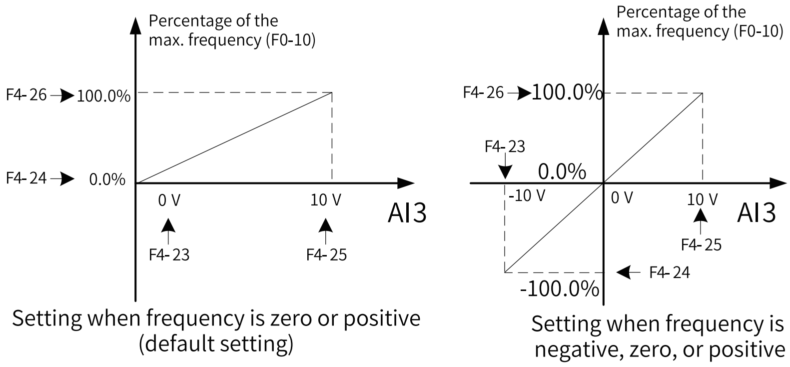


Figure 1-45 Typical curve of AI3

Different from the manually corrected curve, the voltage of the correction point can be filled in automatically to the AI automatically corrected curve. The function of each decimal digital place of A6-30 (AI curve automatic correction) is as follows.

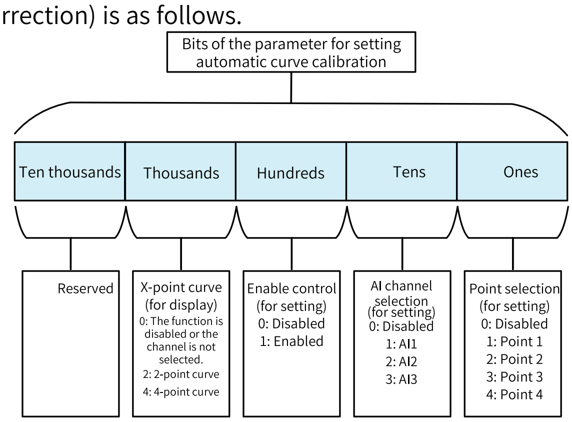


Figure 1-46 Function of each decimal digital place of A6-30

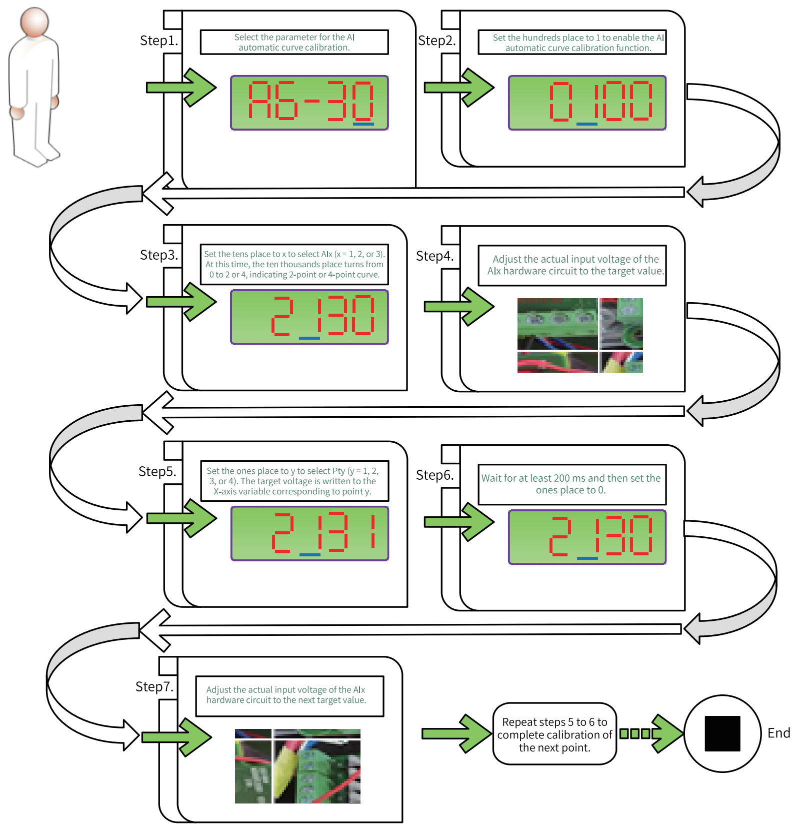


Figure 1-47 Operation of AI curve automatic correction

1.3.7 Analog and Pulse Output Terminal (AO and HDO) Functions

The AC drive is equipped with one analog output terminal AO and one high-speed pulse output terminal HDO as standard. If more AOs are required by field applications, an I/O expansion card can be selected. For the number of AOs on each expansion card, see "Expansion Card". For example, the expansion card MD38IO1 provides one analog output terminal AO2.

The following parameters are used to rectify the zero drift of the AO and the deviation of output amplitude, and customize AO/HDO output curves.

Table 1–21 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
F5-00	FM multi-functional terminal output selection	0	0: Pulse output (FMP) 1: Switch output (FMR)	The FM terminal is a programmable multi-functional terminal, which can be used as the high-speed pulse output (FMP) terminal or open collector digital output terminal (FMR). 0: When the terminal is used for high-speed pulse output, the maximum frequency is 100 kHz. 1: When the terminal is used as open collector output, specifications are the same as DO1.
F5-06	FMP output function selection	0	0: Operating frequency 1: Frequency reference 2: Output current 3: Output torque (absolute value) 4: Output power 5: Output voltage 6: Pulse input 7: AI1 8: AI2 9: AI3 10: Length 11: Count value 12: Communication 13: Motor speed 14: Output current. 100.0% corresponds to 1000.0 A. 15: Bus voltage. 100.0% corresponds to 1000.0 V. 16: Output torque (actual value) Others: F connector	0: Running frequency. 100.0% corresponds to the maximum frequency (F0-10). 1: Frequency reference. 100.0% corresponds to the maximum frequency (F0-10). 2: Output current. 100.0% corresponds to two times the rated motor current. 3: Output torque. 100.0% corresponds to two times the rated motor torque (absolute value). 4: Output power. 100.0% corresponds to two times the rated motor power. 5: Output voltage. 100.0% corresponds to 1.2 times the rated motor voltage. 6: Pulse input. 100.0% corresponds to 100.0 kHz. 7: AI1. 100.0% corresponds to 10 V. 8: AI2. 100.0% corresponds to 10 V. 9: AI3. 100.0% corresponds to 10 V. 10: Length. 100.0% corresponds to FB-05. 11: Count value. 100.0% corresponds to FB-08. 12: Communication. 100.0% corresponds to the AO communication setting value. 13: Motor speed. 100.0% corresponds to the maximum frequency (F0-10). 14: Output current. 100.0% corresponds to 1000.0 A. 15: Bus voltage. 100.0% corresponds to 1000.0 V. 16: Output torque. 100.0% corresponds to two times the rated motor torque, 50.0% corresponds to 0, and 0 corresponds to negative two times the rated motor torque (actual value). Others: F connector When this option is selected, the output function is the signal or function state of the parameter to which the connector is connected.
F5-07	AO1 output function selection	0		
F5-08	Output function selection of AO2 on expansion card	1		
F5-09	Maximum frequency of FMP output	50.00 kHz	0.01 kHz to 100.00 kHz	This parameter indicates the maximum frequency (0.01 kHz to 100.00 kHz) of the FMP terminal output pulse.

Parameter Code	Parameter Name	Default	Value Range	Description
F5-10	AO1 zero offset coefficient	0.0%	-100.0% to 100.0%	On the AO curve, if b indicates zero offset, k indicates gain, and X indicates standard output, the actual output Y is kX plus b (Y = kX + b). The zero offset coefficient 100% of AO1 and AO2 corresponds to 10 V (or 20 mA). The standard output refers to the value corresponding to the analog output of 0 V to 10 V (or 0 mA to 20 mA) with no zero offset or gain correction. Zero offset = Zero offset coefficient x 10 V (or 20 mA) The drive supports two AOs, AO1 and AO2, which can be used to indicate the internal operating parameters in the analog mode. The parameter property indicated is defined by F5-07 and F5-08.
F5-11	AO1 gain	1.00	-10.00 to 10.00	
F5-12	AO2 zero offset coefficient	0.0%	-100.0% to 100.0%	
F5-13	AO2 gain	1.00	-10.00 to 10.00	
F5-36	Minimum input of AO1 curve	0.0%	-100.0 to F5-38	This parameter corresponds to the x axis of the minimum input, that is, the minimum output frequency of AO1 curve.
F5-37	Setting correspond-ing to AO1 curve minimum input	0.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the minimum input, that is, the set value corresponding to the minimum output of AO1 curve.
F5-38	Maximum input of AO1 curve	100.0-%	F5-36 to 100.0%	This parameter corresponds to the x axis of the maximum input, that is, the maximum output frequency of AO1 curve.
F5-39	Setting correspond-ing to AO1 curve maximum input	10.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the maximum input, that is, the set value corresponding to the maximum output of AO1 curve.
F5-40	AO1 output offset	0.00 V	-10.00 V to 10.00 V	AO1 curve linear parameters
F5-41	Minimum input of AO2 curve	0.0%	-100.0 to F5-43	This parameter corresponds to the x axis of the minimum input, that is, the minimum output frequency of AO2 curve.
F5-42	Setting correspond-ing to AO2 curve minimum input	0.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the minimum input, that is, the set value corresponding to the minimum output of AO2 curve.
F5-43	Maximum input of AO2 curve	100.0-%	F5-41 to 100.0%	This parameter corresponds to the x axis of the maximum input, that is, the maximum output frequency of AO2 curve.

Parameter Code	Parameter Name	Default	Value Range	Description
F5-44	Setting corresponding to AO2 curve maximum input	10.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the maximum input, that is, the set value corresponding to the maximum output of AO2 curve.
F5-45	AO2 output offset	0.00 V	-10.00 V to 10.00 V	AO2 curve linear parameters
F5-46	AO curve selection	11	Ones: AO1 curve 0: Two-point curve 1: Gain + deviation Tens: AO2 curve 0: Two-point curve 1: Gain + deviation	The ones and tens places of this parameter are used to set the AO1 and AO2 curve types. 0: Two-point curve Set the 2-point curve parameters of AO1 and AO2 through F5-36 to F5-45. 1: Gain + deviation Set the gain and deviation parameters of AO1 and AO2 through F5-10 to F5-13.
F5-47	AO polarity selection	00	Ones: AO1 selection 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value Tens: AO2 selection 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value	Set the AO1 and AO2 curve output polarity through the ones and tens of this parameter. 0: Normal value AO curve output value unchanged 1: Absolute value Absolute value of the AO curve output value used 2: Opposite to normal value AO curve output value inverted 3: Opposite to absolute value Absolute value of the AO curve output value inverted
F5-48	AO hardware source selection	00	Ones: AO1 source 0: Output function 1: Forced value Tens: AO2 source 0: Output function 1: Forced value	Set the AO1 and AO2 curve input source through the ones and tens of this parameter. 0: Output function Select the reference source based on F5-07 and F5-08. 1: Forced value Select the forced output value based on F5-49 and F5-50.
F5-49	AO forced value 1	0.00 V	0.00 V to 10.00 V	If the ones place of F5-48 is set to "1: Forced value", you can set the AO1 forced value through F5-49.
F5-50	AO forced value 2	0.00 V	0.00 V to 10.00 V	If the tens place of F5-48 is set to "1: Forced value", you can set the AO2 forced value through F5-50.
F5-51	Minimum input of HDO curve	0.00%	-100.00 to F5-53	This parameter corresponds to the x axis of the minimum input, that is, the minimum input frequency of HDO curve.

Parameter Code	Parameter Name	Default	Value Range	Description
F5-52	Percentage corresponding to minimum input of HDO curve	0.00%	0.00% to 100.00%	This parameter corresponds to the y axis of the minimum input, that is, the set value corresponding to the minimum input frequency of HDO curve.
F5-53	Maximum input of HDO curve	100.00%	F5-51 to 100.00%	This parameter corresponds to the x axis of the maximum input, that is, the maximum input frequency of HDO curve.
F5-54	Percentage corresponding to maximum input of HDO curve	100.00%	0.00% to 100.00%	This parameter corresponds to the y axis of the maximum input, that is, the set value corresponding to the maximum input frequency of HDO curve.
F5-55	HDO polarity selection	0	Ones: HDO selection 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value	Set the HDO output polarity through the ones place of this parameter. 0: Normal value HDO output value unchanged 1: Absolute value Absolute value of the HDO output value used 2: Opposite to normal value HDO output value inverted 3: Opposite to absolute value Absolute value of the HDO output value inverted
F5-56	HDO hardware source selection	0	0: Output function 1: Forced value	0: Set F5-51 to F5-55 to set the HDO output value. 1: The forced value set by F5-57 is used as the HDO output value.
F5-57	HDO forced value	0	0.00% to 100.00%	This parameter is used to set the HDO output value forcibly. This parameter is valid only when F5-56 is set to 1.

The analog output 0 V to 10 V corresponds to 0% to 100%. When the AO function is set to 1 (frequency setting), and the drive frequency is set to 50% of the maximum frequency, the output voltage of the AO is 5 V (50% x 10 V).

The FM (pulse output) 0 kHz to 100 kHz corresponds to 0% to 100%. When the FM output function is set to 1 (frequency setting), the drive frequency is set to 50% of the maximum frequency, and F5-09 is set to 100 kHz, the output frequency of the FM terminal is 50 kHz (50% x 100 kHz).

The following is an example of how to calculate AO zero offset coefficient (F5-10) and AO gain (F5-11).

Assume that the AO outputs the operating frequency. The rectified output needs to be 8 V (Y1) when the frequency is 0 Hz (X1) and 4 V (Y2) when the frequency is 40 Hz (X2).

Formula for calculating the gain:

$$K = \frac{(Y1\text{-}Y2) \times Xmax}{(X1\text{-}X2) \times Ymax}$$

Formula for calculating zero offset coefficient:

$$b=\frac{(X1\times Y2)\ -\ (X2\times Y1)}{(X1-X2)\ \times\ Ymax}\times 100\%$$

Xmax is the maximum output frequency 50 Hz (assume that the maximum frequency F0-10 is 50 Hz). Ymax is the voltage and the value is 10 V.

The value of F5-11 (AO gain) is -0.5 and the value of F5-10 (AO zero offset coefficient) is 80%.

Table 1–22 Relationship between analog output signal types and corresponding maximum values (Ymax)

Analog Output Signal Type	Corresponding Max. Value (Ymax)
Voltage	10 V
Current	20 mA/40 mA

Table 1–23 Relationship between analog output content and corresponding maximum values (Xmax)

Analog Output Content	Corresponding Max. Value (Xmax)
Operating frequency	Maximum output frequency
Frequency reference	Maximum output frequency
Output current	2 x Rated motor current
Output torque (absolute value)	2 x Rated motor torque
Output power	2 x Rated power
Output voltage	1.2 x Rated drive voltage
Pulse input	100.00 kHz
AI1	10 V
AI2	10 V, 20 mA, or 40 mA
AI3	10 V
Length	Maximum set length
Count value	Maximum counting value
Communication setting	100.0%
Motor speed	Speed at the maximum output frequency
Output current	1000.0 A
Output voltage	1000.0 V
Output torque (actual value)	2 x Rated motor torque

1.4 Control Performance

1.4.1 V/f Curve Setting

Table 1–24 Straight-line, multi-point, and square V/f curve reference parameters

Param.	Name	Default	Value range	Descriptions
F3-00	V/f curve setting	0	0: Linear V/f 1: Multi-point V/f 2, 9: Reserved 10: V/f complete separation mode 11: V/f semi-separation mode	V/f curve setting. In V/f mode, different V/f curves can be set according to different application conditions. 0: Linear V/f curve The output voltage changes linearly with the output frequency when the frequency is lower than the rated frequency. This curve applies to general mechanical transmission applications such as acceleration of high-inertia fans, punch presses, centrifuges, and water pumps. 1: Multi-point V/f curve The frequency ranges from 0.00 Hz to the rated motor frequency. The range of the voltage point is 0.0% to 100.0%, which corresponds to 0 V to the rated motor voltage. Set the multi-point V/f curve based on load characteristics of the motor. Observe this formula during settings: F3-03 ≤ F3-05 ≤ F3-07 10: V/f complete separation mode The output frequency and output voltage of the drive are independent of each other. The output frequency is determined by the frequency source, and the output voltage is determined by the V/f separation voltage source. This curve applies to torque motor control applications. 11: V/f semi-separation mode In this mode, the voltage and frequency are proportional, which can be set through the voltage source. The relationship between the voltage and frequency is also related to the rated motor voltage and rated motor frequency. The relationship between the AC drive output voltage V and frequency f is: V/f = 2 x (voltage source input) x (rated motor voltage) ÷ (rated motor frequency). Note: The input value of the voltage source is 0% to 100%.
F3-01	Torque boost	2.0%	0.0% to 30.0%	The torque boost function is generally applicable to low-frequency operations of the drive. The output torque of the AC drive in the V/f control mode is proportional to the frequency. During operation at low frequencies, the motor torque is low when the motor runs at a low speed. In this case, you can set this parameter to increase the output voltage of the drive to improve the output torque. Note that the torque boost value must be set properly. Otherwise, overload protection will be triggered.
F3-02	Cut-off frequency of torque boost	50.00 Hz	0.00 Hz to F0-10	When the operating frequency reaches the cutoff frequency of torque boost, the torque boost function is disabled.

Param.	Name	Default	Value range	Descriptions
F3-03	Multi-point V/f frequency 1	0.00 Hz	0.00 Hz to F3-05	Frequency point 1 set by multi-point V/f curve
F3-04	Multi-point V/f voltage 1	0.0%	0.0% to 100.0%	
F3-05	Multi-point V/F frequency 2	0.00 Hz	F3-03 to F3-07	
F3-06	Multi-point V/f voltage 2	0.0%	0.0% to 100.0%	
F3-07	Multi-point V/f frequency 3	0.00 Hz	F3-05 to F1-04	
F3-08	Multi-point V/f voltage 3	0.0%	0.0% to 100.0%	

Straight-line V/f curve

The following figure shows the general constant-torque straight-line V/f curve.

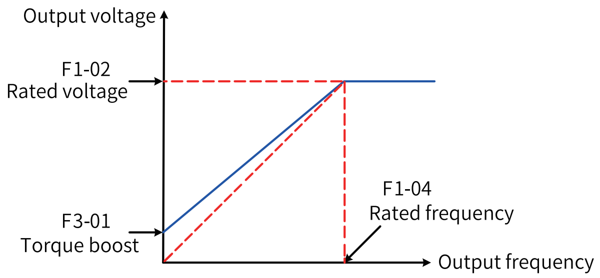


Figure 1-48 General constant-torque linear V/f curve

The output voltage and output frequency change linearly at frequencies lower than the rated frequency. It is applicable to general mechanical transmission applications such as acceleration of high-inertia fans, punch presses, centrifuges, and water pumps.

Multi-point V/f curve

User-defined multi-point V/f curve

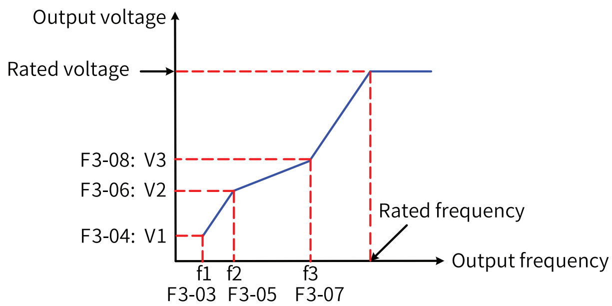


Figure 1-49 User-defined multi-point V/f curve

The multi-point V/f curve is defined by F3-03 to F3-08. The range of the frequency point is 0.00 Hz to the rated frequency of the motor. The range of the voltage point is 0.0% to 100%, corresponding to 0 V to the rated voltage of the motor. Set the multi-point V/f curve based on motor load characteristics. Observe this formula during setting: F3-03 ⩽ F3-05 ⩽ F3-07. To ensure correct setting, the drive limits F3-03, F3-05 and F3-07. Set F3-07 first, then F3-05 and finally F3-03.

Table 1–25 V/f separation curve parameters

Param.	Name	Default	Value range	Descriptions
F3-13	Voltage source for separated V/f	0	0: F3-14 1: AI1 2: AI2 3: AI3 4: Pulse reference (DI5) 5: Multi-reference 6: Simple PLC 7: PID 8: Communication Others: F connector	Defines the target voltage reference source in case of separated V/f. 0: F3-14 The V/f separated voltage is set by F3-14. 1: AI1 The V/f separated voltage is input with the current or voltage signal through the AI1 terminal. The frequency is calculated according to the set AI curve. 2: AI2 The V/f separated voltage is input with the current or voltage signal through the AI2 terminal. The frequency is calculated according to the set AI curve. 3: AI3 The V/f separated voltage is input with the current or voltage signal through the AI3 terminal. The frequency is calculated according to the set AI curve. The AC drive has two AI terminals by default, and the AI3 terminal needs to be provided through the I/O expansion card. 4: Pulse reference (DI5) The V/f separated voltage is input with the pulse frequency through the DI5 terminal. The frequency is calculated according to the corresponding relationship curve between the pulse frequency and operating frequency. 5: Multi-reference In the multi-reference mode, combinations of different DI terminal states correspond to different setting values. The four multi-reference terminals can be grouped in different ways to indicate 16 states, which correspond to 16 frequency references (percentage x maximum frequency) in group FC. 6: Simple PLC The V/f separated voltage is set by simple PLC. For details, see the function description of simple PLC.
(Continued)				7: PID The V/f separated voltage is set by PID. For details, see the PID function description. 8: Communication The V/F separation output voltage is set via communication. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. Others: F connector Read the value of a floating-point connector as the V/f separation voltage in speed control mode by setting the function code number of the connector. This mode is used for expansion besides the common sources.

Param.	Name	Default	Value range	Descriptions
F3-14	Voltage digital setting for V/f separation	0V	0 V to rated motor voltage (F1-02)	The setting range is 0 V to the rated voltage.
F3-15	Voltage rise time of V/f separation	0.0s	0.0s to 1000.0s	This parameter indicates the time required for the output voltage to accelerate from 0 to the rated motor voltage.
F3-16	Voltage decline time of V/f separation	0.0s	0.0s to 1000.0s	This parameter indicates the time required for the output voltage to decelerate from the rated motor voltage to 0.
F3-17	Stop mode for separated V/f	0	0: The frequency and the voltage decline to 0 separately. 1: Te frequency declines to 0 after the voltage declines to 0. 2: Free stop (new)	Stop mode of frequency/voltage 0: The frequency/voltage declines to 0 independently based on respective deceleration time. 1: The voltage declines to 0 based on the deceleration time. Then the frequency declines to 0 based on the deceleration time. 2: The voltage/frequency coasts to stop, regardless of the deceleration curve.

Voltage acceleration time indicates time needed to rise from 0 to rated motor voltage. See t1 in the figure.

Voltage deceleration time indicates time needed to decline from rated motor voltage to 0. See t2 in the figure.

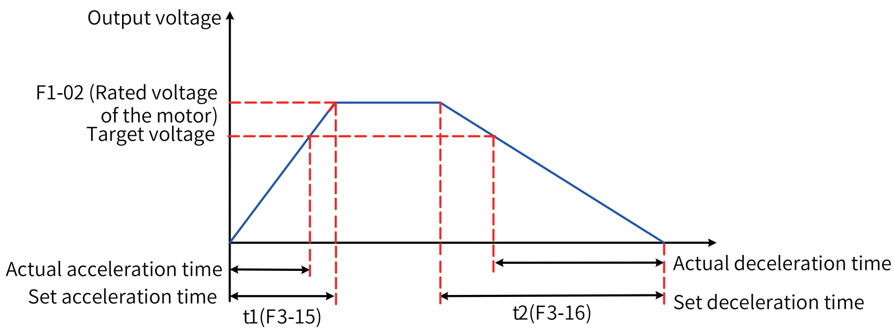


Figure 1-50 Diagram for separated V/f

1.4.2 Output Current (Torque) Limit

During acceleration, operation at constant speed, or deceleration, if the current exceeds the overcurrent stall action current (default: 150%, indicating 1.5 times the rated AC drive current), the current limit mechanism is activated. In this case, the output frequency decreases until the current drops below the overcurrent stall action current. Then, the output frequency increases toward the target frequency. Therefore, the acceleration is prolonged. If the actual acceleration time cannot meet your requirement, increase the value of overcurrent stall action current (F3-18) accordingly.

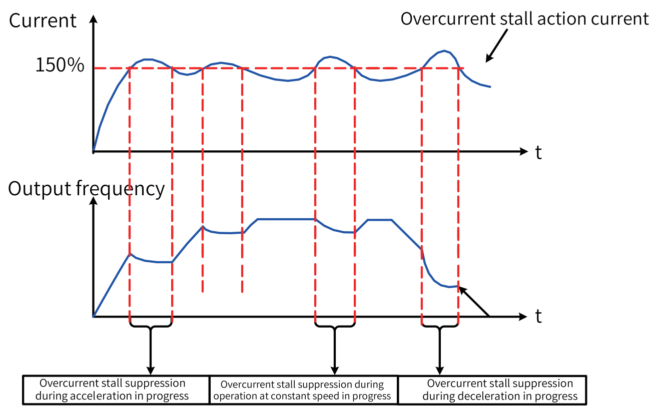


Figure 1-51 Overcurrent stall action

Table 1–26 Related parameter list

Parameter	Name	Default	Value range	Descriptions
F3-18	V/f current limit level	150%	50% to 200%	When the motor current reaches this value, the AC drive starts overcurrent stall function. The default value is 150%, corresponding to 1.5 x rated current of the AC drive.
F3-19	V/f current limit selection	1	0: Enable 1: Disable	Determines whether the V/f current limit function is enabled.
F3-20	V/f current limit gain	20	0 to 100	When the current exceeds the action current of overcurrent stall, the overcurrent stall function is enabled and output frequency decreases. After the current falls below the overcurrent stall threshold, the output frequency increases to the target frequency again, which prolongs the actual acceleration time automatically. The higher the setpoint, the better the suppression effect.
F3-21	Compensation coefficient of V/f speed multiplying current limit	100%	50% to 200%	This parameter reduces the overcurrent stall actuating current at high speed. It is invalid when set to 50%. The recommended value for F3-18 in the field weakening area is 100%.

In the high frequency area, the motor drive current is small. At the same stall current, the motor speed drops faster when the motor runs below the rated frequency than when the motor runs above the rated frequency. To improve motor running characteristic, you can lower down the stall action current when the motor runs above the rated frequency. The method improves acceleration performance and prevents the motor from stall in the application where high running frequency and several times the field weakening are required and load inertia is large, such as centrifuges.

The following is the expression of overcurrent action current exceeding the rated frequency.

$$\text{Overcurrent stall action current} = \left(\frac{fn}{fs}\right) \times k \times \text{LimitCur}$$

fs: running frequency; fn: rated motor frequency; k: compensation factor of speed multiplying current limit level (F3-21); LimitCur: current limit level (F3-18)

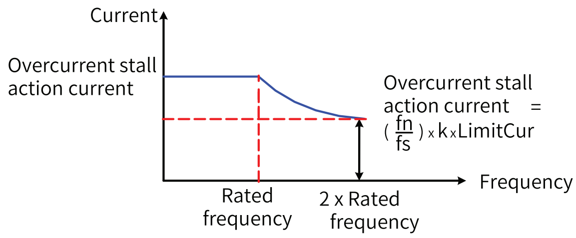


Figure 1-52 Overcurrent stall action at multiplied rated frequency

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Note

For high-power motors with carrier frequency below 2 kHz, lower the overcurrent stall action current. Otherwise, the pulse-by-pulse current limit function is enabled before the overcurrent stall prevention function as ripple current increases, resulting in insufficient torque output.

1.4.3 Overvoltage stall suppression

When the bus voltage rises above the value of F3-22 (overvoltage stall action voltage), the motor enters the generating state (motor speed > output frequency). In this case, the overvoltage stall function is activated, which adjusts the output frequency and extends the deceleration time to prevent trip. If the actual deceleration time cannot satisfy the requirement, increase the over-excitation gain.

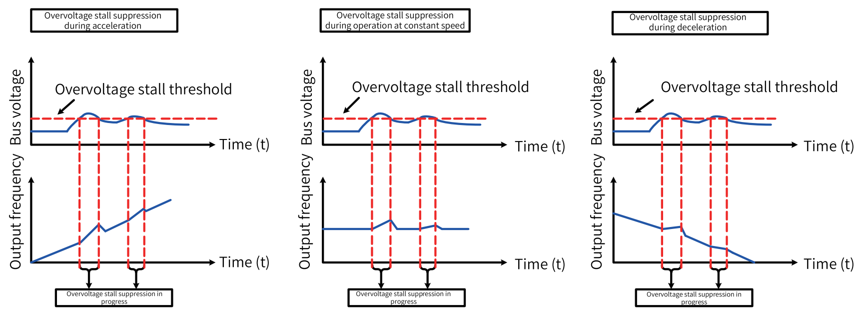


Figure 1-53 Overvoltage stall suppression action

Parameter	Name	Default	Value range	Descriptions
F3-22	V/f voltage limit level	770.0V	330.0 V to 800.0 V	When the bus voltage reaches this value, the AC drive starts overvoltage stall protection.
F3-23	V/f voltage limit selection	1	0: Enable 1: Disable	V/f overvoltage stall suppression is enabled. 0: Inactive 1: Enable (default) The function of F3-23 is equivalent to F9-04 (V/f overvoltage stall suppression protection voltage). When a braking resistor, braking unit, or energy feedback unit is used, set this parameter to 0. Otherwise, the deceleration time may be prolonged.

Parameter	Name	Default	Value range	Descriptions
F3-24	V/f frequency gain for voltage limit	30	1 to 500	Increasing F3-24 improves the control effect of bus voltage, but the output frequency will fluctuate. If the output frequency fluctuates greatly, reduce F3-24 appropriately. The function of F3-24 is the same as F9-03 (Overvoltage stall suppression gain).
F3-25	V/f voltage gain for voltage limit	30	1 to 500	This parameter suppresses the bus voltage. Increasing the parameter value can reduce the overshoot of the bus voltage.
F3-26	Frequency rise threshold for overvoltage stall suppression	5 Hz	0 Hz to 50 Hz	The operating frequency may increase during overvoltage stall suppression. This parameter defines the upper limit of frequency rise.
F3-10	V/f over-excitation gain	64	0 to 200	The higher the over-excitation gain, the better the suppression effect will be. When a braking resistor, braking unit, or energy feedback unit is used, set this parameter to 0. Otherwise, overcurrent may occur during operation.
F3-11	V/f oscillation suppression gain	40	0 to 100	The higher the oscillation gain, the better the suppression effect will be.

Note

Observe the following requirements when using the braking resistor or energy feedback unit.

- Set F3–10 (Overexcitation gain) to 0. Failure to comply may lead to overcurrent during operation.
- Set F3–23 (Overvoltage stall selection) to 0. Failure to comply may prolong the deceleration time.

1.4.4 Speed Loop

Speed loop PI parameters are divided into low-speed parameters and high-speed parameters. If the running frequency is lower than F2-02 (Switchover frequency 1), PI parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI parameters are F2-03 and F2-04. If the running frequency is between F2-02 and F2-05, PI parameters are switched over linearly between two groups of PI parameters, as shown below.

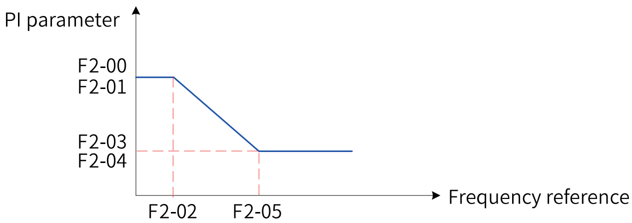


Figure 1-54 Speed loop PI parameters

When the running frequency is smaller than "Switchover frequency 1" (F2-02), the parameters of the speed loop are F2-00 (Speed loop proportional gain 1) and F2-01 (Speed loop integral time 1). When the running frequency is larger than "Switchover frequency 2" (F2-05), The speed loop parameters are F2-03 (speed loop proportional gain 2) and F2-04 (speed loop integral time 2). When the running frequency is between F2-02 and F2-05, the speed loop parameters are linear changes of the low-speed and high-speed PI parameters.

By setting the proportional coefficient and integral time of the speed regulator, you can adjust the dynamic response of the speed vector control (the response of the control system output from the initial state to the final state under the influence of a typical input signal).

Increasing the proportional gain or reducing the integral time can speed up dynamic response of the speed loop. However, too large proportional gain or too small integral time may cause system oscillation.

The recommended adjustment method is to perform dynamic complete motor parameter auto-tuning first, and the AC drive will identify a group of parameters. If the motor parameters cannot be auto-tuned by the AC drive, fine-tune the auto-tuning parameters based on auto-tuning. Increase the proportional gain to ensure that the system does not oscillate. Then reduce the integral time to ensure that the system has a fast response characteristic and overshoot (an important parameter of the dynamic performance indicator of the control system). It indicates that the ratio between the maximum instantaneous deviation value and the steady state value of the modulation is small under step input.

Note

Improper PI parameter settings may lead to a high speed overshoot. In addition, overvoltage may occur when overshoot drops.

Increasing F2-07 improves motor stability but weakens dynamic responsiveness. Decreasing F2-07 weakens motor stability but improves dynamic responsiveness. Note that setting F2-07 to an excessively low value may cause motor oscillation. The default value of F2-07 applies to most of applications.

Parameter	Name	Default	Value range	Descriptions
F2-00	Speed loop proportional gain 1	30	1 to 300	This parameter sets the low-speed speed loop gain Kp. The value of speed loop Kp affects the response speed of the motor speed. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity. The low-speed speed loop Kp is used at the low speed.
F2-01	Speed loop integral time 1	0.500s	0.001 to 10.000	This parameter sets the low-speed speed loop integral time Ti. The reciprocal of the speed loop integral time constant is the integral gain. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. Increasing the speed loop integral time constant slows down the response of the speed loop. In this case, increase the speed loop proportional gain to shorten the response time of the speed loop. The low-speed speed loop Ti is used at the low speed.
F2-02	Switchover frequency 1	5.00 Hz	0.00 to F2-05	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. The parameter value must be lower than F2-05 (Switchover frequency 2).
F2-03	Speed loop proportional gain 2	20	1 to 300	This parameter sets the high-speed speed loop gain Kp. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity.
F2-04	Speed loop integral time 2	1.00s	0.01s to 10.00s	This parameter sets the high-speed speed loop integral time Ti. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. Increasing the speed loop integral time constant slows down the response of the speed loop. In this case, increase the speed loop proportional gain to shorten the response time of the speed loop.

Parameter	Name	Default	Value range	Descriptions
F2-05	Switchover frequency 2	10.00 Hz	F2-02 to F0-10	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. This parameter must be set to a value higher than F2-02 (Switchover frequency 1).
F2-07	Speed loop feedback filter time in SVC mode	0.004s	0.000–0.100s	In the SVC mode, this parameter is used to adjust the speed stability accuracy of the motor. For example, when the running frequency of the motor is lower than the output frequency of the AC drive, you can increase the value of this parameter. In the FVC mode, this parameter is used to adjust the output current of the AC drive under the same load. For example, if the load capacity of a high-power AC drive is weak, decrease the value of this parameter gradually. No adjustment is required under normal circumstances.

1.4.5 Torque Feedforward

Torque feedforward used in the speed control mode improves the torque reference response speed and decreases the speed deviation at the fixed speed. The following figure describes the torque feedforward function.

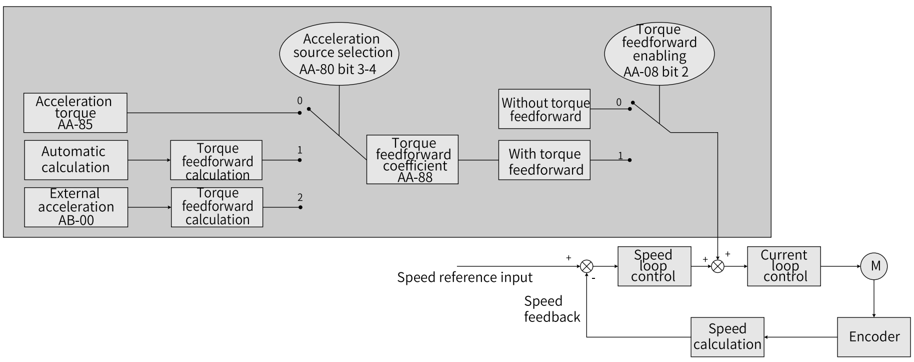


Figure 1-55 Torque feedforward function

Parameter Code	Parameter Name	Value Range	Default	Description
AA-80	Speed loop command word	Bit 0: Speed loop 0: Disable 1: Enable Bit 1: Integral mode 0: Traditional integral 1: Position integral Bit 2: Torque feedforward 0: Disable 1: Enable Bit 3 to bit 4: Acceleration source selection 0: Torque set by parameter 1: Automatic calculation 2: Acceleration set by parameter Bit 5: Anti-load disturbance 0: Disable 1: Enable	19	This parameter specifies the speed loop command word. Bit 0: The speed loop can be disabled in a specific process application. 0: Disable 1: Enable Bit 1: Integral mode 0: Traditional integral 1: Position integral Bit 2: It is used to enable or disable acceleration feedforward. If bit 2 is set to 1, speed deviation can be reduced when the speed reference changes. 0: Disable 1: Enable Bit 3: It is used to select the acceleration feedforward torque source. 0: Torque set by parameter The torque is set by AA-85. 1: Automatic calculation The torque required for acceleration is automatically calculated internally based on the set speed change and inertia. 2: Acceleration set by parameter The software automatically calculates the torque required during acceleration based on the acceleration set by AB-00 and the motor inertia. Bit 5: When the load changes suddenly, setting bit 5 to 1 can reduce the impact of sudden load change on the motor speed and achieve better speed dynamic performance. 0: Disable 1: Enable

Parameter Code	Parameter Name	Value Range	Default	Description
AA-85	Acceleration torque	0: Inactive 1: AI1 2: AI2 (To be continued)	0	When the acceleration feedforward torque source is set to a value other than 0, this parameter is used to set the acceleration torque. 0: Inactive The acceleration torque function is disabled. 1: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 2: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
AA-85	Acceleration torque	(Continued) 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference 7: Motorized potentiometer 8: PID Others: F connector	0	(Continued) 3: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 5: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication. In this case, the AC drive must be installed with a communication card for communicating with the host controller. The communication address is 0x1000, indicating the percentage reference. The value ranges from -10000 to 10000. 0 represents 0%, 10000 represents 100%, and -10000 represents -100%. Note: Communication settings are generally used to write the frequency. It is recommended to select a connector for other parameter source selection. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). 7: Motorized potentiometer The real-time target speed is set by the motorized potentiometer module output. (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
AA-85	Acceleration torque	(Continued)	0	(Continued) 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources. Note: When analog/pulse/communication is used as the reference source, 0 to full range correspond to 0 to 100% of the rated motor torque.
AA-88	Torque feedforward coefficient	0.0% to 6553.5%	100.0	This parameter is used to adjust the feedforward torque. With the acceleration feedforward enabled, if the speed still does not reach the speed reference after the feedback speed adjustment during acceleration, increase this parameter value.

Parameter Code	Parameter Name	Value Range	Default	Description
AB-00	Externally transferred acceleration	0: Inactive 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference (To be continued)	0	When set to a value other than 0, this parameter is used to set the acceleration. 0: Inactive 1: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 2: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 5: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication. In this case, the AC drive must be installed with a communication card for communicating with the host controller. The communication address is 0x1000, indicating the percentage reference. The value ranges from -10000 to 10000. 0 represents 0%, 10000 represents 100%, and -10000 represents -100%. (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
AB-00	Externally transferred acceleration	(Continued) 7: Motorized potentiometer 8: PID (To be continued)	0	(Continued) Note: Communication settings are generally used to write the frequency. It is recommended to select a connector for other parameter source selection. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). 7: Motorized potentiometer The real-time target speed is set by the motorized potentiometer module output. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. (To be continued)
AB-00	Externally transferred acceleration	(Continued) Others: F connector	0	(Continued) Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources. Note: When analog/pulse/communication is used as the reference source, 0 to full range correspond to 0 to 100% of the rated motor torque. When the externally transferred acceleration multiplies the inertia ratio, the value is the torque of the corresponding percentage.

1.4.6 Vector Control Slip Adjustment

In vector control mode (F0-01 is set to 0 or 1), this parameter can be used to adjust the speed stability accuracy. For example, increase this parameter when the running frequency of the motor is lower than the output frequency of the AC drive.

Slip: The slip ratio is an important parameter in motor running, especially in asynchronous motors. It reflects the difference between the rotor speed of the motor and the rotational magnetic field speed of the stator.

Steady-speed accuracy: The degree to which the actual speed deviates from the set speed when the motor runs at a constant speed.

Steady-speed accuracy = (maximum speed - minimum speed) ÷ Set speed × 100%.

For FVC (F0-01 = 1), it can adjust output current of the AC drive. Decrease this parameter gradually when a large rating AC drive is controlling a lightly loaded motor. Adjustment of this parameter is not required normally.

Parameter	Name	Default	Value range	Descriptions
F2-06	Vector control slip gain	100%	50% to 200%	In the SVC mode, this parameter is used to adjust the speed stability accuracy of the motor. For example, when the running frequency of the motor is lower than the output frequency of the AC drive, you can increase the value of this parameter. In the FVC mode, this parameter is used to adjust the output current of the AC drive under the same load. For example, if the load capacity of a high-power AC drive is weak, decrease the value of this parameter gradually. No adjustment is required under normal circumstances.

1.4.7 Vector Control Overexcitation

For high-inertia loads, vector control over-excitation can speed up the motor deceleration. A larger over-excitation gain means better improvement. However, vector control over-excitation increases the output current of the AC drive.

The parameter setting takes the first motor as an example. For other motors, changes parameters in the motor control group.

Parameter	Name	Default	Value range	Descriptions
F6-23	Overexcitation selection	0	0: Disabled 1: Deceleration is effective 2: The deceleration bus overvoltage is effective	Overexcitation trigger condition. When the energy generated during deceleration is too large, the energy generated can be partially consumed by switching on the overexcitation. 0: Disabled 1: Active when the motor is decelerating and generating 2: When the motor decelerates and the bus voltage pump rises above the threshold, the bus voltage threshold is the value of overvoltage suppression minus 100 V.
F6-24	Overexcitation suppression additional current value	100%	0% to 200%	Indicates the current amplitude superimposed based on the original excitation current, which is a ratio to the rated motor current.
F6-25	Overexcitation gain	1.25	0.01 to 2.50	Overexcitation function adjustment coefficient

1.4.8 Torque Upper Limit

The torque upper limit is set as follows in the vector control mode (FVC or SVC).

Parameter Code	Parameter Name	Default	Value Range	Description
F2-09	Torque upper limit source in speed control mode (motoring)	0	0: F2-10 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) Others: F connector	This parameter sets the torque upper limit source in the speed control mode in the motoring status. The details are as follows: 0: F2-10 The torque upper limit in the speed control mode is set by F2-10 (digital setting of torque upper limit in speed control). 1: AI1 The torque upper limit is input by current or voltage signal through the AI1. The torque is calculated according to the preset AI curve. 2: AI2 The torque upper limit is input by current or voltage signal through the AI2. The torque is calculated according to the preset AI curve. 3: AI3 The torque upper limit is input by current or voltage signal through the AI3. The torque is calculated according to the preset AI curve. 4: Pulse reference (DI5) The torque upper limit in the speed control mode is input through DI5 (pulse frequency). The torque is calculated based on the curve of relationship between the pulse frequency and running frequency. 5: Communication setting The frequency is set through communication. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to realize communication with the host controller. This mode is suitable for remote control or centralized control on multiple equipment.

Parameter Code	Parameter Name	Default	Value Range	Description
Continued	Continued	Continued	Continued	Continued 6: Min. (AI1, AI2) The torque upper limit in the speed control mode is the smaller value between AI1 and AI2 inputs. 7: Max. (AI1, AI2) The torque upper limit in the speed control mode is the larger value between AI1 and AI2 inputs. Others: F connector Read the connector value through setting the parameter No. of a floating point connector. The value read is used as the motoring torque upper limit in the speed control mode. In addition to the setting sources of 0 to 7, you can use the connector to expand the setting sources. The maximum value (full range) of options other than 0 is the value of F2-10. The motor is in the motoring state when the actual running direction of the motor is the same as the torque direction. The motor is in the generating state when the actual running direction of the motor is opposite to the torque direction.
F2-10	Digital setting of torque limit in speed control mode	150.0%	0.0% to 600.0%	This parameter defines the digital setting of torque upper limit in the speed control mode.

Parameter Code	Parameter Name	Default	Value Range	Description
F2-11	Torque upper limit source in speed control mode (generating)	0	0: F2-10 1: AI1 2: AI2 3: AI3 4: Pulse reference (DI5) 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) 8: F2-12 Others: F connector	This parameter sets the torque upper limit source in the speed control mode in the generating status. The details are as follows: 0: F2-10 The torque upper limit in the speed control mode is set by F2-10 (digital setting of torque upper limit in speed control). 1: AI1 The torque upper limit is input by current or voltage signal through the AI1. The torque is calculated according to the preset AI curve. 2: AI2 The torque upper limit is input by current or voltage signal through the AI2. The torque is calculated according to the preset AI curve. 3: AI3 The torque upper limit is input by current or voltage signal through the AI3. The torque is calculated according to the preset AI curve. 4: Pulse reference (DI5) The torque upper limit in the speed control mode is input through DI5 (pulse frequency). The torque is calculated based on the curve of relationship between the pulse frequency and running frequency. 5: Communication setting The frequency is set through communication. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to realize communication with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 6: Min. (AI1, AI2) The torque upper limit in the speed control mode is the smaller value between AI1 and AI2 inputs. 7: Max. (AI1, AI2) The torque upper limit in the speed control mode is the larger value between AI1 and AI2 inputs. Others: F connector Read the connector value through setting the parameter No. of a floating point connector. The value read is used as the generating torque upper limit in the speed control mode. This mode is used for expansion besides the common sources. The full range of options other than 0 and 8 is the value of F2-12. The motor is in the motoring state when the actual running direction of the motor is the same as the torque direction. The motor is in the generating state when the actual running direction of the motor is opposite to the torque direction.

Parameter Code	Parameter Name	Default	Value Range	Description
F2-12	Digital setting of torque upper limit in speed control (generating)	150.0-%	0.0% to 600.0%	This parameter defines the generating torque upper limit in the speed control mode.

In the speed control mode, there are eight modes to set the torque upper limit. In the motoring state, the torque upper limit source is defined by F2-09; in the generating state, the torque upper limit source is defined by F2-11.

In the speed control mode, if F2-11 is set to a value ranging from 1 to 8, the torque upper limit differs in the motoring state and in the generating state. In the motoring state, the full range of the torque upper limit is defined by F2-10. In the generating state, the full range of the torque upper limit is defined by F2-12, as shown in the following figure.

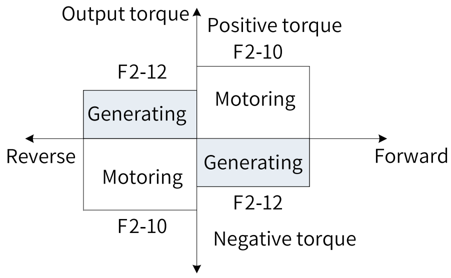


Figure 1-56 Torque upper limit in the speed control mode

Parameter Code	Parameter Name	Default	Value Range	Description
F2-22	Generating power limit selection	0	0: Disabled 1: Enabled in whole process 2: Enabled at constant speed 3: Enabled during deceleration	This parameter is used to set the valid range of the generating power limit. 0: Disabled Generating power limit invalid 1: Enabled in whole process Generating power limit valid in the whole process 2: Enabled at constant speed Generating power limit valid at constant speed 3: Enabled during deceleration Generating power limit valid during deceleration
F2-23	Generating power upper limit	20.0%	0.0% to 200.0%	This parameter is a percentage of the generating power upper limit to the rated motor power. If overvoltage still occurs after enabling the generating power limit function, decrease the value of F2-23.

In scenarios where braking resistors are not used for cam load, quick acceleration/deceleration, and sudden unloading, enabling generating power limit can effectively reduce bus voltage overshoot during motor braking, so as to prevent overvoltage. This parameter is a percentage of the generating power upper limit to the rated motor power. If overvoltage still occurs after enabling the generating power limit function, decrease the value of F2-23.

1.4.9 Torque Control

1. **Select the speed/torque control mode (A0-00).**
   The speed/torque control mode is set by A0-00.

   The multi-function DI supports two torque control-related functions: torque control inhibited (function 29), speed control/torque control switchover (function 46). The two DI functions need to be used together with A0-00 to implement speed control/torque control switchover.

   If the speed control/torque control switchover function (function 46) is invalid, the control mode is determined by A0-00. If the function 46 is valid, the control mode is reverse to the value of A0-00.

   When function 29 (torque control inhibited) is valid, the drive always runs in the speed control mode.

2. **Select the torque mode (A0-10).**
   Torque control supports speed loop output torque limit mode (A0-10 = 0) and direct torque setting mode (A0-10 = 1).

   a. Speed loop output torque limit mode
   Set A0-10 to 0 to select this mode.

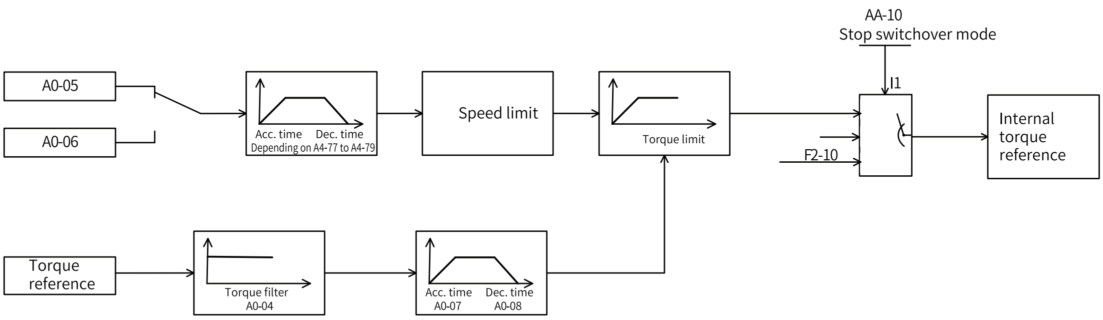


Figure 1-57 Speed loop output torque limit mode

Related parameters

Param.	Name	Default	Value range	Description
A0-01	Mode A - Torque reference source in torque control (drive torque upper limit source)	0	0: A0-03 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) Others: F connector	This parameter is used to set the torque command source. Seven torque sources are available. 0: A0-03 The torque is set numerically in torque control mode. The value is set to A0-03 (Torque digital setting in torque control mode). 1: AI1 The torque upper limit is input by current or voltage signal through the AI1. The torque is calculated according to the preset AI curve. 2: AI2 The torque upper limit is input by current or voltage signal through the AI2. The torque is calculated according to the preset AI curve. 3: AI3 The torque upper limit is input by current or voltage signal through the AI3. The torque is calculated according to the preset AI curve. The AC drive has two AI terminals by default, and the AI3 terminal needs to be provided through the I/O expansion card. 4: Pulse reference (DI5) The torque upper limit in the speed control mode is input through DI5 (pulse frequency). The torque is calculated based on the curve of relationship between the pulse frequency and running frequency. 5: Communication The torque is set by communication in the torque control mode. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. Note: For details on the communication address, see the Communication Guide.
(Continued)				6: Min. (AI1, AI2) In torque control mode, the value calculated by AI1 and AI2 is compared to the smaller value. 7: Max. (AI1, AI2) In torque control mode, the torque is compared with the value calculated by AI1 and AI2. Others: F connector Read the connector value through setting the parameter No. of a floating point connector. The value read is used as the generating torque upper limit in the torque control mode. This mode is used for expansion besides the common sources. Supplementary explanation: 100% corresponds to the A0-03 value when the analog/pulse/communication setting is used as the reference source. For example, if A0-03 is set to 200%, A0-01 selects AI1 analog setting. When AI1 is set to 50%, the actual setting is equal to 50% x 200%.

Param.	Name	Default	Value range	Description
A0-03	Mode A - Torque digital setting in torque control	150.0%	-200.0% to 200.0%	This parameter defines the torque reference in the torque control mode. The torque reference is a relative value. 100.0% corresponds to the rated AC drive torque. The Value ranges from -200.0% to +200.0%, indicating that the maximum torque of the drive is two times the rated torque of the motor. When the torque reference value is positive, the drive operates in the forward direction. When the torque reference value is negative, the drive operates in the reverse direction.
A0-04	Mode A– Torque reference filter time (upper limit)	0 ms	0 ms to 10000 ms	Used to set the torque reference filter time in mode A.
A0-05	Mode A - Maximum positive frequency in torque control	50.00 Hz	0.00 to F0-10	Used to set the maximum positive frequency in mode A.
A0-06	Mode A - Maximum negative frequency in torque control	50.00 Hz	0.00 to F0-10	This parameter defines the maximum running frequency of the AC drive that operates reversely in the torque control mode.
A0-07	Torque rising filter time	0.00s	0.00s to 650.00s	Used to set the torque reference ramp rise time (relative to rated torque) in mode A.
A0-08	Torque falling filter time	0.00s	0.00s to 650.00s	Used to set the reference ramp drop time (relative to rated torque) in mode A.
A4-77	Frequency acceleration time in torque control	0.0s	0.0 to 6500.0	Frequency acceleration time in torque control
A4-78	Frequency deceleration time in torque control	0.0s	0.0 to 6500.0	Frequency deceleration time in torque control
A4-79	Forced use of the fourth set of time in torque control	0	0: Disabled 1: Enable	Forced use of the fourth set of time in torque control

b. Used to set the torque in the torque upper limit mode (mode A). The digital setting of torque reference uses relative value. 100.0% corresponds to the rated motor torque. The Value ranges from -200.0% to 200.0%, indicating that the maximum torque of the drive is two times the rated torque of the motor.
When the torque reference value is positive, the drive operates in the forward direction. When the torque reference value is negative, the drive operates in the reverse direction.

Direct torque setting mode

Set A0-10 to 1 to select this mode.

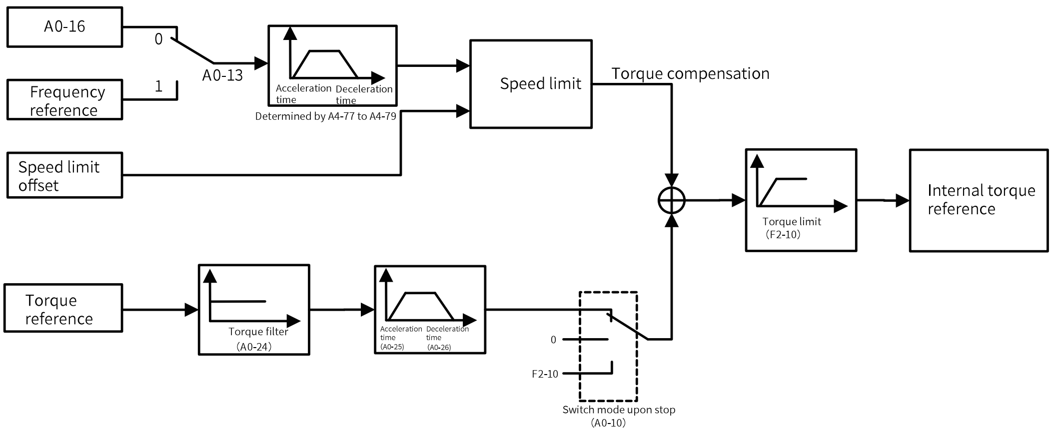
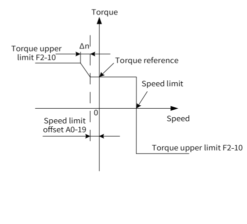
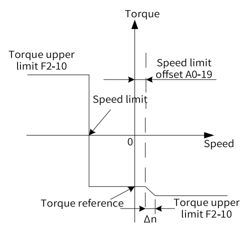
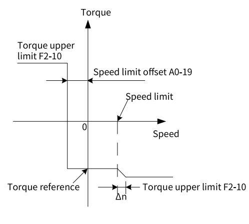
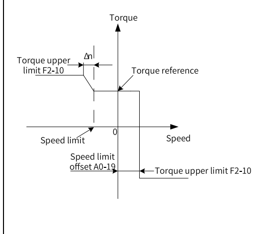
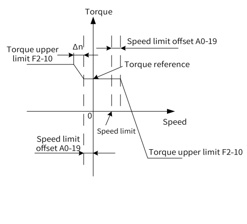
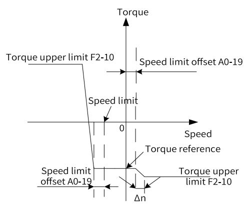
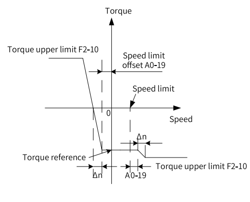
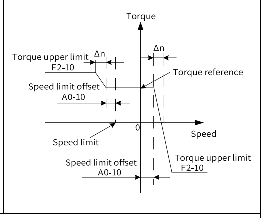
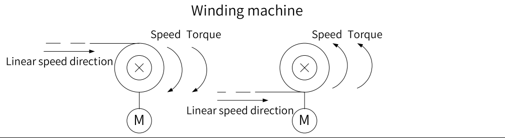
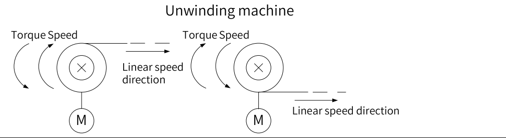


Figure 1-58 Direct torque setting mode

Table 1–27 Speed limit/speed limit offset

Item	Operating Condition			
Operation command	Forward run	Forward run	Forward run	Forward run
Torque reference direction	+	-	-	+
Speed limit direction	+	-	+	-
Normal running direction	Forward run	Reverse run	Forward run	Reverse run
Uni-directional speed limit offset (A0-17 = 1)				
Bi-directional speed limit offset (A0-17 = 0)				
Application example	Winding machine 		Unwinding machine 	

3. **Set the torque reference in the torque control mode.**

   In the direct torque setting mode, set the torque reference through A0-13 and A0-14. In addition, additional torque settings through A0-20 to A0-23 are supported.

   The torque reference is a relative value. The value 100.0% corresponds to the rated motor torque. View the motor output torque through U0-06, and the value 100% corresponds to the rated motor torque.

   Set the frequency upper limit in the torque control mode (A0-05, A0-10, A0-11).

In the torque control mode, the frequency upper limit can be defined by A0-05 or the frequency source.

4. **Set the frequency upper limit in the torque control mode.**
   In the torque control mode, if the load torque is lower than the output torque of the motor, the motor speed keeps increasing. Therefore, the motor speed (that is, the frequency upper limit) must be restricted to prevent accidents such as runaway.

   In the speed loop output limit mode, set the frequency upper limit through A0-05 and A0-06.

   In the direct torque setting mode, set e frequency limit and limit offset through A0-15 to A0-19.

   Set the acceleration/deceleration time of the torque upper limit through A4-77 to A4-79.

5. **Set the torque reference acceleration/deceleration time.**
   In the speed loop output limit mode, set the torque reference filter and acceleration/deceleration time through A0-04, A0-07, and A0-08.

   In the direct torque setting mode, set the torque reference filter and acceleration/deceleration time through A0-24, A0-25, and A0-26.

   In the torque control mode, the difference between the motor output torque and the load torque determines the speed change rate of the motor and load. The motor speed may change quickly, causing noise or mechanical stress. (This refers to internal forces that interact between parts of the object when the object is deformed due to external causes (force and humidity change). To resist this external cause, and to restore the object from the deformed position to the pre-deformed position.) Oversize. Setting the acceleration/deceleration time in the torque control mode helps smooth the motor speed. The acceleration time indicates the time required by the motor to increase from 0 to the motor rated torque. The deceleration time indicates the time required by the motor to decelerate from the motor rated torque to 0.

   In the torque control mode, the acceleration/deceleration time is not required for start with small torque. For applications requiring quick torque response, set the acceleration/deceleration time to 0.00s.

   For example, two AC drives are connected to drive the same load. To balance the load distribution, set one AC drive as the master and select the speed control mode. Set the other one as the slave and select the torque control mode. The slave receives the output torque of the master as the torque command and follows the master rapidly. In this case, the acceleration/deceleration time of the slave in the torque control mode is set to 0.00s.

1.4.10 Current Loop

The PI adjustment parameters of the vector control current loop are automatically calculated based on the motor parameters and do not need to be modified. The PI parameter of the current loop is automatically calculated based on the motor parameters. The parameter value is a multiple of the automatically calculated value (for example, if the proportional gain is 1.5 and the parameter is 2, the actual proportional gain effective is 1.5 x 2 = 3). 1.0 corresponds to the calculated value.

A large current loop PI gain may result in oscillation of the entire control loop. In the case of severe current oscillation or torque fluctuation, manually reduce the PI proportional gain or integral gain.

The parameter setting takes the first motor as an example. For other motors, changes parameters in the motor control group.

Parameter	Name	Default	Value range	Descriptions
AB-59	Current loop Kp adjustment at low speed	1.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-60	Current loop Kp adjustment at high speed	1.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-61	Current loop Ki adjustment at low speed	1.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-62	Current loop Ki adjustment at high speed	2.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-63	Used to set D-axis current loop complex vector adjustment.	1.0	0.1 to 10.0	-
AB-64	Used to set Q-axis current loop complex vector adjustment.	1.0	0.1 to 10.0	-

1.4.11 Improvement of Filed Weakening Performance

Parameter	Name	Default	Value range	Description
F2-19	Field weakening gain	3.0	0.1 to 200.0	Increasing the value of this parameter can improve dynamic response, but too large can cause current oscillation. Therefore, it is recommended to increase the value of this parameter gradually for commissioning. In general, no change is required. Use the default value.
A5-05	Voltage overmodulation coefficient	103%	100% to 115%	By increasing the voltage overmodulation coefficient, the output capacity of the voltage can be increased to effectively increase the carrying capacity of the motor in the weak magnetic zone. At the same time, the output current distortion will be increased.
AB-33	Voltage margin	3%	1% to 50%	Decrease this value to improve the voltage utilization. The current is smaller when the same load is applied in the weak magnetic zone. However, the value is too small, which affects the dynamic performance. The second motor is B9-33. The third motor is BE-33. The fourth motor is CE-33.

1.4.12 Operation and Performance Improvement in FVC Mode

Table 1–28 Procedure for speed control mode with speed sensor

Procedure	Parameter	Description
Check that the drive is wired correctly.	-	If the drive reports E019. xx during auto-tuning, check whether the drive is wired improperly and whether motor parameter are set improperly.
Set the motor parameters.	F1-01, F1-02, F1-03, F1-04, F1-05	
Set the encoder type and pulses per revolution.	F1-27 to F1-28	If the drive reports E020.xx, check whether the encoder and PG card work properly.
Select a control mode.	F0-01	-
Perform motor parameter auto-tuning.	F1-37	Select dynamic complete auto-tuning (2 for asynchronous motor and 12 for synchronous motor) and disconnect the load. The motor can run at a high speed. If the load cannot be disconnected from the motor (such as crane applications), select static complete auto-tuning. Dynamic complete auto-tuning may take a while. Wait until auto-tuning is done before proceeding to the next step.
Set the command source and frequency reference source accordingly.	F0-02, F0-03, F0-08	-
Trial run	A0-00 = 0	-

Table 1–29 Procedure for torque control mode with speed sensor

Procedure	Parameter	Description
Check that the drive is wired correctly.	-	If the drive reports E019.00 during auto-tuning, check whether the drive is wired improperly and whether motor parameter are set improperly.
Set the motor parameters.	F1-01, F1-02, F1-03, F1-04, F1-05	
Set the encoder type and pulses per revolution.	F1-27 to F1-28	If the drive reports E020.00, check whether the encoder and PG card work properly.
Select a control mode.	F0-01	-
Perform motor parameter auto-tuning.	F1-37	Select dynamic complete auto-tuning (2 for asynchronous motor and 12 for synchronous motor) and disconnect the load. The motor can run at a high speed. If the load cannot be disconnected from the motor (such as crane applications), select static complete auto-tuning. Dynamic complete auto-tuning may take a while. Wait until auto-tuning is done before proceeding to the next step.
Set the command source.	F0-02	-
Set torque control parameters.	A0-00, A0-01, A0-03, A0-05	-
Trial run	-	-

Speed loop settings

If the value of the speed loop gain are set too high, the motor may vibrate or produce unusual noise when operating at the frequency lower than the rated frequency. In this case, decrease the values of F2-00 and F2-03, and increase the values of F2-01 and F2-04.

If the system speed overshoot is high during rapid acceleration, increase the speed loop Kp (increase the values of F2-00 and F2-03) and reduce the speed loop Ki (increase the values of F2-01 and F2-04).

In winding/unwinding applications, the roll diameter changes in inverse proportion to the motor speed. Therefore, when the roll diameter is large, increase the value of the speed loop gain to ensure dynamic response of the system (increase the value of F2-00 and reduce the value of F2-01).

For a device running at an extremely low speed (for example, a milling machine running at 0.01 Hz), increase the value of the speed loop gain (especially the speed loop integral gain) to ensure smooth operation. That is, increase the value of F2-00 and decrease the value of F2-01.

Note

In scenarios with poor encoder feedback signals, the speed loop gains cannot be too high. Otherwise, the dynamic response speed of the system is affected. In this case, first take measures to improve the quality of encoder feedback signals (for example, separate power cables of the motor from signal cables of the encoder, and ensure good grounding of the system). Otherwise, directly reducing the speed loop gains will slow down dynamic response of the system, degrading the system operation performance.

Current loop settings

Current loop parameters are automatically obtained after complete auto-tuning. The auto-tuned parameters apply to most of applications. However, you can fine tune these parameters in the following conditions.

If a motor running in FVC mode vibrates or produces usual noise, and the situation is not improved after decreasing the value of the speed loop parameter, decrease the value of the current loop parameter properly.

If the system requires a low overshoot, the value of the speed loop parameter cannot be too low. In this case, if the motor vibrates or produces abnormal noise when running in the FVC mode, decrease the value of the current loop parameter properly.

Solutions to errors during high-speed operation in the FVC mode

Vibrations or operation errors may occur when a motor runs at a high frequency (for example, above 200 Hz) in the FVC mode. In this case, operate the motor with the same frequency in the V/f mode and check whether the feedback frequency (U0-29) is the same as the frequency reference. If there is a large difference (greater than 4 Hz) between these two frequencies, the encoder signal may be distorted (non-orthogonal or abnormal duty cycle). In this case, take the following measures:

Replace the encoder. Check whether the encoder is normal or installed properly and whether the encoder model supports the pulse frequency.

Shortening acceleration/deceleration time in the FVC control mode

During rapid acceleration/deceleration, the actual acceleration/deceleration time is longer than the preset value. To shorten the acceleration/deceleration time, take the following measures.

To shorten the motor acceleration time, increase the torque upper limit in the FVC control mode (increase the value of F2-10 properly, but in no case greater than 180%).

Increasing the torque upper limit shortens the motor acceleration time but also leads to an increase in the motor current, which may easily cause faults such as overload.

Limiting the bus voltage to prevent overvoltage in the FVC control mode

In high inertia or rapid deceleration applications, overvoltage may occur during deceleration. The optimization measures are the same as those used in V/f control mode.

1. Enable overvoltage suppression: Set bit 1 (overvoltage suppression) of AB-25 to 1 in the FVC mode for motor 1. For other motors, set bit 1 of B9-25, BE-25, and CE-25 to 1.
2. Enable the over-excitation function (F6-23).
3. Use an appropriate braking resistor to shorten the deceleration time.

1.4.13 Auxiliary Control

Parameter Code	Parameter Name	Default	Value Range	Description
A5-00	Frequency upper limit for DPWM switchover	2000.0 Hz	5.0 Hz to 6000.0 Hz	The drive supports two PWM wave modulation modes, including CPWM and DPWM. When the operating frequency is higher than the value of A5-00, the DPWM mode is used. When the operating frequency is lower than the value of A5-00, the CPWM mode is used. The DPWM mode can improve the AC drive efficiency, whereas the CPWM mode can reduce the motor noise. Increasing A5-00 to the maximum frequency will reduce the motor noise.
A5-01	PWM modulation mode	0	0: Asynchronous modulation 1: Synchronous modulation	When the result of the carrier frequency divided by the running frequency is smaller than 10, output current oscillation or large current harmonic waves may occur. To address the problem, set this parameter to 1 (synchronous modulation). 0: Asynchronous modulation In this mode, the carrier frequency and signal wave frequency are modulated asynchronously. The carrier frequency usually remains unchanged. The carrier ratio changes with the signal wave frequency. 1: Synchronous modulation When the result of the carrier frequency divided by the running frequency is smaller than 10, output current oscillation or large current harmonic waves may occur. To address the problem, set this parameter to 1 (synchronous modulation).
A5-02	Dead-zone compensation mode	1	0: Disable 1: Compensation mode 1	The dead-zone is set for the drive in the PWM mode to ensure that it is switched off and then switched on. This avoids shoot-through between the upper and lower bridge arms. The presence of the dead zone will result in additional voltage loss caused by PWM wave modulation, resulting in output current distortion. The lower the running frequency, the more obvious the current distortion. Dead zone compensation is required to reduce the effect of the dead zone. 0: Disable Dead zone compensation is disabled. 1: Compensation mode 1 Dead zone compensation is enabled.

Parameter Code	Parameter Name	Default	Value Range	Description
A5-03	Random PWM depth	0	0: Random PWM inactive 1 to 10: Random PWM carrier frequency depth	If the motor noise is loud, setting A5-03 to a non-zero value can suppress the motor noise. The higher the value, the better the effect. However, if the value is too high, the motor control may be affected. Therefore, set this parameter to 1 first during commissioning and then increase it by 1 each time as required.
A5-04	Pulse-by-pulse current limit protection	0	0: Disable 1: Enable	This function is used to minimize the risk of overcurrent faults, ensuring normal operation of the AC drive. It is recommended to disable this function in hoisting applications, such as cranes.
A5-05	Voltage overmodulation coefficient	103%	100% to 115%	Increasing the voltage overmodulation coefficient can enhance the voltage output capacity and effectively improve the load capacity of the motor in the field weakening region, but will increase output current distortion at the same time.
A5-08	Carrier frequency upper limit at low speed	0.0 kHz	0.0 kHz to 8.0 kHz: Carrier frequency upper limit	This parameter defines the upper limit of the carrier frequency when the AC drive is running at a low speed. The limit takes effect when the value is greater than 0.
A5-10	Energy saving control	0	0: Invalid 1: Valid	This function is active only for asynchronous motors in the V/f control mode (F0-01 = 2, F1-00 = 0). 0: Invalid Energy saving control is disabled. 1: Valid Energy saving control is enabled. Enabling energy conservation control can reduce energy consumption of the asynchronous motor when running with no load or light load.

1.4.14 Encoder Signal Processing

The parameter setting takes the first motor as an example. For other motors, change parameters in the motor control group.

Parameter Code	Parameter Name	Default	Value Range	Description
A9-07	Filter time constant for encoder speed measurement	0.004s	0.000s to 10.000s	By adjusting the encoder speed measurement filter time constant, the filtering effect on the encoder signal can be changed. The higher the filter time, the smoother the encoder feedback speed, but the greater the feedback speed delay; the lower the filter time, the greater the encoder feedback speed fluctuation, but the smaller the feedback speed delay; under the FVC control mode, the filter time constant cannot be too low when the resolver and other encoder signal quality is not good.

By adjusting the filter time constant for encoder speed measurement, the filtering effect on the encoder signal can be changed. The longer the filter time, the smoother the encoder feedback speed, but the longer the feedback speed delay time. The shorter the filter time, the greater the encoder feedback speed fluctuation, but the shorter the feedback speed delay time. Set the filter time constant according to working conditions and encoder speed measurement quality. When the resolver and other encoder signal quality is not good, the filter time cannot be too short.

Table 1–30 Encoder disconnection detection

Parameter Code	Parameter Name	Default	Value Range	Description
F1-36	PG disconnection detection time during speed feedback	0	0.0s to 10.0s	This parameter is used to set the encoder disconnection detection time. If it is set to 0.0s, the drive does not detect the encoder disconnection fault. If hardware detection of encoder disconnection is enabled (bit 02 of A9-09 is set to 1), the AC drive reports E020.X when the AC drive detects a disconnection fault and the fault lasts for a period longer than the time specified by F1-36.

The PG card features the encoder disconnection detection by hardware function. This function is available only for the differential encoder. To enable the function, set bit 02 of AA-30. When the AC drive detects a disconnection fault for the time longer than the value of F1-36, the AC drive reports E020.X.

1.4.15 PID Adjustment Methods

This section describes general rules for PID parameter adjustment, which can be used as reference for adjusting process closed-loop control PID parameters (FA-05 to FA-07, and FA-15 to FA-17) and speed loop PI parameters (F2-00 to F2-04).

1. In case of slow response, increase Kp.

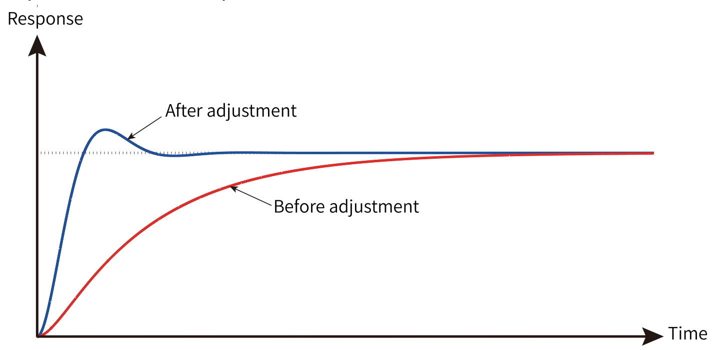


Figure 1-59 Response-time trend after increasing Kp

2. In case of frequent vibration, reduce Kp.

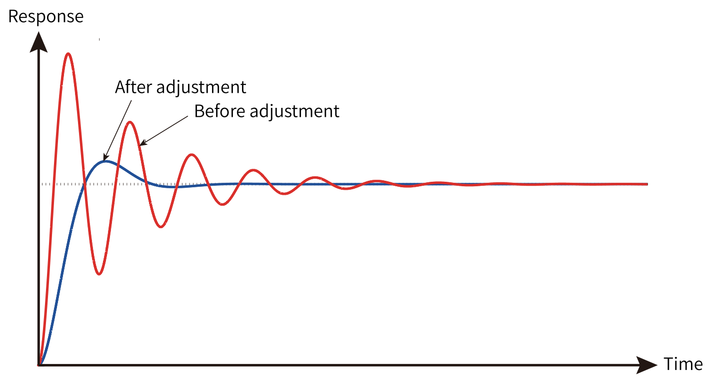


Figure 1-60 Response-time trend after decreasing Kp

3. In case of large overshoot and slow fluctuation, increase Ti.

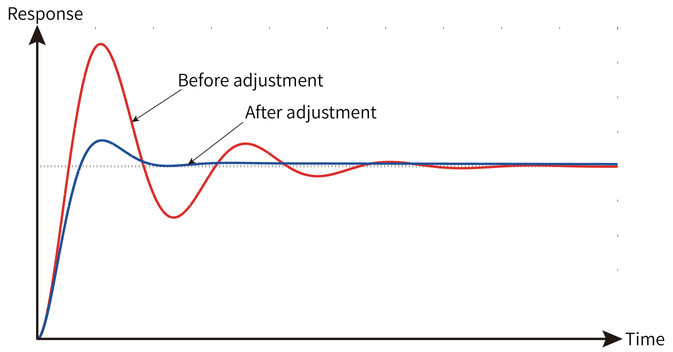


Figure 1-61 Response-time trend after increasing Ti

4. In case of large static difference and slow response at load fluctuation, increase Kp or decrease Ti.

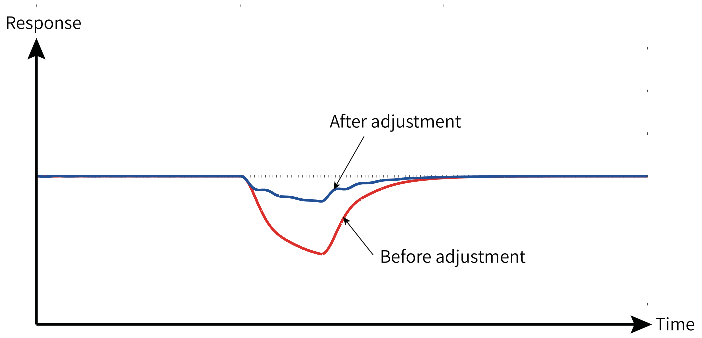


Figure 1-62 Response-time trend after increasing Kp at load fluctuation

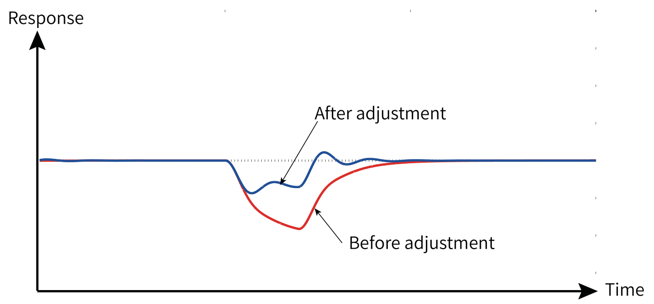


Figure 1-63 Response-time trend after decreasing Ti at load fluctuation

5. If the derivative time Td is set properly, the system stability can be improved. Note that if the derivative time Td is too long, interference and vibration may be caused.

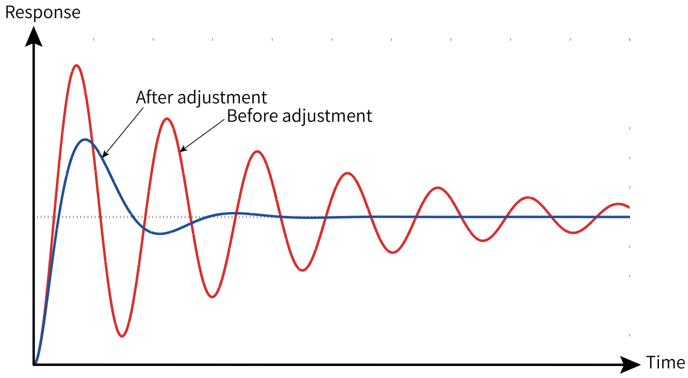


Figure 1-64 Response-time trend after setting the Td

1.5 Application Control

1.5.1 Jog

In some applications, the AC drive needs to run at a low speed temporarily to facilitate equipment testing. In this case, jogging applies. The following figure shows the relationship between the output frequency and acceleration/deceleration time during jogging.

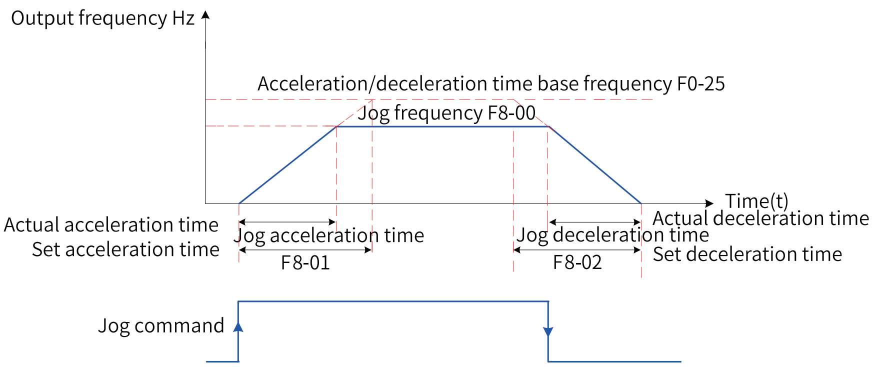


Figure 1-65 Jogging

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F0-02	Operation command source selection	0	0: Operating panel 1: Terminal 2: Communication 3: User-defined	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run, and jog operation. 0: Operating panel The RUN/STOP key on the operating panel can be used to start or stop the drive. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/ three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined mode The command source is defined by the user as needed for expansion.
F0-25	Acceleration/ deceleration time base frequency	1	0: F0-10 (Maximum frequency) 1: Frequency reference 2: 100 Hz 3: Rated frequency	This parameter sets the acceleration/deceleration time base frequency. This parameter defines the target frequency during acceleration and the starting frequency during deceleration.

Parameter Code	Parameter Name	Default	Value Range	Description
F7-01	MF.K key function	0	0: MF.K key disabled 1: Forcibly change to operating panel control 2: Switchover between forward and reverse run 3: Forward jog 4: Reverse jog	This parameter is used to select the MF.K key function selection. 0: MF.K key disabled The MF.K key has no function. 1: 1: Forcibly change to operating panel control If F0-02 is set to 0 (operating panel), the MF.K key is unavailable. If F0-02 is set to 1 (terminal), 2 (communication), or 3 (self-defined control mode), pressing the MF.K key forcibly changes the control mode to the operating panel control mode. 2: Switchover between forward and reverse run Pressing the MF.K key changes the direction of the frequency reference. This function is valid only when the command source is set to the operating panel. 3: Forward jog Pressing the MF.K key implements forward jog (FJOG). This function is valid only when the command source is set to the operating panel. 4: Reverse jog Pressing the MF.K key implements reverse jog (RJOG). This function is valid only when the command source is set to the operating panel.
F8-00	Jog frequency	2.00 Hz	0 to F0-10 (Maximum frequency)	This parameter defines the running frequency of the AC drive in jogging mode.
F8-01	Jog acceleration time	20.0s	0.0s to 6500.0s	This parameter defines the acceleration time of the AC drive in jogging mode.
F8-02	Jog deceleration time	20.0s	0.0s to 6500.0s	This parameter defines the deceleration time of the AC drive in jogging mode.
F8-13	Reverse running prohibition	0	0: Disable 1: Enable	When the frequency defined by communication or analog reference is a negative value, the motor operating direction changes. The frequency in this case is called reverse frequency. You can set whether to allow the motor to operate in reverse state through this parameter. When reverse operation of the motor is not allowed, set F8-13 to 1. When reverse operation of the motor is allowed, set F8-13 to 0.
F8-27	Jog priority mode	0	0: No priority 1: Jog preferred 2: OFF1 preferred	This parameter defines the priority of the jog command and normal operation commands. 0: No priority. The AC drive responds to the operation command that arrives first. 1: Jog preferred. The jog command can interrupt normal running. 2: OFF1 preferred. Normal operation commands can interrupt jogging.

Parameter Code	Parameter Name	Default	Value Range	Description
A4-62	Jog speed 1 source	0	0: Digital setting 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference 7: Motorized potentiometer 8: PID Others: F connector	It is used to set the jog speed 1. 0: Digital setting The jog speed 1 is set by F8-00. 1: AI1 The jog speed 1 is input through AI1, which inputs current or voltage signals. The jog speed 1 is calculated according to the AI curve. 2: AI2 The jog speed 1 is input through AI2, which inputs current or voltage signals. The jog speed 1 is calculated according to the AI curve. 3: AI3 The jog speed 1 is input through AI3, which inputs current or voltage signals. The jog speed 1 is calculated according to the AI curve. 4: Pulse reference The jog speed 1 is set through DI5 pulse frequency. 5: Communication The jog speed 1 is set through communication. The jog speed 1 is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals can be grouped in different ways to indicate 16 states, which correspond to 16 frequency references (percentage x maximum frequency) in group FC. 7: Motorized potentiometer The jog speed 1 is set by the motorized potentiometer module output. 8: PID The jog speed 1 is set through PID output. Others: F connector The jog speed 1 is set through the connector.
A4-66	Jogging ramp source	1	0: Ramp time of normal running 1: Ramp time of jogging	0: Ramp time of normal running The jogging ramp time is the same as the normal running time. 1: Ramp time of jogging The jog ramp time is set separately (F8-01, F8-02).

Example

The following section introduces how to set parameters related to jogging when the operating panel is used as the jogging command source.

Table 1–31 Setting parameters related to jog running

Step	Forward Jogging	Reverse Jogging
1	Set F7-01 to 3 to select forward jogging for the MF.K key.	Set F7-01 to 4 to select reverse jogging for the MF.K key. Set F8-13 to 0 to allow reverse running.
2	Set F0-02 to 0 to select the operating panel as the command source.	Set F0-02 to 0 to select the operating panel as the command source.
3	Set F8-00 (jog frequency), F8-01 (jog acceleration time), and F8-02 (jog deceleration time) properly.	Set F8-00 (jog frequency), F8-01 (jog acceleration time), and F8-02 (jog deceleration time) properly.
4	In the stop status, when the MF.K key is pressed down, the AC drive starts to jog in the forward direction. When the MF.K key is released, the AC drive decelerates to stop.	In the stop status, when the MF.K key is pressed down, the AC drive starts to jog in the reverse direction. When the MF.K key is released, the AC drive decelerates to stop.

1.5.2 Frequency Detection

1.5.2.1 Multi-reference

If multi-reference is selected as the frequency reference source, frequency references are input through different state combinations of the DIs.

Table 1–32 Using multi-reference as the frequency reference source

Procedure	Parameter	Description
Step 1: Select multi-reference as the frequency reference source.	F0-03	F0-03 = 6
Step 2: Determine the number of multi-references.	/	A total of 16 multi-references are supported, which requires four DIs. The relationship between the number of multi-references and the number of DIs is as follows: 2 multi-references: One DI (K1) 3-4 multi-references: Two DIs (K1 and K2) 5-8 multi-references: Three DIs (K1, K2, and K3) 9-16 multi-references: Four DIs (K1, K2, K3, and K4)
Step 3-1: Set the multi-reference function for the DI through parameters in group F4.	F4-00 to F4-09	Multi-reference terminal K1: Set to 12.
		Multi-reference terminal K2: Set to 13.
		Multi-reference terminal K3: Set to 14.
		Multi-reference terminal K4: Set to 15.

Procedure	Parameter	Description
Step 3-2: Set the multi-reference function for the DI through parameters in group F4.	FC-55 = K1	0: Invalid 1: Valid 2: Terminal function input 3 to 18: Corresponds to DI1 to DI16 Others: B connector
	FC-56 = K2	0: Invalid 1: Valid 2: Terminal function input 3 to 18: Corresponds to DI1 to DI16 Others: B connector
	FC-57 = K3	0: Invalid 1: Valid 2: Terminal function input 3 to 18: Corresponds to DI1 to DI16 Others: B connector
	FC-58 = K4	0: Inactive 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector
Step 4: Set the frequency for each multi-reference.[Note]	FC-00 to FC-15	The frequency corresponding to each speed reference is set to a percentage value. 100% corresponds to the maximum frequency (F0-10).
	F0-10	If the frequency reference source is set multi-reference, the value 100% of FC-00 to FC-15 corresponds to the value of F0-10 (Maximum frequency).

Note: The four multi-reference terminals can make up 16 state combinations, corresponding to 16 frequency reference values. For details, see the following table.

Table 1–33 State combinations of the four multi-reference terminals

K4 = FC-58	K3 = FC-57	K2 = FC-56	K1 = FC-55	Reference	Percentage to Maximum Frequency
OFF	OFF	OFF	OFF	Multi-reference 1	FC-00
OFF	OFF	OFF	ON	Multi-reference 2	FC-01
OFF	OFF	ON	OFF	Multi-reference 3	FC-02
OFF	OFF	ON	ON	Multi-reference 4	FC-03
OFF	ON	OFF	OFF	Multi-reference 5	FC-04
OFF	ON	OFF	ON	Multi-reference 6	FC-05
OFF	ON	ON	OFF	Multi-reference 7	FC-06
OFF	ON	ON	ON	Multi-reference 8	FC-07
ON	OFF	OFF	OFF	Multi-reference 9	FC-08
ON	OFF	OFF	ON	Multi-reference 10	FC-09
ON	OFF	ON	OFF	Multi-reference 11	FC-10

K4 = FC-58	K3 = FC-57	K2 = FC-56	K1 = FC-55	Reference	Percentage to Maximum Frequency
ON	OFF	ON	ON	Multi-reference 12	FC-11
ON	ON	OFF	OFF	Multi-reference 13	FC-12
ON	ON	OFF	ON	Multi-reference 14	FC-13
ON	ON	ON	OFF	Multi-reference 15	FC-14
ON	ON	ON	ON	Multi-reference 16	FC-15

1.5.2.2 Frequency Detection (FDT)

This function sets the detection value of the output frequency as well as the hysteresis value upon output cancellation. The hysteresis value is valid only during deceleration. Hysteresis does not occur in detection during acceleration. The following figure shows the frequency detection function.

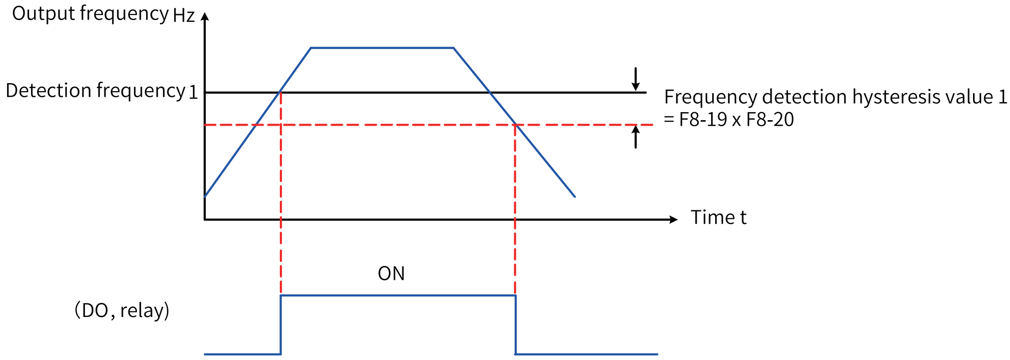


Figure 1-66 Parameters related to frequency detection

Table 1–34 Parameters related to frequency detection

Parameter Code	Parameter Name	Default	Value Range	Description
F8-19	Frequency detection value (FDT1)	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is higher than or equal to the frequency detection value (FDT1), the DO outputs an active signal. When the running frequency of the AC drive is lower than the result of frequency detection value (FDT1) minus frequency detection hysteresis value (FDT1), the DO outputs an inactive signal. The valid range is from 0.00 Hz to F0-10 (maximum frequency).
F8-20	Frequency detection hysteresis rate (FDT1)	5.0%	0.0% to 100.0%	The frequency detection hysteresis value (FDT1) is the result of F8-19 multiplied by F8-20. When the running frequency of the AC drive is higher than or equal to the value of F8-19, the DO outputs an active signal. When the running frequency is lower than a specific value (F8-19 - F8-19 x F8-20), the DO outputs an inactive signal.
F8-28	Frequency detection value (FDT2 level)	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is higher than or equal to the frequency detection value (FDT2), the DO outputs an active signal. When the running frequency of the AC drive is lower than the result of frequency detection value (FDT2) minus frequency detection hysteresis value (FDT2), the DO outputs an inactive signal. The valid range is from 0.00 Hz to F0-10 (maximum frequency).
F8-29	Frequency detection hysteresis rate (FDT2)	5.0%	0.0% to 100.0%	The frequency detection hysteresis value (FDT2) is the result of F8-28 multiplied by F8-29. When the running frequency of the AC drive is higher than or equal to the value of F8-28, the DO outputs an active signal. When the running frequency is lower than a specific value (F8-28 - F8-28 x F8-29), the DO outputs an inactive signal.

1.5.2.3 Jump Frequency

The jump frequency enables the AC drive to avoid mechanical resonance points of the load. The AC drive supports four jump frequencies. If the four frequencies are set to 0, the frequency jump function is disabled.

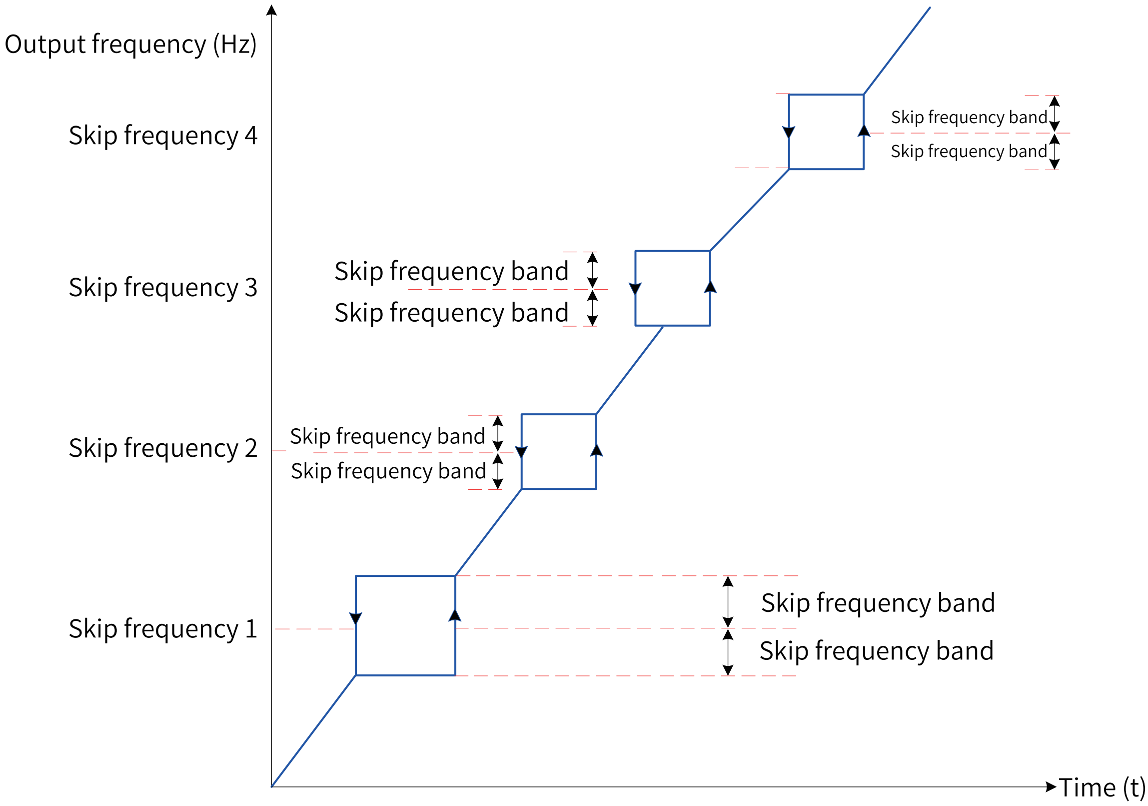


Figure 1-67 Jump frequency

As shown in the preceding figure, when the running frequency approaches the jump frequency during acceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11 (jump frequency amplitude).

When the running frequency approaches the jump frequency during deceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-09	Jump frequency 1	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. For details, see MD520 Series General-Purpose AC Drive Function Guide. Note: This parameter defines the first jump frequency. If it is set to 0, the first jump frequency function is canceled.
F8-10	Jump frequency 2	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. Note: This parameter defines the second jump frequency. If it is set to 0, the second jump frequency function is canceled.
F8-72	Jump frequency 3	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. Note: This parameter defines the third jump frequency. If it is set to 0, the third jump frequency function is disabled.

Parameter Code	Parameter Name	Default	Value Range	Description
F8-73	Jump frequency 4	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. Note: This parameter defines the fourth jump frequency. If it is set to 0, the fourth jump frequency function is disabled.
F8-11	Jump frequency amplitude	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency approaches the jump frequency during acceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11 (jump frequency amplitude). When the running frequency approaches the jump frequency during deceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11.
F8-22	Jump frequency valid status during acceleration/deceleration	0	0: Invalid 1: Valid	This parameter is used to enable or disable the jump frequency function during acceleration/deceleration. When it is disabled, the AC drive continues to run at the running frequency when the running frequency is near the jump frequency during acceleration and deceleration. When it is enabled, the AC drive skips over the jump frequency when the running frequency is near the jump frequency during acceleration and deceleration. The jump range is twice the value of F8-11 (jump frequency amplitude).

1.5.2.4 Reverse Running Prohibition

F8-13 is used to set whether reverse running inhibition is enabled, as shown in the following figure.

F0-09 defines the running direction of the motor. You can change the rotation direction of the motor by modifying this parameter without changing the motor wiring. Modifying this parameter is equivalent to exchanging any two of the motor's U, V, W wires.

Note

After the parameter is initialized, the original rotation direction of the motor is resumed. Exercise cautions when using this function if motor rotation direction change is prohibited after system commissioning is complete.

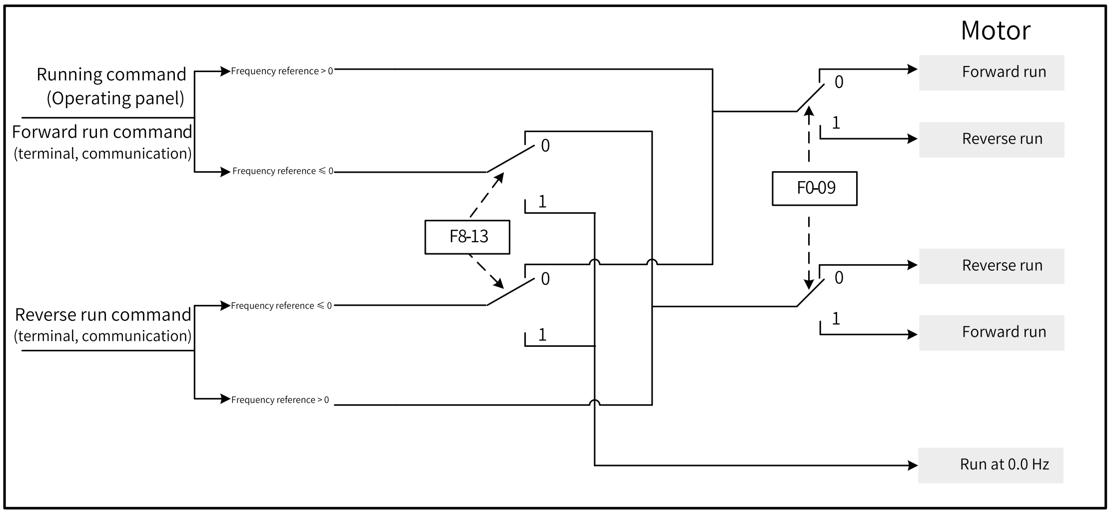


Figure 1-68 Reverse running prohibition

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-13	Reverse running prohibition	0	0: Disable 1: Enable	When the frequency defined by communication or analog reference is a negative value, the motor operating direction changes. The frequency in this case is called reverse frequency. You can set whether to allow the motor to operate in reverse state through this parameter. When reverse operation of the motor is not allowed, set F8-13 to 1. When reverse operation of the motor is allowed, set F8-13 to 0.
F0-09	Running direction selection	0	0: Default direction 1: Direction opposite to the default direction	You can change the rotation direction of the motor by modifying this parameter without changing the motor wiring. Modifying this parameter is equivalent to exchanging any two of the motor's U, V, W wires.

1.5.2.5 Detection Frequency Amplitude

F8-21 defines the detection frequency amplitude. The following figure shows the time sequence diagram of the frequency detection range.

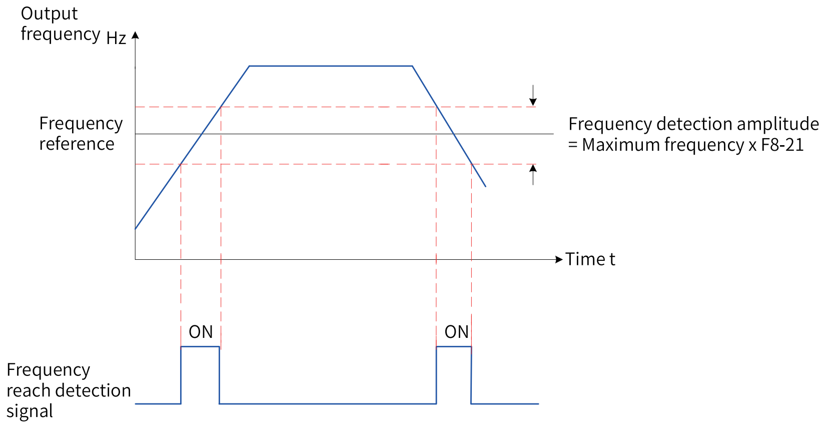


Figure 1-69 Time sequence of the frequency detection range

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-21	Detection frequency amplitude	0.0%	0.0% to 100.0% (maximum frequency)	When the running frequency of the AC drive is within the range of Reference frequency ± Maximum frequency (F0-10) x Detection frequency amplitude (F8-21), the DO outputs an active signal. Note 1: The detection frequency amplitude value is F8-21 x maximum frequency. Note 2: The range includes the maximum and minimum values.

1.5.2.6 Acceleration/Deceleration Time Switchover Frequency

This function enables selection of different acceleration/deceleration time based on the running frequency during running of the AC drive.

The following figure shows the schematic diagram of acceleration/deceleration time switchover. During acceleration, if the running frequency is lower than the value of F8-25, acceleration time 2 is selected. If the running frequency is higher than the value of F8-25, acceleration time 1 is selected. During deceleration, if the running frequency is higher than the value of F8-26, deceleration time 1 is selected. If the running frequency is lower than the value of F8-26, deceleration time 2 is selected.

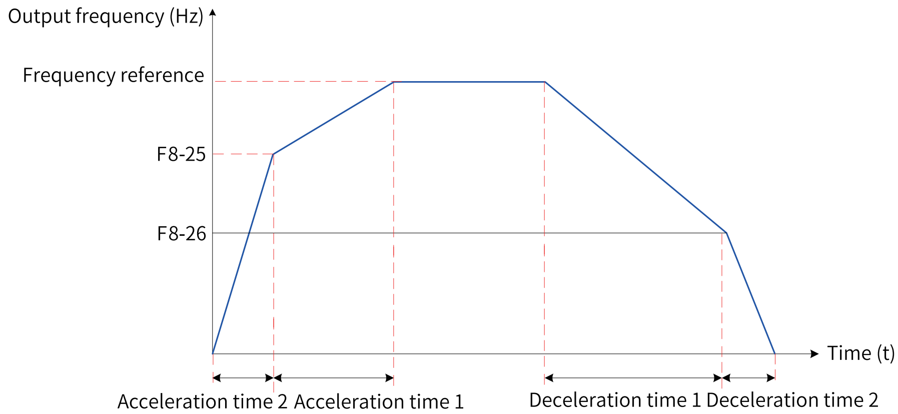


Figure 1-70 Frequency for acceleration/deceleration time switchover

This function is valid only when the DI is not assigned with function 16 (acceleration/deceleration time selection terminal 1) or 17 (acceleration/deceleration time selection terminal 2).

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-25	Frequency for switchover between acceleration time 1 and acceleration time 2	0.00 Hz	0 to F0-10 (Maximum frequency)	This function is used to switch the acceleration/deceleration time based on the running frequency range when the AC drive is running. Note 1: This function is valid only when the DI is not assigned with function 16 (acceleration/deceleration time selection terminal 1) or 17 (acceleration/ deceleration time selection terminal 2). Note 2: The valid range is from 0.00 Hz to F0-10 (maximum frequency).
F8-26	Frequency for switchover between deceleration time 1 and deceleration time 2	0.00 Hz	0 to F0-10 (Maximum frequency)	

1.5.2.7 Detection Frequency

When the running frequency of the AC drive is within the frequency detection range (F8-30 - F8-31 x F0-10 to F8-30 + F8-31 x F0-10, or F8-32 - F8-33 x F0-10 to F8-32 + F8-33 x F0-10), the DO outputs an active signal.

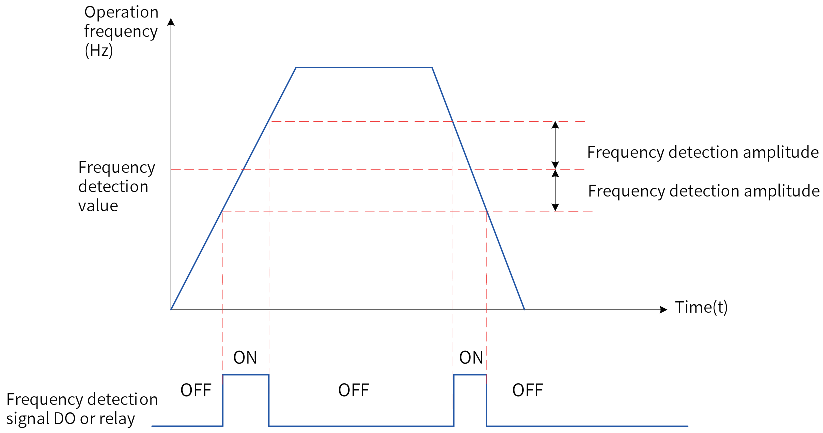


Figure 1-71 Detection frequency

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-30	Detection frequency 1	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is within the frequency detection range (F8-30 - F8-31 x F0-10 to F8-30 + F8-31 x F0-10), the DO outputs an active signal. Note: The following formula must be met: (F8-30 - F8-31 x F0-10) ⩽ operating frequency ⩽ (F8-30 + F8-31 x F0-10).
F8-31	Detection frequency amplitude 1	0.0%	0.1% to 100.0%	When the running frequency of the AC drive is within the frequency detection range (F8-30 - F8-31 x F0-10 to F8-30 + F8-31 x F0-10), the DO outputs an active signal. Note 1: The max. frequency (F0-10) is used as the base of percentage.
F8-32	Detection frequency 2	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is within the frequency detection range (F8-32 - F8-33 x F0-10 to F8-32 + F8-33 x F0-10), the DO outputs an active signal. Note: The following formula must be met: (F8-32 - F8-33 x F0-10) ⩽ operating frequency ⩽ (F8-32 + F8-33 x F0-10).
F8-33	Detection frequency amplitude 2	0.1%	0.1% to 100.0%	When the running frequency of the AC drive is within the frequency detection range (F8-32 - F8-33 x F0-10 to F8-32 + F8-33 x F0-10), the DO outputs an active signal. Note 1: The max. frequency (F0-10) is used as the base of percentage.

1.5.3 Current Detection

1.5.3.1 Zero Current Detection

The DO outputs an active signal when the output current of the AC drive remains at or below the zero current detection level (F8-34) for a period greater than the value of F8-35 (zero current detection delay time).

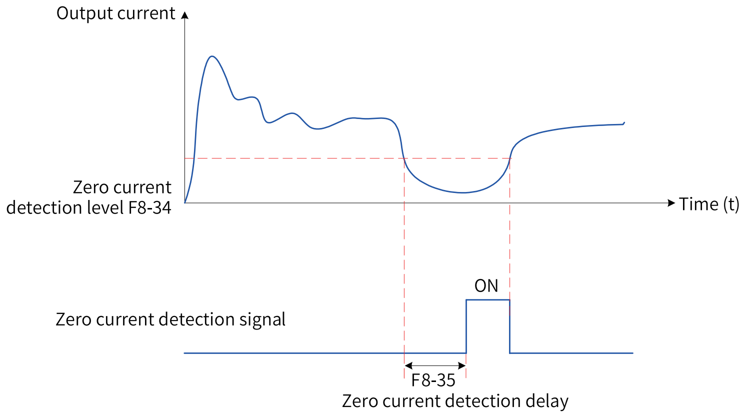


Figure 1-72 Zero current detection

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-34	Zero current detection level	5.0%	0.0% to 300.0% (rated motor current)	The DO outputs an active signal when the output current of the AC drive remains at or below the zero current detection level (F8-34) for a period greater than the value of F8-35 (zero current detection delay time).
F8-35	Zero current detection delay	0.10s	0.01s to 600.00s	

1.5.3.2 Output Current Overlimit

When the output current of the AC drive remains above the output current overlimit threshold (F8-36) for a period longer than the value of F8-37 (output current overlimit detection delay), the DO outputs an active signal.

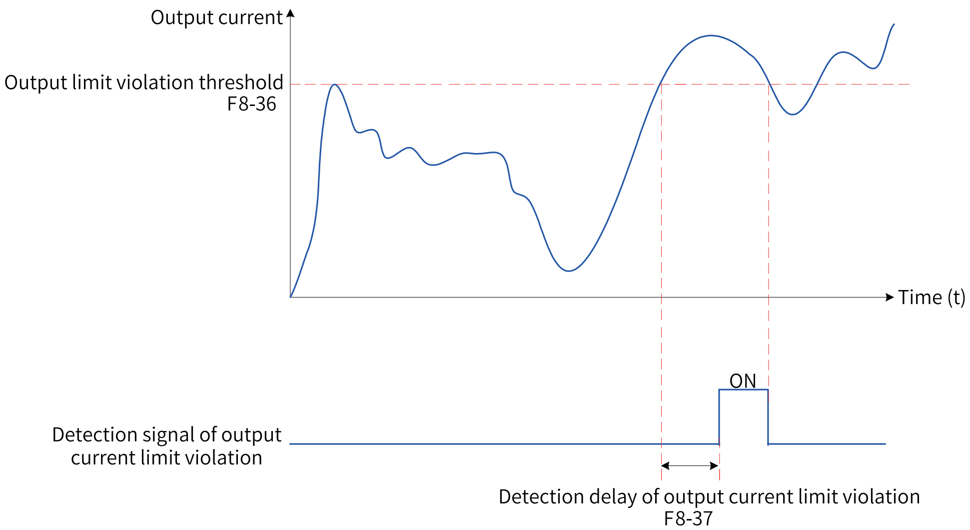


Figure 1-73 Output current overlimit threshold

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-36	Output current overlimit threshold	200.0%	0.0% (no detection) 0.1% to 300.0% (rated motor current)	When the output current of the AC drive remains above the output current overlimit threshold (F8-36) for a period longer than the value of F8-37 (output current overlimit detection delay), the DO outputs an active signal.
F8-37	Output current overlimit detection delay	0.00s	0.00s to 600.00s	

1.5.3.3 Detection Current

When the output current of the AC drive is within the range from Detection current - Detection current amplitude x Rated motor current to Detection current + Detection current amplitude x Rated motor current, the DO outputs an active signal.

The AC drive provides two groups of detection current and amplitude parameters, as shown below.

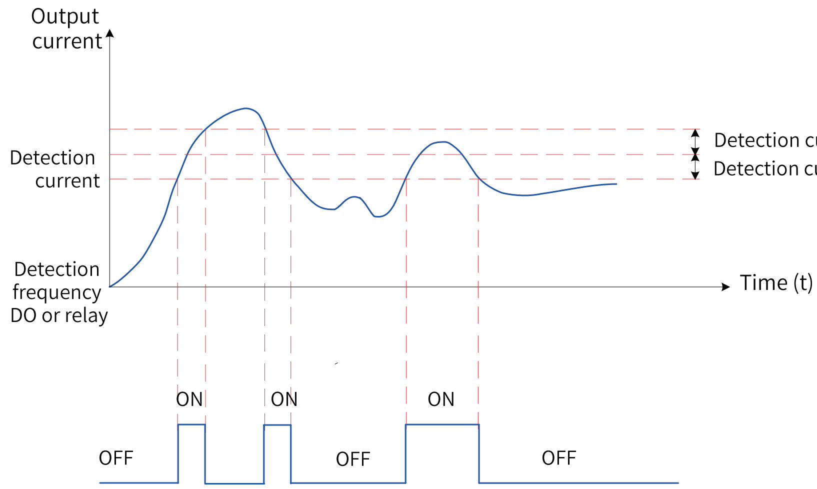


Figure 1-74 Current detection timing diagram

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-38	Detection current 1	100.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-38±F8-39) x Rated motor current, the DO terminal outputs an active signal. Note: The DO is allocated with function 28 "Current 1 reach".
F8-39	Detection current amplitude 1	0.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-38±F8-39) x Rated motor current, the DO terminal outputs an active signal.

Parameter Code	Parameter Name	Default	Value Range	Description
F8-40	Detection current 2	100.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-40±F8-41) x Rated motor current, the DO terminal outputs an active signal. Note 1: The DO is allocated with function 29 "Current 2 reach".
F8-41	Detection current amplitude 2	0.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-40±F8-41) x Rated motor current, the DO terminal outputs an active signal.

1.5.4 Dead Zone Time of Forward/Reverse Run Switchover

This function is used to specify the transition period when the output is 0 Hz during forward/reverse run switchover of the AC drive. The transition period is called dead zone time of forward/reverse run switchover, which can be set through F8-12.

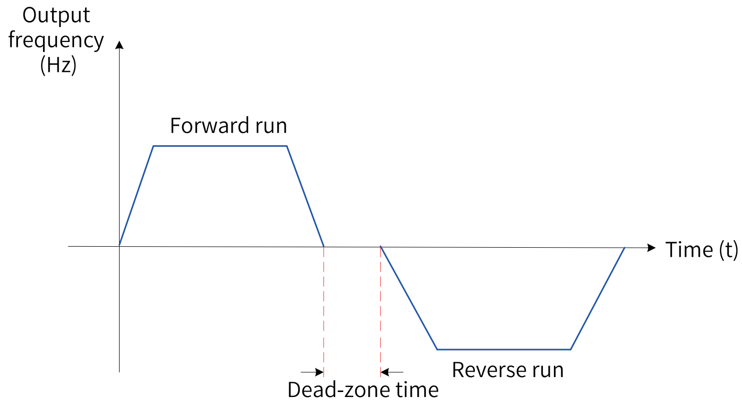


Figure 1-75 Dead zone time of forward/reverse run switchover

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-12	Dead zone time of forward/reverse run switchover	0.0s	0.0s to 3000.0s	This parameter defines the transition time at 0 Hz output during switchover between forward run and reverse run.

1.5.5 Timing Function

The timer starts from 0 upon startup of the AC drive. When the timing duration (F8-44) expires, the AC drive automatically stops, and the DO outputs an active signal. The remaining timing duration can be viewed through U0-20.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-42	Timing function	0	0: Disable 1: Enable	This parameter is used to enable timed operation of the drive. If F8-42 is set to 1, the AC drive starts timing at startup. When the set timing duration is reached, the AC drive stops automatically and meanwhile the corresponding multi-function DO outputs ON signal. The timing duration is set in F8-43 and F8-44, in unit of minute. The AC drive starts timing from 0 each time it starts up and the remaining timing duration can be viewed in U0-20. Note: The DO is allocated with function 30 "Timed operation reached".
F8-43	Timing operation time setting source	0	0: F8-44 1: AI1 2: AI2 3: AI3 Others: F connector	This parameter is used to set the source of timed operation. When other input sources are selected, the input range 100.0% corresponds to the setpoint of F8-44. If AI1 is selected, 10 V corresponds to the setpoint of F8-44.
F8-44	Timing operation time	0.0 min	0.0 min to 6500.0 min	This parameter is used to set the duration of timed operation.

1.5.6 Cumulative Time Reach

When the cumulative power-on time (F7-13) x 3600 + cumulative power-on time (F7-29) exceeds the set cumulative power-on time (F8-16) x 3600 + set power-on time (F8-74), the DO outputs an active signal.

Parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-16	Power-on time reach (hour)	0h	0h to 65535h	If the cumulative power-on time reaches the value set by F8-16 and F8-74, and the set power-on time is not zero, the multi-function DO outputs ON signal. Note: The DO is allocated with function 24 "Cumulative power-on time reach".
F8-74	Power-on time reach (second)	0s	0s to 3599s	

When the cumulative running time (F7-09) x 3600 + cumulative running time (F7-28) exceeds the set cumulative running time (F8-17) x 3600 + set running time (F8-75), the DO outputs an active signal.

Parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-17	Running time threshold (hour)	0h	0h to 65535h	These parameters are used to set the running time threshold of the AC drive. If the cumulative running time reaches the value set by F8-17 and F8-75, and the set running time is not zero, the multi-function DO outputs ON signal.
F8-75	Running time threshold (second)	0s	0s to 3599s	

1.5.7 Current Running Time Reach

Current running time reach

Parameter Code	Parameter Name	Default	Value Range	Description
F8-53	Current running time reach	0.0 min	0.0 min to 6500.0 min	If the current running time reaches the value set by this parameter, the corresponding DO outputs ON signal, indicating that the current running time is reached. Note: The DO is allocated with function 40.

1.5.8 AI1 Voltage Upper/Lower Limit

Parameter Code	Parameter Name	Default	Value Range	Description
F8-45	Lower limit threshold of AI1 input voltage protection value	3.10 V	0.00 V to F8-46	When the AI1 input voltage is higher than the value of F8-46 or lower than the value of F8-45, the DO outputs an active signal indicating "AI1 input limit exceeded".
F8-46	Upper limit threshold of AI1 input voltage protection value	6.80 V	F8-45 to 10.00 V	
A6-51	Lower limit threshold of AI2 input voltage protection value	8.00 V	A6-52 to 10.00 V	When the AI2 input voltage is higher than the value of A6-51 or lower than the value of A6-52, the DO outputs an active signal indicating "AI2 input limit exceeded".
A6-52	Upper limit threshold of AI2 input voltage protection value	2.00 V	0.00 V to A6-51	

Parameter Code	Parameter Name	Default	Value Range	Description
A6-57	Lower limit threshold of AI3 input voltage protection value	8.00 V	A6-58 to 10.00 V	When the AI3 input voltage is higher than the value of A6-57 or lower than the value of A6-58, the DO outputs an active signal indicating "AI3 input limit exceeded".
A6-58	Upper limit threshold of AI3 input voltage protection value	2.00 V	0.00 V to A6-57	
A6-59	AI input protection time	0.01s	0.00s to 1.00s	When the AI input limit keeps being exceeded after the time defined by this parameter elapses, the fault flag will be set.

1.5.9 Module Temperature

Parameter Code	Parameter Name	Default	Value Range	Description
F8-47	Module temperature reach (threshold)	75°C	0°C to 100°C	When the temperature of the inverter heatsink reaches the value of F8-47, the DO outputs an active signal.
F7-07	Inverter heatsink temperature	0°C	-20°C to 120°C	This parameter indicates the temperature of the inverter heatsink.

1.5.10 Fan Control

Parameter Code	Parameter Name	Default	Value Range	Description
F8-48	Cooling fan control	0	0: The cooling fan works when the drive is running.	The fan keeps working during drive running. When the drive stops, the fan works for 10s and then stops if the heatsink temperature is above 40°C and stops immediately if the heatsink temperature is below 40°C.
			1: The cooling fan works always.	When this parameter is set to 1, the fan keeps working after power-on.

1.5.11 Output Power Correction

Parameter Code	Parameter Name	Default	Value Range	Description
F8-54	Output power correction coefficient	100.0%	0.0% to 200.0%	When the output power (U0-05) is not equal to expected value, perform linear correction on the output power via this parameter.

1.5.12 User-Defined Parameters

Group FE consists of user-defined parameters (FE-00 to FE-31). Users can define up to 30 commonly used parameters for easier check and modification.

- If F0.00 is displayed, the corresponding user-defined parameter is empty. In the user-defined parameter mode, the displayed parameters are defined by FE-00 to FE-31, and the sequence is consistent with that in group FE. The parameter is skipped if F0-00 is displayed.
- This group is user-defined. You can select the required parameters from the parameter list and add them to group FE, which facilitates view and modification.
  When the communication protocol is extension protocol, this group of parameters will be mapped automatically after PDOs are configured by the host controller.

  U3-17 and U3-16 indicate PZD1 (AC drive command word) in the communication control mode and PZD2 (AC drive target frequency) in the communication control mode, respectively.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
FP-03	Individualized parameter display	111	Ones: User-defined parameter group 0: Hidden 1: Displayed Tens: User-modified parameter group 0: Hidden 1: Displayed hundreds: Error menu 0: Hidden 1: Displayed	This parameter is used to determine whether the user-defined parameter group, user-modified parameter group, and error menu are displayed on the operating panel through the ones, tens, and hundreds places.
FE-00	User-defined parameter 0	F0-00	0x0 to 0xFFFF	This group is user-defined. You can select the required parameters from the parameter list and add them to group FE, which facilitates view and modification. When the communication protocol is extension protocol, this group of parameters will be mapped automatically after PDOs are configured by the host controller.

Parameter Code	Parameter Name	Default	Value Range	Description
FE-01	User-defined parameter 1	Same as FE-00	Same as FE-00	Same as FE-00
FE-02	User-defined parameter 2			
FE-03	User-defined parameter 3			
FE-04	User-defined parameter 4			
FE-05	User-defined parameter 5			
FE-06	User-defined parameter 6			
FE-07	User-defined parameter 7			
FE-08	User-defined parameter 8			
FE-09	User-defined parameter 9			
FE-10	User-defined parameter 10			
FE-11	User-defined parameter 11	Same as FE-00	Same as FE-00	Same as FE-00
FE-12	User-defined parameter 12			
FE-13	User-defined parameter 13			
FE-14	User-defined parameter 14			
FE-15	User-defined parameter 15			
FE-16	User-defined parameter 16			
FE-17	User-defined parameter 17			
FE-18	User-defined parameter 18			
FE-19	User-defined parameter 19			
FE-20	User-defined parameter 20			
FE-21	User-defined parameter 21			
FE-22	User-defined parameter 22			
FE-23	User-defined parameter 23			

Parameter Code	Parameter Name	Default	Value Range	Description
FE-24	User-defined parameter 24	Same as FE-00	Same as FE-00	Same as FE-00
FE-25	User-defined parameter 25			
FE-26	User-defined parameter 26			
FE-27	User-defined parameter 27			
FE-28	User-defined parameter 28			
FE-29	User-defined parameter 29			
FE-30	User-defined parameter 30			
FE-31	User-defined parameter 31			

1.5.13 Hibernation and Wakeup

Hibernation enables you to set any time period within 24 hours, during which the AC drive stops running and hibernates.

Wakeup is a process that the AC drive wakes up from the hibernation state and starts to run.

To use the hibernation and wakeup functions, set the wakeup frequency, hibernation frequency, and hibernation duration. Generally, set the wakeup frequency (F8-49) equal to or greater than the hibernation frequency (F8-51). The hibernation and wakeup function is disabled if both the wakeup frequency and hibernation frequency are set to 0.00 Hz.

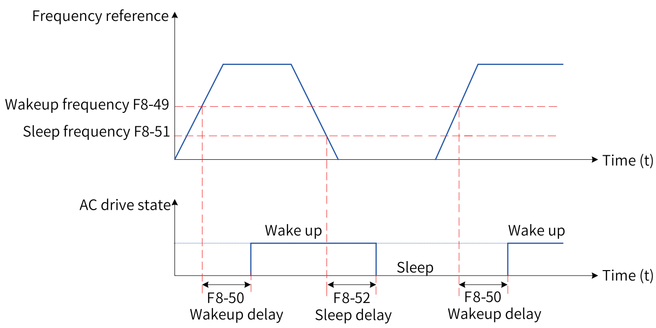


Figure 1-76 Hibernation and wakeup

Note

When sleep is enabled during PID operation, you can set FA-28 (selection of PID operation at stop) to 1 to continue the PID operation or to 0 to stop PID operation.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-49	Wakeup frequency	0.00 Hz	F8-51 (hibernation frequency) to F0-10 (maximum frequency)	In the hibernation state, when the frequency reference keeps equal to or larger than the wakeup frequency (F8-49) for the time set by F8-50 and the current running command is valid, the AC drive starts directly.
F8-50	Wakeup delay	0.0s	0.0s to 6500.0s	
F8-51	Hibernation frequency	0.00 Hz	0.00 Hz to wakeup frequency (F8-49)	During the AC drive running, when the frequency reference keeps lower than or equal to the hibernating frequency (F8-51) for the time set by F8-52, the AC drive enters the hibernation state and coasts to stop.
F8-52	Hibernation delay	0.0s	0.0s to 6500.0s	

1.6 Fault and Protection

1.6.1 Startup Protection

When F8-18 is set to 1, startup protection is enabled to prevent the motor from responding to a command upon power-on or fault reset of the AC drive.

Startup protection can be used in the following scenarios:

- If the running command is valid when the AC drive is powered on (for example, an input terminal is ON before power-on), the AC drive does not respond to the command. The AC drive responds only after the running command is canceled and becomes valid again.
- If the running command is valid when the AC drive fault is reset, the AC drive does not respond to the running command. The startup protection can be disabled only after the running command is canceled.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F8-18	Startup protection	0	0: Disable 1: Enable	The AC drive is equipped with startup protection to prevent the motor from responding to commands upon unexpected power-on or fault reset. In addition, the AC drive does not respond to the run command valid upon fault reset of the AC drive. The run protection can be disabled only after the run command has been cancelled.

1.6.2 Undervoltage Threshold, Overvoltage Threshold, and Pulse-by-Pulse Current Limit Protection

When the bus voltage falls below the value of A5-06 or exceeds the value of A5-09, the AC drive generates an alarm.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A5-06	Undervoltage threshold	350.0 V	140.0 V to 420.0 V	When the bus voltage is lower than the value of A5-06, the AC drive reports E009.1.
A5-09	Overvoltage threshold	820.0V	330.0 V to 820.0 V	When the bus voltage is higher than the value of A5-09, the AC drive reports E005.1. The default value is recommended.
A5-04	Pulse-by-pulse current limit protection	1	0: Enable 1: Enable	This function is used to minimize the possibility of overcurrent faults, ensuring normal operation of the AC drive. It is recommended to disable this function in hoisting applications, such as cranes.

1.6.3 Phase Loss Protection

Parameter Code	Parameter Name	Default	Value Range	Description
F9-12	Protection function selection	11	Ones: Input phase loss protection 0: Disable 1: Protection enabled when both software and hardware input phase loss conditions are met 2: Protection enabled when software input phase loss conditions are met 3: Protection enabled when hardware input phase loss conditions are met Tens: Contactor close protection 0: Disable 1: Enable Hundreds: T13 rectifier fault protection 0: Disable 1: Enable	This parameter determines whether to perform input phase loss or contactor close protection through the ones and tens places. After the input phase loss protection function is enabled, if the three-phase input power supply, driver board, lightning protection board, main control board, or rectifier bridge is abnormal, the drive will report E012.0 (input phase loss). Ones: Input phase loss protection 0: Disable Input phase loss is not detected. 1: Protection enabled when both software and hardware input phase loss conditions are met Input phase loss protection is performed only when the hardware detection and software detection meet the conditions. 2: Protection enabled when software input phase loss conditions are met Input phase loss protection is performed when the software detection meets the conditions. 3: Protection enabled when hardware input phase loss conditions are met Input phase loss protection is performed when the hardware detection meets the conditions. Tens: For models of 450 kW and below, the tens place is used to set the contactor close protection function. For models of 500 kW and above, the tens place is used to set the fan fault selection. 0: Disable contactor close protection 1: Enable contactor close protection Hundreds: T13 rectifier fault protection 0: Disable 1: Enable

Parameter Code	Parameter Name	Default	Value Range	Description
F9-13	Output phase loss protection	01	Ones: Protection against output phase loss during running 0: Disable 1: Enable Tens: Protection against output phase loss before running 0: Disable 1: Enable	The default value 1 indicates the output phase loss protection is enabled. Related options are described as below. Ones: It is used to determine whether to perform output phase loss protection. If the ones place of F9-13 is set to 0, the output phase loss will not be reported when it occurs. In this case, the actual current is larger than the current displayed on the operating panel. Use this function cautiously. 0: Disable Protection against output phase loss during running is disabled. 1: Enable Protection against output phase loss during running is enabled. Tens: Output phase loss detection during running takes about several seconds. In low-frequency operations or applications where risks exist in start with phase loss, this function can be used to detect phase loss fault upon start. However, in applications where short start time is required, do not use this function. 0: Disable Protection against output phase loss before running is disabled. 1: Enable Protection against output phase loss before running is enabled.

1.6.4 Motor Overtemperature Protection

You can view the motor temperature in U0-34. The following table describes parameters related to motor overtemperature protection.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F9-56	AI3 temperature mode - motor temperature sensor type	0°C	0: Temperature sensor not supported (AI used for analog input) 1: PT100 2: PT1000	A motor temperature sensor needs to be connected to the AI3 and PGND terminals on the MD38IO1 expansion card. The AC drive supports PT100 and PT1000 motor temperature sensors. Set the sensor type properly. Set the DIP switch on the MD38IO1 expansion card. For details, see section MD38IO1 expansion card in the AC drive expansion card selection guide. You can view the motor temperature in U0-34.
F9-57	AI3 temperature mode - motor overheat protection threshold	110°C	F9-58 to 200°C	This parameter is used to set the motor overtemperature protection threshold. When the motor temperature exceeds the value of F9-57 (motor overtemperature protection threshold), the AC drive generates the motor overtemperature alarm (E045.1).
F9-58	AI3 temperature mode - motor overheat warning threshold	90°C	0°C to F9-57	When the motor temperature exceeds the motor overtemperature warning threshold (F9-58), the DO terminal allocated with function 39 (Motor overtemperature warning) outputs a valid signal.

1.6.5 Motor Overload Protection

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F9-00	Motor overload protection selection	1	0: Disable 1: Enable	This parameter specifies whether to enable the motor overload protection function. The AC drive determines whether the motor is overloaded according to the inverse time lag curve. When the motor overload is detected, the AC drive will report an overload fault. 0: Enable The motor overload protection function is disabled. If this parameter is set to 0, you are advised to install a thermal relay before the motor for protection. 1: Enable The motor overload protection function is enabled.
F9-01	Motor overload protection gain	1	0.20 to 10.00	It is used to adjust the actual overload fault report time of the AC drive when motor overload occurs. The higher the value of this parameter, the longer the overload time. Note: See the description in the motor overload protection section in the this guide.
F9-02	Motor overload warning coefficient	80%	50% to 100%	The motor overload alarm coefficient is calculated according to the percentage of time during which the motor runs continuously at a certain overload threshold without reporting overload alarm. An alarm signal is sent to the control system through the DO before motor overload protection. This signal is used to determine how long in advance to send the alarm signal before the motor overload protection applies. The higher the coefficient is, the later the alarm signal is sent. When the cumulative output current of the drive exceeds the product of the overload time (Y value of motor overload protection inverse time lag curve) multiplied by F9-02 (motor overload alarm coefficient), the DO outputs a motor overload alarm signal.

To protect different load motors, set the motor overload protection gain based on the overload capacity of the motor. The motor overload protection curve is an inverse time lag curve, as shown in the following figure.

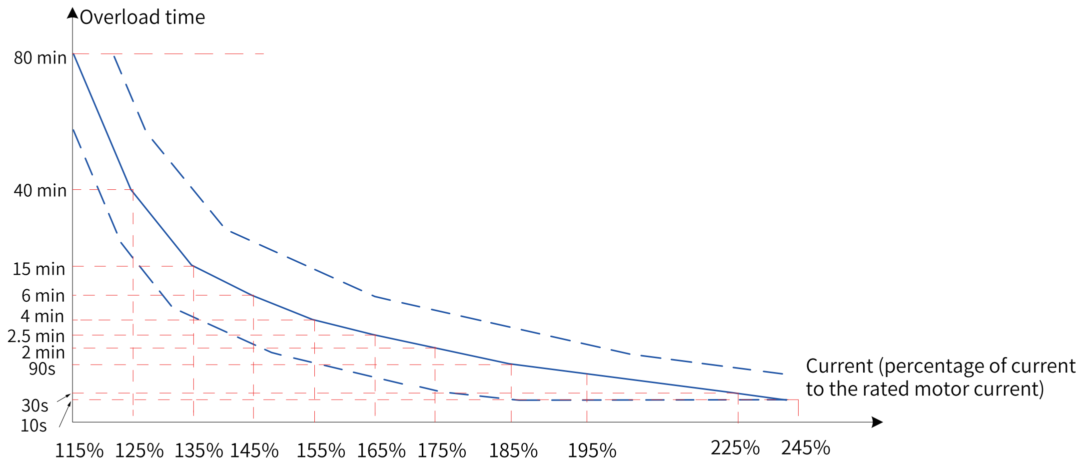


Figure 1-77 Inverse time-lag curve of protection

When the running current reaches 175% of the rated motor current and the motor runs at this level for 2 minutes, or when the running current reaches 115% of the rated motor current and the motor runs at this level for 80 minutes, the AC drive reports a motor overload alarm (E011.1).

1. Example 1

- Assume that the rated motor current is 100 A and F9-01 is set to 1.00. If the running current reaches 125 A (125% of 100 A) and the motor runs at this level for 40 minutes, the AC drive reports a motor overload alarm (E011.1).
- Assume that the rated motor current is 100 A and F9-01 is set to 1.20. If the running current reaches 125 A (125% of 100 A) and the motor runs at this level for 48 minutes (40 x 1.2), the AC drive reports a motor overload alarm (E011.1).

Note

The maximum overload time is 80 minutes and the minimum overload time is 10 seconds.

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2. Example 2

The AC drive reports a motor overload error after the motor runs for 2 minutes at 150% of the rated motor current. As shown by the overload curve, 150% (I) of the rated motor current is between 145% (I1) and 155% (I2) of the rated motor current. The overload error reporting time for 145% of the rated motor current is 6 minutes (T1), and that for 155% of the rated motor current is 4 minutes (T2). Therefore, the overload error reporting time for 150% of the rated motor current in default settings can be calculated. The calculation formula is as follows:

"T = T1 + (T2 – T1) x (I – I1)/(I2 – I1) = 4 + (6 – 4) x (150% – 145%)/(155% – 145%) = 5 (minute)"

Therefore, if the overload fault needs to be reported when the motor runs at 150% of the rated motor current for 2 minutes, set the motor overload protection gain F9-01 to 0.4 (F9-01 = 2/5).

Caution

Note: Set F9-01 properly based on the actual overload capacity. If the value of F9-01 is set too high, the motor may be damaged because the motor overheats but the AC drive does not report the alarm timely.

When the motor overload detection level reaches the value of F9-02 (Motor overload warning coefficient), the DO or fault relay outputs the motor overload warning signal. The value of F9-02 is the percentage of the time duration during which the motor runs continuously at a certain overload point without reporting the overload fault.

On the condition that the motor overload protection gain is set to 1.00 and motor overload warning coefficient is set to 80%, when the motor running current reaches 145% of the rated motor current and the motor runs at this level for 4.8 min (80% x 6), the DO or fault relay outputs the motor overload warning signal.

The motor overload warning function is used to send a warning signal to the control system via the DO before the motor overload protection applies. The motor overload warning coefficient is used to determine how early the alarm signal is sent before the motor overload protection applies. The higher the value is, the later the warning signal is sent. When the cumulative output current of the AC drive exceeds the product of multiplying the overload time (Y value of motor overload protection inverse time lag curve) and F9-02 (motor overload warning coefficient), the DO outputs a motor overload warning signal. When F9-02 is set to 100% and the warning advance value is 0, the motor overload warning and the motor overload protection are triggered simultaneously.

1.6.6 Load Loss Protection

Set F9-63 to 1 to enable load loss detection. When the output current of the AC drive falls below F9-64 (Load loss detection level) for longer than the value of F9-65 (Load loss detection time), the AC drive performs load loss protection action. Once the load recovers during protection, the drive will restore to run at the set frequency.

Parameter	Name	Default	Value range	Descriptions
F9-51	Fault protection action selection 5	10111	Ones: Modbus timeout (E160.X) Tens position: CANopen fault (E161.X) Hundreds position: CANlink fault (E162.X) Thousands position: Reserved Ten thousands position: Expansion card fault (E164.X) The meaning of 0 to 5 is described in the parameter description	The protective actions are set through the ones, tens, hundreds, thousands, and ten thousands of this parameter. 0: Coast to stop The drive coasts to stop. 1: Stop according to the stop mode The AC drive enters the stop state in the stop mode. 2: Continue operation The drive continues to run. 3: Operation with limited power AC drive power limit 4: Operation with limited current Current limit of the AC drive. 5: Ignore fault The fault type is ignored by the drive.
F9-63	Protection upon load loss	0	0: Disabled 1: Enable	If load loss protection is enabled, when output current of the AC drive falls below detection level (F9-64) for longer than time set in F9-65, the AC drive initiates load loss protection action (the action can be selected from F9-49 and the default is coast-to-stop.) Once the load recovers during protection, the drive will restore to run at the set frequency. 0: Inactive The load loss protection detection is invalid. This detection will not be performed. 1: Active The load loss protection detection is active.

Parameter	Name	Default	Value range	Descriptions
F9-64	Load loss detection level	10.0%	0.0% to 100.0%	If load loss protection is enabled, when output current of the AC drive falls below detection level (F9-64) for longer than time set in F9-65, the AC drive initiates load loss protection action (the action can be selected from F9-49 and the default is coast-to-stop.) Once the load recovers during protection, the drive will restore to run at the set frequency.
F9-65	Load loss detection time	1.0s	0.0 to 60.0	

1.6.7 Overspeed Protection

Overspeed protection is available only when the AC drive works in the FVC mode (F0-01 = 1).

During overspeed protection, when the detected motor speed exceeds F0-10 (Maximum frequency) for a percentage higher than F9-67 (Overspeed detection level) and for longer than the time set by F9-68 (Overspeed detection time), the AC drive reports a motor overspeed fault (E043.1) and acts as selected by F9-50 (Fault protection action).

When F9-68 (Overspeed detection time) is set to 0.0s, the overspeed detection function is disabled.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F9-67	Over-speed detection level	20.0%	0.0% to 50.0% (maximum frequency)	During overspeed protection, when the detected motor speed exceeds F0-10 (Maximum frequency) for a percentage higher than F9-67 (Overspeed detection level) and for longer than the time set by F9-68 (Overspeed detection time), the AC drive reports a motor overspeed fault (E043.1) and acts as selected by F9-50 (Fault protection action). When F9-68 (Overspeed detection time) is set to 0.0s, the overspeed detection function is disabled. The overspeed protection is valid only in the FVC mode (F0-01 = 1).
F9-68	Over-speed detection time	1.0s	0.0 to 60.0	

1.6.8 Protection Against Excessive Speed Deviation

The excessive speed deviation detection function is active only when the FVC mode is selected for the AC drive (F0-01 = 1).

When the motor speed detected is higher than the set frequency and the difference is higher than F9-69 for a period longer than the time set by F9-70, the drive reports excessive speed deviation fault (E042.1) and acts accordingly as defined by F9-50.

If F9-70 is set to 0.0s, the excessive speed deviation detection is disabled.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F9-69	Detection level for excessive speed deviation	20.0%	0.0% to 50.0%	When the motor speed detected is higher than the set frequency and the difference is higher than F9-69 for a period longer than the time set by F9-70, the drive reports excessive speed deviation fault (E042.1) and acts accordingly as defined by F9-50. If F9-70 is set to 0.0s, the excessive speed deviation detection is disabled. The speed deviation protection function is valid only when the AC drive is running in SVC (vector control without speed sensor)/FVC (vector control with speed sensor).
F9-70	Detection time for excessive speed deviation	5.0s	0.0 to 60.0	

1.6.9 Motor Stall Protection

Take motor 1 as an example.

Parameter Code	Parameter Name	Default	Value Range	Description
AA-30	Motor protection	1	Bit 0 to bit 2: Reserved Bit 3: Current control error detection Bit 4: Motor step loss error detection Bit 5: Motor stall detection Bit 6: Demagnetization protection for synchronous motor Bit 7 to bit 8: Reserved Bit 9: Parameter setting error Bit 10: Reserved Bit 11: Runaway Protection Bit 12 to bit15: Reserved	This parameter is used to set the protective function of the motor.
AA-31	Motor stall protection time	2.0s	0.0s-65.0s	When the motor speed setpoint exceeds the fault frequency, the torque reaches the limit state, and the fault time is exceeded, a fault indicating the motor is stalled (E093.1) will be reported.
AA-32	Motor stall frequency	6.0%	0.0% to 600.0%	

1.6.10 Motor Step Loss Protection

Parameter Code	Parameter Name	Default	Value Range	Description
AA-30	Motor protection	1	Bit 0 to bit 2: Reserved Bit 3: Current control error detection Bit 4: Motor step loss error detection Bit 5: Motor stall detection Bit 6: Demagnetization protection for synchronous motor Bit 7 to bit 8: Reserved Bit 9: Parameter setting error bit10: Reserved Bit 11: Runaway Protection Bit 12 to bit15: Reserved	This parameter is used to set the protective function of the motor.
AA-33	Step loss detection time	0.5s	0.0s-10.0s	When the feedback flux of asynchronous motor flux controller and the set flux exceed the detection threshold and reach the set time, a step loss fault (E093.2) will be reported.
AA-34	Step loss detection threshold	30.0%	0.0% to 100.0%	

1.6.11 Current Control Error Protection

Parameter	Name	Default	Value range	Description
AA-30	Motor overload protection	1	Bt0 to bit2: Reserved Bit3: Current control error detection Bit 4: Motor stall error detection Bit 5: Motor stall detection Bit6: Synchronous motor demagnetization protection Bit7 to bit8: Reserved Bit9: parameter setting error bit10: Reserved Bit11: Protection of dispersed motorcycles bit12 to bit15: Reserved	Function switches for motor protection.
AA-35	Current control fault detection time	0.05s	0.00s-1.00s	Used to judge whether the motor feedback current follows the set deviation threshold. If the error exceeds the threshold and reaches the set time, a fault (E093.3) will be reported.
AA-36	Motor control error protection threshold	25.0%	0.0% to 200.0%	

1.6.12 Power Dip Ride-Through

The power dip ride-through function ensures continuous system running upon an instantaneous power failure. When an instantaneous power failure occurs, the AC drive keeps the motor in the power generation state to keep the bus voltage at a value around the threshold for enabling power dip ride-through. This prevents the AC drive from stopping due to undervoltage, as shown in the following figure.

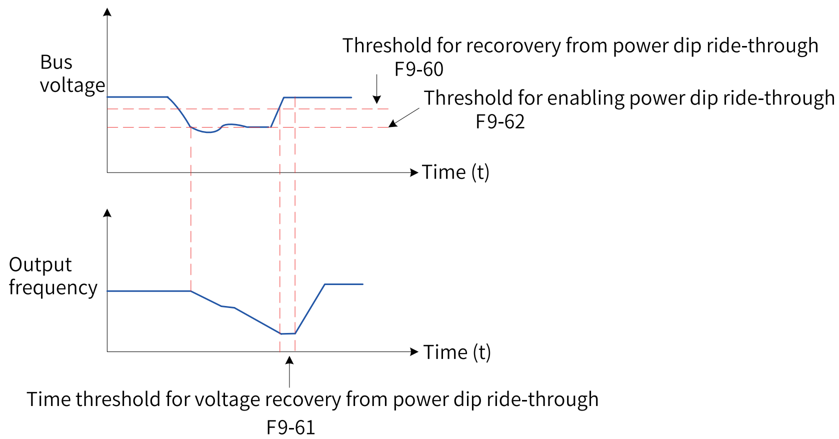


Figure 1-78 The following figure shows the power dip ride-through process.

In the "bus voltage constant control" mode, when the power grid recovers from the failure, the AC drive restores the output frequency to the target output frequency based on the acceleration time. In the "decelerate to stop" mode, when the power grid recovers from the failure, the AC drive decelerates to 0 Hz and stops, and will start only after receiving a start command.

Related Parameters

Parameter Code	Parameter Name	Default	Value Range	Description
F9-59	Power dip ride-through function	0	0: Disable 1: Deceleration (constant control of bus voltage) 2: Decelerate to stop 3: Voltage dip depression	The function enables the AC drive to keep running upon an instantaneous power failure. When an instantaneous power failure occurs, the AC drive keeps the motor in the power generation state to keep the bus voltage at a value around the threshold for enabling power dip ride-through. This prevents the AC drive from stopping due to undervoltage. 0: Disable The power dip ride-through function is disabled. 1: Constant control of bus voltage When a power failure occurs, the bus voltage is retained at a value around the threshold for enabling power dip ride-through. In this mode, when the power grid recovers from the failure, the AC drive restores the output frequency to the target output frequency based on the acceleration time. 2: Decelerate to stop When a power failure occurs, the AC drive decelerates to stop. In this mode, if the drive does not decelerate to 0 and the power supply recovers, the drive continues running. 3: Voltage dip depression This function prevents AC drive stop caused by undervoltage when instantaneous power failure occurs due to voltage dip. You can use F9-66 to set a voltage dip suppression time.
F9-60	Threshold for recovering from power dip ride-through	85%	80% to 100%	This parameter defines the voltage threshold for disabling power dip ride-through. 100% corresponds to 540 V. This value is slightly lower than the bus voltage before a power failure. Upon a power failure, the bus voltage is maintained at about F9-62 (threshold for enabling power dip ride-through). When the power supply recovers, the bus voltage rises from F9-62 (threshold for enabling power dip ride-through) to F9-60 (threshold for recovery from power dip ride-through). During this period, the output frequency of the AC drive keeps decreasing until the bus voltage reaches F9-60 (threshold for recovery from power dip ride-through).
F9-61	Duration for judging voltage recovery from power dip ride-through	0.5s	0.0s to 100.0s	This parameter is used to set the time required for the bus voltage to rise from F9-60 (Threshold of recovery from power dip ride-through) to the voltage before a power failure.
F9-62	Threshold for enabling power dip ride-through	80%	60% to 100%	This parameter defines the bus voltage level upon a power failure. When a power failure occurs, the bus voltage is retained at a value around F9-62 (Threshold for enabling power dip ride-through).

Parameter Code	Parameter Name	Default	Value Range	Description
F9-71	Power dip ride-through gain Kp	40	1 to 100	This parameter is valid only in the constant control of the bus voltage (F9-59 = 1). If undervoltage is likely to occur during power dip ride-through, increase the values of F9-71 and F9-72.
F9-72	Power dip ride-through integral coefficient Ki	30	1 to 100	This parameter is valid only when F9-59 is set to 2. If undervoltage is likely to occur during power dip ride-through, increase the values of F9-71 and F9-72.
F9-73	Deceleration time of power dip ride-through	20.0s	0s to 300.0s	This parameter is valid only when F9-59 (power dip ride-through function) is set to 2 (decelerate to stop). When the bus voltage is lower than the value of F9-62, the AC drive decelerates to stop. The deceleration time is determined by this parameter instead of F0-18.

1.6.13 Automatic Reset Upon Fault

In the case of an undervoltage fault (E009.1), the AC drive resets automatically when the bus voltage restores to the normal range. This reset is not counted in the number of fault auto reset times. In the case of a short circuit to ground (E023.1) and STO BUFFER chip fault (E047.5), the AC drive does not support automatic or manual reset, and you need to reset the AC drive by powering it off and then powering it on again. The fault protection action selection is performed after the number of automatic reset times upon fault is reached.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F9-09	Number of automatic resets upon fault	0	0 to 100	Used to set the automatic fault reset times of the drive. If the number of reset times exceed the value of this parameter, the AC drive remains in the faulty state.
F9-10	Relay action during automatic reset	0	0: The DO does not act 1: The DO acts.	Check whether the fault output function of the digital output terminal is active during automatic fault reset of the AC drive. The fault output function of the digital output terminal is defined by F5-04 = 2. 0: The DO does not act The relay does not act during automatic reset. 1: The DO acts. The relay acts during automatic reset.
F9-11	Interval time of automatic fault reset	1.0s	0.1s to 600.0s	Used to set the delay of auto reset after the AC drive reports a fault.
H2-12	Automatic fault reset enable	1	0: Enable 1: Disable	Used to enable automatic fault reset, which is enabled by default.

Parameter	Name	Default	Value range	Descriptions
H2-15	Auto reset/ Manual reset	1	0: Cancels automatic reset 1: Continue automatic reset	Used to set whether the automatic reset process can be terminated by manual reset. If it is equal to 0, the operator manually resets the fault when a fault occurs. The next time the machine changes to a false signal, the operator manually resets the fault. The machine does not reset automatically. If it is equal to 1, the operator manually resets the fault when it occurs. The machine is reset automatically.
H2-16	Restore the time setting of the automatic reset times	10 min	0 min to 6000min	Sets the time for restoring the Auto Reset Count. 1. When the value is set to 10 minutes, when the number of automatic fault reset times is exhausted (H2-17), the number of automatic fault reset times is reloaded to the number of fault reset times set in F9-09. 2. When set to 0, the number of "automatic fault reset" times is restored.
H2-17	The number of fault reset times has been generated	0	0 to 65535	1. Displays the number of fault reset times that have occurred. 2. When the manual reset and "Restore automatic reset times time" H2-16 are reached, the value of this parameter is automatically cleared.
H2-18	The fault reset times are exhausted	0	0: Number of automatic reset times resumed 1: Auto reset times are not restored	Set whether the fault reset times (H2-17) are restored when the fault reset times are exhausted. 0: When the number of automatic fault reset times is exhausted, the number of automatic fault reset times (H2-17) will be restored automatically after the time of automatic reset times (H2-16). When it is set to 1, the number of automatic fault resets will not be restored automatically after the set number of automatic fault resets is reached.

You can set the automatic fault reset blacklist to prevent automatic fault reset. The AC drive supports 10 fault codes that cannot be reset automatically.

Related parameters

Parameter	Name	Default	Value range	Descriptions
H2-20	Reset failure error code 1 main code	0	0 to 200	This parameter is equivalent to the black list of automatic fault reset. If a fault occurs in the black list, the automatic bit fault action will not be performed.
H2-21	Reset failure error code 1 subcode	0	0 to 9	
H2-22	Reset failure error code 2 main code	0	0 to 200	
H2-23	Reset failure error code 2 subcode	0	0 to 9	
H2-24	Reset failure error code 3 main code	0	0 to 200	
H2-25	Reset failure error code 3 subcode	0	0 to 9	
H2-26	Reset failure error code 4 main code	0	0 to 200	
H2-27	Reset failure error code 4 subcode	0	0 to 9	
H2-28	Reset failure error code 5 main code	0	0 to 200	Same as above
H2-29	Reset failure error code 5 subcode	0	0 to 9	
H2-30	Reset failure error code 6 main code	0	0 to 200	
H2-31	Reset failure error code 6 subcode	0	0 to 9	
H2-32	Reset failure error code 7 main code	0	0 to 200	
H2-33	Reset failure error code 7 subcode	0	0 to 9	
H2-34	Reset failure error code 8 main code	0	0 to 200	
H2-35	Reset failure error code 8 subcode	0	0 to 9	Same as above
H2-36	Reset failure error code 9 main code	0	0 to 200	
H2-37	Reset failure error code 9 subcode	0	0 to 9	
H2-38	Reset failure error code 10 main code	0	0 to 200	
H2-39	Reset failure error code 10 subcode	0	0 to 9	

1.6.14 Automatic Restart upon Fault

When the AC drive reports a fault during operation, the automatic reset upon a fault and automatic restart upon a fault functions enable the AC drive to restart after the AC drive resets upon the fault and after the waiting time for automatic restart upon a fault expires. During restart, if the AC drive receives a stop/manual reset command, it will stop and not restart.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
H2-42	Restart after automatic reset	0	0: Disable 1: Enable	0: The AC drive does not restart after a fault occurs and the fault is automatically reset. 1: The AC drive automatically restarts after a fault occurs and the fault is automatically reset. Note: This function is available only when the automatic fault reset function is enabled.
H2-43	Waiting time for restart after automatic reset upon fault	0.5s	0.0s to 600.0s	This parameter sets the waiting time from automatic fault reset to automatic restart.
H2-44	Forced flying start for automatic restart	0	0: Disable 1: Enable	This parameter sets whether to enable flying start for automatic restart upon fault. 0: The drive restarts according to the start mode set by F6-00 upon a fault. 1: The drive performs flying start upon a fault for restart no matter the settings of F6-00.

You can set a white list containing up to six faults, upon which the AC drive will reset and then restart. Or you can also set a black list containing up to six faults, upon which the AC drive is not allowed to reset or restart.

Related Parameters

Parameter Code	Parameter Name	Default	Value Range	Description
H2-45	Source of fault upon which drive is allowed for restart	1	0: White list 1: Black list	This parameter sets the source of fault upon which the drive is allowed for restart 0: White list. The drive is allowed for restart upon the faults set by H2-46 to H2-57. 1: Black list. The drive is allowed for restart upon faults not set by H2-46 to H2-57.
H2-46	Specified fault master code 1	0	0 to 200	Six groups of fault master codes and subcodes are provided to form fault codes. Determine whether automatic restart after a reset upon a fault is allowed based on the setting of H2-45.
H2-47	Specified fault subcode 1	0	0 to 9	
H2-48	Specified fault master code 2	0	0 to 200	
H2-49	Specified fault subcode 2	0	0 to 9	
H2-50	Specified fault master code 3	0	0 to 200	
H2-51	Specified fault subcode 3	0	0 to 9	
H2-52	Specified fault master code 4	0	0 to 200	
H2-53	Specified fault subcode 4	0	0 to 9	
H2-54	Specified fault master code 5	0	0 to 200	
H2-55	Specified fault subcode 5	0	0 to 9	
H2-56	Specified fault master code 6	0	0 to 200	
H2-57	Specified fault subcode 6	0	0 to 9	

1.6.15 Protective Action Against Fault

The AC drive provides six types of protective actions upon a fault, including coasting to stop, stopping according to the stop mode, continuing operation, operation with limited power, operation with limited current, and ignoring fault.

The actions of coasting to stop, stopping according to the stop mode, limited operation (continuing operation, operation with limited power, and operation with limited current), and ignoring fault are adopted according to the severity of the fault from high to low.

Continuing operation, operation with limited power, and operation with limited current are of the same level.

When continuing operation, operation with limited power, or operation with limited current is selected, the operating panel displays Lxxx.x, such as L042.1.

When "fault cancellation" is selected as the protective action against fault, no prompt will be displayed when a fault occurs. Select this option only when necessary.

Related Parameters

Parameter Code	Parameter Name	Default	Value Range	Description
F9-47	Fault protection action selection 1	0	Ones: Motor overload (E011.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Tens: Input phase loss (E012.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Hundreds: Output phase loss (E013.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Thousands: External fault (E015.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Ten thousands: Reserved	The protective actions are set through the ones, tens, hundreds, thousands, and ten thousands places of this parameter. 0: Coast to stop The drive coasts to stop. 1: Stop according to the stop mode The drive stops according the specified stop mode. 2: Continue to run The drive continues to run. 3: Operation with limited power The drive operates with limited power. 4: Operation with limited current The drive operates with limited current. 5: Ignore fault The fault type is ignored by the drive.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-48	Fault protection action selection 2	0	Ones: Encoder/PG card fault (E020.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Tens: Parameter reading/writing error (E021.x) 0: Coast to stop 1: Stop according to the stop mode Hundreds: PG card fault (E024.x) 0: Coast to stop Ten thousands: Inverter fault (E025.x) 0: Coast to stop Ten thousands: Running time reached (E026.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current	Same as F9–47

Parameter Code	Parameter Name	Default	Value Range	Description
F9-49	Fault protection action selection 3	20	Ones: User-defined fault 1 (E027.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Tens: User-defined fault 2 (E028.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Hundreds: Power-on time reached (E029.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Thousands: Load lost (E030.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Ten thousands: PID feedback lost during running (E031.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current	Same as F9–47

Parameter Code	Parameter Name	Default	Value Range	Description
F9-50	Fault protection action selection 4	2000	Ones: Excessive speed deviation (E042.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Tens: Motor overspeed (E043.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Hundreds: Error in identifying magnetic pole position (E051.x) 0: Coast to stop Thousands: Low liquid level fault (E066.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Ten thousands: Internal fan fault (E65.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current	Same as F9–47

Parameter Code	Parameter Name	Default	Value Range	Description
F9-54	Frequency for continuing to run upon fault	1	0: Current running frequency 1: Frequency reference 2: Frequency upper limit 3: Frequency lower limit 4: Backup frequency upon fault (F9-55) 5: Current running frequency after filtering	This parameter is used to select the frequency at which the AC drive continues operation upon a fault. If this parameter is set to 1, the drive displays A** and continues to run at the frequency defined by F9-54.
F9-55	Backup frequency upon fault	100.0%	0.0% to 100.0%. 100.0% corresponds to the maximum frequency F0-10.	This parameter defines the backup frequency of the drive upon a fault. If a fault occurs during the operation of the drive and the fault protection action is set to "Operating at backup frequency" (F9-54 = 4), the drive displays A** and continues to operate at the backup frequency.
A4-80	Operation with the limited speed	1	0: Limit the maximum operation speed 1: Run at a specified safe speed	0: Limit the maximum operation speed When the drive operates at a limited speed (for example, in case of a fault), the maximum running speed is limited by A4-81 and A4-82. 1: Run at a specified safe speed The drive operates at the frequency set by F9-54.
A4-81	Forward speed limit in limited operation mode	100.0%	0.0% to 100.0%	When A4-80 is set to 0, the positive speed limit is limited by the setpoint of A4-81.
A4-82	Reverse speed limit in limited operation mode	100.0%	0.0% to 100.0%	When A4-80 is set to 0, the negative speed limit is limited by the setpoint of A4-81.
A4-83	Maximum motoring power in limited operation mode	50.0%	0.0% to 400.0%	Maximum motoring power in limited operation mode
A4-84	Maximum regenerative power in limited operation mode	50.0%	0.0% to 400.0%	This parameter sets the maximum regenerative power in the limited operation mode.
A4-87	Maximum allowable current in limited operation mode	90.0%	0.0% to 400.0%	This parameter sets the maximum allowable current in the limited operation mode.

1.6.16 Self-Check

Self-check is a function that automatically checks the abnormality of the AC drive. It is recommended that self-check be performed when the device is used for the first time to check whether internal wiring and external wiring are correct.

The self-check function includes four items: IGBT shoot through self-check, short circuit to ground self-check, output phase loss self-check, and encoder self-check.

Self-check can be started in two ways: manual self-check and pre-running self-check.

- Manual self-check
  The manual self-check consists of static self-check and full self-check, which can be selected through F6-29. The following table lists the sub-items for static self-check and full self-check. Each sub-item can be configured as "Enable" or "Disable" through different bits of F6-28.

F6-28 (Self-Check Configuration)	F6-29 = 1 (Static Self-Check)	F6-29 = 2 (Full Self-Check)
IGBT shoot through self-check (bit 1)	✓	✓
Short circuit to ground self-check (bit 2)	✓	✓
Output phase loss self-check (bit 3)	✓	✓
Encoder self-check (bit 4)	-	✓

  The motor does not rotate during static self-check. During the encoder self-check, the motor accelerates to 50% of the rated motor speed according to the acceleration/deceleration time set by F0-17 and F0-18. After the self-check completes, the motor decelerates back to zero speed.

  1. If the encoder self-check is selected during the full self-check, ensure that the motor can rotate freely. Check the following conditions before starting the self-check:
     - Ensure that the device is not on the construction site.
     - Check for obstacles that affect shaft rotation around the motor shaft.
     - Check whether the motor brake (if any) is closed. If yes, release the brake.
     - Check whether the motor fan works properly.
     - Check whether the device (if any) connected to the motor meets the running conditions, for example, whether the device needs lubrication.
  2. The encoder self-check will be performed in the vector control mode without encoder. Therefore, ensure that the parameter is auto-tuned before self-check.

- Pre-running self-check
  The pre-running self-check is performed every time before AC drive operation. In this mode, only IGBT shoot through self-check, short circuit to ground self-check, and output phase loss self-check are available. Encoder self-check is not supported.

  Each sub-item can be enabled or disabled through different parameters.

  - IGBT shoot through self-check is configured by bit 4 of AA-00.
  - Short circuit to ground self-check is configured by bit 2 of F9-07.
  - Output phase loss self-check is configured by bit 2 of F9-13.

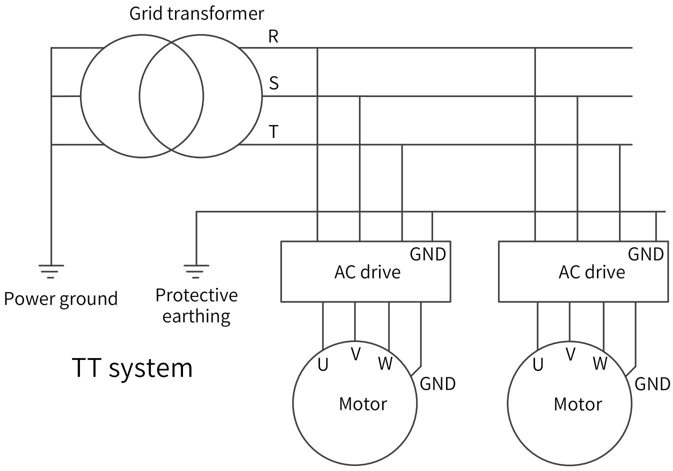
  Precautions for pre-running self-check:

  When flying start is configured for the motor, the pre-running self-check is disabled.

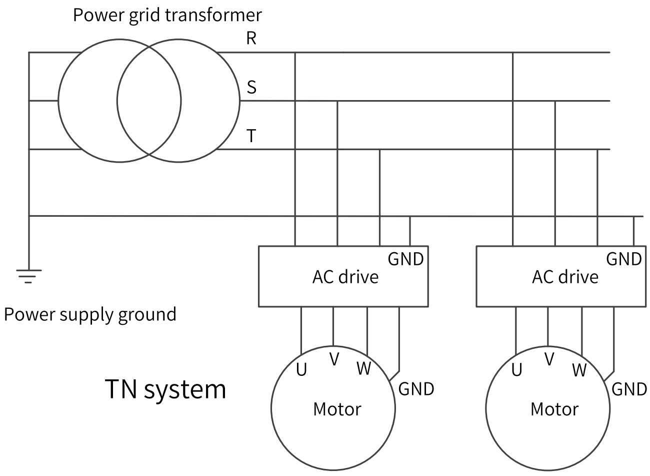
Precautions for self-check:

1. When using the self-check function, ensure that the rated motor current is greater than 0.2 times the rated AC drive current. If the motor power is much lower than the AC drive power, the self-check may fail. In this case, self-check is not recommended.
2. Do not start self-check when the motor is rotating. If self-check is started when the motor still has back EMF, a false fault may be reported.
3. When the grid is an IT system, short circuit to ground cannot be detected during self-check. To enable this function, install an insulation monitor to the IT system. The following figures show different types of grids:

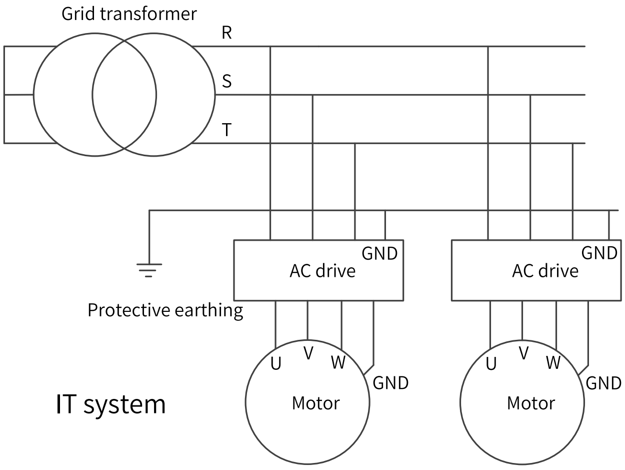
- **TT system**



- **TN system**



- **IT system**



IT system

Parameters related to self-check

Parameter Code	Parameter Name	Default	Value Range	Description
F6-28	Manual self-check	7	Bit 0: IGBT shoot through self-check 0: Disable 1: Enable Bit 1: Short circuit to ground self-check 0: Disable 1: Enable Bit 2: Phase loss self-check 0: Disable 1: Enable Bit 3: Reserved	This parameter defines the sub items of manual self-check. After enabling self-check by setting this parameter, you can select different self-check commands through F6-29. Self-check on each sub item is enabled separately by using a bit. The value 1 indicates "Enable", and 0 indicates "Disable". Bit 0: IGBT shoot through self-check 0: Disable 1: Enable Bit 1: Short circuit to ground self-check 0: Disable 1: Enable Bit 2: Phase loss self-check 0: Disable 1: Enable bit3: Reserved
F6-29	Manual self-check command	0	0: Disable 1: Static self-check 2: Full self-check 3: Static fault automatic diagnosis 4: Automatic diagnosis for with-load rotation fault 5: Automatic diagnosis for no-load rotation fault	This parameter is used to select different self-test modes. The self-check items are configured through F6-28. After the self-check is performed, the parameter restores to 0. 0: Disable 1: Static self-check is performed. In this mode, self-check on the encoder cannot be performed. 2: Full self-check is performed. 3: Static fault automatic diagnosis is performed. 4: Automatic diagnosis for with-load rotation fault is performed. 5: Automatic diagnosis for no-load rotation fault is performed.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-07	Short circuit to ground protection	1	Ones: Protection against short circuit to ground upon power-on 0: Invalid 1: Valid Tens: Protection against short circuit to ground before running 0: Invalid 1: Valid	Ones: Perform short circuit to ground self-check upon power-on. Tens: Short circuit to ground self-check before running is performed. If flying start (F6-00 = 1) is enabled, short circuit to ground self-check before running is forcibly disabled.
F9-13	Output phase loss protection	1	Ones: Protection against output phase loss during running 0: Disable 1: Enable Tens: Protection against output phase loss before running 0: Enable 1: Enable	The default value 1 indicates the output phase loss protection is enabled. Related options are described as below. Ones: It is used to determine whether to perform output phase loss protection. If F9-13 is set to 0, the output phase loss will not be reported when it occurs. In this case, the actual current is larger than the current displayed on the operating panel. Use this function cautiously. 0: Disable Protection against output phase loss during running is disabled. 1: Enable Protection against output phase loss during running is enabled. Tens: Output phase loss detection during running takes about several seconds. In low-frequency operations or applications where risks exist in start with phase loss, this function can be used to detect phase loss fault upon start. However, in applications where short start time is required, do not use this function. 0: Disable Protection against output phase loss before running is disabled. 1: Enable Protection against output phase loss before running is enabled.

Parameter Code	Parameter Name	Default	Value Range	Description
AA-00	Parameter auto-tuning before startup	1	Bit 0: Magnetic pole position auto-tuning of the synchronous motor 0: Disable 1: Enable Bit 1: Quick auto-tuning of stator resistance 0: Disable 1: Enable Bit 2 to Bit 3: Magnetic pole position auto-tuning during high-frequency injection 0: Disable 1: Enable 2: Self-adaptive Bit 4: IGBT shoot through self-check 0: Disable 1: Enable Bit 5 to bit 6: reserved 0: Disable 1: Enable Bit 7: Pre-positioning before start of synchronous motor 0: Disable 1: Enable Bit 8: Auto-tuning of stator resistance upon power-on 0: Disable 1: Enable	This parameter is used to configure steps related to automatic inspection and auto-tuning before start of the motor.

1.7 Safety Function

1.7.1 Safety Overview

1.7.1.1 List of Safety Functions

List of Safety Functions

- Safe torque off (STO)
  The STO function immediately shuts off the torque or force output of the motor based on an input signal from an external device. This function complies with stop category 0 of EN 60204-1. If the motor is running when the STO function is activated, it coasts to stop.

1.7.1.2 Terms and Abbreviations

Terms and Abbreviations	Description
Cat.	Safety category. It includes B, 1, 2, 3, and 4.
DCavg	Average diagnostic coverage (%)
DTI	Diagnostic test interval time
SFF	Safe failure fraction
PFHd	Probability of dangerous Failure per Hour
PL	Performance level
SC	Systematic capability
SIL	Safety integrity level
T_1	Proof test interval
DI	Digital input
DO	Digital output
MTTFd	Mean time to dangerous failure

1.7.1.3 Safety Standards and Specifications

Standards Compliance

- North American standards (UL)
  UL 61800-5-1

  CSA C22.2 No. 274
- EU Directives and Standards
  Low Voltage Directive 2014/35/EU, EN 61800-5-1

  EMC Directive 2014/30/ EU, EN 61800-3

  Machinery Directive 2006/42/EC (Function Safety), IEC 61800-5-2
- Safety standard

Option Model	Safety standards	Reference standards
MD520	Functional safety	IEC 61508: 2010 ISO 13849-1: 2015 ISO 13849-2: 2012 IEC 62061: 2021 IEC 61800-3: 2017 EN 61508: 2010 EN ISO 13849-1: 2015 EN ISO 13849-2: 2012 EN IEC 62061: 2021 EN IEC 61800-3: 2018
	EMC	IEC 61000-6-7: 2014 IEC 61326-3-1: 2017 IEC 61800-5-2: 2016 IEC 61800-3: 2017 EN 61000-6-7: 2015 EN 61326-3-1: 2017 EN 61800-5-2: 2017 EN IEC 61800-3: 2018
	LVD	IEC 61800-5-1:2007/AMD1: 2016 EN 61800-5-1:2007/A1: 2017

- Safety specifications

Items	Safety parameters
SIL	SIL3, IEC61508
PFHd	3.13E-09, 3.1% of SIL3, IEC 61508
Cat.	3, EN ISO 13849–1
PL	e, EN ISO 13849-1
MTTFd	326 years (high)
DCavg	⩾ 90% (medium)
T_1	20 years
HFT	1
SC	SC3
Application mode	High demand or continuous mode
Response time (under nominal voltage)	⩽ 20 ms

1.7.1.4 Precautions for Use

Safety Instructions

The chapter contains the warning symbols used in this guide and the safety precautions that you must obey when you install or service the safe option module of the drive. Failure to comply with the safety instructions may lead to injury, death or damage. Please read this chapter before installation.

Illustrations, pictures, or figures used in this manual are intended as examples only and may not cover all products to which this manual applies.

The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.

Table 1–35 Description for warning symbols

Key	Indication	Description	Consequences in case of disregard
Example:  General hazards  Special hazards Electric shock	DANGER	Major risk	Ignoring the warning can result in severe physical injury or even death.
	WARNINGS	General risk	Ignoring the warning may result in severe physical injury or even death.
	CAUTION	Minor risk	Ignoring the warning may result in minor physical injury.
	STOP!	Damage to equipment or environment	Ignoring the warning may result in damage to equipment or environment.

Note

- Users must incorporate safety measures in system design and electrical installation for both normal operation and troubleshooting.
- The design, installation, commissioning, and maintenance of the system must be implemented by trained and experienced professionals. They should read the operation guide and related safety information.

It is the responsibility of the machine builder/OEM/system integrator to make sure that the essential health and safety function requirements specified in the Machinery Directive are met. Risk analysis and risk assessment is needed before using a product. Make sure that adequate measures are taken to eliminate/reduce the relating risks and components chosen must meet the safety requirements.

This section describes the information that is required before starting operation.

- Read the following safety precautions, risk assessment information, and limitations before starting operation.
- Use of the safety function: Use the safety function after properly understanding all of these information.

Note

If the safety function is used incorrectly or the safety function does not meet safety requirements at the site, physical injuries may arise.

Safety Precautions

Carefully read and observe the following important precautions when using safety functions:

- STO function is not intended as a replacement for the emergency stop function (E-stop). If no other measures are taken and the power supply cannot be cut off in case of emergency, the high voltage parts of motors and AC drives are still charged, which may brings the risk of electric shock or other risks caused by electricity. Therefore, the maintenance of electrical parts of the AC drives or motors can only be implemented after the AC drive system is isolated from the main power supply.

- Depending on the standards and requirements for a particular application, it may be possible to use STO as an integral part of an E-stop system. However, its main purpose is for use in a dedicated safety control arrangement whose purpose is to prevent any hazard from occurring, without the use of an E-stop.
- An E-stop is often provided in a machine to allow for unexpected situations where an operator sees a hazard and can take action to prevent an accident.
- The design requirement for an E-stop differs from that of a safety interlock. Generally, the E-stop is required to be independent from any complex or "intelligent" control. It may use purely electromechanical devices to either disconnect the power or initiate a controlled rapid stop using other means such as dynamic or regenerative braking.

Caution

- The design of safety-related systems requires specialist knowledge. To ensure that a complete control system is safe, it is necessary for the whole system to be designed according to recognized safety principles. The use of individual sub-systems such as drives with STO function, which are intended for safety-related applications, does not in itself ensure that the complete system is safe.
- The STO function can be used to stop the AC drive in emergency stop situations.
- In processes without personnel protection, it is recommended not to stop the AC drive by using the STO function. If the STO function is used to stop a running AC drive, the AC drive will gradually stop. If this is not acceptable, the system should be stopped using the correct mode instead of the STO function.
- This publication is a guide to the application of Inovance STO function, and also on the design of safety-related systems for machinery control.
- It is the responsibility of designer of the end product or application to ensure that it is safe and in compliance with the relevant regulations.

Risk Assessment

- Before using the safety function, perform risk assessment on AC drive system in advance Make sure that the safety integrity level of the standards is met.
- The following residual risks can be present even when the safety functions operate. Therefore, safety must always be given consideration during risk assessment.
- If external forces (such as gravitational force with a vertical axis) are applied when the safety functions are operating, the motor will rotate due to the action of these external forces. Therefore, you must use a separate mechanical brake to secure the motor.

Note

- When multiple IGBT power transistors are faulty, the AC drive generates an alignment torque no matter whether STO function is triggered, which may maximally rotate the motor shaft by 180/p degrees.
- p: Number of motor pole pairs.

To ensure safety, users should decide all the risk assessments and residual risks in the entire machine equipment. A company and individual who constructed the safety related system must take full responsibility for installation and commissioning of the system. Additionally, when complying with a European machinery directive, the related sub system must acquire safety standards certification, and the whole equipment or system is subject to all risk assessments and safety class certification.

The following shows residual risks concerning the safety function of this product.

Common residual risks

- At the shipment to end-users, check the settings of safety related components with programming tools and monitored/displayed contents on display and record and save the setting data concerning the safety observation function and the programming tools you used. Perform them using a check sheet, etc.
- The safety will not be ensured such as in assembling machine until installing, wiring, and adjustment are completed properly. Install, wire, and adjust your system referring to installation guide for each unit.
- Only qualified personnel are authorized to install, start-up, repair or adjust the machines in which these components are installed. Only trained engineers should install and operate the equipment.
- Separate the wiring for safety observation function from other signal wiring.
- Protect the cables with appropriate ways (routing them in a cabinet, using a cable guard, etc.).
- We recommend using a switch, relay, sensor, etc. which comply with safety standards. When using a switch, relay, sensor, etc. which do not comply with safety standards, perform a safety confirmation.
- Keep the required clearance/creepage distance depending on voltage you use.
- The time to a safety observation error depends on parameter settings.

- **Safe torque off (STO)**
  This function only cuts off the torque of the motor, and does not cut off the power supply of the AC drive. Cut off the power supply of the AC drive to make sure the AC drive is powered off before maintenance.

Note

Trigger the STO function for the AC drive at least once every three months.

1.7.2 Safe Torque Off

1.7.2.1 Function Overview

Safety torque off (Safe Torque Off) is a safety function that complies with IEC 61800- 5- 2:2016. The AC drive is optionally integrated with the STO function. When the STO function is triggered, the drive turns off the RDY signal and enters the safety state, in which the drive control signal of the power semiconductor is blocked and the motor input current is cut off, preventing the drive from generating torque on the motor shaft end and stopping the motor.

The STO function blocks the output of PWM signals to the power layer of the AC drive through external redundant hardware terminals STO1 and STO2, thus preventing the movement of the motor. These two +24 VDC signals must be at high level to enable normal operation of the drive. If either one or both signals are set to "low" level, the PWM signals will be blocked.

1.7.2.2 Parameters

Parameters related to the safety function module are shown as follows.

Item	Parameter	Range	Default	Description
F9-79	STO status reset	0: Manual reset 1: Automatic reset	1	Used to enable STO fault reset mode. If this function is enabled, STO is reset automatically when STO1 and STO2 are recovered.
U0-96	STO status word monitoring	0 to 65535	0	It displays the monitored STO status word. Bit 0: STO1 disconnection flag. 1: STO1 disconnected; 0: STO1 connected Bit 1: STO2 disconnection flag. 1: STO2 disconnected; 0: STO2 connected Bit 2: DO output flag (active when the DO is assigned with function 42). 1: DO output; 0: DO not output Bit 3: STO status flag. (If the STO function is activated, the panel displays STO status.) 1: STO activated; 0: STO deactivated

1.7.2.3 Function Triggering

To use the input signal function of the safety module, connect cables correctly. If either the STO1 or STO2 signal is disconnected, the system enters the safety state.

Table 1–36 STO function

STO2 input	STO1 input	PWM state	System State	Reset
H	H	Normal	Normal	/
H	L	Blocked	E047.2; inconsistent inputs	Manual reset
L	H	Blocked	E047.2; inconsistent inputs	Manual reset
L	L	Blocked	STO activated	Reset automatically or manually as defined by F9-79.

Note

- H (1): The corresponding input is connected to the 24 V voltage.
- L (0): The corresponding input is disconnected from the 24 V voltage.

1.7.2.4 Sequence Diagrams

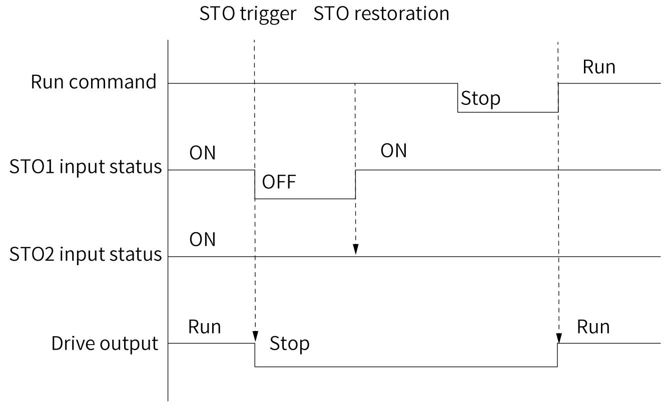


Figure 1-79 Safety function (turned off when triggered by STO1)

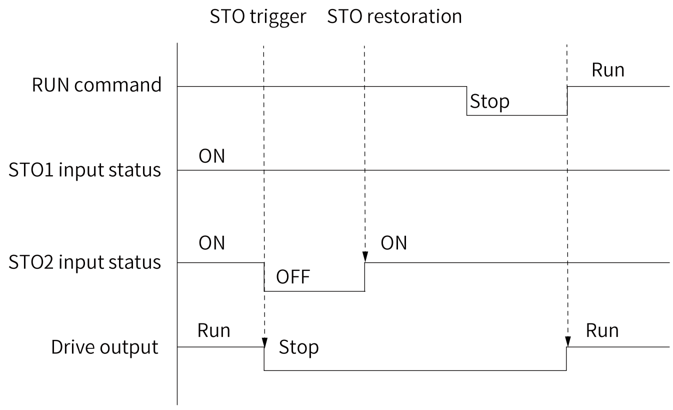


Figure 1-80 Safety function (turned off when triggered by STO2)

1.8 Monitoring

The monitoring function enables you to view the drive state on the operating panel. You can view monitoring parameters in the following two ways.

1. In the stop or operation state, you can view multiple status parameters by switching every bit of F7-03, F7-04, and F7-05 through the keys on the operating panel.
   In the operation state, 32 operating status parameters are available. F7-03 (Parameter 1 displayed during operation) and F7-04 (Parameter 2 during operation) determine whether to display the parameter corresponding to each binary bit. In the stop state, 16 stop status parameters are available. Each binary bit of F7-05 (Parameter displayed at stop) determines whether the corresponding parameter is displayed.

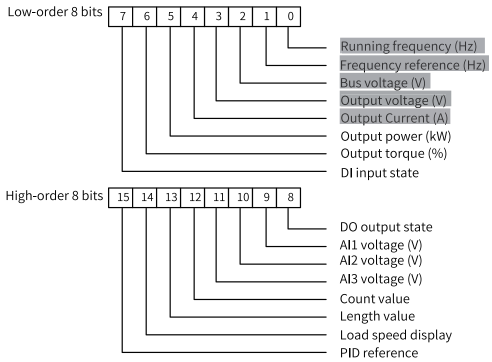
   For example, to view the parameters in the operation status on the operating panel, such as the running frequency, bus voltage, output voltage, output current, output power, and PID reference, perform the following operations.

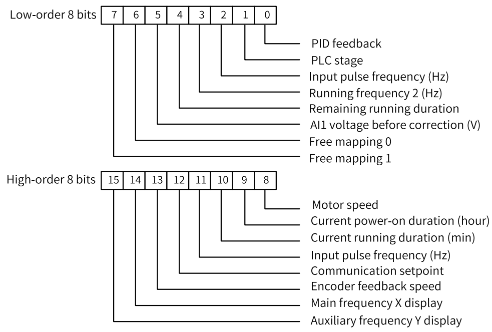
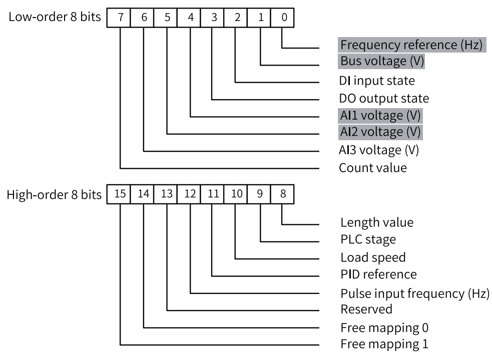
   Each bit of F7-03 (Parameter 1 displayed on led operating panel during operation) corresponds to one parameter. Set the corresponding bit to 1. Convert the binary value to a hexadecimal value and set F7-03 to this hexadecimal value. For specific conversion methods, see *"Table 1–38 Converting a*

binary number into the hexadecimal equivalent" on page 214. You can view related parameter values by switching every bit of F7-03 through the keys on the operating panel.

Other monitoring parameters are viewed in the same way as F7-03. The corresponding relationship between the monitoring parameters and every bit of F7-03, F7-04, and F7-05 is as follows.

Table 1–37 Corresponding relationship between the monitoring parameters and every bit of F7-03, F7-04, and F7-05

Parameter Code	Parameter Name	Default	Value Range	Description
F7-03	Parameter 1 displayed on LED operating panel during operation	0x1F	0000–0xFFFF	If a parameter needs to be displayed during running, set its corresponding bit to 1. After converting the binary number to a hexadecimal number, set F7-03 to the hexadecimal number. Note: The shaded parameters are displayed by default. 

Parameter Code	Parameter Name	Default	Value Range	Description
F7-04	Parameter 2 displayed on LED operating panel during operation	0	0000–0xFFFF	This parameter defines the parameters displayed on the LED operating panel when the AC drive is running. You can view the parameters corresponding to each bit by pressing the left and right shift keys. The value 1 of a bit indicates that the parameter is displayed, and the value 0 of the bit indicates that the parameter is hidden. Each parameter is displayed in the hexadecimal format. 
F7-05	Parameter displayed on the LED operating panel upon stop	0x33	0000–0xFFFF	This parameter defines the parameters displayed on the LED operating panel when the AC drive is in stop state. You can view the parameters corresponding to each bit by pressing the left and right shift keys. The value 1 of a bit indicates that the parameter is displayed, and the value 0 of the bit indicates that the parameter is hidden. Each parameter is displayed in the hexadecimal format.  Note: The shaded parameters are displayed by default.

Note

When the AC drive is powered off and on again, the parameters that are selected before power-off are displayed.

The monitoring parameters corresponding to each bit of F7-03, F7-04, and F7-05 do not completely correspond to all the monitoring parameters in group U0. If the parameter to be monitored cannot be found by F7-03, F7-04, and F7-05, search it in group U0 through the key by using method 2.

To convert a binary number into a hexadecimal equivalent, do as follows:

From right to left, every four binary digits correspond to one hexadecimal digit. If there are less than four binary digits left, fill in with 0 to make the number of left binary digits to be four. Then, convert every four binary digits into a decimal number. 0000 to 1111 in the binary format correspond to 0 to 15 in the decimal format and 0 to F in the hexadecimal format. Convert the decimal number into a hexadecimal equivalent according to the corresponding relationship between decimal and hexadecimal numbers. See the following table for details.

For example, the binary number is 011 1101 1111 1001. After adding 0 to the highest place, the binary number changes to 0011 1101 1111 1001. According to the preceding table, the hexadecimal equivalent is 3DF9.

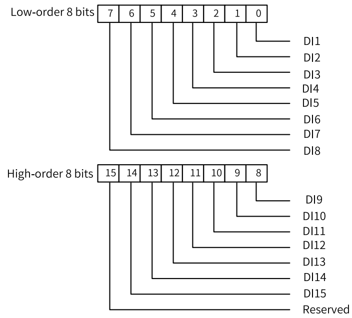
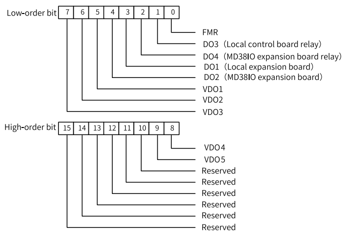
Table 1–38 Converting a binary number into the hexadecimal equivalent

Binary	1111	1110	1101	1100	1011	1010	1001	1000	0111	0110	0101	0100	0011	0010	0001	0000
Decimal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Hexadecimal	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0

2. Use the operating panel to enter group U0 and view the monitoring parameters. *"Table 1–39 Monitoring parameters in group U0" on page 214*The monitoring parameters are only readable.

Table 1–39 Monitoring parameters in group U0

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-00	Operating frequency	0.01 Hz	0.00 Hz to 655.35 Hz	It displays the absolute value of the AC drive operating frequency. See *"Figure 1–81" on page 222* .
U0-01	Frequency reference	0.01 Hz	0.00 Hz to 655.35 Hz	It displays the absolute value of the AC drive frequency reference. See *"Figure 1–81" on page 222* .
U0-02	Bus voltage	0.1 V	0.00 V to 6553.5 V	It displays the AC drive bus voltage.
U0-03	Output voltage	1 V	0 V to 65535 V	It displays the output current of the AC drive in the running state.
U0-04	Output current	0.01 A	0.00 A to 655.35 A	It displays the output current of the AC drive in the running state.
U0-05	Output power	0.1 kW	-3276.8 kW to 3276.7 kW	It displays the output power of the AC drive in the running state.
U0-06	Output torque	0.10%	-3276.8% to 3276.7%	It displays the output torque of the AC drive in the running state. This percentage takes the rated motor torque as the basis.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-07	DI input state	1	0x0000 to 0xFFFF	It displays the state value of the DI. After it is converted to binary data, each bit corresponds to one DI signal. The value 1 indicates high level input, and the value 0 indicates low level input. The corresponding relationship between bits and DIs is as follows. 
U0-08	DO output state	1	0x0000 to 0xFFFF	It displays the state value of the DO. After the value is converted to a binary number, every bit of the binary number corresponds to one DO signal. The value 1 indicates high level output, and the value 0 indicates low level output. The relationship between bits and DOs is as follows. 
U0-09	AI1 voltage	0.01 V	-10.57 V to 10.57 V	It displays AI1 voltage.
U0-10	AI2 voltage	0.01 V	-10.57 V to 10.57 V	It displays AI2 voltage. Note: When AI2 inputs current signals, AI2 supports the current range from 0 mA to 20 mA When the impedance is selected to be 500 Ω, the corresponding voltage range of U0-10 is 0 V to 10 V. When the impedance is selected to be 250 Ω, the corresponding voltage range of U0-10 is 0 V to 5 V.
U0-11	AI3 voltage	0.01 V	-10.57 V to 10.57 V	It displays AI3 voltage.
U0-12	Count value	1	0 to 65535	It displays the value in the counting function.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-13	Length	1	0 to 65535	It displays the value in the fixed length function.
U0-14	Load speed display	1 rpm	0 rpm to 65535 rpm	It displays the load target speed, which is affected by F7-06 (U0-14 = U0-14 x F7-06).
U0-15	PID reference	1	0 to 65535	PID reference = PID reference (percentage) x FA-04 (PID reference feedback range)
U0-16	PID feedback	1	0 to 65535	PID feedback = PID feedback (percentage) x FA-04 (PID reference feedback range)
U0-17	PLC stage	1	0 to 15	It displays current simple PLC stage, which supports 16 speeds. Note: The PLC supports a total of 16 speeds from speed 0 to speed 15.
U0-18	Pulse input frequency	0.01 kHz	0.00 kHz to 655.35 kHz	It displays the high-speed pulse sampling frequency of DI5.
U0-19	Feedback speed	0.01 Hz	-327.68 Hz to 327.67 Hz	It displays the feedback speed (Hz). See *"Figure 1–81" on page 222* .
U0-20	Remaining running time	0.1 min	0.0 min to 6553.5 min	It displays the remaining running time when the timing function is enabled.
U0-21	AI1 voltage before calibration	0.001 V	-32.768 V to 32.767 V	It displays the actual value of analog input sampling voltage/ current. The voltage/current used has been corrected linearly to reduce the deviation between the sampling voltage/current and the actual input voltage/current. You can check U0-09 for the corrected voltage/current.
U0-22	AI2 voltage before calibration	0.001 V	-32.768 V to 32.767 V	It displays the actual value of analog input sampling voltage/ current. The voltage/current used has been corrected linearly to reduce the deviation between the sampling voltage/current and the actual input voltage/current. You can check U0-10 for the corrected voltage/current.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-23	AI3 voltage before calibration	0.001 V	-32.768 V to 32.767 V	It displays the actual value of analog input sampling voltage/ current. The voltage/current used has been corrected linearly to reduce the deviation between the sampling voltage/current and the actual input voltage/current. You can check U0-11 for the corrected voltage/current.
U0-24	Motor speed	1 rpm	0 rpm to 65535 rpm	It displays the motor feedback speed (rpm).
U0-25	Current power-on time	1 min	0 min to 65535 min	-
U0-26	Current operating time	0.1 min	0.0 min to 6553.5 min	-
U0-27	Pulse input frequency	1 Hz	0 Hz to 65535 Hz	It displays DI5 high-speed pulse sampling frequency. It is the same as U0-18 but in different units.
U0-28	Communication setpoint	0.01%	-100.00% to 100.00%	It displays data written by means of the communication address 0x1000. The setpoint of address 0x1000 determines the base of this percentage.
U0-29	Encoder feedback speed	0.01 Hz	-599.00 Hz to 599.00 Hz	It displays the motor running frequency (Hz) measured by the encoder. For details, see *"Figure 1–81" on page 222* .
U0-30	Display of main frequency X	0.01 Hz	-599.00 Hz to 599.00 Hz	It displays the main frequency X (Hz).
U0-31	Display of auxiliary frequency Y	0.01 Hz	-599.00 Hz to 599.00 Hz	It displays the auxiliary frequency Y (Hz).
U0-32	Memory address view	1	0 to 65535	-
U0-33	Synchronous motor rotor position	0.1°	0.0° to 360.0°	-
U0-34	AI3 temperature mode - motor temperature value	1°C	-50°C to 300°C	It indicates the motor temperature sampled through AI3. For motor temperature detection, see F9-57 (Type of motor temperature sensor).
U0-35	Target torque	0.1%	-600.0% to 600.0%	This parameter indicates the current torque upper limit reference, which is a percentage of the rated motor torque.
U0-36	Resolver position	1	0 to 360	-
U0-37	Power factor angle	0.1°	-3276.8° to 3276.7°	This parameter indicates the current power factor angle.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-38	ABZ position	1	0 to 360	This parameter displays the number of phase-A and phase-B pulses of the ABZ encoder. This value is four times the number of pulses that the encoder runs. For example, if 4000 is displayed, the actual number of pulses that the encoder runs is 4000/4 = 1000. The value increases when the encoder rotates in the forward direction and decreases when the encoder rotates in the reverse direction. After increasing to 65535, the value will be set to 0 and increase from 0 again. After decreasing to 0, the value be set to 65535 and decrease from 65535 again. You can check whether installation of the encoder is normal by viewing U0-38.
U0-39	Target voltage upon V/f separation	1 V	0 V to F1-02	This parameter displays the target output voltage in V/f separation status.
U0-40	Output voltage upon V/f separation	1 V	0 V to F1-02	This parameter displays the actual output voltage in the V/f separation state.
U0-45	Fault subcode	1	0 to 9	It displays the fault subcode.
U0-46	Minor fault code	0.1	0 to 6553.5	–
U0–47	Encoder position feedback (high-order 16 bits)	1	0 to 65535	It displays the high-order 16 bits of the encoder position feedback.
U0–48	Encoder position feedback (low-order 16 bits)	1	0 to 65535	It displays the low-order 16 bits of the encoder position feedback. Note: It displays the low-order 16 bits of the ABZ pulse. The parameter value is four times the number of actual encoder pulses. For example, if 4000 is displayed, the number of actual encoder pulses is 1000 (4000/4). The value increases when the encoder rotates in the forward direction and decreases when the encoder rotates in the reverse direction. After increasing to 65535, the value will be set to 0 and increase from 0 again. After decreasing to 0, the value be set to 65535 and decrease from 65535 again. You can check whether installation of the encoder is normal by viewing U0-48.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-58	Number of motor revolutions	1	0 to 65535	It displays the number of phase Z pulses of the ABZ or UVW encoder. The parameter value increases or decreases by 1 every time the encoder rotates one revolution forward or reversely. You can check whether the encoder is installed properly through U0-58.
U0-59	Frequency reference	0.01%	-100.00% to 100.00%	It displays the current frequency reference. The parameter value takes the maximum frequency of the drive (F0-10) as the base.
U0-60	Operating frequency	0.01%	-100.00% to 100.00%	It displays the current operating frequency. The parameter value takes the maximum frequency of the drive (F0-10) as the base.
U0-61	AC drive state	1	Bit 1, bit 0	0: Stop; 1: Forward running; 2: Reverse running
			Bit 3, bit 2	0: Constant speed; 1: Acceleration; 2: Deceleration
			Bit 4	0: Bus voltage normal; 1: Undervoltage
U0-62	Current fault code	1	0 to 65535	It displays the current fault master code. For example, if the fault E015.1 (external terminal NO fault) is reported, this parameter displays 15.
U0-63	Torque sent in point-to-point communication	0.01%	-327.68% to 327.67%	-
U0-64	Number of slaves in master-slave control	1	0 to 65535	-
U0-65	Torque upper limit	0.1%	-600.0% to 600.0%	It displays the torque upper limit. The parameter value takes the rated motor torque as the base.
U0-66	Model of communication expansion card	1	0 to 65535	It displays the model of the communication expansion card. 100: CANopen 200: PROFIBUS DP 300: CANlink 400: PROFINET 500: EtherCAT 600: EtherNet/IP
U0-67	Software version of communication expansion card.	1	0 to 65535	-

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-68	AC drive state read through DP card	1	0 to 65535	bit 0: 0: Stop 1: Run Bit 1: 0: Forward run 1: Reverse run Bit 2: Whether the AC drive has a fault 0: Normal 1: Faulty Bit 3: Whether the frequency reaches the pre-set value 0: No 1: Yes Bit 4: Whether communication is normal 0: Abnormal 1: Normal Bit 5 to bit 7: Reserved Bits 8-15: Fault master code. For details, see specific fault descriptions.
U0-69	Frequency read through communication expansion card	0.01 Hz	-327.68 Hz to 327.67 Hz	-
U0-70	Speed read through communication expansion card	1 rpm	-32768 rpm to +32767 rpm	-
U0-71	Current read through communication expansion card	0.1 A	0.0 A to 6553.5 A	It displays the current read through the communication expansion card.
U0-73	Motor SN	1	0 to 65535	-
U0-76	Low-order bits of cumulative power consumption	0.1 kWh	0 kWh to 6553.5 kWh	It displays high-order/low-order bits of cumulative power consumption. Calculation formula: Total power consumption = U0-77 x 10000 + U0-76.
U0-77	High-order bits of cumulative power consumption	1 kWh	0 kWh to 65535 kWh	
U0-80	EtherCAT slave name	1	0 to 65535	-
U0-81	EtherCAT slave alias	1	0 to 65535	-
U0-83	EtherCAT XML file version	1	0 to 65535	-
U0-84	Number of lost EtherCAT synchronization frames	1	0 to 65535	-

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-85	Maximum number of error frames and invalid frames over EtherCAT port 0 per unit time	1	0 to 65535	-
U0-86	Maximum number of error frames and invalid frames of EtherCAT port 1 per unit time	1	0 to 65535	-
U0-87	Maximum number of error frames forwarded by EtherCAT port per unit time	1	0 to 65535	-
U0-88	Maximum number of error frames processed by EtherCAT data frame processing unit per unit time	1	0 to 65535	-
U0-89	Maximum number of lost links over the EtherCAT port per unit time	1	0 to 65535	-
U0-90	AI2 temperature mode - motor temperature value	1°C	-50°C to 300°C	It indicates the motor temperature sampled through AI2. For motor temperature detection, see F9-75 (Type of motor temperature sensor).
U0-91	AC drive running frequency (unsigned)	0.01 Hz	0.00 Hz to 655.35 Hz	It displays the AC drive running frequency (unsigned).
U0-92	AI2 temperature mode - motor temperature value	0.1°C	-50.0°C to 300.0°C	It indicates the motor temperature sampled through AI2. For motor temperature detection, see F9-75 (Type of motor temperature sensor).
U0-95	STO initialization flag	1	0 to 65535	-
U0-96	STO status word monitoring	1	0 to 65535	It displays the monitored STO status word. Bit 0: STO1 disconnection flag 1: STO1 disconnected; 0: STO1 connected Bit 1: STO2 disconnection flag 1: STO2 disconnected; 0: STO2 connected Bit 2: DO output selection (valid when function 42 is allocated to DO) 1: DO output; 0: DO not output Bit 3: STO status (if active, the operating panel displays STO status). 1: STO activated; 0: STO deactivated
U0-97	STO model	1	0 to 65535	-

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-98	STO AD sampling value (1.2 V)	1	0 to 65535	-
U0-99	STO AD sampling value (5 V)	1	0 to 65535	-

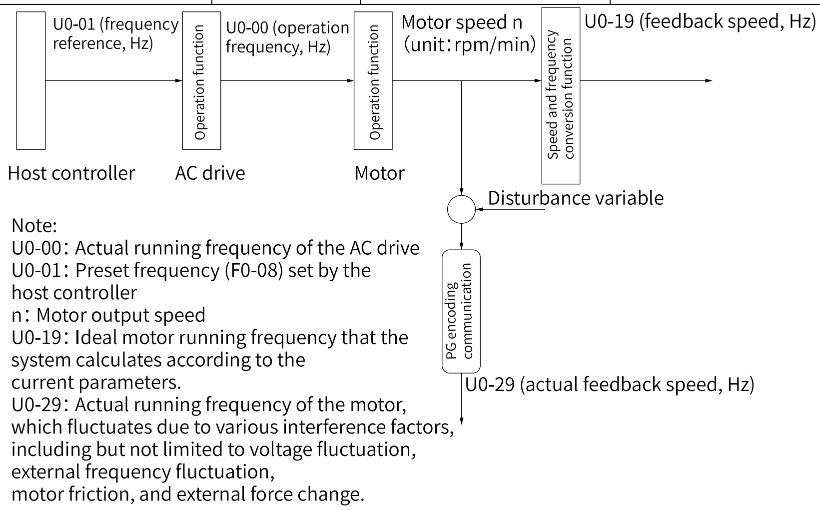


Figure 1-81 Relationship among U0-00, U0-01, U0-19, and U0-29

2 Process Functions

2.1 Wobble Function

With the wobble function, the output frequency of the AC drive wobbles up and down around the frequency reference (F0-07). This function is applicable to industries such as textile and chemical fiber, and reciprocating motion, and winding/unwinding applications.

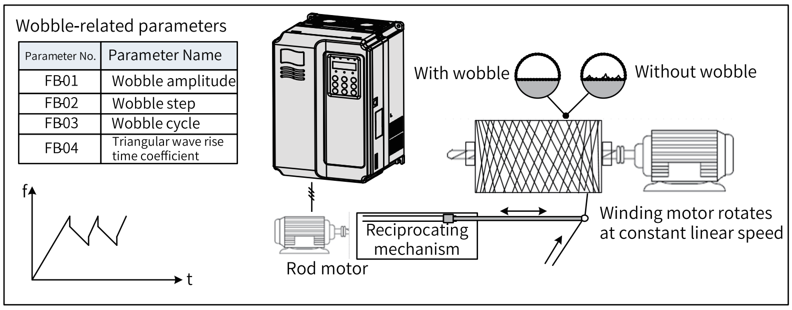


Figure 2-1 Application scenario of the wobble function

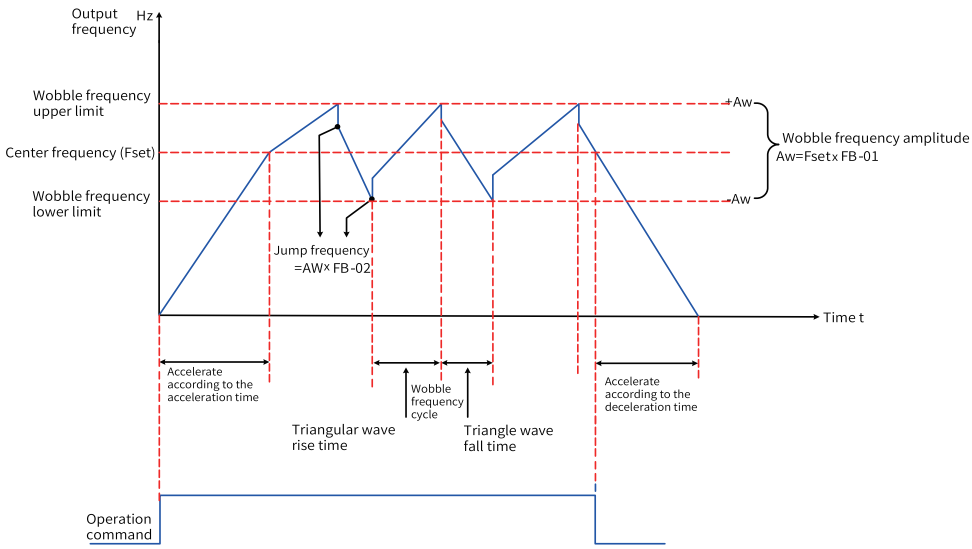


Figure 2-2 Working principle of the wobble function

Parameter Code	Parameter Name	Default	Value Range	Description
FB-00	Wobble setting mode	0	0: Relative to the center frequency 1: Relative to the maximum frequency	0: Relative to the center frequency (F0-07, frequency source superposition selection). This mode is a variable wobble system, in which the wobble changes with the center frequency. 1: Relative to the maximum frequency (F0-10). This mode is a fixed wobble system, in which the wobble amplitude is fixed. Note: For detailed instructions on using this function, refer to section Wobble Control Function in the MD520 Series General-Purpose AC Drive Function Guide.
FB-01	Wobble amplitude	0.0%	0.0% to 100.0%	When FB-01 is set to 0, the wobble function is disabled.

Parameter Code	Parameter Name	Default	Value Range	Description
FB-02	Jump frequency amplitude	0.0%	0.0% to 50.0%	This parameter defines the wobble amplitude and jump frequency amplitude. The wobble frequency is limited by the frequency upper limit and frequency lower limit.
FB-03	Wobble cycle	10.0s	0.1s to 3000.0s	This parameter defines the time of a complete wobble cycle.
FB-04	Wobble triangular wave rise time coefficient	50.0%	0.1% to 100.0%	This parameter indicates the percentage of triangular wave rising time to FB-03 (wobble cycle).

1. **Wobble calculation**

   When FB-00 is set to 0 (relative to the center frequency), wobble frequency (AW) = F0-07 (frequency source superposition selection) x FB-01 (wobble amplitude).

   When FB-00 is set to 1 (relative to the maximum frequency), wobble frequency (AW) = F0-10 (maximum frequency) x FB-01 (wobble amplitude).

2. **Jump frequency calculation**

   During wobble, jump frequency = wobble frequency (AW) x FB-02 (jump frequency amplitude).

   When FB-00 is set to 0 (relative to the center frequency), the jump frequency is a variable.

   When FB-00 is set to 1 (relative to the maximum frequency), the jump frequency is a fixed value.

3. **Calculation of the triangular wave rise/fall time**

   Triangular wave rise time (unit: s) = FB-03 (wobble cycle) x FB-04 (triangular wave rise time coefficient)

   Triangular wave fall time (unit: s) = FB-03 (wobble cycle) x (1 – FB-04 (triangular wave rise time coefficient))

   (Wobble cycle = Triangular wave rise time + Triangular wave fall time)

2.2 Fixed Length Control Function

The AC drive supports fixed length control in which the length pulses can be collected only by DI5. To use this function, allocate function 27 (length count input) to DI5.

Parameter Code	Parameter Name	Default	Value Range	Description
FB-05	Length reference	1000 m	0 m to 65535 m	This parameter specifies the length value to be controlled in fixed length control mode.
FB-06	Actual length	0 m	0 m to 65535 m	The actual length is a monitored value. Actual length (FB-06) = Number of pulses sampled by terminal/Number of pulses per meter (FB-07).
FB-07	Number of pulses per meter	100.0	0.1 to 6553.5	This parameter indicates the number of pulses outputted per meter. The length pulse is collected by DI5, which must be assigned with the length count input function (F4-04 = 27).

In the following figure, the actual length is the monitored value. Actual length (FB-06) = Number of pulses sampled by terminal/Number of pulses per meter (FB-07) When the actual length (FB-06) exceeds or equals the length reference (FB-05), the relay or DO allocated with function 10 (Length reached) outputs an active signal. During fixed length control, length reset can be implemented by a multi-function DI with function 28 assigned. For details, see the following figure.

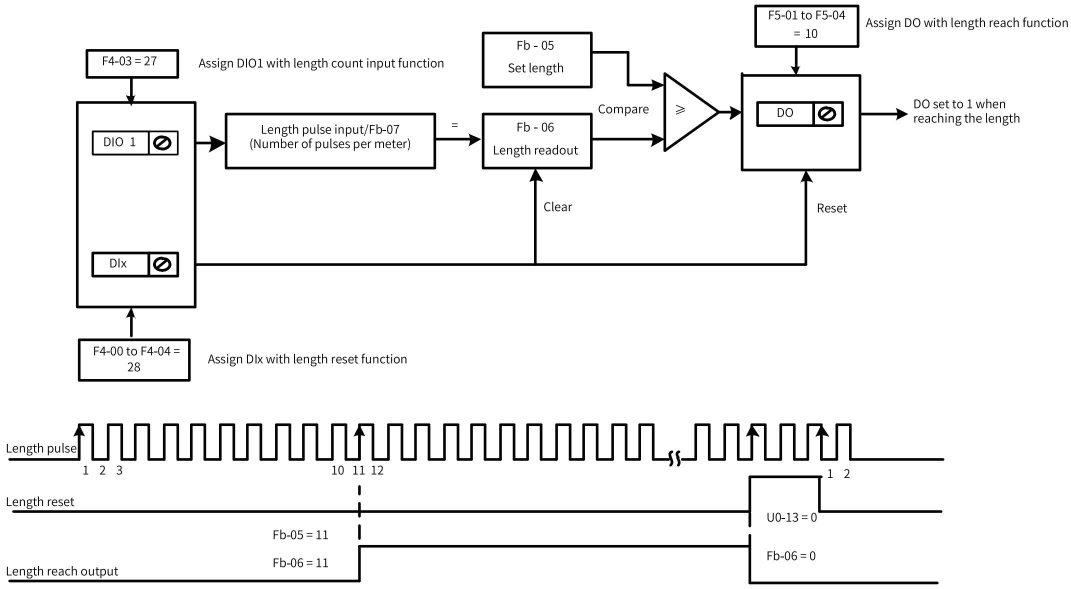


Figure 2-3 Fixed length control

Parameter Code	Parameter Name	Value Range	Description
F4-04	DI5 function selection	27	Length counting input
F4-00 to F4-09 (any one)	DI1 to DI10 function selection (any one)	28	Length reset
F5-01 to F5-05 (any one)	Terminal output function selection (any one)	10	Length reached

Under the fixed length control mode, the length can be calculated only through the number of pulses because the direction cannot be identified. When the T/A-T/B signal output by the relay with the length reach function allocated is fed to the stop input terminal of the AC drive, the AC drive stops automatically.

2.3 Counting Function

The DI allocated with function 25 (counter input) is used to collect the count value (when the pulse frequency is high, the DI5 must be used).

Parameter Code	Parameter Name	Default	Value Range	Description
FB-08	Count value reference	1000	0 to 65535	When the count value reaches FB-08, the DO outputs an active signal indicating that the count value reference has reached. Note 1: For detailed instructions on using this function, refer to the section "Counting Function" in the MD520 Series General-Purpose AC Drive Function Guide.
FB-09	Designated count value	1000	0 to 65535	When the counting value reaches FB-09, the DO outputs an active signal indicating that the designated counting value has reached. The value of FB-09 must be lower than or equal to the value of FB-08.

When the count value reaches the value of FB-08, the DO outputs an active signal indicating that the count value reference has reached. When the count value reaches FB-09, the DO outputs an active signal indicating that the designated count value has reached.

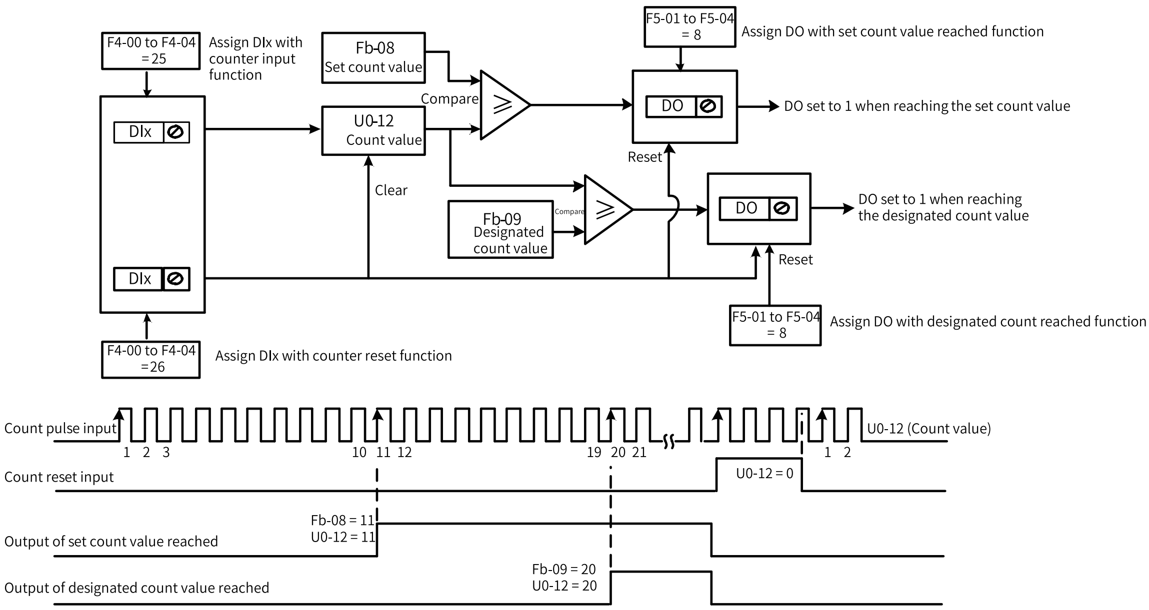


Figure 2-4 Schematic diagram of the counting function

Parameter Code	Parameter Name	Value Range	Description
F4-00 to F4-09 (any one)	DI1 to DI10 function selection (any one)	25	Counter input
F4-00 to F4-09 (any one)	DI1 to DI10 function selection (any one)	26	Counting reset
F5-01 to F5-04 (any one)	Terminal output function selection (any one)	8	Counting value reference reached
F5-01 to F5-04 (any one)	Terminal output function selection (any one)	9	Designated counting value reached

- DI5 must be used when the pulse frequency is high.
- One DO can be assigned with either the "count value reference reach" function or the "designated count value reach" function.
- The counter keeps counting when the AC drive is running or stops until the count value reference is reached.

- The count value is retentive at a power failure.
- When the count value reach signal of the DO is fed to the AC drive stop input terminal, the AC drive stops automatically.

2.4 Simple PLC Function

The simple PLC function is different from the user programmable function of the MD500. Simple PLC can only complete simple combination of multi-reference. For details on the user programmable function, see the descriptions of group FC.

Parameter Code	Parameter Name	Default	Value Range	Description
FC-16	Simple PLC running mode	0	0: Stop after running one cycle 1: Keep final values after running for one cycle 2: Repeat after running one cycle	When using the simple PLC to set the main frequency (F0-03 = 7), set FC-00 to FC-15 to select the simple PLC frequency, set FC-16 to select the operation mode of the simple PLC, and set FC-17 to select whether to retain the operating stage and frequency of the simple PLC after power failure or stop. 0: Stop after running one cycle The AC drive stops after running for one cycle, and will not start up until receiving a running command. 1: Keep final values after running for one cycle The AC drive automatically retains the final running frequency and direction after running for one cycle. When the drive is started again, it runs from the initial PLC state. 2: Repeat after running one cycle The AC drive automatically starts another cycle after running for one cycle, and will not stop until receiving a stop command. Note that the AC drive will stop according to the stop mode set by F6-10

Simple PLC can be the frequency source or V/f separation voltage source. The following figure describes the simple PLC used as the frequency source. When the simple PLC is used as the frequency source, the positive or negative values of FC-00 to FC-15 determines the running direction. If the parameter values are negative, the AC drive runs in the reverse direction.

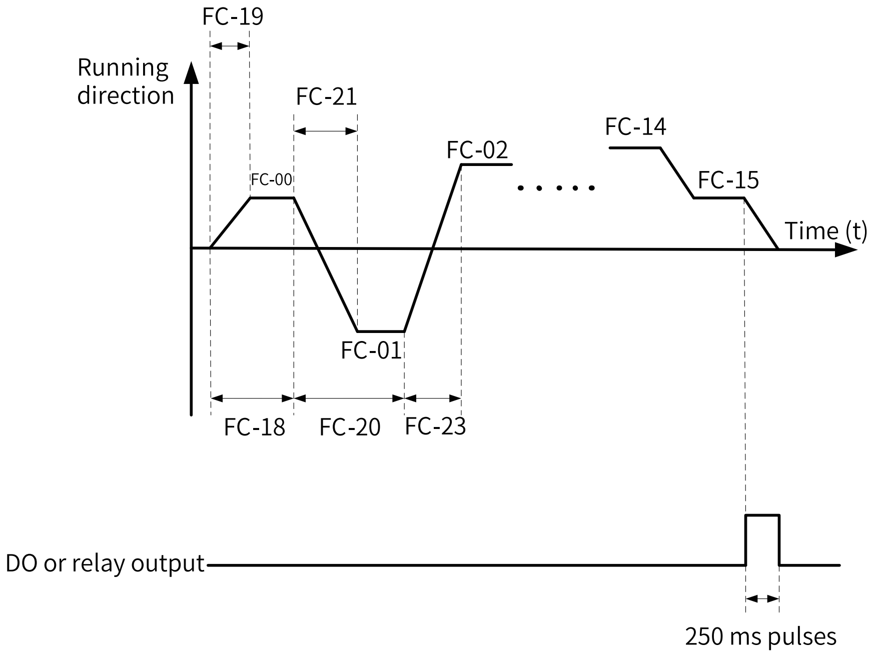


Figure 2-5 Simple PLC

When used as the frequency source, the PLC supports the following three running modes. When used as the V/f separated voltage source, the modes are not supported. Where:

- 0: Stop after running one cycle. The AC drive stops after running for one cycle, and starts after receiving another running command.
- 1: Keep the final value after running one cycle. The AC drive keeps the final running frequency and direction after running one cycle.
- 2: Repeat after running one cycle. The AC drive automatically starts another cycle after running one cycle, and stops only when receiving a stop command.

PLC retention upon power failure indicates that the AC drive memorizes the PLC running phase and running frequency before power failure and will continue to run from the memorized values after it is powered on again. If "Non-retentive upon power failure" is selected, the AC drive restarts the PLC process after it is powered on again. PLC retention upon stop indicates that the AC drive memorizes the PLC running phase and running frequency upon stop and will continue to run from the memorized values after it operates again. If "Non-retentive upon stop" is selected, the AC drive restarts the PLC process after it operates again.

Parameter Code	Parameter Name	Value Range	Description
FC-17	Simple PLC retention selection upon power failure	Ones: Retention selection upon power failure 0: Non-retentive upon power failure 1: Retentive upon power failure Tens: Retention selection upon stop 0: Non-retentive upon stop 1: Retentive upon stop	The running mode of the simple PLC is set by FC-16. FC-17 is used to determine whether the running stage and running frequency of the PLC before power failure are memorized upon power failure or shutdown. Ones: Retention selection upon power failure The AC drive restarts the simple PLC process upon power-on each time. When it is set to 1, the AC drive retains the PLC operation stage and operating frequency upon power failure and continues to run from the retained values after the drive is powered on again. Tens: Retention selection upon stop The AC drive restarts the simple PLC process upon power-on each time. When it is set to 1, the AC drive retains the PLC operation stage and operating frequency upon stop and continues to run from the retained values after the drive is started again.
FC-18	Running time of multi-reference 1 set by simple PLC	0.0s (h) to 6553.5s (h)	This parameter indicates the running time of multi-reference x (x = 1 to 16) set by simple PLC The operating time is the sum of acceleration or deceleration time and operating time at constant speed and target frequency.
FC-19	Acceleration/ Deceleration time of multi-reference 1 set by simple PLC	0 to 3	0: Group 1 acceleration/deceleration time (F0-17 and F0-18) 1: Group 2 acceleration/deceleration time (F8-03 and F8-04) 2: Group 3 acceleration/deceleration time (F8-05 and F8-06) 3: Group 4 acceleration/deceleration time (F8-07 and F8-08)
FC-20	Running time of multi-reference 2 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-18
FC-21	Acceleration/ Deceleration time of multi-reference 2 set by simple PLC	0 to 3	Same as FC-19
FC-22	Running time of multi-reference 3 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-18

Parameter Code	Parameter Name	Value Range	Description
FC-23	Acceleration/ Deceleration time of multi-reference 3 set by simple PLC	0 to 3	Same as FC-19
FC-24	Running time of multi-reference 4 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-18
FC-25	Acceleration/ Deceleration time of multi-reference 4 set by simple PLC	0 to 3	Same as FC-19
FC-26	Running time of multi-reference 5 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-27	Acceleration/ Deceleration time of multi-reference 5 set by simple PLC	0 to 3	Same as FC-18
FC-28	Running time of multi-reference 6 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-29	Acceleration/ Deceleration time of multi-reference 6 set by simple PLC	0 to 3	Same as FC-18
FC-30	Running time of multi-reference 7 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19

Parameter Code	Parameter Name	Value Range	Description
FC-31	Acceleration/ Deceleration time of multi-reference 7 set by simple PLC	0 to 3	Same as FC-18
FC-32	Running time of multi-reference 8 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-33	Acceleration/ Deceleration time of multi-reference 8 set by simple PLC	0 to 3	Same as FC-18
FC-34	Running time of multi-reference 9 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-35	Acceleration/ Deceleration time of multi-reference 9 set by simple PLC	0 to 3	Same as FC-18
FC-36	Running time of multi-reference 10 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-37	Acceleration/ Deceleration time of multi-reference 10 set by simple PLC	0 to 3	Same as FC-18
FC-38	Running time of multi-reference 11 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19

Parameter Code	Parameter Name	Value Range	Description
FC-39	Acceleration/ Deceleration time of multi-reference 11 set by simple PLC	0 to 3	Same as FC-18
FC-40	Running time of multi-reference 12 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-41	Acceleration/ Deceleration time of multi-reference 12 set by simple PLC	0 to 3	Same as FC-18
FC-42	Running time of multi-reference 13 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-43	Acceleration/ Deceleration time of multi-reference 13 set by simple PLC	0 to 3	Same as FC-18
FC-44	Running time of multi-reference 14 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-45	Acceleration/ Deceleration time of multi-reference 14 set by simple PLC	0 to 3	Same as FC-18
FC-46	Running time of multi-reference 15 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19

Parameter Code	Parameter Name	Value Range	Description
FC-47	Acceleration/ Deceleration time of multi-reference 15 set by simple PLC	0 to 3	Same as FC-18
FC-48	Running time of multi-reference 16 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-49	Acceleration/ Deceleration time of multi-reference 16 set by simple PLC	0 to 3	Same as FC-18
FC-50	Time unit of simple PLC operation	0: s (second) 1: h (hour)	This parameter defines the unit of the simple PLC running time for each speed.
FC-51	Multi-reference 1 source	0: FC-00 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: PID 6: Preset frequency (F0-08) Others: F connector	The frequency reference of multi-reference 1 can be selected through seven ways, including digital setting, analog input, pulse frequency, PID, and preset frequency. 0: FC-00 The frequency reference is set by FC-00. 1: AI1 The frequency reference is set by AI1. 2: AI2 The frequency reference is set by AI2. 3: AI3 The frequency reference is set by AI3. 4: Pulse reference The frequency reference is set by pulse frequency. 5: PID The frequency reference is set by PID. 6: Preset frequency (F0-08) The frequency reference is set by F0-08 Others: F connector The frequency reference is set by connector.

2.5 Master/Slave Control Function

Rigid connection and flexible connection

The master/slave control function is designed for multi-drive applications, in which the system is driven by multiple AC drives and motor shafts are coupled by gears, chains, or conveyor belts. Master/Slave control enables even distribution of loads among the drive units. The external control signals are connected only to the master that controls the slaves through serial communication.

The master works in the typical speed control mode and the slaves follow the torque or speed reference of the master. There are two types of master/slave control connection modes: rigid connection and flexible connection, as shown in the following figure.

- When motor shafts of the master and slaves are connected rigidly by chains or gears, the slaves must work in the torque control mode to avoid speed difference among drive units.
- When motor shafts of the master and slaves are connected flexibly, the slaves must work in the speed control because slight speed difference among drive units is allowed. When the master and slaves are in the speed control mode, the droop rate must be used.

Note

Only CANlink communication is supported.

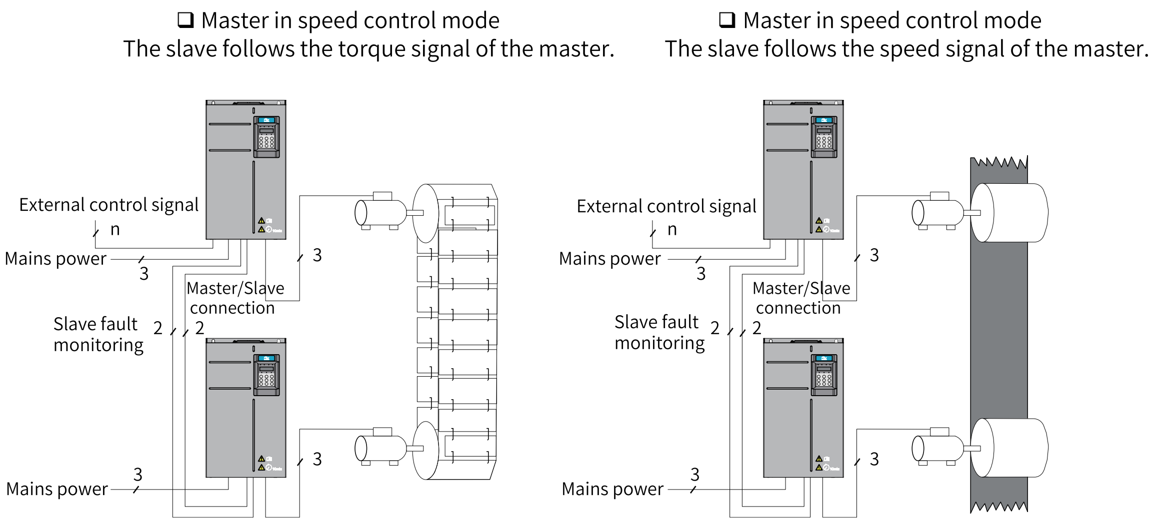


Figure 2-6 Rigid/Flexible connection

Master/slave connection

To avoid control conflict, all drive units connected to the same machinery must receive the external control signals only through the master. When wiring the master and slaves, connect all external control signal cables only to the master, and never using the operating panel or fieldbus system to control the slaves, as shown below.

If the DI needs to connect to the 24 V power supply, see wiring methods of connection to the internal or external 24 V power supply in the sink wiring method or source wiring method in MD520 Series General-Purpose AC Drive Manual Package or the MD520 Series General-Purpose AC Drive Installation Guide.

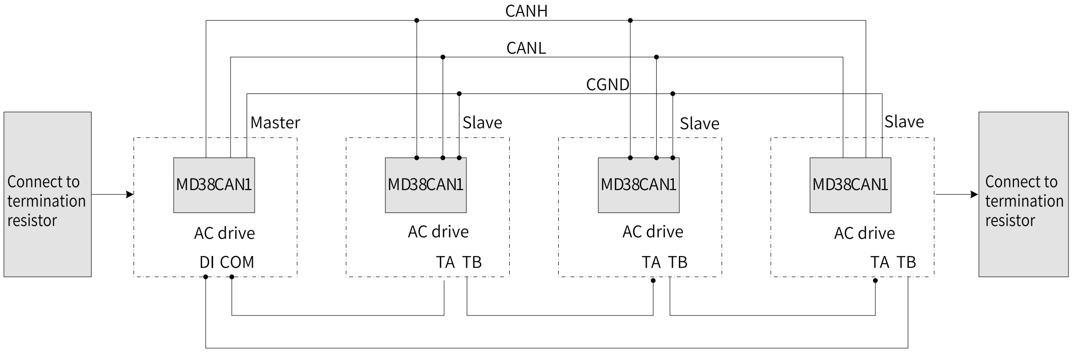


Figure 2-7 Connections between the master and slaves

When a slave becomes faulty, the fault information is sent to the master in one of the following ways. When the slave stops due to a fault, the master stops running.

1. The relay is used for slave fault feedback.
2. The faulty slave sends the fault information to the master through communication after the tens place of A8-02 is set to 1.

Droop control

F8-15 is used for droop control. The droop control function allows slight speed difference between the master and slaves to avoid conflict between them. Only when the master and slaves are in the speed control mode, the droop rate needs to be adjusted. A proper droop rate is gradually obtained during drive running. Do not set F8-15 to a very large value. Otherwise, steady speed will decline obviously when the load is large. You must set F8-15 for both the master and the slave.

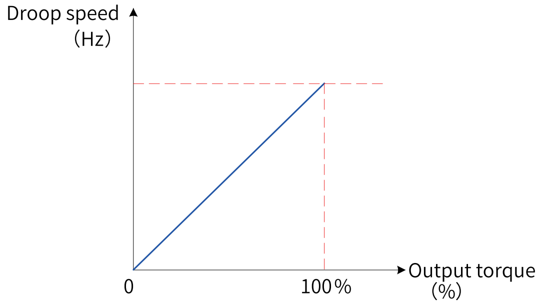


Figure 2-8 Relationship between droop rate and output torque

Droop speed = Synchronous frequency x output torque x (F8-15/10)

For example, if F8-15 is set to 1.00, the synchronous frequency is 50 Hz, and the output torque is 50%, the actual frequency of the AC drive is 47.5 Hz, which is calculated by 50 Hz - 50 Hz x 50% x (1.00/10).

Related parameters

A8-00 to A8-07

Example

The following tables describe parameter settings for rigid connection and flexible connection.

- Rigid connection

Table 2–1 Parameter settings for the master in the speed control mode (A0-00 = 0)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	0	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F2-10	Torque upper limit in speed control mode	0.0% to 600.0%	150.0%	Yes

Table 2–2 Parameter settings for the slave in the torque control mode (A0-00 = 1)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	1	No

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
A8-02	Slave following master's command	Ones: Whether to follow master's command 0: Not following master's running command 1: Following master's running command Tens: Transmitting slave fault information 0: Not transmitting slave fault information 1: Transmitting slave fault information Hundreds: Whether to display alarm when slave becomes offline 0: Not displaying alarm when slave becomes offline 1: Displaying alarm when slave becomes offline	Ones: 1 Tens: 1	No
A8-03	Function selection for data received by the slave	0: Operating frequency 1: Target frequency	0	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F8-07	Acceleration time 4 (Frequency acceleration time in torque control)	0.0s to 6500.0s	0.0s	No
F8-08	Deceleration time 4 (Frequency deceleration time in torque control)	0.0s to 6500.0s	0.0s	No
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	No
FD-02	Local address	1 to 247	1	No
A0-00	Speed/Torque control mode selection	0: Speed control 1: Torque control	1	No

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
A0-01	Mode A - Torque reference source in torque control (drive torque upper limit source)	0: A0-03 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) Others: F connector	0	No
A0-03	Mode A - Torque digital setting in torque control	-200.0% to 200.0%	130.0%	Same as the setting of F2-10 of the master
A0-07	Mode A - Torque rise filter time	0.00s to 650.00s	0.00s	No
A0-08	Mode A - Torque drop filter time	0.00s to 650.00s	0.00s	No

Do not set the startup frequency in the torque control mode. Otherwise, the startup shock current will be large.

- Flexible connection

Table 2–3 Parameter settings for the master in the speed control mode (A0-00 = 0)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens position: Reserved Hundreds position: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	0	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F8-15	Droop control	0.00% to 10.00%	1.00 Hz	Yes
F0-17	Acceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No
F0-18	Deceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No

Table 2–4 Parameter settings for the slave in the speed control mode (A0-00 = 0)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	1	No

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
A8-02	Slave following master's command	Ones: Whether to follow master's command 0: Not following master's running command 1: Following master's running command Tens: Transmitting slave fault information 0: Not transmitting slave fault information 1: Transmitting slave fault information Hundreds: Whether to display alarm when slave becomes offline 0: Not displaying alarm when slave becomes offline 1: Displaying alarm when slave becomes offline	11	No
A8-03	Function selection for data received by the slave	0: Operating frequency 1: Target frequency	0	No
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	No

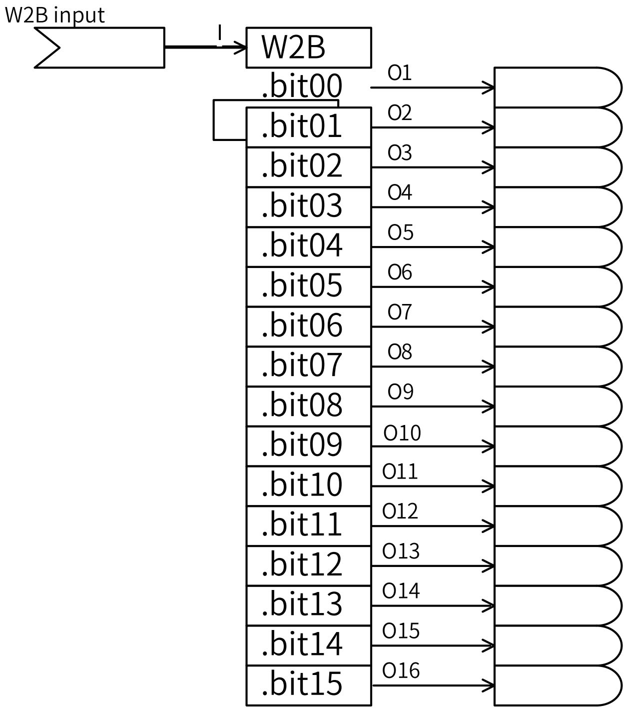
Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
F0-03	Main frequency source	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	9	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F0-17	Acceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No
F0-18	Deceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No
F8-15	Droop control	0.00% to 10.00%	1.00 Hz	Yes
FD-02	Local address	1 to 247	1	No
A0-00	Speed/Torque control mode selection	0: Speed control 1: Torque control	0	No

2.6 Programming Module

2.6.1 Word-to-Bit Conversion

Word-to-bit conversion module (A to H)

1. **Diagram**



2. **Operation**

When the input I is a single word, the output O1 to O16 correspond to bit 00 to bit 15 of the input I.

When the input I is a double word, the output O1 to O16 correspond to high-order 16 bits (bit 00 to bit 15) of the input I.

3. **Connection**

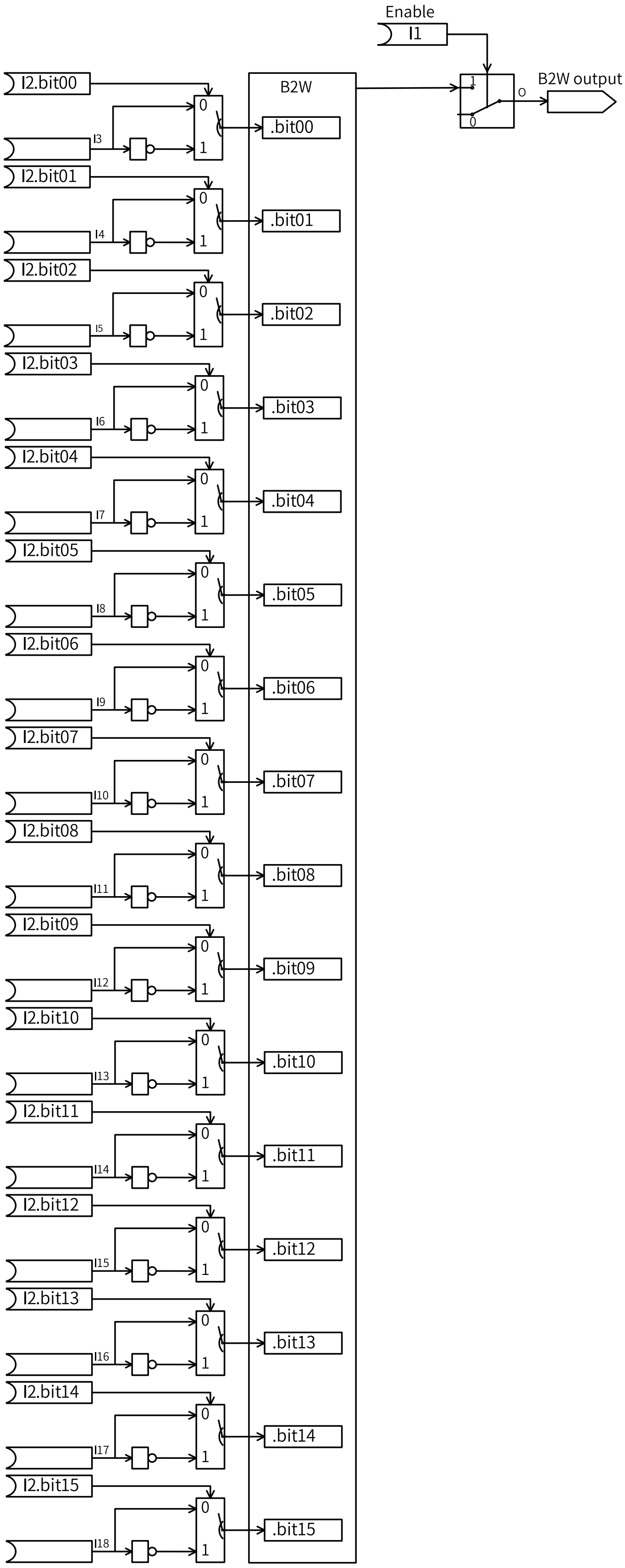
Input I: Single word connector and double word connector

Output O1 to O16: Bit connector

Word-to-Bit Conversion Module		A	B	C	D	E	F	G	H
Input	I	C1-00	C1-01	C1-02	C1-03	C1-04	C1-05	C1-06	C1-07
Output	O1 (bit 00)	L1-76	L1-92	L2-08	L2-24	L2-40	L2-56	L2-72	L2-88
	O2 (bit 01)	L1-77	L1-93	L2-09	L2-25	L2-41	L2-57	L2-73	L2-89
	O3 (bit 02)	L1-78	L1-94	L2-10	L2-26	L2-42	L2-58	L2-74	L2-90
	O4 (bit 03)	L1-79	L1-95	L2-11	L2-27	L2-43	L2-59	L2-75	L2-91
	O5 (bit 04)	L1-80	L1-96	L2-12	L2-28	L2-44	L2-60	L2-76	L2-92
	O6 (bit 05)	L1-81	L1-97	L2-13	L2-29	L2-45	L2-61	L2-77	L2-93
	O7 (bit 06)	L1-82	L1-98	L2-14	L2-30	L2-46	L2-62	L2-78	L2-94
	O8 (bit 07)	L1-83	L1-99	L2-15	L2-31	L2-47	L2-63	L2-79	L2-95
	O9 (bit 08)	L1-84	L2-00	L2-16	L2-32	L2-48	L2-64	L2-80	L2-96
	O10 (bit 09)	L1-85	L2-01	L2-17	L2-33	L2-49	L2-65	L2-81	L2-97
	O11 (bit 10)	L1-86	L2-02	L2-18	L2-34	L2-50	L2-66	L2-82	L2-98
	O12 (bit 11)	L1-87	L2-03	L2-19	L2-35	L2-51	L2-67	L2-83	L2-99
	O13 (bit 12)	L1-88	L2-04	L2-20	L2-36	L2-52	L2-68	L2-84	L3-00
	O14 (bit 13)	L1-89	L2-05	L2-21	L2-37	L2-53	L2-69	L2-85	L3-01
	O15 (bit 14)	L1-90	L2-06	L2-22	L2-38	L2-54	L2-70	L2-86	L3-02
	O16 (bit 15)	L1-91	L2-07	L2-23	L2-39	L2-55	L2-71	L2-87	L3-03

Bit-to-word module (A to D)

1. **Diagram**



2. **Operation**

When the input I1 is set to 0, the module is disabled and the output O equals to 0.

The bit 00 to bit 15 of the inverse flag input I2 correspond to the inverse flags of I3 to I18. When the bit is 1, the inputs I3 to I18 are reversed. Use the reversed I3 to I18 as bit 00 to bit 15 of the hexadecimal number and output to O.

3. **Connection**

Input I1: 0: Disable; 1: Enable

Input I2: 16-bit unsigned number

Input I3 to I18: 0, 1, DI input, and bit connector input

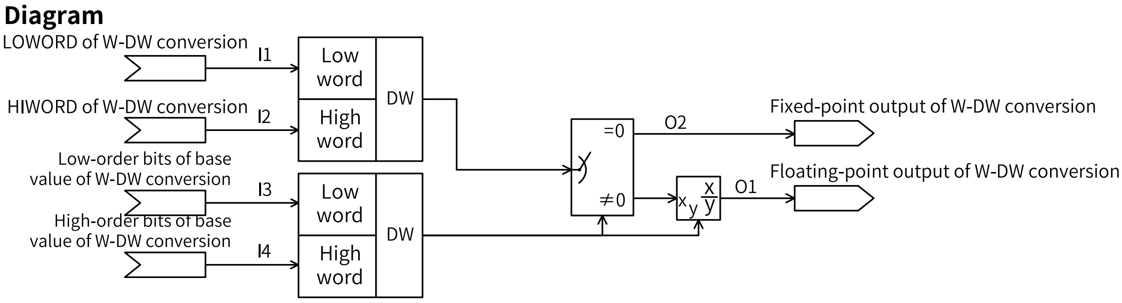
Output O: word connector

Word-to-Bit Module		A	B	C	D
Input	I1	C1-12	C1-30	C1-48	C1-66
	I2	C1-13	C1-31	C1-49	C1-67
	I3 (bit 00)	C1-14	C1-32	C1-50	C1-68
	I4 (bit 01)	C1-15	C1-33	C1-51	C1-69
	I5 (bit 02)	C1-16	C1-34	C1-52	C1-70
	I6 (bit 03)	C1-17	C1-35	C1-53	C1-71
	I7 (bit 04)	C1-18	C1-36	C1-54	C1-72
	I8 (bit 05)	C1-19	C1-37	C1-55	C1-73
	I9 (bit 06)	C1-20	C1-38	C1-56	C1-74
	I10 (bit 07)	C1-21	C1-39	C1-57	C1-75
	I11 (bit 08)	C1-22	C1-40	C1-58	C1-76
	I12 (bit 09)	C1-23	C1-41	C1-59	C1-77
	I13 (bit 10)	C1-24	C1-42	C1-60	C1-78
	I14 (bit 11)	C1-25	C1-43	C1-61	C1-79
	I15 (bit 12)	C1-26	C1-44	C1-62	C1-80
	I16 (bit 13)	C1-27	C1-45	C1-63	C1-81
	I17 (bit 14)	C1-28	C1-46	C1-64	C1-82
	I18 (bit 15)	C1-29	C1-47	C1-65	C1-83
Output	O	L7-21	L7-22	L7-23	L7-24

2.6.2 Word-to-Double Word Conversion

Word-to-double word conversion module (A to D)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} O1: \dfrac{I1 \times 65535 + I2}{I3 \times 65535 + I4}, I3 \times 65535 + I4 \neq 0 \\ O2: I1 \times 65535 + I2, I3 \times 65535 + I4 = 0 \end{cases}$$

When the base value with l3 as the high-order 16 bits and l4 used as the low-order 16 bit is not zero, the output equals the double word with l1 as the high-order 16 bits and I2 as the low-order 16 bits divided by the base value. The result is output to O1.

When the base value with l3 as the high-order 16 bits and l4 used as the low-order 16 bit is zero, the output equals the double word with l1 as the high-order 16 bits and I2 as the low-order 16 bits. The double word is output directly to O2 without base value conversion.

3. **Connection**

Input I1 and I2: Word connector and double word connector

Input I3 and I4: 16-bit unsigned number

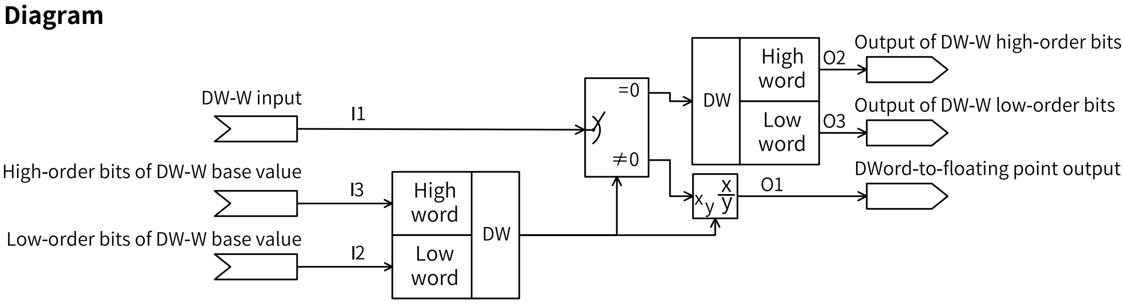
Output O1: Floating point connector

Output O2: Double word connector

Word-to-Double Word Conversion Module	Input				Output	
	I1	I2	I3	I4	O1	O2
A	C2-00	C2-01	C2-02	C2-03	LD-31	L9-00
B	C2-04	C2-05	C2-06	C2-07	LD-32	L9-01
C	C2-08	C2-09	C2-10	C2-11	LD-33	L9-02
D	C2-12	C2-13	C2-14	C2-15	LD-34	L9-03

Double word-to-word conversion module (A to D)

1. **Diagram**



2. **Operation**

$$O=\begin{cases} O1:\dfrac{I1}{I2\times 65535+I3}, & I2\times 65535+I3\neq 0 \\ \begin{cases} O2:(I1>>16)\&0xFFFF \\ O3:I1\&0xFFFF \end{cases}, & I2\times 65535+I3=0 \end{cases}$$

When the base value with I2 as the high-order 16 bits and I3 as the low-order 16 bits is not zero, the output equals the value of I1 divided by the base value. The result is output is to O1.

When the base value with I2 as the high-order 16 bits and I3 as the low-order 16 bits is zero, the output O2 is the high-order 16 bits of I1 and the output O3 is the low-order 16 bits of I1.

3. **Connection**

Input I1: Double word connector

Input I2 and I3: unsigned number

Output O1: Floating point connector

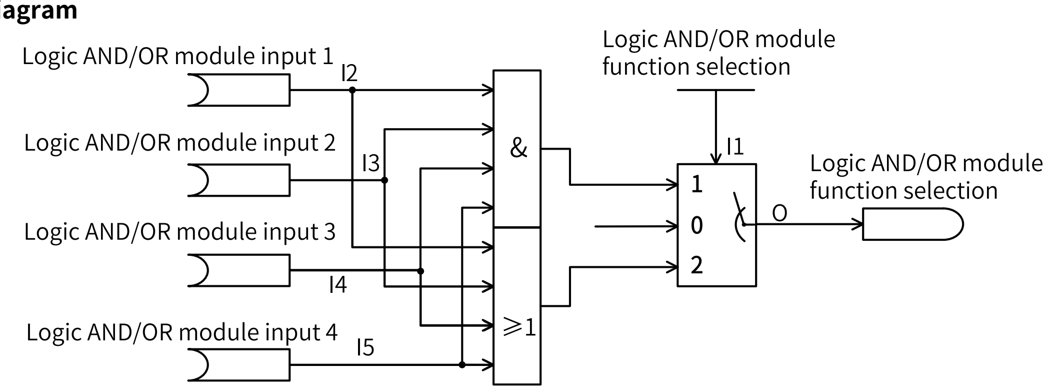
Output O2 and O3: Word connector

DW-W Conversion	Input			Output		
	I1	I2	I3	O1	O2	O3
A	C2-32	C2-33	C2-34	LD-35	L7-25	L7-26
B	C2-35	C2-36	C2-37	LD-36	L7-27	L7-28
C	C2-38	C2-39	C2-40	LD-37	L7-29	L7-30
D	C2-41	C2-42	C2-43	LD-38	L7-31	L7-32

2.6.3 Logic Operation

Logic AND/OR Module (A to L)

1. **Diagram**



2. **Operation**

When I1 for enabling logic AND/OR module is set to 0, the module is inactive, and the output (O) is 0.

When I1 for enabling logic AND/OR module is set to 1, the logic AND module is valid and the output (O) is I2 & I3 & I4 & I5.

Only when I2, I3, I4, and I5 are all true, the output (O) will be true; Otherwise, the output (O) is false. The truth table is as follows.

Input				Output
I2	I3	I4	I5	O
0	X	X	X	0
X	0	X	X	0
X	X	0	X	0
X	X	X	0	0
1	1	1	1	1

When I1 for enabling logic AND/OR module is set to 2, logic OR is valid and the output (O) is I2 | I3 | I4 | I5.

Only when I2, I3, I4 and I5 are false, the output (O) is false; otherwise, the output (O) is true. The truth table is as follows.

Input				Output
I2	I3	I4	I5	O
1	X	X	X	1
X	1	X	X	1
X	X	1	X	1
X	X	X	1	1
0	0	0	0	0

3. **Connection**

Input I1: 0: module disabled; 1: logic AND module; 2: logic OR module

Input I2, I3, I4, and I5: 0, 1, DI input, and bit connector input

Output (O): Bit connector

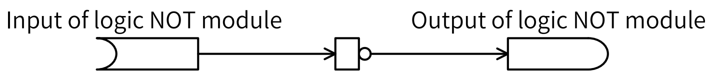
Logic AND/OR Module	Input					Output
	I1	I2	I3	I4	I5	O
A	C3-00	C3-01	C3-02	C3-03	C3-04	L3-36
B	C3-05	C3-06	C3-07	C3-08	C3-09	L3-37
C	C3-10	C3-11	C3-12	C3-13	C3-14	L3-38
D	C3-15	C3-16	C3-17	C3-18	C3-19	L3-39
E	C3-20	C3-21	C3-22	C3-23	-	L3-40
F	C3-24	C3-25	C3-26	C3-27	-	L3-41
G	C3-28	C3-29	C3-30	C3-31	-	L3-42
H	C3-32	C3-33	C3-34	C3-35	-	L3-43
I	C3-36	C3-37	C3-38	C3-39	-	L3-44
J	C3-40	C3-41	C3-42	C3-43	-	L3-45
K	C3-44	C3-45	C3-46	C3-47	-	L3-46
L	C3-48	C3-49	C3-50	C3-51	-	L3-47

Note

Logic AND/OR modules A to D support four input terminals, and Logic AND/OR modules E to L support three input terminals.

Logic NOT Module (A to P)

1. **Diagram**



2. **Operation**

- When the input (I) is set to 0, the module is disabled and the output is 0

  O = 0

- When the input (I) is not 0, the output is opposite to the input I.

  $O = \overline{I}$

Output of logic NOT module

Input	Output
I	O
0	1
1	0

3. **Connection**

Input I: 0, 1, DI input, and bit connector input

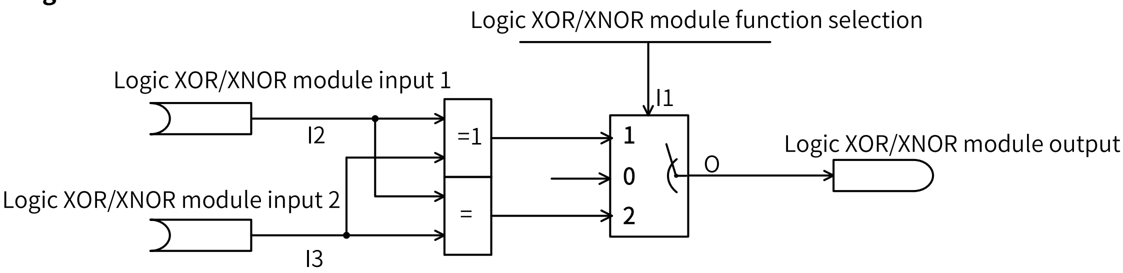
Output (O): Bit connector

Logic NOT Module	Input	Output
	I	O
A	C3-56	L3-52
B	C3-57	L3-53
C	C3-58	L3-54

Logic NOT Module	Input	Output
	I	O
D	C3-59	L3-55
E	C3-60	L3-56
F	C3-61	L3-57
G	C3-62	L3-58
H	C3-63	L3-59
I	C3-64	L3-60
J	C3-65	L3-61
K	C3-66	L3-62
L	C3-67	L3-63
M	C3-68	L3-64
N	C3-69	L3-65
O	C3-70	L3-66
P	C3-71	L3-67

Logic XOR/XNOR Module (A to H)

1. **Diagram**



2. **Operation**

When I1 for enabling the logic XOR/XNOR module is set to 0, the module is disabled, and the output (O) is 0. O = 0

When I1 for enabling the logic XOR/XNOR module is set to 1, the module is enabled. O = (!I2 & I3) | (I2 & !I3)

When I2 and I3 are the same, the output (O) is 0. When I2 and I3 are different, the output (O) is 1. The truth table is as follows.

Input		Output
I2	I3	O
0	0	0
1	0	1
0	1	1
1	1	0

When I1 for enabling the logic XOR/XNOR module is set to 2, the logic XNOR module is enabled. O = (I2 & I3) | (!I2 & !I3)

When I2 and I3 are the same, the output (O) is 1. When I2 and I3 are different, the output (O) is 0. The truth table is as follows.

Input		Output
I2	I3	O
0	0	1
1	0	0

Input		Output
0	1	0
1	1	1

3. **Connection**

Input l1: 0: module disabled; 1: logic XOR module; 2: logic XNOR module

Input I2 and I3: 0, 1, DI input, and bit connector input

Output (O): Bit connector

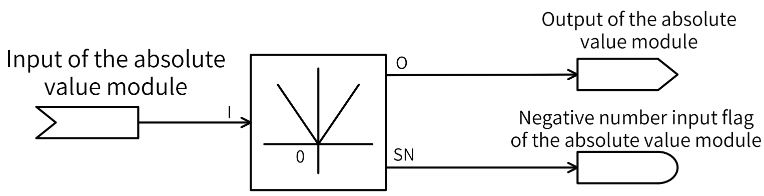
Table 2–5

Logic XOR/XNOR Module	Input			Output
	I1	I2	I3	O
A	C3-72	C3-73	C3-74	L3-68
B	C3-75	C3-76	C3-77	L3-69
C	C3-78	C3-79	C3-80	L3-70
D	C3-81	C3-82	C3-83	L3-71
E	C3-84	C3-85	C3-86	L3-72
F	C3-87	C3-88	C3-89	L3-73
G	C3-90	C3-91	C3-92	L3-74
H	C3-93	C3-94	C3-95	L3-75

2.6.4 Mathematical Operation

Absolute value module (A to H)

1. **Diagram**



2. **Operation**

$$O=|I|$$

$$SN=\begin{cases}1, I<0\\0, I\geqslant 0\end{cases}$$

The output O equals the absolute value of the input I. When the input value is negative, the SN is 1; otherwise, the SN is 0.

3. **Connection**

Input I: AI, HDI, Aim, motorized potentiometer, PID, word connector, double word connector, and floating point connector

Output O: Word connector, double word connector, and floating point connector

Output SN: bit connector

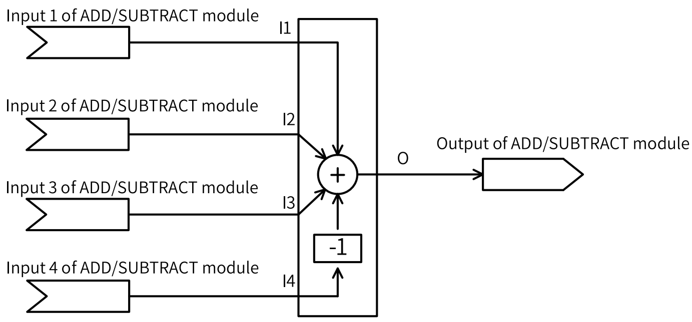
Absolute Value Module	Input	Output	
	I	O	SN
A	C4-00	LD-08	L4-16
B	C4-01	LD-09	L4-17

Absolute Value Module	Input	Output	
	I	O	SN
C	C4-02	LD-10	L4-18
D	C4-03	LD-11	L4-19
E	C4-04	LD-12	L4-20
F	C4-05	L9-08	L4-21
G	C4-06	L9-09	L4-22
H	C4-07	L9-10	L4-23

Note The modules A–E are floating-point absolute value modules, and the modules F–G are fixed-point absolute value modules.

Addition and subtraction module (A to H)

1. **Diagram**



2. **Operation**

O=I1+I2+I3-I4

The output O equals the sum of I1, I2, and I3 minus I4.

3. **Connection**

Input I1, I2, I3, and I4: AI, HDI, Aim, motorized potentiometer, PID, word connector input, and float connector input

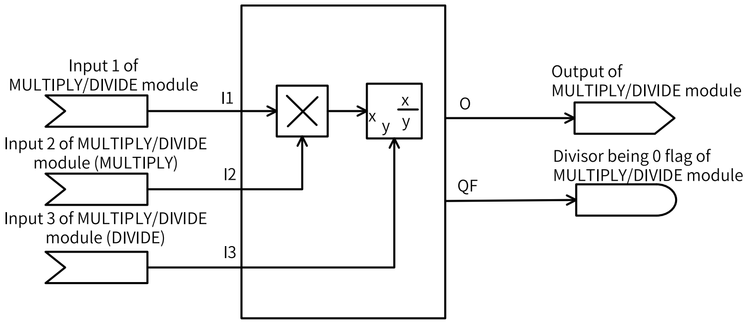
Output O: Double word connector and floating point connector

Addition and Subtraction Module	Input				Output
	I1	I2	I3	I4	O
A	C4-08	C4-09	C4-10	C4-11	LD-13
B	C4-12	C4-13	C4-14	C4-15	LD-14
C	C4-16	C4-17	C4-18	C4-19	LD-15
D	C4-20	C4-21	C4-22	C4-23	LD-16
E	C4-24	C4-25	C4-26	C4-27	LD-17
F	C4-28	C4-29	C4-30	C4-31	L9-11
G	C4-32	C4-33	C4-34	C4-35	L9-12
H	C4-36	C4-37	C4-38	C4-39	L9-13

Note The modules A–E are floating-point ADD/SUBTRACT modules, and the modules F–H are fixed-point ADD/ SUBTRACT modules.

Multiplication and division module (A to H)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I1 \times I2, I3 = 0 \\ \dfrac{I1 \times I2}{I3}, I3 \neq 0 \\ 0 \quad , I3 = 0 \end{cases}$$

$$QF = \begin{cases} 1 \ , I3 = 0 \\ 0 \ , I3 \neq 0 \end{cases}$$

When I3 is set to 0, the output is the product of I1 multiplied by I2.

When I3 is set to other options, if the input value I3 is 0, the output is 0 and the divisor is the zero flag bit which is 1; if the input value I3 is not 0, the output is the product of (I1 x I2)/I3, and the divisor is the zero flag bit which is 0.

3. **Connection**

Input I1, I2, and I3: AI, HDI, Aim, motorized potentiometer, PID, word connector input, double word connector, and floating point connector input

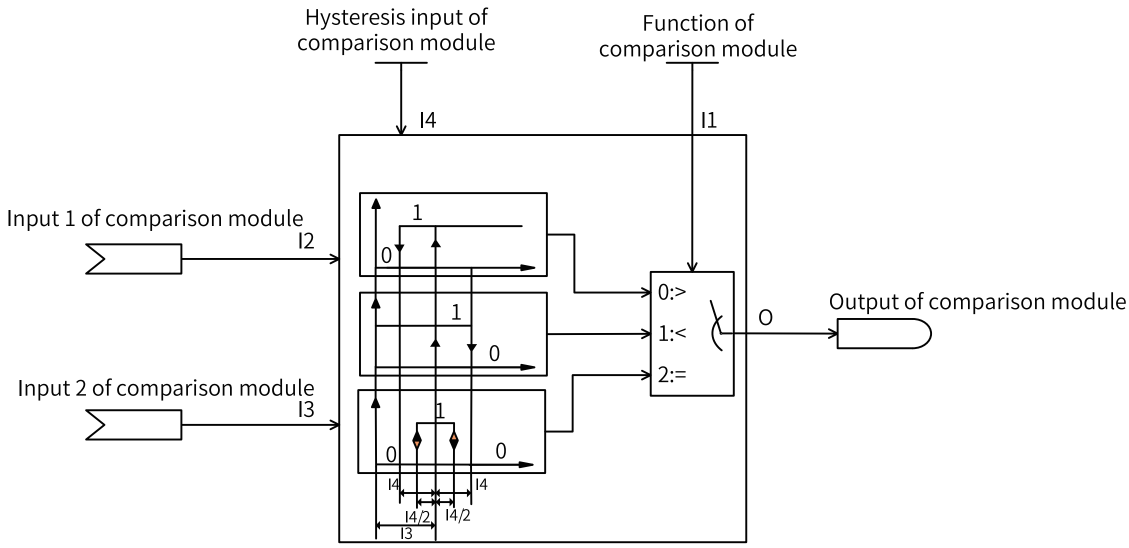
Output O: Double word connector and floating point connector

Multiplication and Division Module	Input			Output
	I1	I2	I3	O
A	C4-40	C4-41	C4-42	LD-18
B	C4-43	C4-44	C4-45	LD-19
C	C4-46	C4-47	C4-48	LD-20
D	C4-49	C4-50	C4-51	LD-21
E	C4-52	C4-53	C4-54	LD-22
F	C4-55	C4-56	C4-57	L9-14
G	C4-58	C4-59	C4-60	L9-15
H	C4-61	C4-62	C4-63	L9-16

Note The modules A–E are floating-point MULTIPLY/DIVIDE modules, and the modules F–H are byte MULTIPLY/DIVIDE modules.

Comparison module (A to H)

1. **Diagram**



2. **Operation**

Hysteresis input I4 suppresses frequent connection and disconnection.

- When l1 (comparison module function) is set to 0, before I2 increases from 0 to I3 in the forward direction, the output O keeps low level. When I2 increases to a value higher than I3, the output O changes from low level to high level. When I2 keeps increasing, the output O keeps high level. If I2 decreases but keeps higher than I3 - l4, the output O keeps high level. Only when I2 is lower than I3 - l4, the output O changes from high level to low level.
- When l1 (comparison module function) is set to 1, before I2 increases from 0 to I3+I4 in the forward direction, the output O keeps high level. When I2 increases to a value higher than I3+I4, the output O changes from high level to low level. When I2 keeps increasing, the output O keeps low level. If I2 decreases but keeps higher than I3, the output O keeps low level. Only when I2 is lower than I3, the output O changes from low level to high level.
- When l1 (comparison module function) is set to 2, the output keeps high level if I2 is within the range of I3-I4/2 to I3+I4/2; otherwise, the output is low level.

3. **Connection**

Input l1: 0 (module disabled);1: Input 1 > Input 2; 2: Input 1 < Input 2; 3: Input 1 = Input 2

Input I2 and I3: AI, HDI, Aim, motorized potentiometer, PID, word connector input, double word connector, and floating point connector input

Input I4: Floating point number with two decimal places

Output O: Bit connector

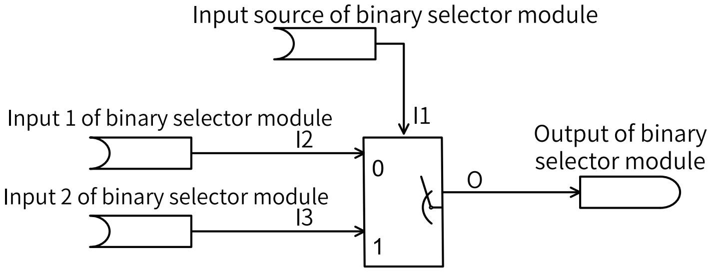
Comparison Module	Input				Output
	I1	I2	I3	I4	O
A	C4-64	C4-65	C4-66	C4-67	L4-00
B	C4-68	C4-69	C4-70	C4-71	L4-01
C	C4-72	C4-73	C4-74	C4-75	L4-02
D	C4-76	C4-77	C4-78	C4-79	L4-03
E	C4-80	C4-81	C4-82	C4-83	L4-04
F	C4-84	C4-85	C4-86	C4-87	L4-05
G	C4-88	C4-89	C4-90	C4-91	L4-06
H	C4-92	C4-93	C4-94	C4-95	L4-07

NoteThe modules A–E are floating-point comparison modules, and the modules F–H are fixed-point comparison modules.

2.6.5 Switch Function

Binary selector module (A to H)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

When I1 (binary selector module) is set to 0, the output O equals I2. When I1 (binary selector module) is set to 1, the output O equals I3.

3. **Connection**

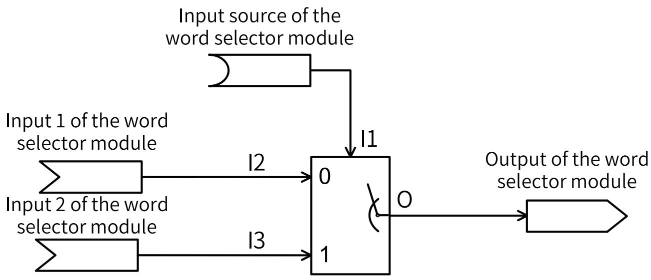
Input I1, I2, and I3: 0, 1, DI input, double word connector, or bit connector

Output (O): Bit connector

Binary Selector Module	Input			Output
	I1	I2	I3	O
A	C5-00	C5-01	C5-02	L3-04
B	C5-03	C5-04	C5-05	L3-05
C	C5-06	C5-07	C5-08	L3-06
D	C5-09	C5-10	C5-11	L3-07
E	C5-12	C5-13	C5-14	L3-08
F	C5-15	C5-16	C5-17	L3-09
G	C5-18	C5-19	C5-20	L3-10
H	C5-21	C5-22	C5-23	L3-11

Word selector module (A to D)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

When I1 (word selector module) is set to 0, the output O equals I2. When I1 (digital selector module) is set to 1, the output O equals I3.

3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

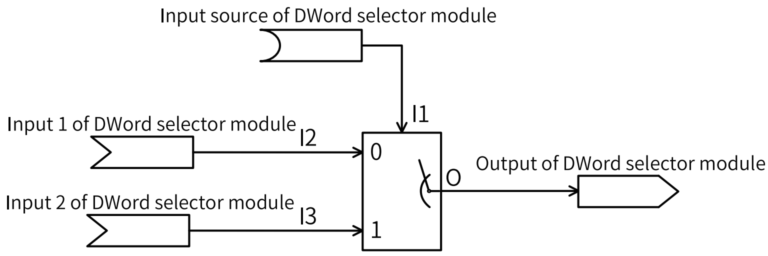
Input I2 and I3: Word connector and double word connector

Output O: Word connector

Word Selector Module	Input			Output
	I1	I2	I3	O
A	C5-24	C5-25	C5-26	L7-41
B	C5-27	C5-28	C5-29	L7-42
C	C5-30	C5-31	C5-32	L7-43
D	C5-33	C5-34	C5-35	L7-44

Double word selector module (A to D)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

When I1 (double word selector module) is set to 0, the output O equals I2. When I1 (double word selector module) is set to 1, the output O equals I3.

3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

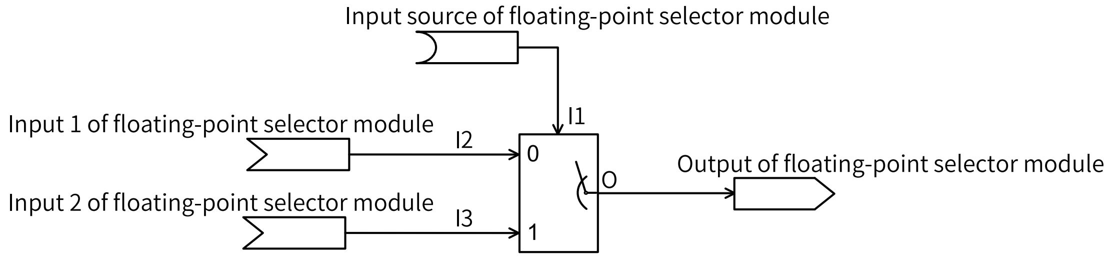
Input I2 and I3: Word connector, word connector, and double word connector

Output O: Double word connector

Double Word Connector	Input			Output
	I1	I2	I3	O
A	C5-36	C5-37	C5-38	L9-04
B	C5-39	C5-40	C5-41	L9-05
C	C5-42	C5-43	C5-44	L9-06
D	C5-45	C5-46	C5-47	L9-07

Floating point selector module (A to H)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

Input I2, I3: AI, HDI, Aim, motorized potentiometer, PID, and floating point connector input

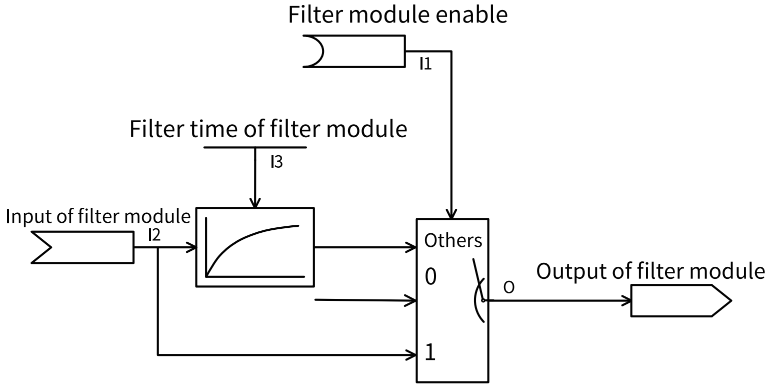
Output O: Floating point connector

Floating Point Selector Module	Input			Output
	I1	I2	I3	O
A	C5-48	C5-49	C5-50	LD-00
B	C5-51	C5-52	C5-53	LD-01
C	C5-54	C5-55	C5-56	LD-02
D	C5-57	C5-58	C5-59	LD-03
E	C5-60	C5-61	C5-62	LD-04
F	C5-63	C5-64	C5-65	LD-05
G	C5-66	C5-67	C5-68	LD-06
H	C5-69	C5-70	C5-71	LD-07

2.6.6 Control Function

Filter module (A to F)

1. **Diagram**



2. **Operation**

When I1 is set to 0, the filter module is disabled and the output O is 0.

Set I1 to a non-zero value. If the input value is 1, the filter module is disabled and the output O equals I2. If the input value is 0, the output O equals the filter value of the input I.

3. **Connection**

Input I1: 0 (filter module disabled), 1 (filter module enabled, but filtering disabled), 2 (filter module and filtering enabled, DI input, or bit connector input

Input I2: AI, HDI, Aim, motorized potentiometer, PID, word connector input, and floating point connector input

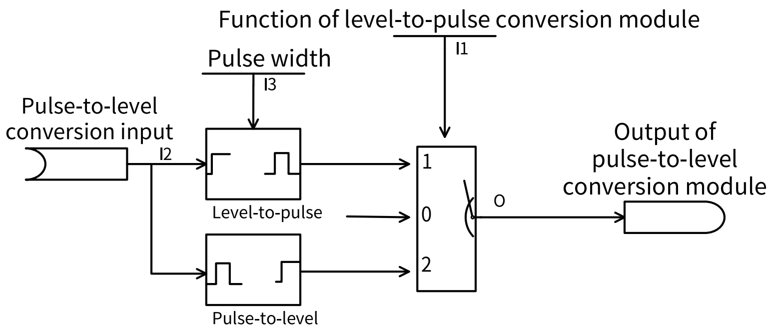
Input I3: Floating point number with three decimal places

Output O: Double word connector and floating point connector

Filter module	Input			Output
	I1	I2	I3	O
A	C6-00	C6-01	C6-02	LD-23
B	C6-03	C6-04	C6-05	LD-24
C	C6-06	C6-07	C6-08	LD-25
D	C6-09	C6-10	C6-11	LD-26
E	C6-12	C6-13	C6-14	L9-17
F	C6-15	C6-16	C6-17	L9-18

Level-to-pulse conversion module (A to D)

1. **Diagram**

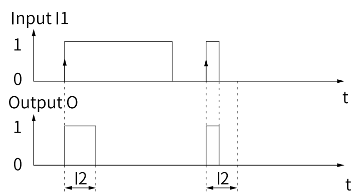


2. **Operation**

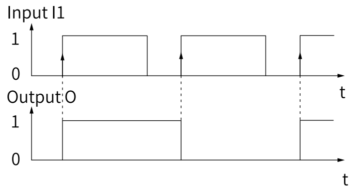
When I1 is set to 0, the module is disabled and the output is 0.

When I1 is set to 1, level-to-pulse conversion is valid, and the output is set to 1 within the pulse time l3 on the rising edge of input l2.

If input I1 is 0, the output is 0 immediately regardless of whether the pulse duration is reached.



When l1 is set to 2, pulse-to-level conversion is valid. In this case, the output is set to 1 on the first rising edge of input I2, and set to 0 on the second rising edge of input I2, and so on. That is, the output is set to 1 on each odd rising edge of input I2, and set to 0 on each even rising edge of input I2.



3. **Connection**

Input l1: 0: Module disabled; 1: Level-to-pulse conversion; 2: Pulse-to-level conversion

Input I2: 0, 1, DI input, and bit connector input

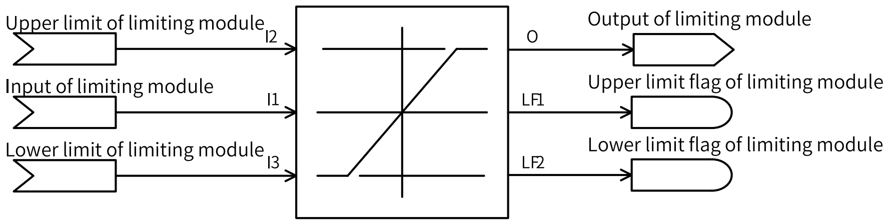
Input I3: Floating point number with two decimal places

Output O: Bit connector

Level-to-pulse Conversion Module	Input			Output
	I1	I2	I3	O
A	C6-24	C6-25	C6-26	L3-84
B	C6-27	C6-28	C6-29	L3-85
C	C6-30	C6-31	C6-32	L3-86
D	C6-33	C6-34	C6-35	L3-87

Limiting module (A to F)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I1, I3 \le I1 \le I2 \\ I2, I1 \ge I2 \\ I3, I1 \le I3 \end{cases}$$

$$LF1 = \begin{cases} 0, I3 \le I1 \le I2 \\ 1, I1 \ge I2 \end{cases}$$

$$LF1 = \begin{cases} 0, I3 \le I1 \le I2 \\ 1, I1 \le I3 \end{cases} \quad LF1 = \begin{cases} 0, I3 \le I1 \le I2 \\ 1, I1 \le I3 \end{cases}$$

When the input I1 is higher than the upper limit I2, the output O is equal to I2, and the upper limit flag position LF1 is set to 1. When the input I1 is lower than the lower limit I3, the output O is equal to I3, and the lower limit flag position LF2 is set to 1. When the input l1 is within the range of the lower limit to the upper limit, the output is equal to the input.

3. **Connection**

Input I1, I2, and I3: AI, HDI, Aim, motorized potentiometer, PID, word connector input, and floating point connector input.

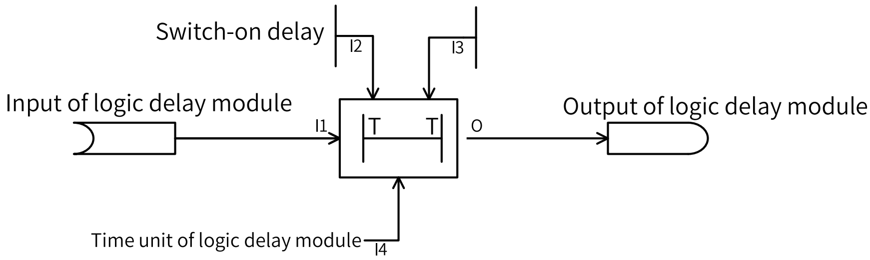
Output O: Double word connector and floating point connector

Output LF1 and LF2: Bit connector

Limiting Module	Input			Output		
	I1	I2	I3	O	LF1	LF2
A	C6-36	C6-37	C6-38	LD-27	L4-48	L4-49
B	C6-39	C6-40	C6-41	LD-28	L4-50	L4-51
C	C6-42	C6-43	C6-44	LD-29	L4-52	L4-53
D	C6-45	C6-46	C6-47	LD-30	L4-54	L4-55
E	C6-48	C6-49	C6-50	L9-19	L4-56	L4-57
F	C6-51	C6-52	C6-53	L9-20	L4-58	L4-59

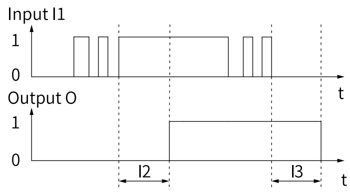
Logic delay module (A to H)

1. **Diagram**



2. **Operation**

The output O will delay for switch-on when the input l1 changes from low level to high level, and the delay time is determined by the l2 switch-on delay time and the l4 time unit. The output O will also delay for switch-off when the input l1 changes from high level to low level, and the delay time is determined by the l3 switch-off delay time and the l4 time unit. Pulse signals shorter than the delay time are filtered out during delay, as shown in the following figure.



3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

Input I2 and I3: unsigned number

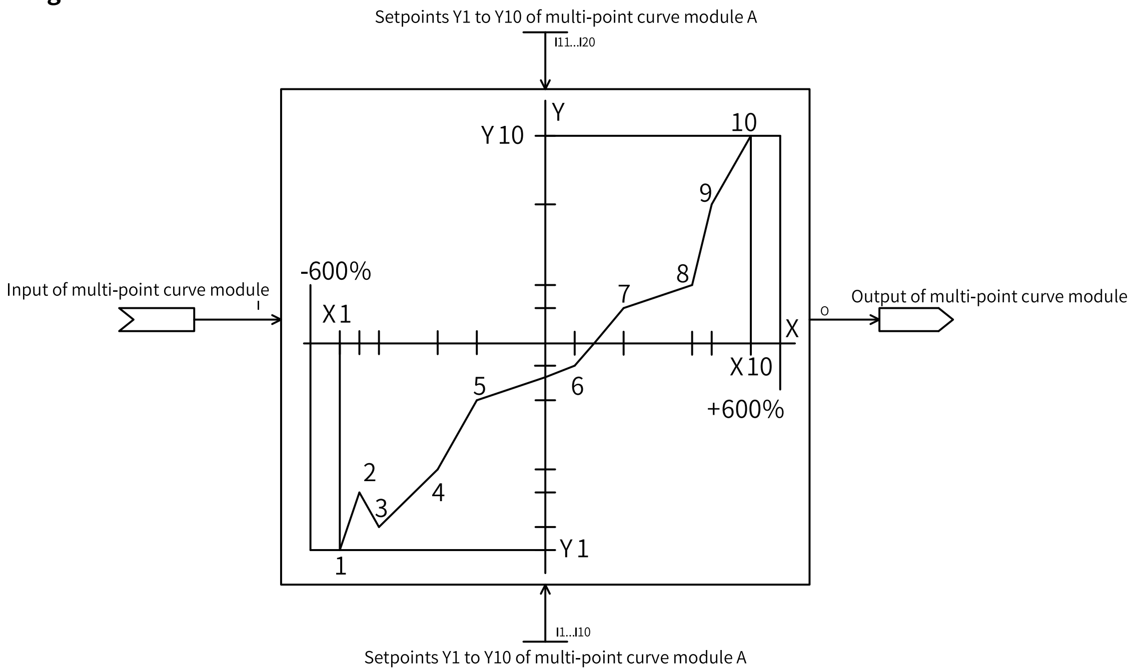
Input I4: 0: No delay: 1: 10 ms: 10: 100 ms; 100: 1s; 1000: 10s; 6000: 1 min; 12000: 2 min

Output (O): Bit connector

Logic Delay Module	Input				Output
	I1	I2	I3	I4	O
A	C6-54	C6-55	C6-56	C6-57	L3-20
B	C6-58	C6-59	C6-60	C6-61	L3-21
C	C6-62	C6-63	C6-64	C6-65	L3-22
D	C6-66	C6-67	C6-68	C6-69	L3-23
E	C6-70	C6-71	C6-72	C6-73	L3-24
F	C6-74	C6-75	C6-76	C6-77	L3-25
G	C6-78	C6-79	C6-80	C6-81	L3-26
H	C6-82	C6-83	C6-84	C6-85	L3-27

2.6.7 Multi-point curve

1. **Diagram**



2. **Operation**

The coordinate is valid only when X1 ⩽ X2 ⩽· · ·⩽ X10 is satisfied. When the input is outside the active coordinate point, the output is equal to the ordinate value of adjacent valid coordinate point. When the input is within the valid coordinate point, the corresponding ordinate value is calculated based on the curve.

Assume that the coordinate is valid and number of coordinates inputted is lower than 10. If the last abscissa inputted is negative, the abscissa and the following abscissa whose value is 0 are kept, and the subsequent coordinate values are discarded. If the last abscissa inputted is positive, the abscissa is kept, and the subsequent coordinate values are discarded.

If the conditions of X1 ⩽ X2 ⩽· · ·⩽ X10 is not satisfied, the drive reports L32.4 (limit-type fault). If two X coordinates are the same but the Y coordinates are different, the drive also reports L32.4 (limit-type fault).

3. **Connection**

Input I: Float point connector

Input I1 to I20: One decimal floating point number

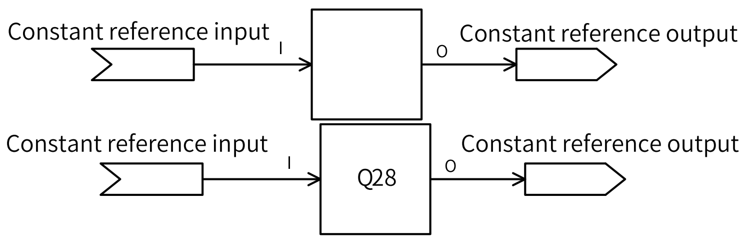
Output O: Floating point connector

Multi-point Curve Module		A	B
Input	I	C7-00	C7-21
	I1 (X1)	C7-01	C7-22
	I2 (X2)	C7-02	C7-23
	I3 (X3)	C7-03	C7-24
	I4 (X4)	C7-04	C7-25
	I5 (X5)	C7-05	C7-26
	I6 (X6)	C7-06	C7-27
	I7 (X7)	C7-07	C7-28
	I8 (X8)	C7-08	C7-29
	I9 (X9)	C7-09	C7-30
	I10 (X10)	C7-10	C7-31
	I11 (Y1)	C7-11	C7-32
	I12 (Y2)	C7-12	C7-33
	I13 (Y3)	C7-13	C7-34
	I14 (Y4)	C7-14	C7-35
	I15 (Y5)	C7-15	C7-36
	I16 (Y6)	C7-16	C7-37
	I17 (Y7)	C7-17	C7-38
	I18 (Y8)	C7-18	C7-39
	I19 (Y9)	C7-19	C7-40
	I20 (Y10)	C7-20	C7-41
Output	O	LD-46	LD-47

2.6.8 Constant Value

Constant value setting (1 to 42)

1. **Diagram**



2. **Operation**

O = I.

The output O equals the input I.

Constant value setting modules 1 to 5 are used to set floating point numbers with two decimal places. The setting range is -300.00 to +300.00.

Constant value setting modules 6 to 21 are used to set floating point numbers with one decimal place. The setting range is -3000.0 to +3000.0.

Constant value setting modules 22 to 26 are used to convert the input floating point number with two decimal places to the fixed point number for output through Q28. The setting range is -300.00 to +300.00.

Constant value setting modules 27 to 42 are used to set fixed point numbers. The setting range is 0 to 65535.

3. **Connection**

Input I: Unsigned number, floating point number with one decimal place, and floating point number with two decimal places

Output O: Word connector and floating-point connector

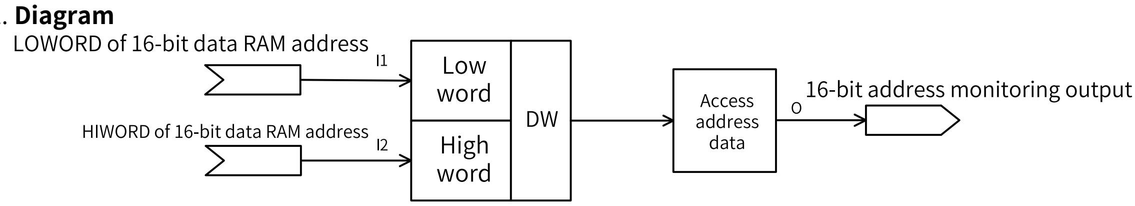
Constant Value Setting Module	Input	Output	Remarks
	I	O	
1	C8-00	LD-65	Floating point number with two decimal places
2	C8-01	LD-66	Floating point number with two decimal places
3	C8-02	LD-67	Floating point number with two decimal places
4	C8-03	LD-68	Floating point number with two decimal places
5	C8-04	LD-69	Floating point number with two decimal places
6	C8-05	LD-70	Floating point number with one decimal place
7	C8-06	LD-71	Floating point number with one decimal place
8	C8-07	LD-72	Floating point number with one decimal place
9	C8-08	LD-73	Floating point number with one decimal place
10	C8-09	LD-74	Floating point number with one decimal place
11	C8-10	LD-75	Floating point number with one decimal place
12	C8-11	LD-76	Floating point number with one decimal place
13	C8-12	LD-77	Floating point number with one decimal place
14	C8-13	LD-78	Floating point number with one decimal place
15	C8-14	LD-79	Floating point number with one decimal place
16	C8-15	LD-80	Floating point number with one decimal place
17	C8-16	LD-81	Floating point number with one decimal place
18	C8-17	LD-82	Floating point number with one decimal place
19	C8-18	LD-83	Floating point number with one decimal place
20	C8-19	LD-84	Floating point number with one decimal place

Constant Value Setting Module	Input	Output	Remarks
	I	O	
21	C8-20	LD-85	Floating point number with one decimal place
22	C8-21	L7-00	Floating point number conversion to fixed point number through Q28
23	C8-22	L7-01	Floating point number conversion to fixed point number through Q28
24	C8-23	L7-02	Floating point number conversion to fixed point number through Q28
25	C8-24	L7-03	Floating point number conversion to fixed point number through Q28
26	C8-25	L7-04	Floating point number conversion to fixed point number through Q28
27	C8-26	L7-05	Fixed point number
28	C8-27	L7-06	Fixed point number
29	C8-28	L7-07	Fixed point number
30	C8-29	L7-08	Fixed point number
31	C8-30	L7-09	Fixed point number
32	C8-31	L7-10	Fixed point number
33	C8-32	L7-11	Fixed point number
34	C8-33	L7-12	Fixed point number
35	C8-34	L7-13	Fixed point number
36	C8-35	L7-14	Fixed point number
37	C8-36	L7-15	Fixed point number
38	C8-37	L7-16	Fixed point number
39	C8-38	L7-17	Fixed point number
40	C8-39	L7-18	Fixed point number
41	C8-40	L7-19	Fixed point number
42	C8-41	L7-20	Fixed point number

2.6.9 Any Parameter Control

Any 16-bit data address monitoring (1–5)

1. **Diagram**



2. **Operation**

Enter I1 as the low word and I2 as the high word. Find the corresponding data through the 32-bit address and output it to O.

The address range allowed for monitoring is as follows:

0x20000000 to 0x2001FFFE

0x24000000 to 0x2404FFFE

3. **Connection**

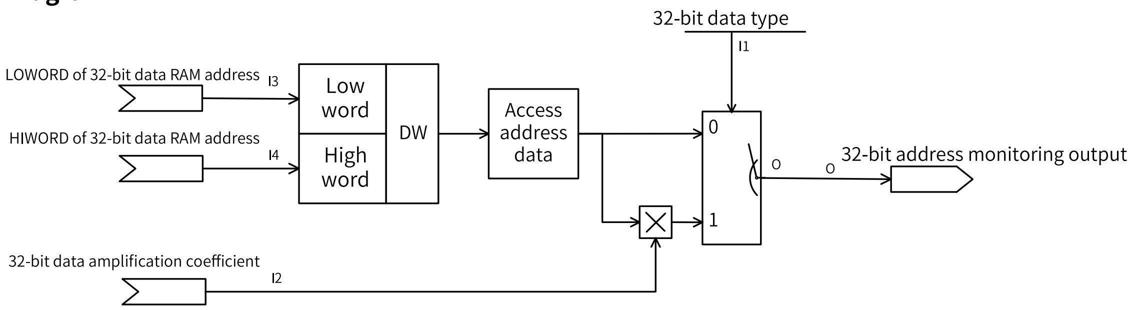
Input I1 and I2: hexadecimal unsigned number

Output O: word connector

16-bit Data Address Monitoring	Input		Output
	I1	I2	O
1	C9-00	C9-01	L7-36
2	C9-02	C9-03	L7-37
3	C9-04	C9-05	L7-38
4	C9-06	C9-07	L7-39
5	C9-08	C9-09	L7-40

Any 32-bit data address monitoring (1–5)

1. **Diagram**



2. **Operation**

Enter I1 as the low word and I2 as the high word. Find the corresponding data through the 32-bit address. If data type selection I3 is set to 0, the data is output directly to O. If data type selection I3 is set to 1, the data is output to O after being multiplied by the magnification factor I4.

The address range allowed for monitoring is as follows:

0x20000000 to 0x2001FFFC

0x24000000 to 0x2404FFFC

3. **Connection**

Enter I1 and I2, which are unsigned numbers.

Input I3 and I4: hexadecimal unsigned number

Output O: word connector

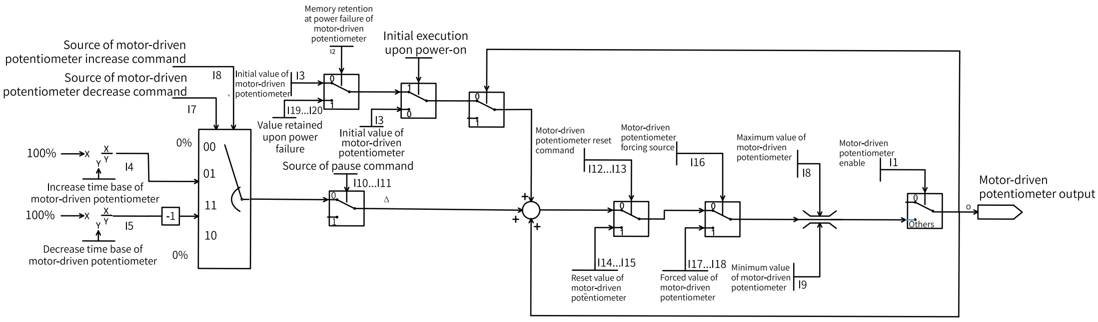
32-bit Data Address Monitoring	Input				Output
	I1	I2	I3	I4	O
1	C9-10	C9-11	C9-12	C9-13	L9-21
2	C9-14	C9-15	C9-16	C9-17	L9-22

32-bit Data Address Monitoring	Input				Output
	I1	I2	I3	I4	O
3	C9-18	C9-19	C9-20	C9-21	L9-23
4	C9-22	C9-23	C9-24	C9-25	L9-24
5	C9-26	C9-27	C9-28	C9-29	L9-25

2.6.10 Motorized Potentiometer

Constant value setting (1 to 42)

1. **Diagram**



2. **Operation**

- When I1 is 0, the motorized potentiometer is disabled and the output O is 0. When I1 is 1, the motorized potentiometer is enabled.
- When I2 is 1, the motorized potentiometer restores the values of I19 and I20 before power-off upon power-on for the first time. When I2 is 0, the motorized potentiometer restores the initial value of l3 upon power-on for the first time.
- When I1 is enabled and the value is not restored to the value memorized before power-off, the output O of the motorized potentiometer is the initial value of I3.
- When I6 is set to 1, the motorized potentiometer increases the output O based on the increasing time base set by I4. When I7 is set to 1, the motorized potentiometer decreases the output O based on the increasing time base set by I5.
- When the motorized potentiometer increases, the maximum value of the output O is I8. When the motorized potentiometer decreases, the minimum value of the output O is I9.
- When I10 and I11 are 1, the output O change pauses. When I10 and I11 become 0, the output O continues to change.
- When I12 and I13 are 1, the output O is reset to the specified value. If the reset value source I14 is 0, the output O is reset to the value specified by I15, which is the digital setting of the reset value. If the reset value source I14 is other values, the output O is reset to the value specified by I14.
- When I16 is 1, the output O is forced to the specified value. If the forced value source I17 is 0, the output O is forced to the value specified by l18, which is the digital setting of the force value. If the forced value source I17 is other values, the output O is forced to the value specified by I17.
- I19 and I20 are per unit values after the motor potentiometer output memory value is converted by Q28.

3. **Connection**

Input I: Unsigned number, floating point number with one decimal place, and floating point number with two decimal places

Output O: Word connector and floating-point connector

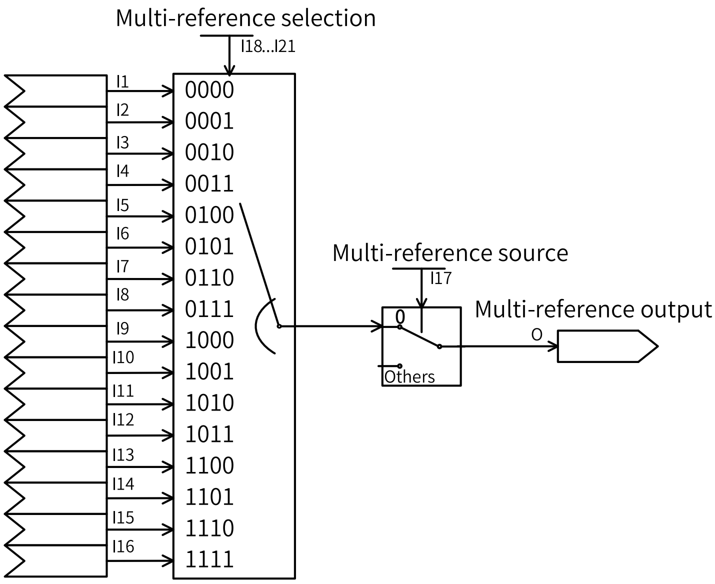
Motorized Potentiometer			Remarks
Input	I1	FB-20	Motorized potentiometer enable
	I2	FB-21	Retention at power failure of motorized potentiometer
	I3	FB-22	Initial value of motorized potentiometer
	I4	FB-23	Increasing time base of motorized potentiometer
	I5	FB-24	Decreasing time base of motorized potentiometer
	I6	FB-25	Source of motorized potentiometer increasing command
	I7	FB-26	Source of motorized potentiometer decreasing command
	I8	FB-27	Maximum value of motorized potentiometer output
	I9	FB-28	Minimum value of motorized potentiometer output
	I10	FB-29	Source 1 of motorized potentiometer pause command
	I11	FB-30	Source 2 of motorized potentiometer pause command
	I12	FB-31	Source 1 of motorized potentiometer reset command
	I13	FB-32	Source 2 of motorized potentiometer reset command
	I14	FB-33	Source of motorized potentiometer reset value
	I15	FB-34	Reset value digital setting of motorized potentiometer
	I16	FB-35	Source of motorized potentiometer force command
	I17	FB-36	Source of motorized potentiometer force value
	I18	FB-37	Force value digital setting of motorized potentiometer
	I19	FB-38	High-order bits of motorized potentiometer storage
	I20	FB-39	Low-order bits of motorized potentiometer storage

Motorized Potentiometer			Remarks
Output	O	LD-45	Final output value of motorized potentiometer
	ForceVal	LD-39	Force value of motorized potentiometer
	ResetVal	LD-40	Reset value of motorized potentiometer
	MaxVal	LD-41	Maximum value of motorized potentiometer
	MinVal	LD-42	Minimum value of motorized potentiometer
	InitVal	LD-43	Initial value of motorized potentiometer
	ProcessOutput	LD-44	Process operation output value of motorized potentiometer

2.6.11 Multi-reference

Multi-reference module

1. **Diagram**



2. **Operation**

When I17 for setting the multi-reference source is set to 0, combinations of bit values for I18 to I21 are used to set multi-reference 1 (I1) to multi-reference 16 (I16), and the corresponding multi-reference is output to O.

When I17 is set to a value other than 0, the corresponding value is output to O.

Multi-reference	I21 (bit 3)	I20 (bit 2)	I19 (bit 1)	I18 (bit 0)	Effective Value
Multi-reference 1	0	0	0	0	I1
Multi-reference 2	0	0	0	1	I2
Multi-reference 3	0	0	1	0	I3
Multi-reference 4	0	0	1	1	I4
Multi-reference 5	0	1	0	0	I5

Multi-reference	I21 (bit 3)	I20 (bit 2)	I19 (bit 1)	I18 (bit 0)	Effective Value
Multi-reference 6	0	1	0	1	I6
Multi-reference 7	0	1	1	0	I7
Multi-reference 8	0	1	1	1	I8
Multi-reference 9	1	0	0	0	I9
Multi-reference 10	1	0	0	1	I10
Multi-reference 11	1	0	1	0	I11
Multi-reference 12	1	0	1	1	I12
Multi-reference 13	1	1	0	0	I13
Multi-reference 14	1	1	0	1	I14
Multi-reference 15	1	1	1	0	I15
Multi-reference 16	1	1	1	1	I16

3. **Connection**

I1 to I16: One decimal floating-point number

I17: AI, pulse, PID, preset frequency, or floating point connector

I18 to I21: 0, 1, DI input value, or bit connector input value

Output O: Floating point connector or system information

Multi-reference			Output Connector	
Input	I1	FC-00	SetVal1	LD-49
	I2	FC-01	SetVal2	LD-50
	I3	FC-02	SetVal3	LD-51
	I4	FC-03	SetVal4	LD-52
	I5	FC-04	SetVal5	LD-53
	I6	FC-05	SetVal6	LD-54
	I7	FC-06	SetVal7	LD-55
	I8	FC-07	SetVal8	LD-56
	I9	FC-08	SetVal9	LD-57
	I10	FC-09	SetVal10	LD-58
	I11	FC-10	SetVal11	LD-59
	I12	FC-11	SetVal12	LD-60
	I13	FC-12	SetVal13	LD-61
	I14	FC-13	SetVal14	LD-62
	I15	FC-14	SetVal15	LD-63
	I16	FC-15	SetVal16	LD-64
	I17	FC-51	-	-
	I18	FC-55	-	-
	I19	FC-56	-	-
	I20	FC-57	-	-
	I21	FC-58	CurSel	FC-52/U2-05
Output	O	LD-48/FC-53/U2-06	-	-

2.7 Brake Control

Before the drive runs, the mechanical brake is used to block the motor and the driven device in the zero speed state.

The brake control logic conditions can be set through parameters in group A7. You can determine whether to enable brake control and whether feedback detection is enabled for brake through A7-00. When brake control is enabled, set relevant parameters based on the actual working conditions of equipment and load for effective control by the brake logic to achieve operation safety.

- If A7-00 is set to 2, the brake with feedback is selected and the system detects the brake feedback status set by A7-03. If the brake release feedback signal is not obtained within the time set by A7-04, a fault is reported, indicating that brake release fails.
- If A7-00 is set to 1, the brake is controlled by the time reference and the actual status is not detected.

A7-17, A7-18, and A7-19 can be used to set the brake release conditions. For example, you can set the brake to be released only when the output torque is greater than a specified value. This ensures that the gravity load does not slip at the moment of brake release. In particular, the system speed loop does not act and no torque is output before the brake release. Therefore, after setting the brake release conditions, set the starting torque through A7-06 to meet the brake release conditions.

2.7.1 Typical Brake Configuration

When using the brake, you can refer to the following typical configurations. The default values of parameters in group A7 are not listed in the following table.

1. Simple brake configuration

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information

2. The brake has no feedback and only has the start torque to avoid shorting stator during brake release.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-06	Start torque source in the vector control mode	2: Digital setting of start speed
A7-07	Digital setting of start torque	Set the parameter according to the estimated load weight.

3. The brake has no feedback and only has the start torque to avoid shorting stator during brake release.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.

Parameter Code	Parameter Name	Value Range
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-09	Start speed source	1: Digital setting of start speed
A7-10	Digital setting of start speed	Set the parameter according to the estimated load weight.

4. The brake has no feedback. The retentive torque is used as the start torque.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-06	Start torque source in the vector control mode	1: Retentive torque
A7-07	Digital setting of start torque	Use the torque set by A7-7 as the retentive torque when the motor is started for the first time. You can set the parameter according to the estimated load weight.
A7-08	Retentive start torque gain coefficient	Set it to 100% in normal scenarios. To adjust the proportion of the retentive torque, set this parameter.
A7-16	Brake release command source	This parameter specifies an external brake control condition. When it is set to 0, the brake cannot be released. When the brake is released, setting A7-16 to 0 will not close the brake.
A7-17	Comparison value source for brake release	This parameter specifies an additional condition for determining brake release. If A7-17 is set to 0, the condition is invalid. After A7-17 is set to a connector, the brake release condition is met, and the connector value is greater than the value of A7-18 for a duration set by A7-19, the brake will be released.
A7-18	Comparison threshold for brake release	
A7-19	Brake release delay	

5. The brake can be released only when the brake has feedback and the output torque is higher than 35% of the rated torque.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	2: With brake and detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-03	Brake feedback source	4: DI3. When the brake feedback source is set to DI3, the value 1 indicates brake release and 0 indicates brake close.
A7-06	Start torque source in the vector control mode	2: A7-07
A7-07	Digital setting of start torque	40% (the value must be greater than 35%)
A7-17	Comparison value source for brake release	LC-12 (output torque)

Parameter Code	Parameter Name	Value Range
A7-18	Comparison threshold for brake release	35%
A7-19	Brake release delay	0.2s (You can decrease this value to avoid fluctuation of measured value and to accelerate brake release.)

Note

If the brake release comparison condition is not set, the brake can be released after the set start torque is reached. However, the actual torque may be deviated.

6. Typical settings and problem handling

Brake release time setting:

- Short brake release time will cause severe brake wear, and overshooting may occur during brake release.
- Long brake release time will cause slow command response and shorting stator during the brake release.
- Set a short brake duration. Observe the output torque using an oscilloscope. When the torque drops significantly, the time when the brake release command is received to the time when the torque drops is the actual brake release time.

Brake close time setting:

- If the brake close time is too short, the torque will be canceled when the brake is not fully applied, causing the heavy load to slip.
- If the brake close time is too long, which may result in unstable control when the device runs at zero speed in the SVC speed.
- Set the brake close time to the brake release time. When the shorting stator braking mode occurs upon brake close, slowly increase the brake close time.

When the load slips upon brake release, do as follows:

- Increase the value of the speed loop gain by increasing the value of F2-00 and decreasing the value of F2-01 properly.
- Set A7-09 to 2 to set the brake start speed direction the same as the motor running direction, and set the brake start frequency through A7-10.
- Set the brake start torque through A7-06, A7-07, and A7-08, and adjust the brake start torque properly [Note 1].

Caution

- [Note 1]: The fixed brake starting torque is not suitable for machines with counterweight. Load changes may reverse the brake release speed.
- The brake feedback source is set to parameter interconnection, which can be any DI or bit connector.
- If the brake feedback source is the DI, check that the DI command from the feedback point source will not cause the AC drive to run or get faulty and ensure that the brake function is normal.

2.7.2 Time Sequence Diagram

- Vector control

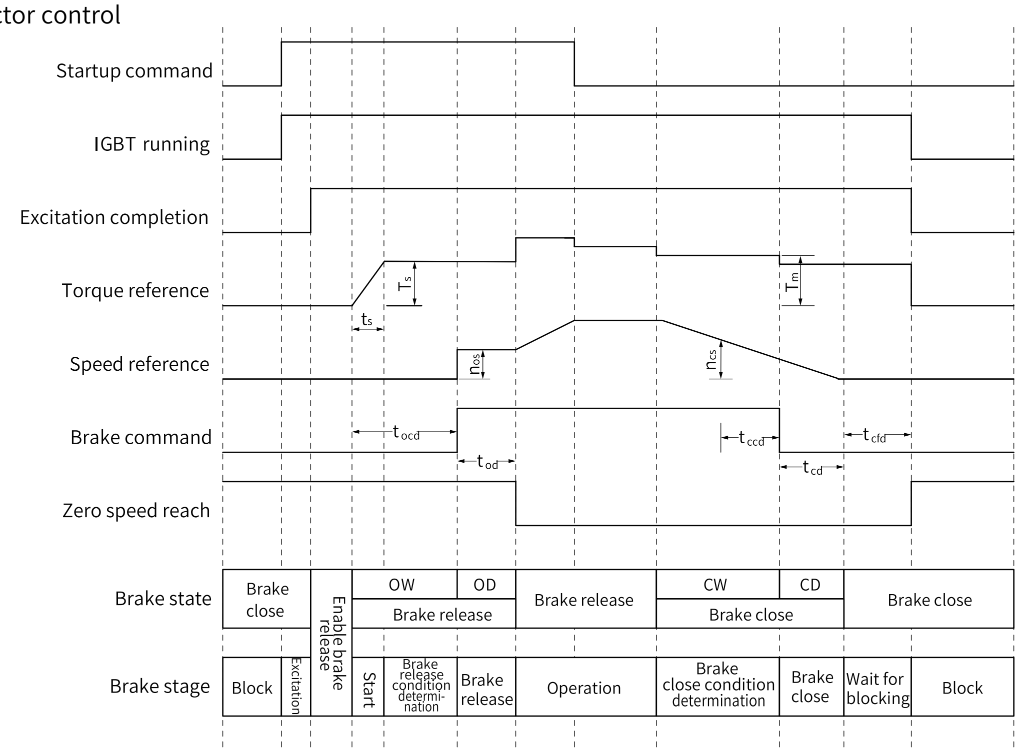


Figure 2-9 Brake time sequence

Abbreviation	Description	Abbreviation	Description
T_s	Starting torque upon brake release	T_m	Retentive torque upon brake close
n_{os}	Starting speed upon brake release	n_s	Speed threshold upon brake close
t_s	Acceleration time for brake starting torque	t_{ocd}	Comparison delay upon brake release
t_{od}	Brake release time	t_{ccd}	Brake close delay time
t_{cd}	Brake close time	t_{cfd}	Brake feedback fault delay time
OW	Brake release waiting time	OD	Brake release delay time
CW	Brake close waiting time	CD	Brake close delay time

- V/f control

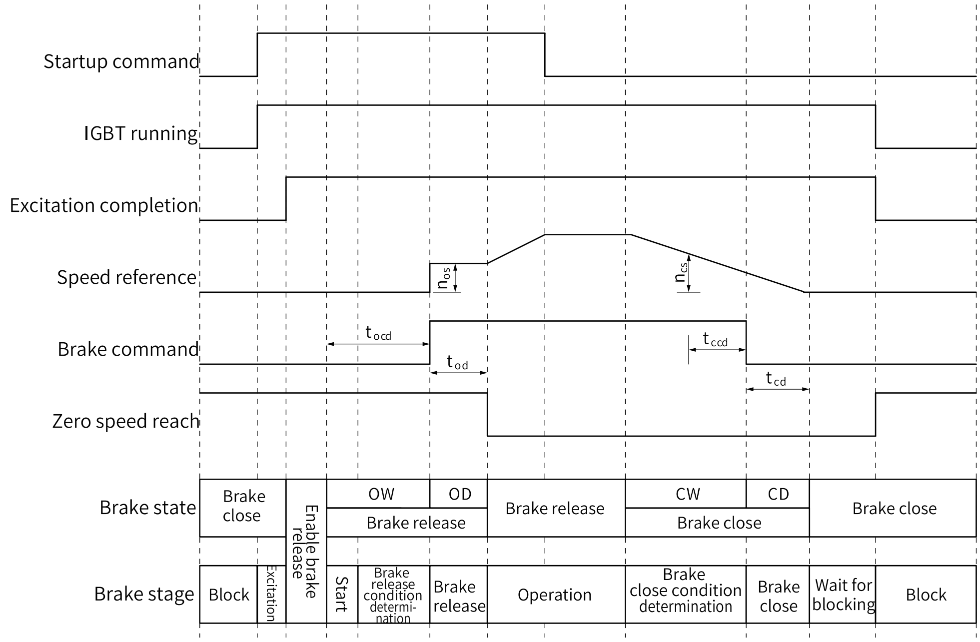


Figure 2-10 Brake time sequence

Abbreviation	Description	Abbreviation	Description
n_{os}	Starting speed upon brake release	n_{cs}	Speed threshold upon brake close
t_{ocd}	Comparison delay upon brake release	t_{od}	Brake release time
t_{ccd}	Brake close delay time	t_{cd}	Brake close time
OW	Brake release waiting time	OD	Brake release delay time
CW	Brake close waiting time	CD	Brake close delay time

2.7.3 Overview of Brake Stages

All brake actions can be performed only after the operating command is received and the motor is prepared. For asynchronous motors, brake starts after motor pre-excitation. For synchronous motors, brake starts after the motor magnetic pole angle is obtained.

In case of a fault or an emergency stop command, a brake that is being released immediately enters the closed stage and the brake close command is output.

Brake release and close are generally triggered by operating commands.

In case of OFF2 emergency stop, coast to stop, or that A7-11 is set to 1 at any time, the brake module immediately outputs the close signal (L4-76 = 0).

Parameter Code	Parameter Name	Description
A7-11	Forced brake close command source	0: Inactive 1: Immediately output brake close signal (L4-76 = 0)

Note

The brake force command is to forcibly close the brake. In this case, the device does not exit the running state and may output torque.

This function is generally used for brake force test. You can use the forced brake close command to test whether the brake mechanism meets the brake force requirements during high-speed operation.

It is recommended to use a customized fault when emergency stop is configured. In the emergency stop state, the brake module immediately outputs a close signal by reporting the fault and outputting the OFF2 emergency stop command. At the same time, the AC drive enters the stop state.

Brake release permission

The brake can proceed with the next stage only after the brake release permission command (A7-16) is activated. Brake release permission is enabled by default.

Brake release preparation stage

Brake release preparation stages include start torque establishment, brake release condition determination, and brake release.

1. Start torque establishment:
   This function is only valid in the vector control mode. To prevent shorting stator braking mode (for PMSM) upon brake release due to gravity load, sufficient torque is output based on the setting of A7-06. If A7-06 is set to 0, no torque is output before brake release.

2. Brake release condition determination:
   After the start torque is established, you can set A7-17 to A7-19 to add additional start conditions. By default, there is no additional condition. After the start torque is established, the brake release acts.

3. Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient)
   The start torque retentive value is the output torque upon previous braking.

   Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient)

   The start torque retentive value is the output torque upon previous braking.

   Set the start speed source.

   0: The start speed is disabled.

   1: The start speed is enabled. When the start speed is set to a positive value, the start speed direction is forward (positive frequency). When the start speed is set to a negative value, the start speed direction is reverse (negative frequency).

   2: The start speed is enabled. The absolute value of the start speed is that of A7-10 (digital setting of start speed). When the value of A7-10 (digital setting of start speed) is positive, the start speed direction is the same as the final operating direction of the motor. When the value of A7-10 (digital setting of start speed) is negative, the start speed direction is opposite to the final operating direction of the motor.

   Brake release:

   The brake release signal (L4-76 = 1) is output in this stage. In addition, the ramp function generator (RFG) is enabled. If A7-09 is valid, the RFG starts to accelerate from the speed indicated by A7-10. If A7-09 is invalid, the RFG starts to accelerate from 0.

Parameter Code	Parameter Name	Description
A7-06	Start torque source in vector control mode	This parameter is used to set the start torque source in the vector control mode. 0: The start torque is disabled. 1: The start torque is enabled. The start torque is equal to the retentive torque (LC-69) multiplied by the retentive gain factor (A7-08). If no torque value is recorded, the function of option 1 equals that of option 2. 2: The start torque is enabled. The start torque value is determined by A7-07 (Digital setting of start torque).
A7-07	Digital setting of start torque	When A7-06 (Start torque source in vector control mode) is set to 2, the start torque is the value of A7-07.
A7-08	Retentive start torque gain coefficient	Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient) The start torque retentive value is the output torque upon previous braking.
A7-09	Start speed source	This parameter is used to set the start speed source. 0: The start speed is disabled. 1: The start speed is enabled. When the start speed is set to a positive value, the start speed direction is forward (positive frequency). When the start speed is set to a negative value, the start speed direction is reverse (negative frequency). 2: The start speed is enabled. The absolute value of the start speed is that of A7-10 (digital setting of start speed). When the value of A7-10 (digital setting of start speed) is positive, the start speed direction is the same as the final operating direction of the motor. When the value of A7-10 (digital setting of start speed) is negative, the start speed direction is opposite to the final operating direction of the motor.
A7-10	Digital setting of start speed	The starting speed value is the speed value corresponding to current per-unit parameter.
A7-16	Brake release permission source	0: Inactive 1: Valid 2: Disable 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7 10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector

Parameter Code	Parameter Name	Description
A7-17	Comparison value source for brake release	If the value of A7-17 is higher than the value of A7-18 for the time longer than the value set by A7-19, the brake release applies.
A7-18	Comparison threshold for brake release	This parameter sets the comparison threshold for brake release.
A7-19	Brake release delay	This parameter sets the brake release delay time.

Note

Different values of A7-20 and A7-21 indicate different start torque during forward and reverse rotation, which meets different application requirements.

Brake release action stage

Brake release includes the brake detection stage and brake release completion stage.

- Brake detection stage: When receiving the brake release command, the device maintains the RFG output and waits for the completion of brake release.
  - If A7-00 is set to 1, the device waits for the duration set by A7-01 and exits this stage after the duration expires.
  - When A7-00 is set to 2 and the duration set by A7-01 expires, the feedback point of A7-03 is detected. If the feedback point is detected as low level, the device exits the state. If the feedback point detected keeps as high level for the duration longer that the value of A7-04, a fault will be triggered and the brake cannot be released.
- Brake release completion state: The RFG is enabled and the RFG output speed is allowed to increase based on the time reference. The brake output state remains unchanged unless the stop or brake closing command is received. If A7-00 is set to 2, whether the feedback point of A7-03 is at a low level will be always detected.

Brake close preparation stage

When the brake close command is received, the brake output is not immediately closed but enters the closing preparation stage.

- Brake close determination conditions: When the actual speed keeps lower than the value of A7-12 for the duration longer than the value of A7-13, or the ramp output speed keeps lower than the value of A7-14 for the duration longer than the value of A7-15 (0 indicates invalid condition), the brake closing conditions are met, and the retentive torque and brake output closing stage starts.

- Retentive torque: When A7-06 is set to 1, the torque before brake closing is memorized as the torque output for the next startup.
- Brake close: After the stage starts, the brake close signal (L4-76 = 0) is output and then the brake close action stage starts.

Brake close action stage

Brake close includes the brake close detection stage and brake close completion stage.

- Brake close detection stage: After the brake close command is received, the device waits for the completion of brake release. Before the brake is closed, the device keeps the current output to prevent the shorting stator braking mode.
  - If A7-00 is set to 1, the device waits for the duration set by A7-02 and exits this stage after the duration expires.
  - When A7-00 is set to 2 and the duration set by A7-02 expires, the feedback point of A7-03 is detected. If the feedback point is detected as high level, the device exits the state. If the feedback point detected keeps as low level for the duration longer than the value of A7-04, a fault will be triggered and the brake cannot be closed.
- Brake close completion: When the brake close is completed, the ramp output speed is forced to 0. The brake output remains at the closed state unless the operation or brake release command is received.

Blocking waiting stage

The blocking waiting stage starts from the time when the brake close command takes effect to the time when the motor speed reaches zero.

When the motor feedback speed keeps lower than the zero speed set by AA-14 for the time set by AA-15, the system determines that the motor reaches zero speed and the PWM output is blocked.

2.7.4 Common Function Descriptions

Start torque and start speed selection

The start torque is valid only in the vector control mode. Generally, different configurations can be selected based on the control mode, as shown below.

Control Mode	Start torque	Start Speed
FVC	Supported	Not supported
SVC	Supported	Supported and configurable
V/f	Supported	Not supported

For details on start torque automatic memory, see the section of "Automatic memory of start torque". Functions of parameters for start torque are the same as those for start torque, expect that start torque and start speed are used in different brake stages. Enable the start torque first and then the start speed. Assume that when the drive outputs a positive speed, the motor rotates in the forward direction. When the drive outputs a negative speed, the motor rotates in the reverse direction. The details are as follows:

- Digital setting: The motor start direction can only be set through related parameters and cannot be set through the forward/reverse rotation commands. If the digital setting value is positive, the motor rotates in the forward direction. If the digital setting value is negative, the motor rotates in the reverse direction.
- Determined by digital setting and motor running direction: When the digital setting value is positive, the motor rotation direction (start torque/speed phase) is consistent with the target speed direction. When the digital setting value is negative, the motor rotation direction (start torque/speed phase) is opposite to the target speed direction. When the target speed is 0, the final stable running direction is determined by the running direction of the last non-zero speed. The speed direction of the first operation upon power-on is positive by default. For details, refer to the following table.

Digital Setting Value	Target Speed (Final Stable Running Direction)	Motor Running Direction (Start Torque/Speed Phase)
Positive	Positive	Forward
Positive	Negative	Reverse
Negative	Positive	Reverse
Negative	Negative	Forward run

Automatic memory of start torque

When A7-06 is set to 1, the internal torque memory function of the AC drive is activated. Upon each stop, the torque before brake closing is recorded and will be used as the start torque output upon the next startup. This reduces load drop during brake release. The automatic torque memory function can well adapt to load changes during operation.

When the function is used, a torque fault may occur during the stop process due to external brake faults.

When the automatic memory of start torque function is activated for the first time, the initial value of the torque is the value of A7-07.

The A7-08 parameter can be set to adjust the coefficient for automatic torque memory. If A7-08 is set to 80% and the retentive torque during the stop process is 50%, the start torque will be 40%.

Excitation disabling delay

To improve the working efficiency of asynchronous motors, users may want to keep continuous output of motor exciting current for a period even if the brake is closed during the stop process. In this way, when users start motors again within a short period, the brake can directly run without need of motor excitation (excitation time for some motors may take 3s to 5s).

When the motor feedback speed keeps lower than the zero speed set by AA-14 for the time set by AA-15, the motor reaches zero speed, and PWM output is blocked. Therefore, if the value of AA-15 increases, excitation can last longer after the motor reaches the zero speed, eliminating the need for excitation upon next brake release.

In addition, if the brake close action time set by A7-02 is increased, the brake module can force the brake to output current, keeping excitation for a period after stop.

Parameter Code	Parameter Name	Description
AA-14	Zero-speed threshold	This parameter defines the threshold for motor zero speed during deceleration to stop. An excessively low setpoint may cause the motor stop failure when the motor speed is near zero but exceeds this threshold. An excessively high setpoint may cause the motor to rotate when the drive output has been blocked. Set this parameter based on the actual stop performance. 100.0% corresponds to rated motor frequency.
AA-15	Zero speed determination time	The drive blocks output when the motor actual speed keeps lower than the zero speed threshold during deceleration to stop after the period defined by this parameter elapses.

Start torque restriction

In some lifting load scenarios, the brake can be released only when the load torque is greater than the threshold for security reasons. The speed loop does not act before the brake release. Therefore, the torque cannot be output even if the speed is specified. In this case, set A7-06 for the start torque. The torque can be measured by using two methods:

1. Use the comparison function of A7-17 for AC drive detection. Set A7-06 to a start torque value higher than the threshold, set A7-17 to the output torque indicated by LC-12, set A7-18 to the comparison threshold, and set A7-19 to the delay time. When the absolute value of A7-17 keeps greater than the value of A7-18 for the time longer that the value of A7-19, the AC drive enters the brake release state.
2. The torque is detected on the PLC. After the conditions are met, the PLC transmits a status bit to the AC drive through communication. Set A7-06 to a start torque value higher than the threshold, and then set A7-16 to the received PLC status bit. After the operating command is received, the AC drive does not enter the brake release state until the bit is set to 1. When the brake is released, setting A7-16 to 0 will not close the brake.

Note

When torque detection is not configured, the system enters the next stage when the set starting torque reaches the target value. In this case, the actual output torque may be slightly deviated.

2.7.5 Related Parameters

Parameter Code	Parameter Name	Value Range	Description
A7-00	Brake function selection	0: Disable brake 1: Enable brake without detection information 2: Enable brake with detection information	This parameter is used to set the brake function. 0: Disable brake 1: Enable brake without detection information 2: Enable brake with detection information
A7-01	Brake release time	0.00s to 30.00s	This parameter specifies the duration from brake close to brake release, that is, the action time of the brake mechanism. As the brake mechanism ages, the action time increases. In this case, adjust this parameter according to the actual mechanism response speed.

Parameter Code	Parameter Name	Value Range	Description
A7-02	Brake close time	0.00s to 30.00s	This parameter specifies the duration from brake release to brake close, that is, the action time of the brake mechanism. As the brake mechanism ages, the action time increases. In this case, adjust this parameter according to the actual mechanism response speed.
A7-03	Brake feedback source	0: Invalid 1: Valid 2: Invalid 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7 10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector	When there is brake feedback, you need to set the brake feedback source, which can be the DI or bit connector.
A7-04	Brake feedback fault delay time	0.00s to 30.00s	After the brake acts and the AC drive does not receive feedback within the time set by this parameter, the AC drive considers that the brake mechanism is abnormal and reports a brake fault.
A7-05	Start torque direction	0: Digital setting 1: Determined by digital setting and motor operating direction	This parameter is used to set the start torque direction. 0: The start torque is determined by the value of A7-07 (digital setting of start torque). A positive value indicates positive torque and a negative value indicates negative torque. 1: The absolute value of the start torque is that of A7-07 (digital setting of start torque). When the value of A7-07 is positive, the start torque direction is consistent with the final operating direction of the motor. When the value of A7-07 is negative, the start torque direction is opposite to the final operating direction of the motor.

Parameter Code	Parameter Name	Value Range	Description
A7-06	Start torque source in the vector control mode	0: Disable 1: Retentive torque 2: Digital setting Others: F connector	This parameter is used to set the start torque source in the vector control mode. 0: The start torque is disabled. 1: The start torque is enabled. The start torque is equal to the retentive torque (LC-69) multiplied by the retentive gain factor (A7-08). If no torque value is recorded, the function of option 1 equals to that of option 2. 2: The start torque is enabled. The start torque value is determined by A7-07 (Digital setting of start torque).
A7-07	Digital setting of start torque	-200.0% to 200.0%	When A7-06 (Start torque source in the vector control mode) is set to 2, the start torque is the value of A7-07.
A7-08	Retentive start torque gain coefficient	0.0% to 300.0%	Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient) The start torque retentive value is the output torque upon previous braking.
A7-09	Start speed source	0: Disable 1: Digital setting of start speed 2: Determined by digital setting of start speed and motor operating direction	This parameter is used to set the start speed source. 0: Disable 1: The start speed is enabled. When the start speed is set to a positive value, the start speed direction is forward (positive frequency). When the start speed is set to a negative value, the start speed direction is reverse (negative frequency). 2: The start speed is enabled. The absolute value of the start speed is that of A7-10 (digital setting of start speed). When the value of A7-10 (digital setting of start speed) is positive, the start speed direction is the same as the final operating direction of the motor. When the value of A7-10 (digital setting of start speed) is negative, the start speed direction is opposite to the final operating direction of the motor.
A7-10	Digital setting of start speed	-30.0% to 30.0%	The start speed is the speed corresponding to the current per-unit value parameter.

Parameter Code	Parameter Name	Value Range	Description
A7-11	Forced brake close command source	0: Invalid 1: Valid 2: Invalid 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7 10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector	This parameter is used to set the forced brake close command source to force brake close. The brake closes forcibly when a forced brake command is sent in any stage. 0: Disable forced brake close 1: Enable forced brake close 2: Disable forced brake close 3 to 18: The DI is used to set whether to enable forced brake close. If the terminal is active, the forced brake command takes effect. Otherwise, the forced brake command is invalid. Others: The parameter connected to B connector is used to set whether to enable forced brake close.
A7-12	Actual speed monitoring threshold for brake close	0.0% to 100.0%	When the feedback speed reaches the value of A7-12 (Actual speed monitoring threshold for brake close) for the duration set by A7-13 (Actual speed monitoring time for brake close), the brake close starts.
A7-13	Actual speed monitoring time for brake close	0.00s to 300.00s	
A7-14	Set speed monitoring threshold for brake close	0.0% to 100.0%	When the set speed reaches the value of A7-14 (Set speed monitoring threshold for brake close) for the duration of A7-13+A7-15, the brake close starts.
A7-15	Set speed monitoring time for brake close	0.00s to 60.00s	

Parameter Code	Parameter Name	Value Range	Description
A7-16	Brake release permission source	0: Invalid 1: Valid 2: Invalid 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7 10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector	This parameter is used to set the source for brake release permission commands.
A7-17	Comparison value source for brake release	0: Disable 1: AI1 2: AI2 3: AI3 4: HDI 5: Aim 6: Multi-reference output 7: Motorized potentiometer output 8: PID Others: F connector	If the value of A7-17 is higher than the value of A7-18 for the time longer than the value set by A7-19, the brake release applies.
A7-18	Comparison threshold for brake release	0.0% to 300.0%	This parameter sets the comparison threshold for the brake release delay time.
A7-19	Brake release delay	0.00s to 30.00s	This parameter defines the brake release delay time.

3 Troubleshooting

3.1 Common Faults and Diagnosis

3.1.1 Alarm and Fault Display

Upon exceptions, the AC drive stops output immediately, the fault indicator blinks, and the contact of the fault relay acts. The operating panel of the AC drive displays a fault code (example: E002.1), as shown in the following figure.

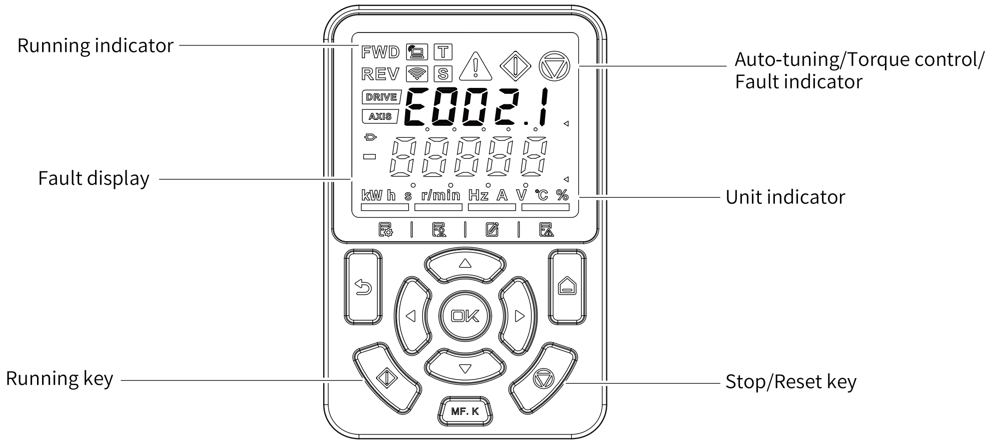


Figure 3-1 Display of faults

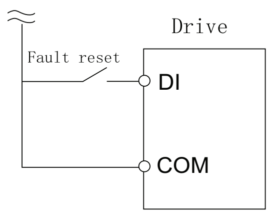
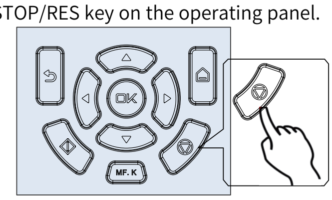
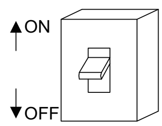
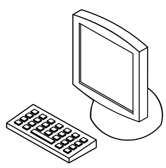
Caution

Do not repair or modify the AC drive by yourself. In case of any fault that cannot be rectified, contact the agent or Inovance for technical support.

3.1.2 Restart After Fault Occurrence

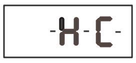
View the current fault code, fault subcode, fault information, minor fault code, minor fault subcode, minor fault information, warning code, warning subcode, warning information through the operating panel.

Table 3–1 Fault view and start method after fault occurrence

Stage	Solution	Description
Upon fault	Fault record 1: View the current fault code, fault subcode, fault information, minor fault code, minor fault subcode, minor fault information, warning code, warning subcode, warning information through the operating panel.	View the record through H0-00 to H0-53.
	Fault record 2: View the frequency, current, bus voltage, input terminal status, output terminal status, AC drive status, power-on time, running time, status word A, status word B, and command word of the last three faults through the operating panel.	View the record through F9-14 and F9-44.
	Fault record 3: View the fault code, fault subcode, fault information, frequency, current, bus voltage, input terminal status, output terminal status, AC drive status, power-on time, running time, status word A, status word B, and command word of the last six faults through the operating panel.	View the record through parameters in groups H3 to H8.
Before fault reset	Before fault reset, find the fault cause and remove the fault according to the fault type displayed on the operating panel.	-
Reset mode to clear faults	1. Allocate function 9 (fault reset) to the DI by setting any of F4-00 to F4-09 to 9.	
	2. Check that F7-02 is set to 1 (default value), indicating that the STOP/RES key is available in any operating mode.	Press the STOP/RES key on the operating panel. 
	3. Power off and then power on the AC drive for automatic reset. Disconnect the main circuit power supply. Wait until the fault code disappears, and then connect the power supply again.	
	4. Reset the drive through communication. When F0-02 (Command source) is set to 2 (Communication control), write "7" (Fault reset) to communication address 2000H using the host controller to reset the AC drive after the fault is cleared.	

3.1.3 Common Troubleshooting

Table 3–2 Common faults and solutions

No.	Symptom	Possible Cause	Solution
1	There is no display upon power-on. 	The drive is not connected to the grid or the grid voltage is too low.	Check the power supply.
		The switched-mode power supply (SMPS) on the driver board of the AC drive is faulty.	Check whether the 24 V output voltage and 10 V output voltage on the control board are normal.
		The control board is disconnected from the driver board and operating panel.	Disconnect the main circuit from the power supply, and then re-connect the 8-pin and 40-pin flat cables.
		The pre-charge resistor of the AC drive is damaged.	Contact the agent or Inovance for technical support.
		The control board or the operating panel is faulty.	
		The rectifier bridge is damaged.	
2	"-H-C" is displayed after power-on. 	The cable connecting the driver board and the control board is in poor contact.	Re-connect the 8-pin and 28-pin flat cables.
		Related components on the control board are damaged.	Contact the agent or Inovance for technical support.
		The motor or the motor cable is short circuited to the ground.	
		The Hall sensor is faulty.	
		The mains voltage is too low.	
3	"E023.1" is displayed upon power-on. 	The motor or the motor cable is short circuited to ground.	Check the insulation status of the motor and the output cable with a megger.
		The AC drive is damaged.	Contact the agent or Inovance for technical support.
4	The display is normal upon power-on. However, after the drive starts to run, "-H-C-" is displayed and the drive stops immediately. 	The fan is damaged or does not rotate.	Replace the fan.
		The cable of the external control terminal is short circuited.	Eliminate external short circuit.
5	E014.1 (module overtemperature) is reported frequently.	The carrier frequency is set too high.	Reduce the carrier frequency (F0-15).
		The cooling fan is damaged, or the air duct is blocked.	Replace the cooling fan or clean the air duct.
		Devices (thermistor or other devices) inside the AC drive are damaged.	Contact the agent or Inovance for technical support.

No.	Symptom	Possible Cause	Solution
6	The motor does not rotate when the AC drive is running.	The wiring between the AC drive and the motor is abnormal.	Check that the wiring between the AC drive and the motor is correct.
		Motor parameters of the AC drive are set incorrectly.	Restore parameters to default settings and reset related parameters.
			Ensure encoder parameters and motor rated parameters are set properly, such as rated frequency and rated speed of the motor.
			Check that F0-01 (control mode) and F0-02 (operation mode) are set properly.
			Modify F3-01 (Torque boost) in the V/f control mode during start with heavy load.
		The cable connecting the driver board and the control board is in poor contact.	Re-connect the cable to ensure it is connected securely.
		The driver board is faulty.	Contact the agent or Inovance for technical support.
7	DI inactive	The related parameters are set incorrectly.	Check and set the parameters in group F4 again.
		The external signal is incorrect.	Re-connect the external signal cable.
		The jumper between OP and +24V becomes loose.	Secure the jumper between OP and +24V.
		The control board is faulty.	Contact the agent or Inovance for technical support.
8	The motor speed cannot be increased in the FVC mode.	The encoder is faulty.	Replace the encoder disk and double check the cable connection.
		The encoder cable is connected improperly or in poor contact.	Reconnect the encoder to ensure good contact.
		The PG card is faulty.	Replace the PG card.
		The driver board is faulty.	Contact the agent or Inovance for technical support.
9	Frequent overcurrent and overvoltage faults	Motor parameters are set incorrectly.	Set the motor parameters again or perform motor parameter auto-tuning.
		The acceleration/deceleration time is improper.	Set proper acceleration/deceleration time.
		The load fluctuates.	Contact the agent or Inovance for technical support.
10	"E017.1" is detected upon power-on or running.	The soft startup contactor is not closed.	Check whether the contactor cable is loose.
			Check whether the contactor is faulty.
			Check whether 24 V power supply of the contactor is faulty.
			Contact the agent or Inovance for technical support.
11	The motor coasts to stop or the brake fails during deceleration or decelerating-to-stop.	The encoder is disconnected, or overvoltage stall suppression protection is enabled.	If the AC drive is in the FVC mode (F0-01 = 1), check the encoder cable connection.
			If a braking resistor is configured, disable the overvoltage stall suppression protection function by setting F3-23 to 0.

3.1.4 Troubleshooting During Trial Run in Different Control Modes

- SVC mode (F0-01= 0; default: 0)
  In this mode, the drive controls the motor speed and torque in a scenario without an encoder for speed feedback. Auto-tuning on motor parameters is required to obtain the motor parameters.

Table 3–3 Troubleshooting in SVC mode

Problem	Solution
Overload or overcurrent during motor start	Set motor parameters F1-01 to F1-05 according to the motor nameplate. Perform auto-tuning (F1-37) on motor parameters. If possible, select dynamic complete auto-tuning.
Slow torque/speed response and motor oscillation occur at a frequency below 5 Hz.	Increase the value of F2-00 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-01 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-00 and increase the value of F2-01.
Slow torque/speed response and motor oscillation occur at a frequency above 5 Hz.	Increase the value of F2-03 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-04 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-03 and increase the value of F2-04.
Low speed accuracy	If the speed deviation is too large when the motor runs with load, increase the value of F2-06 (Vector control slip compensation gain) by the step value of 10%.
Obvious speed fluctuation	Increase the value of A9-05 (Speed filter time) by the step value of 0.001s when motor speed fluctuates abnormally.
Loud motor noise	Increase the value of F0-15 (Carrier frequency) by the step value of 1.0 kHz. Note that increasing the carrier frequency will lead to an increase in the motor leakage current.
Insufficient motor torque or force	Check whether the torque upper limit is too low. If yes, increase the value of F2-10 (Torque upper limit in speed control mode) in the speed control mode or the value of the torque reference in the torque control mode.

- FVC mode (F0-01 = 1)
  This mode is applicable to scenarios with an encoder for speed feedback. In this mode, you need to set the encoder pulses per revolution, encoder type, and encoder direction correctly and perform auto-tuning on motor parameters.

Table 3–4 Troubleshooting in FVC mode

Problem	Solution
Overload or overcurrent fault during start	Set the encoder pulses per revolution, encoder type, and encoder direction correctly.
Overload or overcurrent is detected during motor running.	Set motor parameters F1-01 to F1-05 according to the motor nameplate. Perform auto-tuning (F1-37) on motor parameters. If possible, select dynamic complete auto-tuning.
Slow torque/speed response and motor oscillation occur at a frequency below 5 Hz.	Increase the value of F2-00 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-01 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-00 and F2-01.

Problem	Solution
Slow torque/speed response and motor oscillation occur at a frequency above 5 Hz.	Increase the value of F2-03 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-04 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-03 and F2-04.
Obvious speed fluctuation	Increase the value of F2-07 (Speed filter time) by the step value of 0.001s when motor speed fluctuates abnormally.
Loud motor noise	Increase the value of F0-15 (Carrier frequency) by the step value of 1.0 kHz. Note that increasing the carrier frequency will lead to an increase in the motor leakage current.
Insufficient motor torque or force	Check whether the torque upper limit is too low. If yes, increase the value of F2-10 (Torque upper limit in speed control mode) in the speed control mode or the value of the torque reference in the torque control mode.

- V/f control mode (F0-01 = 2)
  This mode applies to applications without an encoder for speed feedback. You only need to set the rated motor voltage and rated motor frequency correctly.

Table 3–5 Troubleshooting in V/f control mode

Problem	Solution
Motor oscillation during operation	Decrease the value of F3-11 (Oscillation suppression gain in V/f mode) by the step value of 5. The minimum value is 5.
Overcurrent at startup with high power	Decrease the value of F3-01 (Torque boost) by the step value of 0.5%.
Excessively high current during operation	Set F1-02 (Rated motor voltage) and F1-04 (Rated motor frequency) correctly. Decrease the value of F3-01 (Torque boost) by the step value of 0.5%.
Loud motor noise	Increase the value of F0-15 (Carrier frequency) by the step value of 1.0 kHz. Note that increasing the carrier frequency will lead to an increase in the motor leakage current.
Overvoltage during deceleration or when heavy load is suddenly removed	Set F3-23 Overvoltage stall suppression) to 1 (Enable). Increase the value of F3-24/F3-25 (Frequency gain/Voltage gain for overvoltage stall suppression, 30 by default) by the step value of 10 gradually. The permissible maximum value is 100. Decrease the value of F3-22 (Overvoltage stall suppression action voltage, default: 770 V) by the step value of 10 V. The permissible minimum value is 700 V.
Overcurrent during acceleration or when heavy load is suddenly added	Increase the value of F3-20 (Overcurrent stall suppression gain, default: 20) by the step value of 10. The permissible maximum value is 100. Decrease the value of F3-18 (Overcurrent stall suppression action current, default: 150%) by the step value of 10%. The permissible minimum value is 50%.

3.2 List of Faults and Alarms

For complete information on fault and alarm codes, see *MD520 Series General-Purpose AC Drive Parameter Guide.*

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www.inovance.com

Add.: Inovance Headquarters Tower, High-tech Industrial Park,
Guanlan Street, Longhua New District,
Shenzhen 518000, P.R. China

Tel: (0755) 2979 9595 Fax: (0755) 2961 9897

Suzhou Inovance Technology Co., Ltd.

www.inovance.com

Add.: No.52, Tian'e Dang Road, Wuzhong District,
Suzhou 215104, P.R. China

Tel: (0512) 6637 6666 Fax: (0512) 6285 6720