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MD880 (LC)-40 Series Active Rectifier

Function Guide

Industrial Automation | New Energy Vehicle | Intelligent Elevator | Intelligent Robot | Digital Energy | Rail Transit

Data code 19012509A03

Legal Information

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Due to continuous updates and improvements of products and technologies, the content of this documentation may not fully match the actual products. In the event of any discrepancies, the actual products shall prevail.

The contents are subject to change without notice due to product upgrade.

Waste Disposal

Storage, use, and disposal of this product (including optional accessories) must comply with local laws and regulations.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel can identify the risks of the product/system and prevent possible dangers.

Proper Use of the Product

Proper transportation, storage, assembly, installation, commissioning, operation, and maintenance are required to ensure the safe operation of the product without any problems. The required ambient conditions must be met. All operations must follow the guidelines provided in this documentation.

Preface

Introduction

This product targets at high-end transmission applications and features high-performance speed and torque control, high reliability, flexible system integration, easy commissioning and maintenance, and high power density. The MD880 series products are divided into two topological structures, namely single-drive system and multi-drive system, which can be air-cooled and water-cooled. The product is applicable to a wide range of industries, including metallurgy, oil, paper making, cranes, vessels, shield machines, and test benches.

This guide describes function applications, and troubleshooting of the product. For complete information on parameters and fault codes, see MD880(LC)-40 Series Active Rectifier Parameter Guide.

Note

- The drawings in the user guide are shown for demonstration only, which may not match the product purchased.
- The user guide is subject to change without notice due to product upgrade, specification modifications as well as efforts to improve the accuracy and convenience of the user guide.

More documents

Document	Code	Description
MD880 (LC)-40 Series Active Rectifier Function Guide	19012452	Presents function application and troubleshooting methods of the product.
MD880 (LC)-40 Series Active Rectifier Commissioning Guide	19012453	Presents the commissioning tool, commissioning flowchart, specific commissioning procedure, and parameters of the product.
MD880 (LC)-40 Series Active Rectifier Parameter Guide	19012640	This guide describes parameters and fault codes of the drive.
MD880 Series Variable Frequency Drive Communication Guide	19012451	Presents the specifications, networking, and communication configuration of the product.
MD880LC Series AC Drive (Multi-drive System) Hardware Guide	19012447	Presents the system composition, technical specifications, components, dimensions, options (including installation accessories, cables, and peripheral electrical components), expansion cards, certifications, and standards.
MD880LC Series AC Drive (Multi-drive System) Installation Guide	19012448	Presents preparations before installation, unpacking and transportation, mechanical installation, electrical installation, daily maintenance, and component replacement.
MD880-40 Series Active Rectifier Hardware Guide	19011311	Presents technical specifications, components, dimensions, mechanical installation, electrical installation, routine maintenance, and component replacement.

Revision history

Date	Document version	Software version	Revision
August 2026	A03	Version: B02 Firmware code: 0302AK12 Version tags: A2-08=451.25/A2-09=000.00/A2-10=451.12/A2-11=000.01	**Changed:** • Updated *"11.1.4 Fault Severity Level Change and Automatic Reset" on page 167*. • Updated the safety precautions.
February 2026	A02	Version: B02 Firmware code: 0302AK12 Version tags: A2-08=451.25/A2-09=000.00/A2-10=451.12/A2-11=000.01	**Changed:** • Updated *"3.6.2 System Time" on page 31*. • Updated *"3.7.1 Restoring Parameters to Default" on page 34*. **New:** • Added *" Multi-timer module" on page 130*. • Added *"8.13 General Timer and Counter" on page 138*. • Added *" High/Low Voltage Ride-Through Function" on page 83*. • Added *"8.2.8.1 Carrier Synchronization Communication" on page 99*. • Added legal information, industrial information security, service and support.
February 2025	A01	-	Made minor corrections.
January 2024	A00	-	First release

Access to the guide

This guide is not delivered with the product. You can download the PDF version in the following ways:

- Visit https://www.inovance.com/global, and choose Support > Documentation Download.
- Scan the QR code on the product with your smartphone.
- Scan the QR code below to install the My Inovance app, where you can search for and download the guide.

Warranty disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. Maintenance will be charged after the warranty expires.

Even within the warranty period, maintenance can be charged for the following product damage:

- Damage caused by operations not following the instructions in the guide
- Damage caused by fire, flood, or abnormal voltage

- Damage caused by using the product for unintended functions
- Damage caused by using the product outside the specified scope
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

When applicable, relevant maintenance fee will be charged according to the latest Price List of Inovance. If otherwise agreed upon, the agreed terms and conditions shall prevail.

For details, see the Warranty Card.

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1 Fundamental Safety Instructions

1.1 General Safety Instructions

Safety disclaimer

- This chapter provides essential safety instructions for proper use of the product. Before using this product, read through the guide and comprehend all the safety instructions. Failure to comply with the safety instructions may result in death, severe injury, or equipment damage.
- "DANGER", "WARNING", and "CAUTION" signs in this guide are only supplements to the safety instructions, and do not reflect all safety instructions to be followed.
- Use this product according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
- Inovance shall take no responsibility for any personal injury or property damage caused by improper use.

Safety levels and definitions



Indicates that failure to comply with the notice can result in death or severe personal injury.



Indicates that failure to comply with the notice may result in severe personal injury or death.



Indicates that failure to comply with the notice may result in minor or moderate injury or equipment damage.

Safety precautions

- Drawings in the user guide are sometimes shown without covers or protective guards. Install the covers or protective guards as specified, and then perform operations in accordance with the instructions.
- The drawings in the guide are shown for illustration only and may be different from the product you purchased.
- Operators must take mechanical protection measures to protect their safety. For example, they must wear safety shoes, safety clothing, safety glasses, protective gloves and sleeves, or other protective equipment.

Unpacking



- Do not install the product in the case of any damage, rust, or signs of use on the product or accessories upon unpacking.
- Do not install the product in the case of water seepage into the product or missing or damaged components upon unpacking.
- Do not install the product in the case of any discrepancy between the product you received and the product name on the packing list.



- Check whether the packing is intact and whether there is damage, water seepage, dampness, and deformation before unpacking.
- Unpack the package layer by layer. Do not strike the package violently.
- Check for damage, rust, or dents on the surfaces of the product and accessories upon unpacking.
- After unpacking, check the contents against the packing list to ensure that the equipment and accessories are in the correct quantities, and that all documentation is complete.

Storage and transportation



- Large or heavy equipment must be handled by qualified professionals using specialized hoisting equipment. Failure to comply could result in personal injury or equipment damage.
- Before hoisting the equipment, ensure that components such as the front cover and terminal blocks are secured firmly with screws. Loosely connected components may fall off and result in personal injury or equipment damage.
- Do not stand or stay below the product which is being hoisted.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply could result in personal injury or equipment damage.



- Handle the equipment with care and mind your step during transportation to prevent personal injury or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply could result in personal injury.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply could result in equipment damage.
- Do not store or transport the equipment in locations where the equipment may be exposed to splashing water or rain, direct sunlight, strong electric field, strong magnetic field, or strong vibration.
- Store the equipment for up to three months. Take stricter protective measures and carry out the necessary inspections for a longer storage time.
- Pack the equipment securely and properly before transportation. Use a fully enclosed container for long-distance transportation.
- Do not transport the equipment with other devices or items that may impact or cause harm to the equipment.

Installation
DANGER • Ensure peripheral power distribution requirements are met, and select circuit breakers, fuses, cables, and cable terminals correctly. • Use standard torque for screw fastening, and use appropriate terminal crimping tools for crimping terminals. • Ensure heat dissipation requirements are met and design inlet and outlet airflow duct properly. • Avoid environments with dripping water, conductive foreign objects (such as carbon fiber filaments, conductive metal dust, metal chips), and salt spray. **Failure to follow the above instructions will pose a fire risk.** • This equipment must be operated only by trained and qualified electrical personnel. Operations can be performed by professionals only.
WARNING • Read through the guide and safety instructions before installation. • Do not install this equipment in places with strong electric or magnetic field. • Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply may result in mechanical hazards. • Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock. • When installing the equipment in an enclosed environment (such as a cabinet or case), use cooling devices (such as fans or air conditioners) to cool the space and meet the installation environment requirements. Failure to do so can result in equipment overtemperature or fire accidents. • Do not retrofit the equipment. • Do not fiddle with the bolts used to fix equipment components or the bolts marked in red. • When the equipment is installed in a cabinet or terminal device, appropriate guard devices (guards for fire, electrical, and mechanical protection) meeting applicable IEC standards and local laws and regulations must be provided. • Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction. • Install the equipment onto an incombustible object such as a metal. Keep the equipment away from combustible objects. Failure to comply may result in a fire. **The edges of the equipment metal enclosure are sharp. Note the following precautions during installation to avoid personal injury or cable damage:** • When performing installation, handling, or maintenance operations, always wear cut-resistant gloves. • Avoid direct skin contact with enclosure edges and cut surfaces during operation.
Caution • Cover the top of the product with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the product and causing faults. After installation, remove the cloth or paper on top of the product to prevent over-temperature caused by poor ventilation due to blocked ventilation holes. • Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring

DANGER

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Before wiring, switch off all power supplies of the device. Wait for at least the time designated on the warning label before further operations because residual voltage still exists after power-off. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safe voltage range. Failure to comply can result in electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board and other exposed live parts with power on. Failure to comply can result in electric shock.
- Make sure that the equipment and product are grounded properly. Failure to comply can result in the risk of electric shock.

WARNING

- Do not connect the power cable to output terminals of the equipment or product. Failure to comply may cause equipment damage or even a fire.
- When connecting a drive with the motor, make sure that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used must comply with corresponding cross-sectional area and shielding requirements. The shield of the shielded cable must be grounded at one end properly.
- Tighten the terminal screws with the torque specified in the user guide. Insufficient or excessive torque may cause overheating and damage to the joint, which could result in fire.
- After wiring is done, ensure that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply could result in electric shock or equipment damage.
- Avoid direct skin contact with enclosure edges and cut surfaces during operation.
- Route cables carefully during wiring. Avoid pressing them against sharp edges, which may cause squeezing or cutting. It is recommended to use protective sleeves or route cables away from such edges.
- If the enclosure has a protective film, remove it only after installation is completed and all work involving sharp edges has been finished.

Caution

- During wiring, follow the proper electrostatic discharge (ESD) procedures, and wear an antistatic wrist strap. Failure to comply may result in damage to the equipment or internal circuits.
- Use the shielded twisted pair cable to wire the control circuit, and connect the shield to the grounding terminal of the equipment. Failure to comply may result in equipment malfunction.

Power-on

DANGER

- Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Before power-on, make sure that the power supply meets equipment requirements to prevent equipment damage or even a fire.
- After power-on, do not open the cabinet door or protective cover of the equipment. Do not touch any terminals, or remove any part of the equipment at power-on. Failure to comply will result in an electric shock.

WARNING

- Perform a trial run after wiring and parameter setting to ensure that the equipment operates safely. Failure to comply may result in personal injuries or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in a fire. Using an incorrect supply voltage may cause a fire.
- Before power-on, check that no one is near the equipment, motor, or other mechanical parts. Failure to comply may result in personal injury or even death.

Operation



- The equipment must be operated only by professionals. Failure to comply can result in injury or death.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply can result in electric shock.

The equipment is equipped with the automatic restart function. After power supply recovery or fault clearance, do not enable this function when the equipment is running, being inspected, or when personnel are in contact with the drive mechanism. Before enabling the automatic restart function, check the following:

- No personnel are working on the load side, and no foreign objects cause blockages.
- All safety protection devices (such as safety doors, emergency stop circuits) are properly engaged.
- Prominent "Automatic restart" safety warning signs have been posted on the equipment and the site.



- Do not touch the enclosure, fan, or resistor with bare hands. Failure to comply may result in burns.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance



- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not perform maintenance on the equipment with power-on. Failure to comply may result in an electric shock.
- Before maintenance, disconnect all the power supplies of the equipment and wait for at least the time specified on the warning label.
- When using a permanent magnet (PM) motor, do not touch the motor terminals while the motor is rotating, because induced voltage may be present at the terminals even after the product is powered off. Failure to comply may result in electric shock.



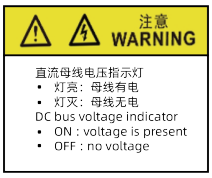
- Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair
DANGER • Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals. • Do not repair the equipment with power-on. Failure to comply may result in electric shock. • Before inspection or repair, disconnect all the power supplies of the equipment and wait for at least the time specified on the warning label.
WARNING • Submit a request for repair based on the warranty agreement. • When the fuse is blown or the circuit breaker or earth leakage current breaker (ELCB) trips, wait for at least the time specified on the warning label before power-on or other operations. Failure to comply may result in personal injury or death and equipment damage. • Troubleshooting and repair of a faulty or damaged equipment must be performed by professionals based on the repair instructions, with the repair records kept properly. • Replace quick-wear parts of the equipment according to the replacement instructions. • Do not use damaged equipment. Failure to comply can result in death, personal injury, or severe equipment damage. • Recheck the wiring and reset the parameters after equipment replacement.

Disposal
WARNING • Dispose of the retired equipment in accordance with applicable national regulations and standards. Failure to comply can result in property damage, personal injury, or death. • Recycle retired equipment in accordance with industry waste disposal standards to avoid environmental pollution.

Safety Label

To ensure safe operation, comply with equipment-related safety labels. The following table describes the meanings of the safety labels.

Safety Label	Description
	DC bus voltage indicator • ON: Bus energized • OFF: Bus de-energized
	DC bus voltage indicator • ON: Hazardous voltage exists, which may result in electric shock.
	• Maintenance can be performed by professionals only. • Disconnect all the power supplies before maintenance and wait for at least 15 minutes before opening the cover. (Different devices have different time, subject to the actual label on the device.) • Read the maintenance instructions before maintenance.

1.2 Industrial Information Security

The product provides interfaces for network connection and data transmission. To protect factories, systems, machines, and networks from cyberattacks, it is essential to implement proper protection mechanism for industrial security.

Customers are responsible for providing and maintaining a secure connection between the product and their network or any other network to protect their factories, systems, machines, and networks from unauthorized access. Such systems or machines can be connected to an enterprise network or the Internet only when a secure connection is established and appropriate security measures (such as using antivirus software or installing firewalls) are in place.

Inovance continuously develops and improves its products and solutions to enhance safety. It is strongly recommended that you update the product promptly and always use the latest version.



Malware (such as viruses, Trojans, and worms) can bring the device into an unsafe operating state, resulting in death, serious injury, and property damage. Observe the following precautions:

- It is recommended to use the latest software version based on actual operation conditions. If the product version is no longer supported or the latest version is not used, customers will be exposed to increased risk of cyber attacks.
- Develop and maintain appropriate protective measures (including but not limited to antivirus software, firewalls, WAF, IPS/IDS, situational awareness system, identity authentication, data encryption) to prevent the files in mobile storage devices from being damaged by malware, and to protect the products, networks, systems, and interfaces from unauthorized access, tampering, hacking, data leakage, or information theft.
- Check all safety-related interfaces and settings after commissioning.

2 Function List

Table 2–1 Drive configuration list

Level 1 category	Level 2 category	Level 3 category	Hyperlink
Drive configura-tion	Control word and status word	Startup and operation	For details, see *"4.1.1 Start and Operation" on page 44*
		Emergency stop command	For details, see *"4.1.2 Emergency Stop Command" on page 45*
		Control word	For details, see *"4.1.4 Control Word" on page 47*
		Status word	For details, see *"4.1.5 Status Word" on page 48*
		State machine	For details, see *"4.1.6 State Machine" on page 49*
	Setpoint channel	Voltage reference	For details, see *"4.2.1 Voltage Reference" on page 55*
		Current reference	For details, see *"4.2.2 Current Reference" on page 56*
		Motorized potentiometer	For details, see *"4.2.3 Motorized Potentiometer" on page 58*
		Multi-reference	For details, see *"4.2.4 Multi-reference Setting" on page 59*

Table 2–2 Self-check and auto-tuning list

Level 1 category	Level 2 category	Level 3 category	Hyperlink
Self-test and auto-tuning	Phase sequence self-test	-	For details, see *"5.1 Phase Sequence Self-test" on page 62*
	Capacitor auto-tuning	-	For details, see *"5.2 Capacitor Auto-tuning" on page 62*

Table 2–3 Control interface list

Level 1 category	Level 2 category	Level 3 category	Hyperlink
Control interface	Digital input (DI)	-	For details, see *"6.1 Digital Input (DI)" on page 64*
	Digital output (DO)	-	For details, see *"6.2 Digital Output (DO)" on page 66*
	Analog input (AI)	-	For details, see *"6.3 Analog Input (AI)" on page 66*
	Analog Output (AO)	-	For details, see *"6.4 Analog Output (AO)" on page 68*
	High-speed digital input (HDI)	-	For details, see *"6.5 High-Speed Digital Input (HDI)" on page 70*
	High-speed digital output (HDO)	-	For details, see *"6.6 High-speed Digital Output (HDO)" on page 70*
	I/O function module (HIO)	Digital I/O (DIO)	For details, see *"6.7.1 DI or DIO" on page 72*
		Analog input (AI)	For details, see *"6.7.2 Analog Input (AI)" on page 75*
		Analog Output (AO)	For details, see *"6.7.3 Analog Output (AO)" on page 78*
		Relay output (RO)	For details, see *"6.7.4 Relay Output (RO)" on page 79*

Table 2–4 Control performance list

Level 1 category	Level 2 category	Level 3 category	Hyperlink
Control perform-ance	Operation mode	-	For details, see *"7.1 Operation Mode" on page 81*
	DC droop control	-	For details, see *"7.2 DC Droop Control" on page 81*
	High/Low voltage ride-through function	Low voltage ride-through function	For details, see *"7.3.1 Low Voltage Ride-Through Function" on page 83*
		High voltage ride-through function	For details, see *"7.3.2 High Voltage Ride-Through Function (Bus Voltage Adaptive Function)" on page 85*

Table 2–5 Function application list

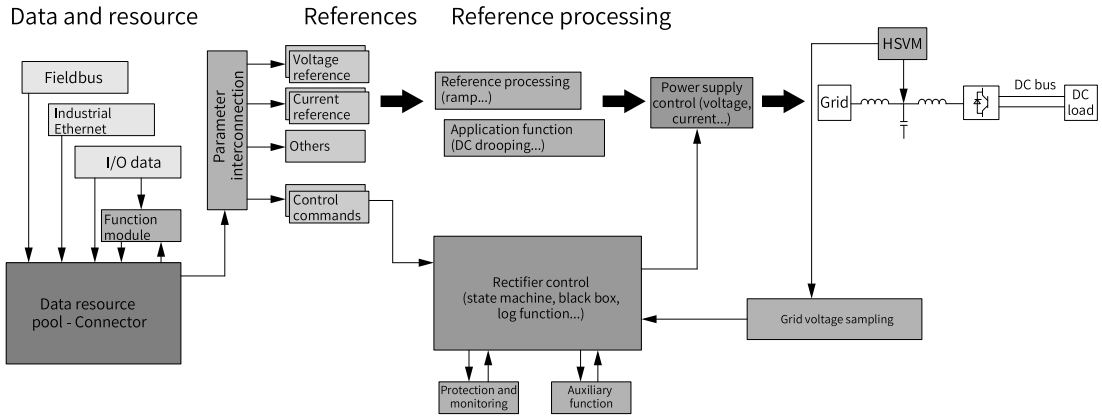
Level 1 category	Level 2 category	Level 3 category	Hyperlink
Function application	Synchronous voltage sampling module	-	For details, see *"8.1 Synchronous Voltage Detection Module" on page 87*
	Communication module	Fieldbus adapter	For details, see *"8.2.1 Fieldbus Adapter" on page 88*
		Process data configuration	For details, see *"8.2.2 Process Data Configuration" on page 89*
		Communication base value	For details, see *"8.2.3 Communication Base Value" on page 90*
		Communication expansion module	For details, see *"8.2.4 Communication Expansion Module" on page 91*
		InoLink communication network	For details, see *"8.2.5 InoLink Communication Network" on page 91*
		Bus adapter slot configuration	For details, see *"8.2.6 Fieldbus Adapter Slot Configuration" on page 94*
		Application case of the fieldbus adapter	For details, see *"8.2.7 Application Case of the Fieldbus Adapter" on page 96*
		Carrier synchronization communication	For details, see *"8.2.8.1 Carrier Synchronization Communication" on page 99*
		Master-slave parallel control	For details, see *"8.2.8.2 Master-Slave Parallel Control" on page 101*
	Word-to-bit function	Word-to-bit block (1 to 4)	For details, see *"8.3.1 Word-to-Bit Block (1 to 4)" on page 103*
		Bit-to-Word block (1 to 4)	For details, see *"8.3.2 Bit-to-Word Block (1 to 4)" on page 104*
	Logical operation function	Logic AND block (A to D)	For details, see *"8.3.1 Word-to-Bit Block (1 to 4)" on page 103*
		Logic OR block (A to D)	For details, see *"8.4.2 Logic OR Block (A to D)" on page 106*
		Logic NOT block (A to H)	For details, see *"8.4.3 Logic NOT Block (A to H)" on page 107*
		Logic XOR/XNOR block (A to D)	For details, see *"8.4.4 Logic XOR/XNOR Block (A to D)" on page 108*
		Logic AND/OR block (A to H)	For details, see *"8.4.5 Logic AND/OR Block (A to H)" on page 109*
	Word-to-DWord function	Word-to-DWord (1 to 5)	For details, see *"8.5.1 Word-to-DWord Conversion (1 to 5)" on page 110*
		DWord-to-Word (1 to 5)	For details, see *"8.5.2 DWord-to-Word Conversion (1 to 5)" on page 111*
	Switch function block	Binary selector block (1 to 8)	For details, see *"8.6.1 Binary Selector Block (1 to 8)" on page 112*
		Digital selector block (1 to 16)	For details, see *"8.6.2 Digital Selector Block (1 to 16)" on page 113*

Level 1 category	Level 2 category	Level 3 category	Hyperlink
Function application	Control function block	Filter block (A to D)	For details, see *"8.7.1 Filter Block (A to D)" on page 114*
		Level-to-pulse block (A to D)	For details, see *"8.7.2 Level-to-Pulse Block (A to D)" on page 115*
		Logic delay block (A to H)	For details, see *"8.7.3 Logic Delay Block (A to H)" on page 116*
		Pulse generator block (1 to 3)	For details, see *"8.7.4 Pulse Generator Block (1 to 3)" on page 117*
	Arithmetic function block	Absolute value block (A to D)	For details, see *"8.8.1 Absolute Value Block (A to D)" on page 118*
		Add/Subtract block (A to D)	For details, see *"8.8.2 Add/Subtract Block (A to D)" on page 119*
		Multiply/Divide block (A to D)	For details, see *"8.8.3 Multiply/Divide Block (A to D)" on page 119*
		Compare block (A to E)	For details, see *"8.8.4 Compare Block (A to E)" on page 120*
		Limiter block (A to D)	For details, see *"8.8.5 Limiter Block (A to D)" on page 121*
		Proportional block (1 to 15)	For details, see *"8.8.6 Proportional Block (1 to 15)" on page 122*
	Multi-point curve block	-	For details, see *"8.9 Multi-Point Curve Block" on page 125*
	Constant setting block	-	For details, see *"8.10 Constant Setting Block" on page 126*
	Parameter monitoring and modification	Parameter monitoring (1 to 10)	For details, see *"8.11.1 Parameter Monitoring (1 to 10)" on page 127*
		Parameter mapping (1 to 16)	For details, see *"8.11.2 Parameter Mapping (1 to 16)" on page 128*
	Multi-timer block	Function of the multi-timer block	For details, see *"8.12.1 Function of the Multi-timer Block" on page 130*
		Parameters of multi-timer block	For details, see *"8.12.2 Description of Multi-timer Block Parameters" on page 130*
		Application case of multi-timer block	For details, see *"8.12.3 Application Case of Multi-timer Block" on page 137*
	General timer and counter	-	For details, see *"8.13 General Timer and Counter" on page 138*

3 System Introduction

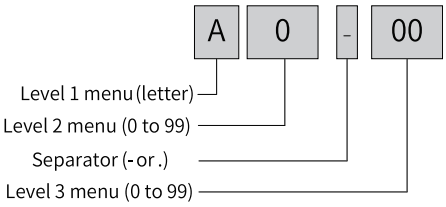
3.1 Descriptions of Function Framework

The HCU-40 adopts modular design with each function module assigned with a specific sub-function. The function modules function as a whole through parameter interconnection system (see *"3.3.1 Connector Parameters" on page 23*) to fulfill user requirements. The host controller supports data exchange with HCU-40 through communication protocols to control the output of the rectifier. The free function blocks support free programming and simple logic control without host controllers. The following figure shows the function framework.



3.2 Parameter Setpoint and Output Value

The parameters of HCU-40 are represented by a three-level menu, as shown in the following figure.



Note

- The separator for the parameter menu can be "-" or ".", which have the same meaning. That is, A0-00 and A0.00 have the same meaning. The separator "-" is usually used in the user guide and the separator "." is usually used in the LED panel.
- The level 1 menu uses English letters including A/b/C/d/E/F/H/L/n/o/P/U, which are case-sensitive for easy display on the LED panel.

- The set value of a parameter is the value of the parameter set by the user for the parameter.
- The output value of a parameter is the value read by the HCU-40 control module.

For most parameters, the output value is equal to the setpoint. However, in HCU-40 control module parameters, parameter setpoints of a certain type of reference source are taken from another parameter B and the output value of parameter A is equal to that of parameter B.

In this guide, the value of the parameter represents the set value, and the value of the [parameter] represents the output value, as shown in the following examples:

- U9-32 = 100%
- C0-00 = 1932
- [C0-00] = 100%

C0-00 represents the channel 1 voltage setting source. It comes from the value of U9-32. When U9-32 is 100%, the actual output value of [C0-00] is 100%.

For reference source parameter C0-00, the setpoint 1932 only indicates the setpoint source and U9-32 connector value. In this case, [C0-00] is used to indicate the actual output value of the parameter, which is 100%.

3.3 Parameter Interconnection System

To set the HCU control module parameters, select and set the parameters properly to define the source.

For example, when DI1 input is used to implement the custom OFF1 command (start/stop command) of channel 1, set b1-01 to U0-02 (1002). In that case, U0-02 represents a bit connector that indicates the DI1 input status, and you can select any bit connector as the input source through b1-01.

Note

1002 indicates the number of connector U0-02.

- Example 1:
  A9-00 = U0-02: U0-02 indicates the DI1 status of HCU, and A9-00 is the control channel selection switch. This setting indicates that DI1 is used to switch the control channel. When DI1 is low level, channel 1 is active. Otherwise, channel 2 is active.

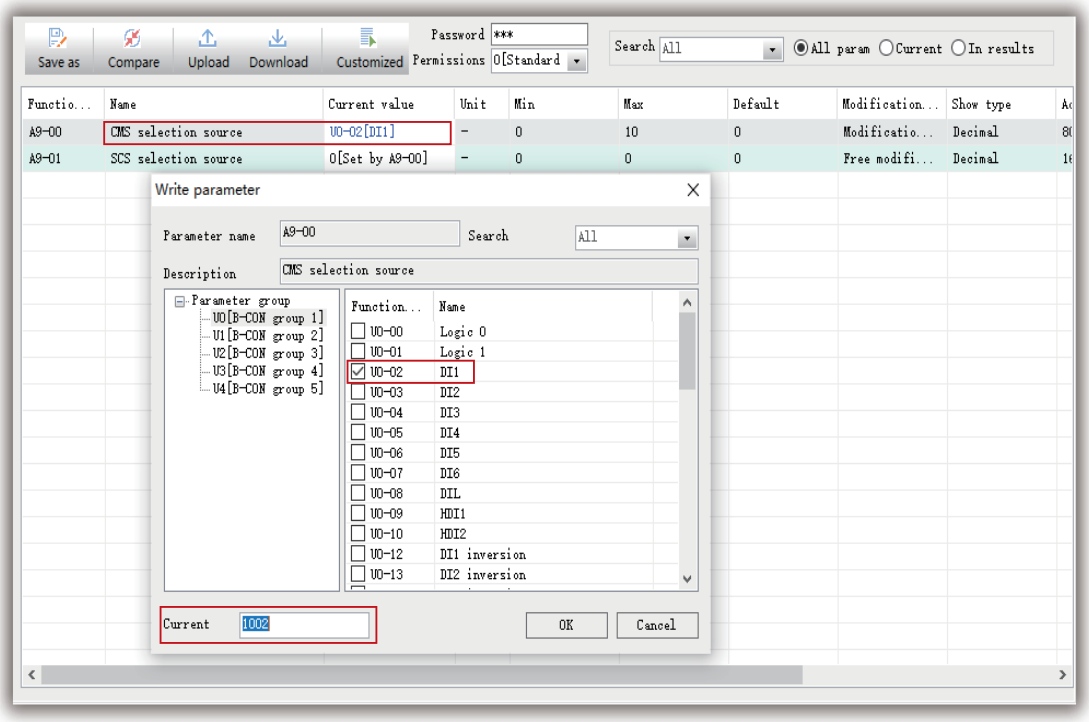


Figure 3-1 DI1 as channel selection source

- Example 2:
  C0-00 = U5-45: U5-45 indicates the value of PZD2 of process data received by bus adapter A. C0-00 is the voltage reference source of setpoint channel 1. It indicates that the voltage reference of setpoint channel 1 is derived from PZD2 of process data received by bus adapter A.

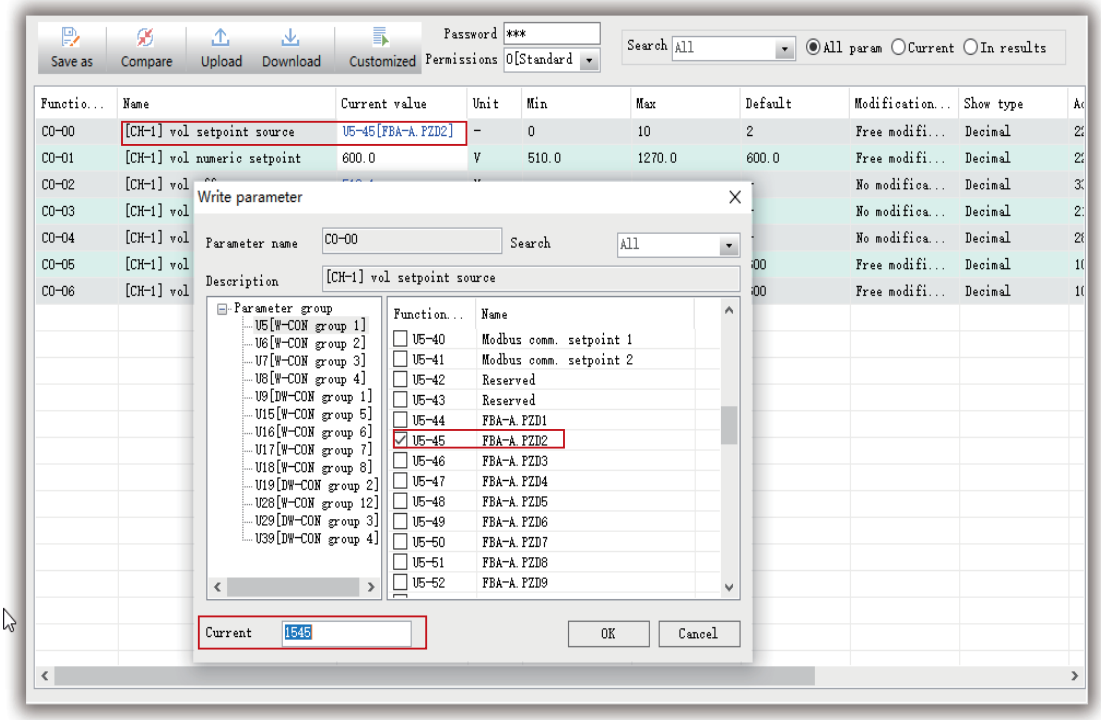


Figure 3-2 PZD2 of bus adapter A as the voltage setting source of channel 1

3.3.1 Connector Parameters

Group U parameters are read-only parameters that allow you to view the drive status and data. The parameters, also called connectors, can be read or used by other parameters.

Connectors are classified as follows based on the type of connector values.

- Bit connectors (B connectors) indicate digital values of 0 and 1, including digital input (DI), digital output (DO), a bit of a communication word, a bit of a control word or a state word, and status information of a fault. Bit connectors are located in groups U0 to U4 and U20.
- Word connectors (K connectors) indicate analog values, including values (voltage, current, and power) related to drive control, data received through communication or the analog input (AI) and analog output (AO) for hardware testing. Word connectors are located in groups U5 to U9, U16 to U18, and U25 to U26.

Connector parameters are required for the use of continuous oscilloscope/trigger oscilloscope/ black box records of InoDriveStudio. Only connector parameters can be read and used by other parameters and modules.

3.3.2 Setting Source Parameters

The parameters that support source selection of connectors are called setting source parameters, which are classified as follows based on different connector types:

- Bit setting source parameter: Used to set the source as a bit connector and read the connector value as the setting source parameter output.
- Word setting source parameter: Used to set the source as a word connector and read the connector value as the setting source parameter output.

1000 to 3699 represent the numbers of connectors U0-00 to U26-99.

You can set a connector as the source of multiple setting source parameters. Only one connector can be selected for each setting source parameter at a time.

3.4 Per-Unit Value System

In general circuit calculations, the units of current, voltage, power, and impedance are denoted by A, V, W and Ω respectively. This method of expressing physical quantities with actual named units is known as the named unit system.

Calculations with named values are inconvenient as parameters differ greatly for power modules with different ratings. Therefore, the per-unit system is commonly used to simplify calculation and analyze changes of physical states.

The per-unit value is a value mark method commonly used in calculation to indicate the relative value of each physical quantity and parameter. The per-unit value for a named value may vary with different base values. The conversion relationship between the per-unit value and named value is as follows.

Per-unit value = Named value/Base value

To unify the setting mode, the HCU uses related model parameters to represent test and control values as per-unit values.

- Voltage: Value related to the rated voltage is used as the voltage base value.
- Current: The rated current (A2-03) of the device is used as the current base value. The total underated current is used as the base value in parallel mode.
- Power: The rated power (A2-01) of the device is used as the current base value. The total underated current is used as the base value in parallel mode.

Base value	Parameter	Per-unit value
Base value of per-unit voltage	d3-00	400 V system: 600 V 690 V system: 1050 V
Per-unit base value of current	d3-01	Single mode: A2-03 Parallel mode: A2-03 x number of parallel units
Base value of per-unit power	d3-02	Single mode: A2-01 Parallel mode: A2-01 x number of parallel units

3.4.1 Value Range of Per-Unit Values

The value range of 16- and 32-bit per-unit values in the HCU control module is from -799.9% to 799.9%. However, 32-bit values provide higher precision as they contain more valid numbers and can be represented as -799.99% to 799.99%. The following table shows the data error for 16- and 32-bit per-unit values of 123.45%.

	Storage value	Per unit value	Absolute error	Relative error
16-bit per-unit value	5056	123.4375%	-0.0125%	1.0126%
32-bit per-unit value	331383570	123.44999984%	-0.00000016%	< 0.0001%

3.4.2 Representation of Per-Unit Values

The HCU displays parameters as integers with 16- and 32-bit precision. The following definitions are used to represent per-unit values:

- When per-unit values are represented by 16-bit parameters, 100% is indicated by 4096 (hexadecimal 0x1000) with precision up to 0.0244%. This method is used to represent per unit values of current, voltage, and power. The applicable value range is -799.9% to +799.9%.
- When per-unit values are represented by 32-bit parameters, 100% is indicated by the hexadecimal value 0x1000 0000. This method represents numerical values with higher precision. The applicable value range is -799.99% to +799.99%. This method is used to represent motor torque.

16- and 32-bit numerical values can be converted mutually. A 32-bit value with the 16 least significant bits (LSBs) removed can be used as a 16-bit value. A 16-bit value added with 16 zeros in the LSB position can be used as a 32-bit value.

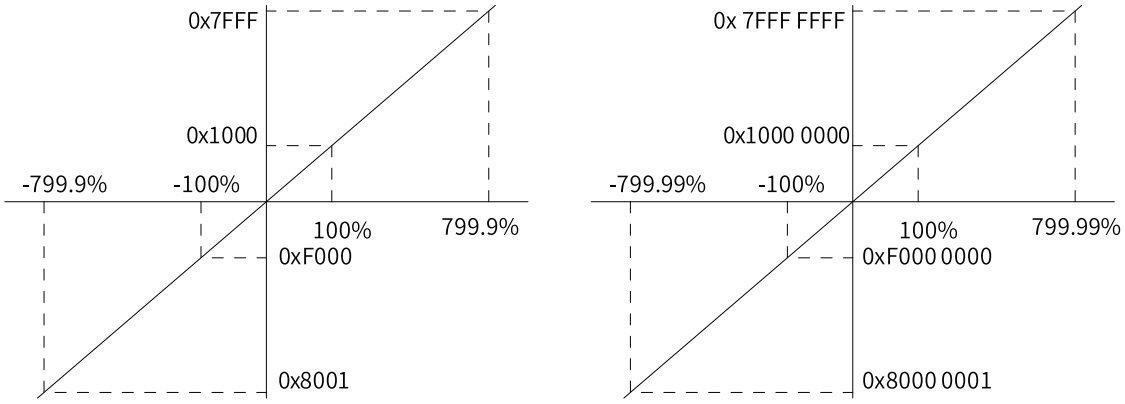


Figure 3-3 16-bit and 32-bit values represented in per-unit values

3.5 Reference Channel and Local Control

The HCU control module supports two groups of reference channels, each of which contains one group of control channel and one group of setpoint channel. A9-00 is used to switch the control channel, as shown in the following figure.

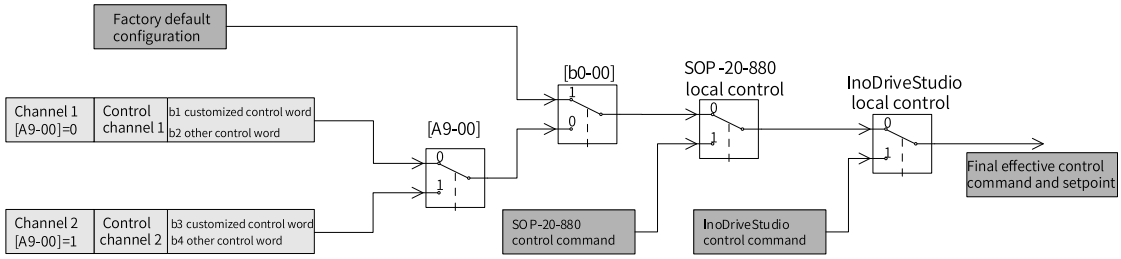


Figure 3-4 Control channel selection

A9-01 is used to switch the setpoint channel, as shown in the following figure.

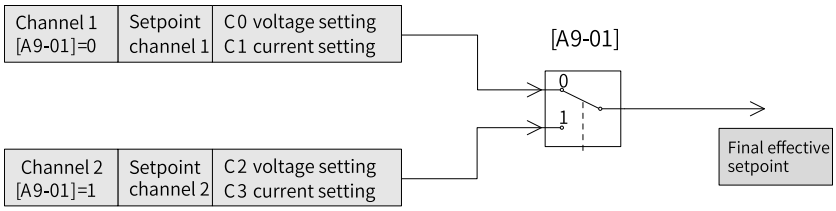


Figure 3-5 Reference channel selection

The HCU uses default parameters by default, and the start/stop mode of the device is fixed. To configure the start/stop mode of the device using the control channel, disable the default setting first ([b0-00] = 0).

3.5.1 Overview of Local Control and Remote Control

The concepts of "local" and "remote" in this manual are defined in the view of the HCU-40 control module.

- Remote control: Refers to the mode where the device is controlled through the control channel or default configuration.
- Local control: Refers to the mode where SOP-20-880 or InoDriveStudio is used to control the device. This mode is mainly used for commissioning and maintenance. In the local control, command words set by the control channel are not active.

Note

Some cabinet manufacturers may add start/stop buttons and potentiometers to the drive cabinet door or local operating console to implement device control. This is defined as local control and PLC control as remote control. This is different from the local and remote concepts described in this document.

For the HCU-40 control module, remote control refers to the control implemented through cabinet door or PLC. In this case, control commands or references are set through terminals or communication, and control source is switched by switching the two channels. The local/remote switchover button on the cabinet door or operating console is usually connected to the HCU-40 control module through a DI terminal which is set as the source of A9-00 for reference channel switchover.

3.5.2 Local Control and Remote Control

Local control through InoDriveStudio enjoys the highest level of commissioning priority. When you get the control permission through InoDriveStudio, the command channel and SOP-20-880 can no longer get the control permission. The switchover between local and remote control can only be performed in the stop state.

- You can view the status of local/remote control through U1-78. Specifically, 0 indicates that local control is enabled, and 1 indicates that remote control is enabled.
- Set whether to enable default configuration through b0-00. Specifically, you can set b0-00 to 0 to disable the default configuration, and set b0-00 to 1 to enable the default configuration. When the default configuration is enabled, the control channel command word is disabled.
- You can check U1-32 to see whether the default configuration is valid. The value 0 indicates invalid and 1 indicates valid.

Switch the control channel through A9-00. You can view the control channel status through U0-26. Specifically, the value 0 indicates that control channel 1 is active, and the value 1 indicates that control channel 2 is active.

For details on control sources and corresponding status, see the following table.

IDS local control	SOP local control	[b0-00]	[A9-00]	U1-78	U0-26	U1-32	Control command source
1	x	0	0	0	0	0	InoDriveStudio
1	x	0	1	0	1	0	InoDriveStudio
1	x	1	0	0	0	1	InoDriveStudio
1	x	1	1	0	1	1	InoDriveStudio
0	1	0	0	0	0	0	SOP-20-880
0	1	0	1	0	1	0	SOP-20-880
0	1	1	0	0	0	1	SOP-20-880

IDS local control	SOP local control	[b0-00]	[A9-00]	U1-78	U0-26	U1-32	Control command source
0	1	1	1	0	1	1	SOP-20-880
0	0	1	0	1	0	1	Default configuration
0	0	1	1	1	1	1	Default configuration
0	0	0	0	1	0	0	Control channel 1
0	0	0	1	1	1	0	Control channel 2

Note

When the factory default configuration is active, the control channel is inactive. Other control words and setpoint channels are still active. You can set the proper setpoint channel through channel selection (A9-01).

Start through SOP-20-880 operating panel

After connecting SOP-20-880 to HCU-40, press the Loc/Rem key of the SOP-20-880 to switch to local control. The control permission can only be switched in the stop state.

When "Local" is displayed at the bottom left of the interface, SOP-20-880 is granted with the control permission. In this case, the start/stop control word commands are disabled. To restore the control channel function, switch back to remote control through SOP-20-880.

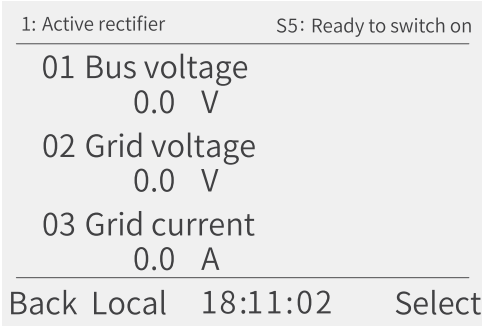


Figure 3-6 Local control through SOP-20-880

You can set A10-00 to 0 to disable local control through SOP-20-880. After setting, the Loc/Rem key of SOP-20-880 is invalid.

After SOP-20-880 gets the control permission, the start/stop commands of the device can be controlled by pressing the keys of SOP-20-880.

Start/Stop control through InoDriveStudio

For start through InoDriveStudio, see *MD880-40 Series Active Rectifier Commissioning Guide*.

Start/Stop control through control channel

For details on configuration, see *"3.5.3 Control Channel and Reference Channel" on page 28* and *"4.1.7.1 Terminal Start/Stop Block Switchover" on page 50*.

Start/Stop control through default configuration

Generally, the active rectifier module is delivered as a cabinet unit which provides start/stop keys by default. For details, see the following table.

Param.	Meaning	Default configuration	Description
b0-02	Default start command source	DI2 0→1: Start	Unconfigurable
b0-03	Default stop command source	DI5 1: Stop	Unconfigurable
b0-04	Default operation command source	1: Operation allowed	Configurable
b0-05	Default reset signal source	0→1: Reset	Unconfigurable

3.5.3 Control Channel and Reference Channel

In remote control, select the control channels and reference channels properly for reference channel setting. The scope of application of control channels and reference channels vary with control permissions. For details, see *"Table 3-1 Control channel and reference channel" on page 28*.

Set A9-00 (Reference channel) and A9-01 (Reference channel) properly to select the reference source as required.

Table 3–1 Control channel and reference channel

Type	Scope of application	Description
InoDriveStudio	Control panel Control channel 1: group b2 Control channel 2: group b4 Reference channel 1: groups C0 and C1 Reference channel 2: groups C2 and C3	• The control panel is used to start/stop the rectifier. • The setpoint is derived from the selected reference channel.
SOP-20-880	Start/Stop button Control channel 1: group b2 Control channel 2: group b4 Reference channel 1: groups C0 and C1 Reference channel 2: groups C2 and C3	• The OFF1 command source is SOP-20. • The setpoint is derived from the selected reference channel.
Default configuration	Group b0 Reference channel 1: groups C0 and C1 Reference channel 2: groups C2 and C3	• Default configurations are used as the OFF1 command source. • The setpoint is derived from the selected reference channel.

Type	Scope of application	Description
Control channel 1	Groups b1, b2, b5, and b6 Reference channel 1: groups C0 and C1 Reference channel 2: groups C2 and C3	• Control channel 1 is used to start/stop the rectifier. • The setpoint is derived from the reference channel 1.
Control channel 2	Groups b1, b2, b5, and b6 Reference channel 1: groups C0 and C1 Reference channel 2: groups C2 and C3	• Control channel 2 is used to start/stop the rectifier. • The setpoint is derived from the reference channel 2.

3.5.4 Control Channel Switchover

The switchover between local and remote control can only be performed in the stop state. In remote control, the two groups of control channels support switchover in any status. The following table shows the status change for control channel switchover.

Table 3-2 Status change for control channel switchover

Status before switchover	OFF1 before switchover	OFF1 after switchover	Status after switchover
Startup lockout	1	0	Startup lockout
Startup lockout	1	1	Startup lockout
Ready to switch on	0	0	Ready to switch on
Ready to switch on	0	1	Startup lockout
Started	1	0	Ready to switch on
Started	1	1	Keep the startup state

The control channel switchover allows control permission switchover between two different control stations. For example, after the local operating panel is started by DI, you can directly switch to PLC centralized control, or manually switch the equipment in PLC centralized control mode to the local operating panel control mode.

Note

- If the state machine is in "ready to switch on" state (OFF1 = 0) before control channel switchover and the value of OFF1 changes to 1 after the switchover, the state machine switches to the "Startup lockout" state. In this case, the state machine can return to the "ready to switch on" state only after OFF1 is set to 0 again.
- If b6-09 is set to 1 (forced switch-off upon control source change), when the control source changes, forcible switch-off applies and the switchover relationship in *"Table 3-2 Status change for control channel switchover" on page 29* is not activated.

3.6 Drive Object Configuration Information

3.6.1 Station ID and Baud Rate

When connecting the HCU to SOP-20-880 or InoDriveStudio, set the station number and baud rate correctly. When multiple HCUs are cascaded in the same network, ensure that the baud rate of each device in the same network is consistent and the station numbers are different. Set the station number and baud rate of each HCU separately through SOP-20-880.

- Method 1: Connect the SOP-20-880 to the HCU, choose "Menu > 01 Parameter settings > A system > A10 SOP-20/repeater communication ", select A10-03 SOP-20/repeater communication address or A10-04 SOP-20/repeater communication baud rate, and set the correct communication baud rate and station ID.
- Method 2: When creating a project on the InoDriveStudio, scan the device, and change the device baud rate and ID, as shown in the following figure.

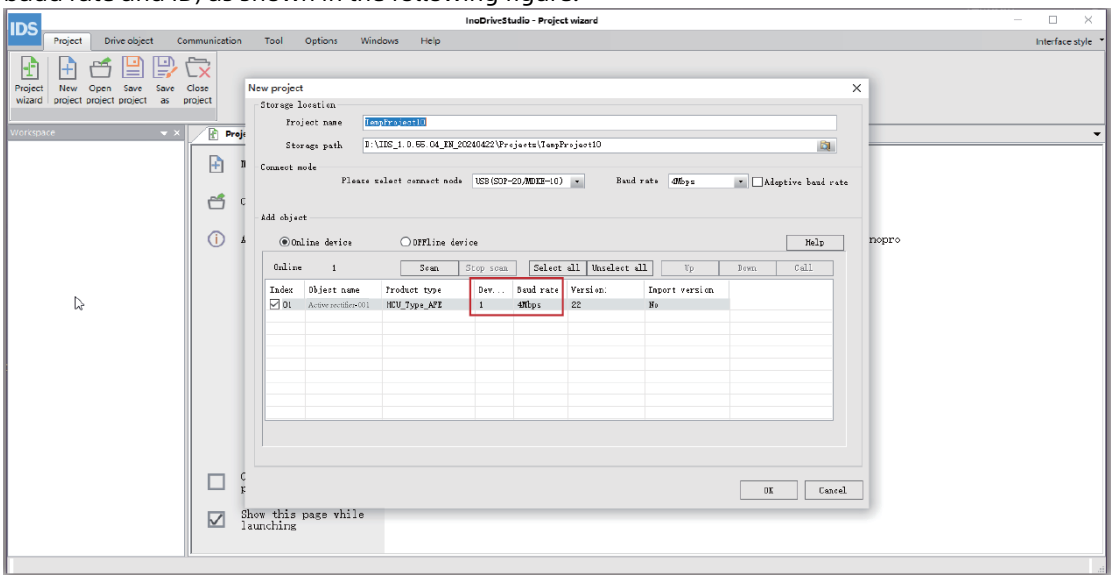


Figure 3-7 Changing the station ID and baud rate

- Method 3: Connect the InoDriveStudio to the device and then change the station ID (A10-03) and baud rate (A10-04) in the parameter list.

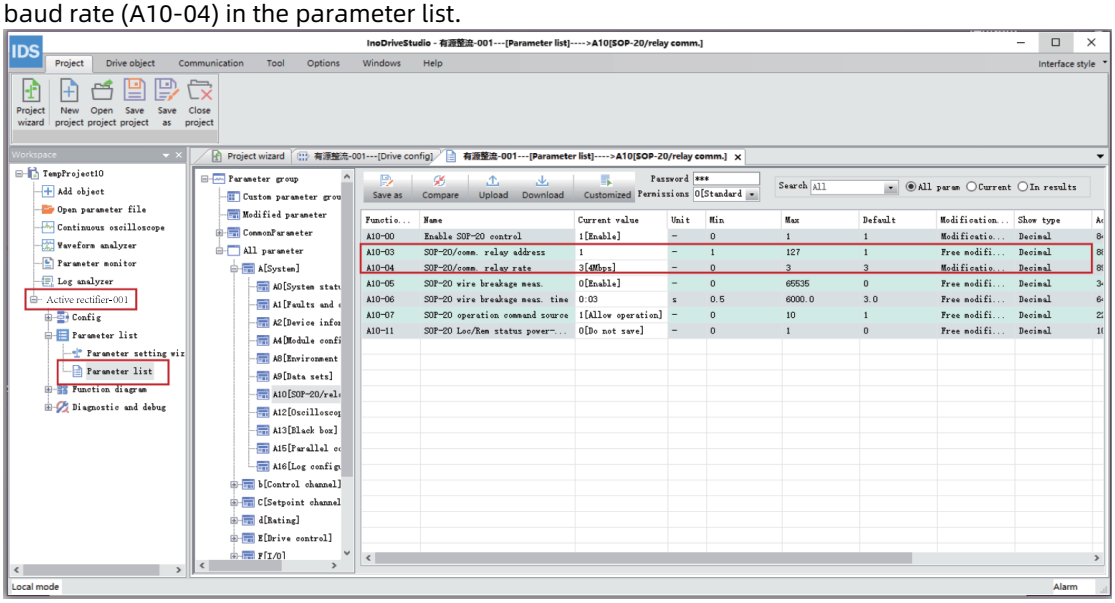


Figure 3-8 Changing the station ID and baud rate in the parameter list

- Method 4: Access the drive object configuration interface of the InoDriveStudio and change the station ID and baud rate.

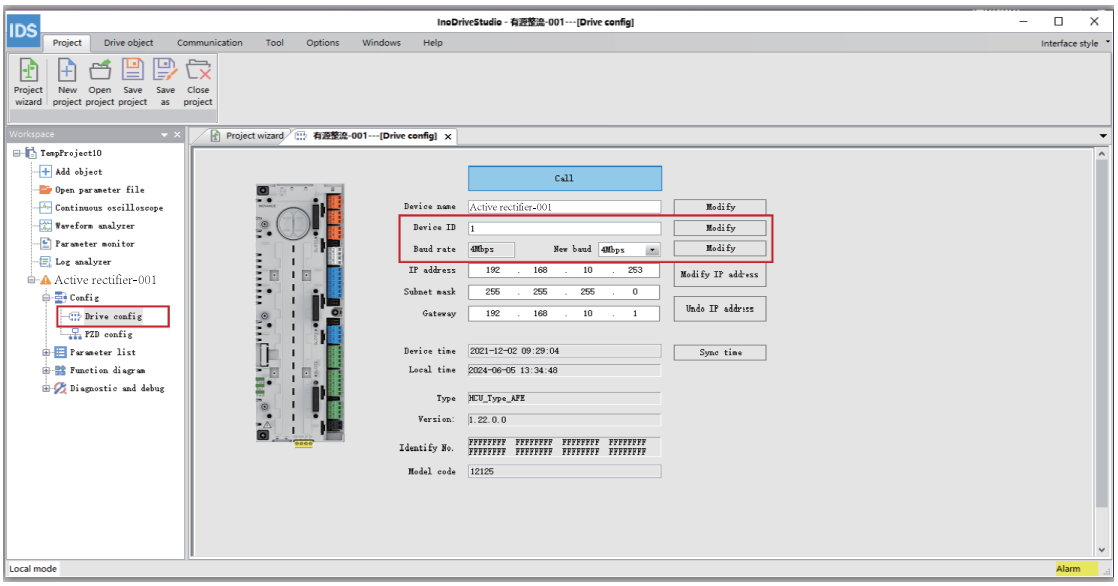


Figure 3-9 Changing the station ID and baud rate on the configuration interface

3.6.2 System Time

The HCU provides a built-in RTC clock IC that supports system date and time records. Use SOP-20-880 and InoDriveStudio to view and modify the system time.

Viewing and modifying device time through SOP-20-880

- Mode 1
  Choose "Menu > 05 System setting > 04 Date/Time > 03 Device object time" to access the system time interface where you can view the current system date and time and directly change the system time.
- Method 2
  Choose "Menu > 05 System setting > 04 Date/Time > 03 Sync object time" to synchronize the SOP-20-880 time to the HCU.

Viewing and modifying device time through InoDriveStudio

- Mode 1
  Choose "Config → Drive config" to view the HCU system time (device time) and PC time (local time). Click the "Sync time" button to synchronize the PC time to the HCU.

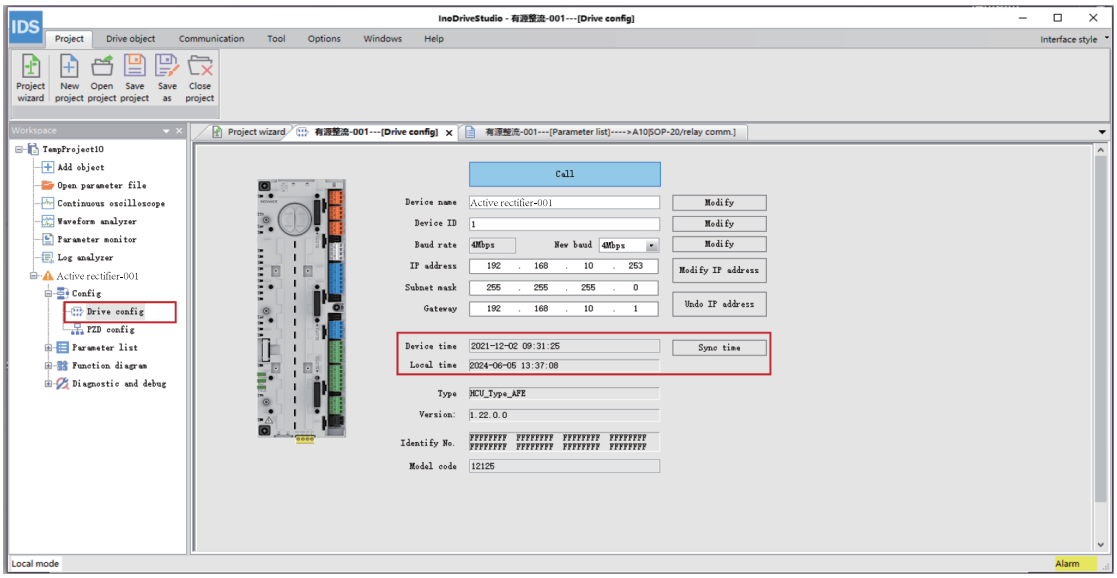


Figure 3-10 InoDriveStudio system time

- Method 2

  Set A8-60...A8-65 to change the system date and time. Then, set A8-66 to 1 to activate the system time setting. After successful setup, system date and time (A2-42 to A2-45) will be updated synchronously.

Param.	Name	Setting range	Remarks
A8-60	System time setting - Year	2021 to 2099	-
A8-61	System time setting - Month	1 to 12	-
A8-62	System time setting - Day	1 to 31	-
A8-63	System time setting - Hour	0 to 23	-
A8-64	System time setting - Minute	0 to 59	-
A8-65	System time setting - Second	0 to 59	-
A8-66	System time setting confirmation	0 to 1	When this parameter is set to 1, the above system clock setting parameters are activated, and the parameter reverts to 0 after 1s.

Viewing system date and time via parameters

Enter parameter group A2 to directly view the system date and time via parameters.

Param.	Name
A2-42	Current year
A2-43	Current date
A2-44	Current time
A2-45	Current second

3.6.3 Device Name

The HCU supports custom device names which can be retentive upon power off. When A8-00 is set to 1, the device name is not restored. When A8-00 is set to 2, the device name is restored to default. There are three methods to view and change the device name.

- Method 1

  When creating a project on the InoDriveStudio, scan the device and change the device name, as shown in the following figure.

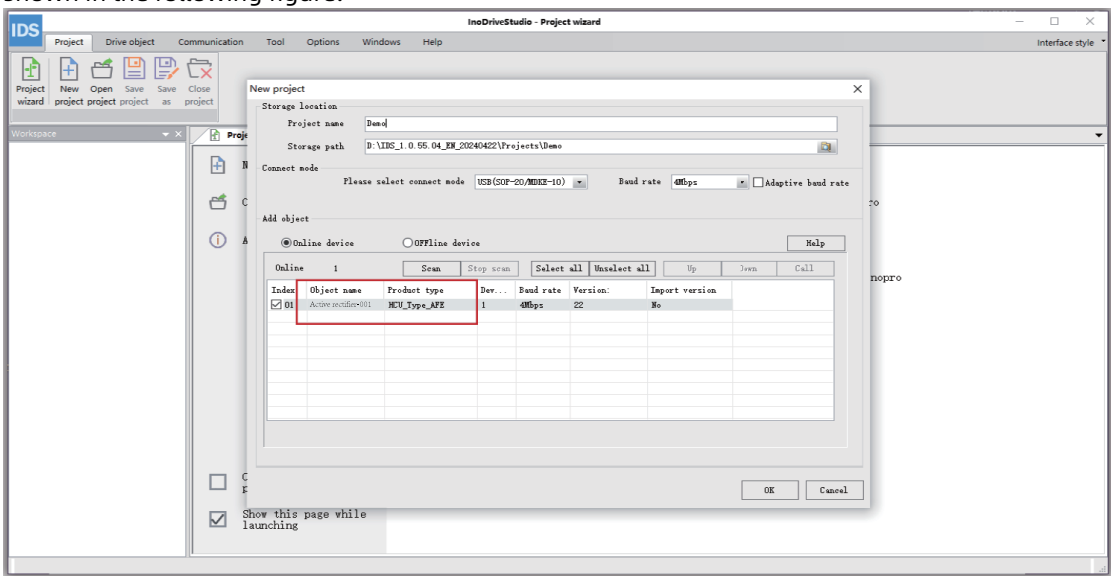


Figure 3-11 Modifying the device name

- Method 2

  On the main interface of the InoDriveStudio, right-click the device object to select "Rename" to directly modify the device name.

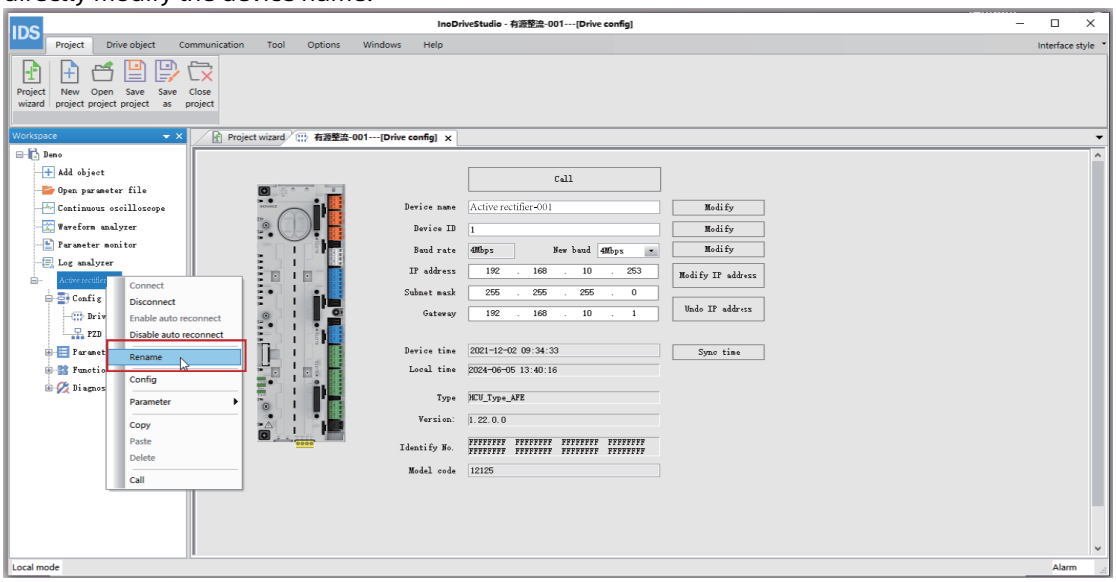


Figure 3-12 Renaming the device

- Method 3

  Open the InoDriveStudio, choose "Config > Drive object config" to access the drive object configuration information tab. Modify the device name, as shown in the following figure.

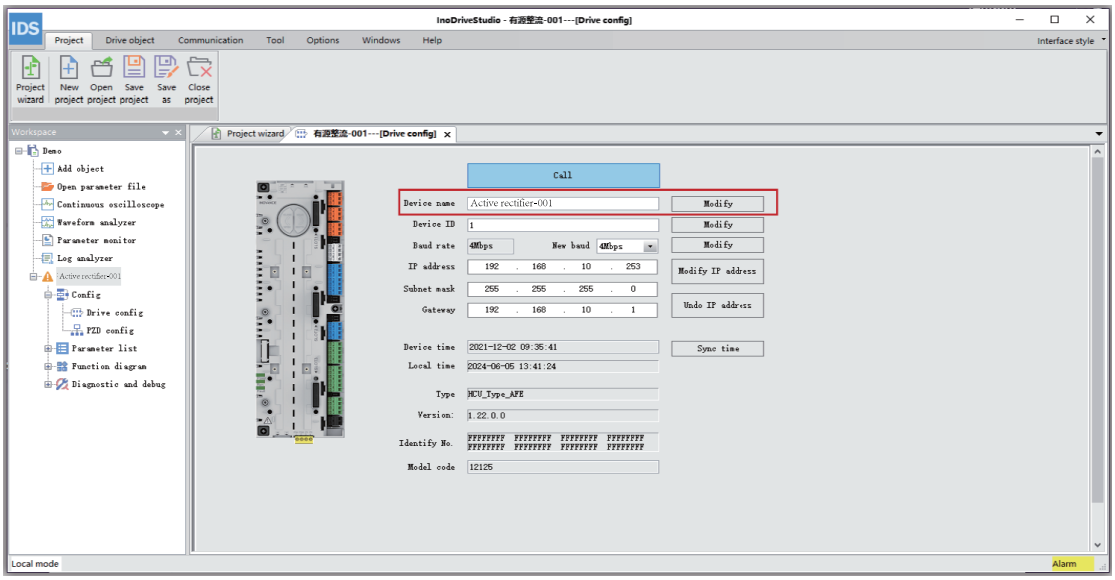


Figure 3-13 Modifying the device name

Note

When multiple devices are cascaded in the same monitoring network and connected through InoDriveStudio, ensure that the device names are different.

3.7 Parameter Backup

3.7.1 Restoring Parameters to Default

In group A8 (Environment setting), set A8-00 to select the operation as needed. Then, set A8-01 to confirm the operation of A8-00 and restore the specified parameter to default.

Parameters

1. Set A8-00 to 1 or 6 to restore some parameters to default.
   Set A8-00 to 1 to restore some parameters to default.

   Set A8-00 to 6 to restore some parameters to default (excluding communication card commissioning parameters).

2. Set A8-01 to 1 to confirm the operation of A8-00.

Note

- The parameters related to the power module model are restored to the default values of the model instead of the factory values.
- The log parameters in groups H1 to H8, device names, A10-03, A10-04, d1-00, d2-01, and E0-15 are not restored.
- Setting A8-00 to 6 restores some parameters to default (excluding communication card commissioning parameters) - This option does not restore parameters related to the communication card commissioning function, thereby ensuring normal use of the communication card commissioning link. The following related parameters are not restored:
  - Bus adapter: n1-00, n2-00
  - PROFINET IO: n17-00
  - EtherNet/IP: n41-00, n41-02, n41-03, n41-04, n41-05, n41-06, n41-07, n41-08, n41-09, n41-10, n41-11, n41-12, n41-13, n41-14, n41-15, n41-16, n41-17, n41-18, n41-19, n41-20
  - EtherCAT: n14-00, n14-02, n14-03, n14-06

All parameters

1. A8-00 = 2 or 7

   A8-00 = 2: Restore all parameters to default

   A8-00 = 7: Restore all parameters to default (excluding communication card tuning parameters)

2. Set A8-01 to 1 to confirm the operation of A8-00.

Note

- The parameters related to the power module model are restored to the default values of the model instead of the factory values.
- The log parameters in parameter groups H1 to H8, A10-03, and A10-04 are not restored.
- A8-00 = 7: Restore all parameters to default (excluding communication card commissioning parameters). This option will not restore parameters related to the communication card commissioning function, ensuring normal operation of the communication card commissioning link. The following related parameters are not restored:
  - Bus adapter: n1-00, n2-00
  - PROFINET IO: n17-00
  - EtherNet/IP: n41-00, n41-02, n41-03, n41-04, n41-05, n41-06, n41-07, n41-08, n41-09, n41-10, n41-11, n41-12, n41-13, n41-14, n41-15, n41-16, n41-17, n41-18, n41-19, n41-20
  - EtherCAT: n14-00, n14-02, n14-03, n14-06

Log parameters

1. Set A8-00 to 3 to select log parameters to be cleared.
2. Set A8-01 to 1 to confirm the operation of A8-00.

Note

- The log parameters in groups H1 to H8 are cleared.
- Values of U9-00 and U9-01 are cleared.

Deleting log files in the SD card of HCU

1. Set A8-00 to 4 to select the black box logs to be cleared.
2. Set A8-01 to 1 to confirm the operation of A8-00.

Note

- The parameter file backed up on the SD card will be deleted, and all current settings of the parameters remain unaffected.
- For details about backup parameter files of the SD card, see *"3.7.2 Backing Up Parameters with the SD Card" on page 36*.

Log clear

1. Set A8-00 to 5 to select the logs to be cleared.
2. Set A8-01 to 1 to confirm the operation of A8-00.
3. All the historical logs will be cleared.

Note

Once cleared, the log records cannot be restored.

3.7.2 Backing Up Parameters with the SD Card

In group A8 (environment setting), set A8-05 to select the operation as needed. Then, set A8-06 to confirm the operation of A8-05 so that parameters can be saved and restored as required.

Saving parameters to the SD card

Do as follows:

1. Set A8-05 to 1 to back up all HCU parameters to the SD card.
2. Set A8-06 to 1 to confirm the operation of A8-05.
3. You can save HCU parameters on the SD card for future use in case of spare parts replacement. Only one parameter file can be backed up. Data that backed up later will override the previous backup record.
4. When status 2 "Saving completed" is displayed in A8-07, the backup is successful.

Recovering parameters from the SD card to HCU

Do as follows:

1. Set A8-05 to 2 to recover all HCU parameters from the backup file of the SD card.
2. Set A8-06 to 1 to confirm the operation of A8-05.
3. Use the parameters backed up on the SD card to override current parameters of the HCU, which enables fast parameter recovery from the original SD card when using a spare HCU.
4. When status 5 "Recovery completed" is displayed in A8-07, parameters are recovered successfully. If not, no backup file is in the SD card, or the SD card is currently being used by another process.

Verifying parameter files

Do as follows:

1. Set A8-05 to 3 to select the verification parameters.
2. Set A8-06 to 1 to confirm the operation of A8-05.

3. The program verifies parameters backed up in the SD card and current parameters of HCU.

Deleting log files in the SD card

Do as follows:

1. Set A8-00 to 4 to clear the log parameter files in the SD card.
2. Set A8-01 to 1 to confirm the operation of A8-00.
3. The parameter files backed up in the SD card are deleted. Current parameter setpoints are not affected.

3.7.3 Backing up Parameters with SOP-20-880

After selecting the device to be operated with SOP-20-880, entering "System operation > Parameter copy" to back up and store parameters.



Figure 3-14 After login, access the parameter copying interface

Saving parameters to SOP-20-880

1. Select "Read parameters" to read all parameters of the device. Then, store the parameters to the SD card of SOP-20-880.
2. Set the custom part of the file name before reading parameters. The custom part consists of 5 bytes. Use the left and right direction keys to select the byte to be set. You can set the byte value (ranging from 0 to 9 and A to Z) by up and down keys. The format of the file name is as follows: Device name - 5-digit user-defined name.ipv

Example: Active rectifier - 12ABC.ipv

Note: The device name is active rectifier. The custom field name is 12ABC.

Press  to read and copy the parameters after the file name is set. The message "Parameters are copied successfully" will be displayed on the interface. Specific reasons will be displayed if parameter-read/write fails.

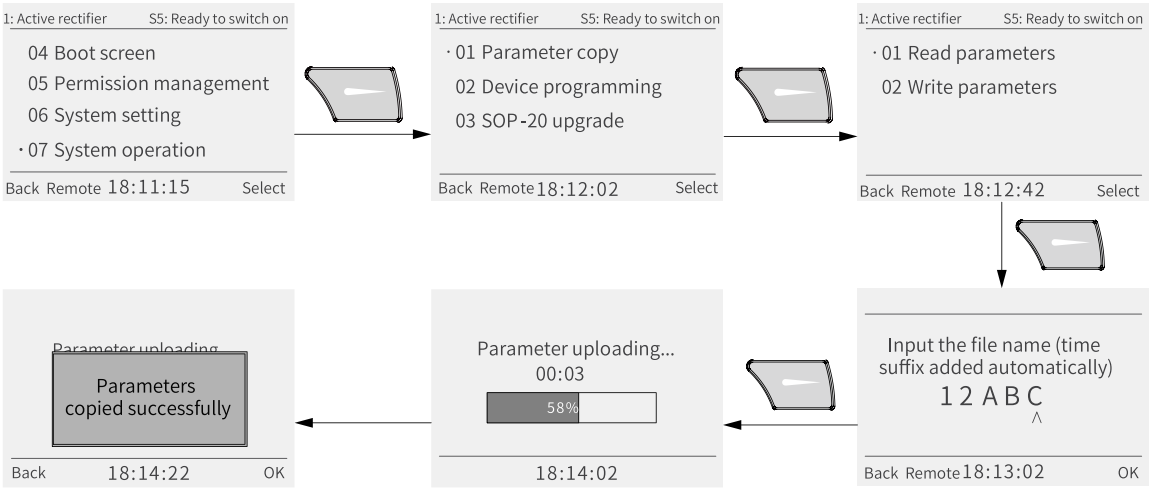


Figure 3-15 Saving parameters to SOP-20-880

Restoring parameters from SOP-20-880

Select "Write parameters" to download the parameters saved in SOP-20-880 to the HCU.

Select a parameter file on the SD card before performing writing parameters. Select "Copy all" to restore all parameters from the HCU to the file.

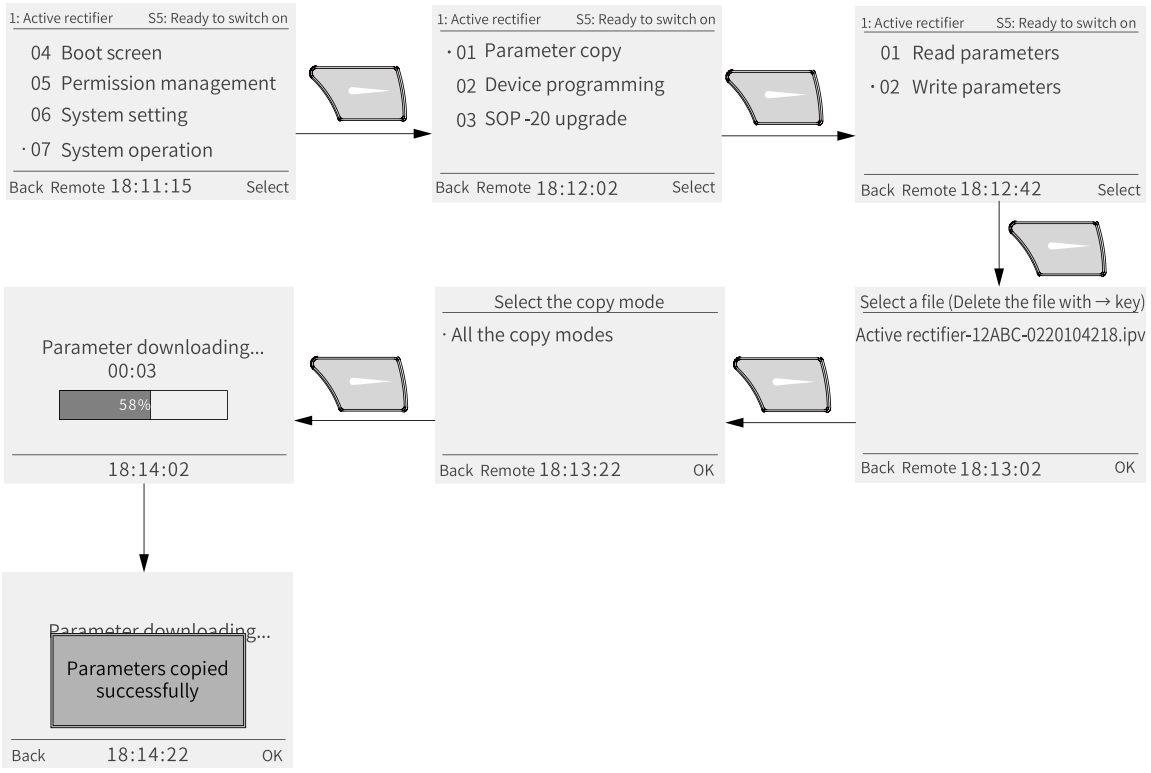


Figure 3-16 Example of writing parameters

Note

All parameter files that are copied, saved, and read are saved in the SD card of SOP-20-880. Ensure that the SD card is properly installed before using the parameter copy function.

3.7.4 Backing up Parameters with InoDriveStudio

You can use InoDriveStudio to back up the parameters to your computer through the "Upload" function. Also, you can restore the backup parameters from your computer to the HCU through the "Download" function.

Saving parameters to the computer

Click "Upload" to open a file saving dialog box. Select the path and enter the file name. Then, click "Save" to upload and save all HCU parameters to the file (.inoprm).

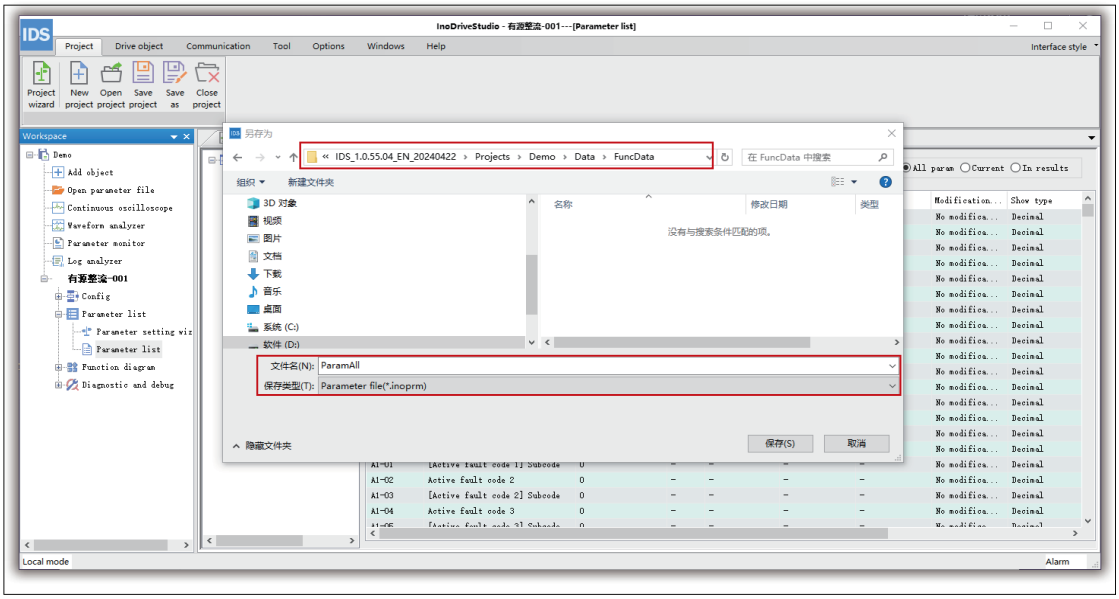


Figure 3-17 Saving parameters

Restoring parameters from the computer to HCU

Click "Download" in the parameter list interface to display dialog box that asking you to open a file, then select the file name and click the Open button to download parameters saved in the file to this HCU.

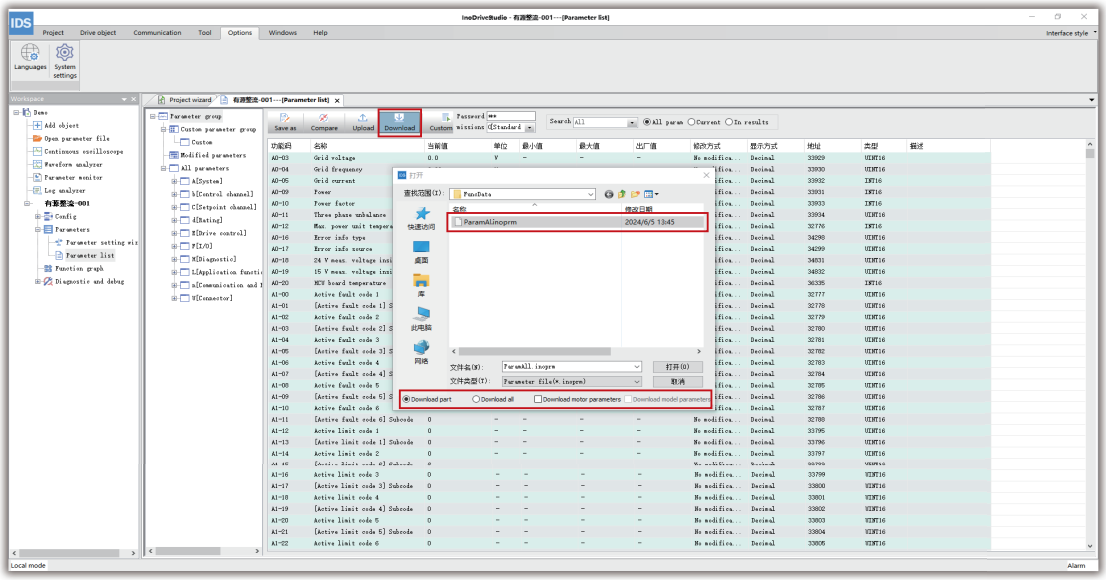


Figure 3-18 Restoring parameters

The following shows the two parameter download modes:

- Download part
  Download all the parameters except model-related parameters, A10-04 (SOP-20-880 communication baud rate), and A10-03 (communication address). Filtered download mode is suitable for most of cases where backup parameters need to be restored.
- Download all
  Download all the parameters except model-related parameters. If A10-04 (SOP-20-880 communication baud rate) and A10-03 (communication address) differ from current parameters, the system informs you to make necessary modification (take caution during modification to prevent communication failure caused by repetitive station number). You can check "Download model parameter" to download all parameters.

Caution

Select whether to download model parameters carefully. Model parameters can only be downloaded by professionals. Failure to comply may result in mal-function of the device or damage the drive or user equipment.

3.8 Parameter Lock

To prevent inadvertent or unauthorized modification of parameters, you can enable the parameter lock function through A8-30 so that parameters can be read-only. After the parameter lock password is set, only users with the password can operate on A8-30, preventing unauthorized modification of the AC drive parameters.

3.8.1 Setting the Password for Locking Parameters

The HCU-40 controller is not equipped with a parameter lock password by default, which allows all users to set A8-30. If a parameter lock password is set, only users with the password are allowed to set A8-30.

To set a parameter lock password, do as follows:

1. Set A8-25 to 3. Then, A8-28 displays "20 Waiting for password input". If no operation is performed within the waiting time of 60s, A8-28 displays "22 Password input timeout". Then, you need to set A8-25 to 3 again.
2. Enter the password in A8-26, and "21 Waiting for another password input" is displayed in A8-28.
3. Enter the password again in A8-27. The password must be the same as that entered in A8-26. Otherwise, the password setting can fail. If the password setting fails, set the password again from the first step.
4. After "28: Password set successfully" is displayed in A8-28, the password for parameter is set successfully.

Table 3–3 Technical data

Param.	Name	Setpoint
A8-25	Operation mode of password	0: No action 1: Verify password 2: Cancel password 3: Set password
A8-26	Entering password for locking parameters	Range: 0 to 65535
A8-27	Re-enter the password after password setting	Range: 0 to 65535
A8-28	Password status display upon parameter lock	0: No password set 1: Password has been set 20: Waiting for password input 21: Waiting for password input again 22: Password input timeout 23: Password verification failure 24: Password verification success 25: Attempt to cancel password failed 26: Password canceled successfully 27: Password setting failure 28: Password set successfully
A8-29	Function status display upon parameter lock	0: A8-30 cannot be set by users 1: A8-30 can be set by users
A8-30	Parameter lock	0: Inactive 1: Active

3.8.2 Modifying the Parameter Lock Password

If you need to change the password after setting it up, cancel and reset the password again. Perform the following steps to cancel the password.

1. Set A8-25 to 2. Then, A8-28 displays "20 Waiting for password input". If no operation is performed within a waiting time of 60s, A8-28 displays "22 Password input timeout". In this case, you need to set A8-25 to 2 again.
2. Input the password through A8-26.
3. After A8-28 displays "25 Password canceled successfully", the parameter lock password is canceled successfully.
4. Wait for 1s before setting the parameter lock password according to section *"3.8.1 Setting the Password for Locking Parameters" on page 41*.

3.8.3 Service Data Object (SDO)

When the parameter lock function is enabled, parameters can be written through the mailbox data of adapter A and adapter B by default. You can write the parameter through Modbus or PROFIBUS-DP communication. If you do not want the host controller to change the parameters of the AC drive through the mailbox data, you can set them through A8-31. For descriptions of parameter A8-31, see the following table.

Param.	Name	Setpoint
A8-31	Parameter setting selection after parameter lock	bit00: Device name 0: Configurable 1: Unconfigurable bit01: Parameter written through adapter A email data 0: Configurable 1: Unconfigurable bit02: Parameter written through adapter B email data 0: Configurable 1: Unconfigurable bit03 to bit15: Reserved

3.8.4 Designated Unlocked Parameters

Use A8-32 to A8-41 to modify parameters as needed after the parameter lock function is enabled. In that case, a total of 10 parameters can be assigned. Set the parameter communication address for A8-32 to A8-41. You can go to section "Parameter List" to view the address. For parameters A8-32 to A8-41, see the following table.

Table 3–4 Technical data

Parameter	Name	Setpoint
A8-32	Designated unlocked parameter address 1	Range: 0 to 65535
A8-33	Designated unlocked parameter address 2	Range: 0 to 65535

Parameter	Name	Setpoint
A8-34	Designated unlocked parameter address 3	Range: 0 to 65535
A8-35	Designated unlocked parameter address 4	Range: 0 to 65535
A8-36	Designated unlocked parameter address 5	Range: 0 to 65535
A8-37	Designated unlocked parameter address 6	Range: 0 to 65535
A8-38	Designated unlocked parameter address 7	Range: 0 to 65535
A8-39	Designated unlocked parameter address 8	Range: 0 to 65535
A8-40	Designated unlocked parameter address 9	Range: 0 to 65535
A8-41	Designated unlocked parameter address 10	Range: 0 to 65535

4 Drive Configuration

4.1 Control Word and Status Word

The control word serves as a major method to control the drive. The drive status switchover and function enabling depend on bit settings of the control word.

A status word is a collection of bits that encapsulates the operation status of a drive.

4.1.1 Start and Operation

Control word

In HCU-40, there are two commands related to start/stop control of the rectifier module, which can be set through the start/stop control word.

- OFF1 command
  When the OFF2 command is inactive and no fault occurs, the system enters S5 (ready to switch on) status. When the OFF1 command changes from 0 to 1 (rising edge), the rectifier enters S7 (ready to run) after S6 (pre-charging) is done, waiting for an operation permission command.

  When OFF1 is set to 0, the rectifier stops and the state machine returns to S5 (ready to switch on) status.

- Operation permission command
  When the rectifier is started through OFF1 command and soft start is done, you can use the operation permission command to trigger the IGBT. When OFF1 is set to 0, the operation permission command cannot be used to control the rectifier independently.

  When the operation permission command is inactive, the IGBT will not be triggered even after the rectifier is started through OFF1. In this case, the rectifier stays in S7 (ready to run) status. Only after the operation permission command is active, the IGBT will be triggered again.

  During normal operation, the operation permission command must keep active (high level).

Table 4–1 OFF1 and operation permission command source

b0-00 (Default configuration enable)	A9-00 (Command channel selection)	Control source	OFF1	Operation permission command
1: Active	-	-	DI2 and DI5	b0-04/b6-06/b6-07
0: Inactive	0: Command channel 1	0: Terminal start/ stop module	Group b5	b5-08/b5-09
		1: User-defined start/stop	b1-01	b1-03
	1: Command channel 2	0: Terminal start/ stop module	Group b5	b5-13/b5-14
		1: User-defined start/stop	b3-01	b3-03

Note

When the drive starts and stops through SOP-20-880, the operation permission command can be set by A10-07.

Startup Sequence

After receiving the start command (OFF1), the HCU-40 control module first controls the auxiliary contactor to close. At this time, the three-phase AC input charges the DC bus through the pre-charge circuit, causing the DC voltage to rise gradually.

After charging is done, the HCU-40 controls the main circuit breaker to close and waits until the main circuit breaker is closed. After receiving the main circuit breaker close feedback signal (DI3), it disconnects the auxiliary contactor and waits for the time defined by E0-00 (2.5s by default).

After the waiting time is reached, the rectifier enters the normal operation mode if the operation permission command is valid. Take the voltage mode as an example. The startup sequence of the rectifier is shown in the following figure.

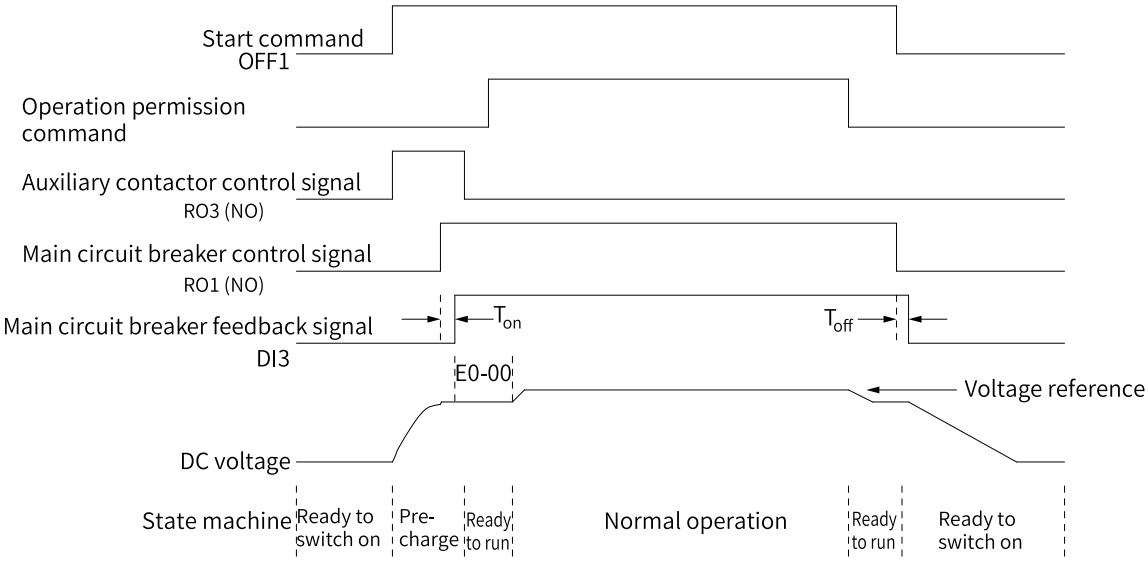


Figure 4-1 Startup sequence of the rectifier (voltage mode)

Note

- When the main circuit breaker close delay exceeds E7-08 (5s by default) or the switch-off delay exceeds E7-09 (2s by default), the main circuit breaker feedback error F73-1 is triggered.
- The auxiliary contactor control signal is of the RO3 NO contact and cannot be changed.
- The main circuit breaker control signal is of RO1 NO contact, and the feedback signal is DI3 and cannot be changed.

4.1.2 Emergency Stop Command

OFF2 emergency stop: After receiving the command, the IGBT output is blocked unconditionally, and the system is switched off. Emergency stop is active at low level. That is, when OFF2 is set to 0, emergency stop applies.

Multiple OFF2 command sources are available. The active parameters vary with the control channel setting. If any of the OFF2 command sources is set to 0, the rectifier executes OFF2 emergency stop.

Table 4–2 List of valid sources of OFF2 commands

Command channel	Control source	OFF2 source							
		b1-02	b2-00	b2-01	b3-02	b4-00	b4-01	SOP	IDS
[A9-00] = 0	b1-00 = 0 Terminal start/stop	x	Active	Active	x	x	x	x	x
	b1-00 = 1 Custom start/stop	Active	Active	Active	x	x	x	x	x
	Default	x	Active	Active	x	x	x	x	x
	SOP control	x	Active	Active	x	x	x	x	x
	IDS control	x	Active	Active	x	x	x	x	Active
[A9-00]=1	b3-00 = 0 Terminal start/stop	x	x	x	x	Active	Active	x	x
	b3-00 = 1 Custom start/stop	x	x	x	Active	Active	Active	x	x
	Default	x	x	x	x	Active	Active	x	x
	SOP control	x	x	x	x	Active	Active	x	x
	IDS control	x	x	x	x	Active	Active	x	Active

Note

- "X" in the table indicates that the OFF2 source is inactive, and "active" indicates that the OFF2 source is active.
- By default, b2-00 and b4-00 are from DIL.

4.1.3 Control Mode

The default HCU control mode is the voltage mode. You can set different operating modes through E0-01 (Active rectifier mode), as shown in the following table.

Operation mode	Active rectifier mode (E0-01)
Voltage mode	0 [Voltage mode]
Current mode	1 [Current mode]

Note

You need to set a proper operating mode according to the actual operating conditions. For details on the operating conditions of different operating modes, see *"7.1 Operation Mode" on page 81*.

4.1.4 Control Word

Control word 1 (U8-07)

Bit	Name	Param.	Value	Description
0	Start/stop (OFF1)	For details, see *"Table 4-1 OFF1 and operation permission command source" on page 44*	0	Stop: The drive enters S5 (ready to switch on).
			0→1	Start: The drive enters S5 (Ready to switch on), S2 (Power-on detection), S6 (Pre-charging), and S7 (Ready to run) in sequence at the rising edge.
1	Output lockout (OFF2)	For details, see *"Table 4-2 List of valid sources of OFF2 commands" on page 46*	0	The IGBT is locked out and the drive enters status S4 (Startup lockout).
			1	Mandatory condition for start
2	Reserved	-	-	-
3	Operation permission	For details, see *"Table 4-1 OFF1 and operation permission command source" on page 44*	0	The IGBT does not work.
			1	In S7 (Ready to run) state, the drive performs pre-operation inspection before operation.
4 to 6	Reserved	-	-	-
7	Fault reset	b0-05 b1-04 b2-02/b2-03 b3-04 b4-02/b4-03 b5-09/b5-14	0	No fault reset command
			0→1	Used to trigger fault reset. If the current fault cause is cleared, the fault state is cleared. In this case, the drive enters S4 (Startup lockout) state.
8 to 9	Reserved	-	-	-
10	Remote control permission	-	0	Remote control disabled
			1	Control by reference channel 1 or reference channel 2 allowed
11	Reserved	-	-	-
12	Motorized potentiometer increase	C4-05	0	Inactive
			1	The motorized potentiometer output is increased at the predefined slope.
13	Motorized potentiometer decrease	C4-06	0	Inactive
			1	The motorized potentiometer output is decreased at the predefined slope.
14	External fault 1	H0-00	0	Inactive
			1	External fault 1 is triggered.
15	External fault 2	H0-01	0	Inactive
			1	External fault 2 is triggered.

Control word 2 (U8-08)

Bit	Name	Param.	Value	Description
0	External alarm 1	H0-02	0	Inactive
			1	External alarm 1 is triggered.
1	External alarm 2	H0-03	0	Inactive
			1	External alarm 2 is triggered.
2 to 3	Reserved	-	-	-
4 to 7	Multi-reference data selection	C6-01 to C6-04	0 to 15	See C6-01 to C6-04. One of the fixed values of C6-05 to C6-20 is selected as the multi-reference output value.
8	Command channel selection	A9-00	0	Activate reference channel 1 When the default configuration is not enabled, select b1/b2 as the control channel.
			1	Activate reference channel 2 When the default configuration is not enabled, select b3/b4 as the control channel.
9	Reference channel selection	A9-01	0	Activate setpoint channel 1 Select group C0/C1 as the setpoint channel.
			1	Activate setpoint channel 2 Select group C2/C3 as the setpoint channel.
10 to 15	Reserved	-	-	-

4.1.5 Status Word

Status word 1 (U8-09)

Bit	Name	Value	Description
0	Ready to switch on	0	The drive is faulty or external conditions are not met. (See the description of "Power-on blocked".)
		1	Switch-on preparation is done. The value is fixed to 1 no matter whether an operation permission command (OFF1) is available.
1	Ready to run	0	No start command
		1	The value is fixed to 1 no matter whether an operation permission command is received after a startup command is received and the bus voltage is established.
2	Run	0	No operation permission signal is available.
		1	The value is 1 during normal operation.
3	Fault activation	0	No fault
		1	Fault activated
4	Output lockout (OFF2)	0	Output lockout activated
		1	Output lockout not activated
5	Reserved	-	-

Bit	Name	Value	Description
6	Startup lockout	0	Normal
		1	External conditions are not met (OFF2 activated) or a fault occurs.
7	Alarm or minor fault	0	Normal
		1	A minor fault occurs or an alarm is generated.
8	Reserved	-	-
9	Remote control permission	0	The control channel is disabled, and commissioning is controlled by InoDriveStudio.
		1	Command channel control allowed
10	Reserved	-	-
11	Reserved	-	-
12	Reserved	-	-
13	Reserved	-	-
14	Reserved	-	-
		-	-
15	IGBT operation	0	IGBT is in the lockout state.
		1	IGBT has been triggered.

Status word 2 (U8-10)

Bit	Name	Value	Description
0-2	Reserved	-	-
3	Normal operation	0	Non-operational
		1	OFF1 command used as the start command
4 to 5	Reserved	-	-
6	Parameter auto-tuning	0	Parameter auto-tuning not performed
		1	Parameter auto-tuning in progress
7	Minor fault activated	0	No minor fault currently
		1	Minor fault activated
8	Alarm activated	0	No alarm currently
		1	Alarm activated
9 to 10	Reserved	-	-
11	SOP-20-880 local control activated	0	SOP-20 local control not activated
		1	SOP-20 local control is activated using the Loc/Rem key on SOP-20, which replaces the control channel for controlling the drive operation.
12 to 15	Reserved	-	-

4.1.6 State Machine

The following table shows the state machines included in the AFE.

Status	Name	Description
S1	System initialization	The program is initialized and waits for control voltage establishment. The system enters status S4 when conditions are met.
S2	Power-on inspection	The system directly enters status S6 if no power-on auto-inspection item is selected.
S3	Fault	The system enters status S3 when a fault occurs in any states except S20 and S21. The system enters status S4 after all faults are reset and cleared.

Status	Name	Description
S4	Startup lockout	When OFF2 is set to 1 and OFF1 is set to 0, the system enters status S5. When OFF2 is set to 0 or OFF1 is set to 1, the system stays in status S4.
S5	Ready to switch on	Waiting for startup When the rising edge is generated by OFF1 command, the system enters status S2.
S6	Pre-charge	Pre-charging in progress When charging is done and the main breaker feedback signal is received, the system enters status S7. When the hold time of status S6 exceeds the preset time (15s by default) defined by E7-10, a soft start error is reported.
S7	Ready to run	The system enters status S9 after receiving the operation permission signal.
S9	Pre-operational inspection	The system executes the selected pre-operational inspection items. If no item is selected, the system skips this state to enter status S12.
S12	Run	Normal operational state S5 (OFF1 = 0) S4 (OFF2 = 0)
S20	Parameter recovery	Parameter recovery in progress The system enters status S4 after parameters are restored to default values.
S21	Parameter download	Parameters are being downloaded through SOP-20-880. The system enters status S4 after the download is done.

4.1.7 Terminal Start/Stop Block

The HCU-40 supports two groups of terminal start/stop modules (terminal module 1 and terminal module 2), both of which share the same functions and can be switched over. Only one terminal start/stop module is active at a time.

The terminal start/stop module outputs three command words: start command (OFF1), operation command, and reset command.

The two groups of terminal start/stop modules are generally configured for different control modes, which allows you to switch among different control modes by selecting different modules.

4.1.7.1 Terminal Start/Stop Block Switchover

The two groups of terminal start/stop blocks support online switchover. For technical data on output command switchover of terminal start/stop block, see the following table.

Table 4–3 Technical data of output command switchover

Param.	Effective terminal start/stop block (b5/-00)	OFF1 (b5/-01)	Operation permission	Reset command
b5-04 = 0	0: Block 1	b5-02 b5-05 [b5-06] [b5-07]	[b5-08]	[b5-09]
b5-04 = 1	1: Block 2	b5-03 b5-10 [b5-11] [b5-12]	[b5-13]	[b5-14]

4.1.7.2 Basic Parameters of the Terminal Start/Stop Block

Set the terminal start/stop block through the following five basic parameters: mode, input 1, input 2, operation command source, and reset command source. For parameter functions, see the following table.

Table 4–4 Basic parameter table

Param.	Name	Function
b5-00	Effective terminal start/stop block	Displays the effective terminal start/stop block. 0: Block 1 1: Block 2
b5-01	Terminal start/stop block OFF1 state	Displays the OFF1 status of the terminal start/stop block.
b5-02	[Block 1] OFF1 state	Displays the OFF1 state of terminal start/stop block 1.
b5-03	[Block 2] OFF1 state	Displays the OFF1 state of terminal start/stop block 2.
b5-04	Terminal start/stop block 1/2 selection	Used to select the terminal start/stop block. b5-04 = 0: Terminal start/stop block 1 b5-04 = 1: Terminal start/stop block 2
b5-05	[Block 1] mode	Used to set the control mode of terminal start/stop block 1. 0: Level mode IN1 (1) 1: IN1 (1), IN2 (0->1) Edge trigger mode 1 2: IN1 (1), IN2 (0->1 hold) Edge trigger mode 2 3: IN1 (0->1), IN2 (0) Edge trigger mode 3 For details, see *"4.1.7.3 Terminal Start/Stop Mode: Level Mode" on page 52* and *"4.1.7.6 Terminal Start/Stop Mode: Edge Trigger Mode 3" on page 54*
b5-06	[Block 1] input 1	Used to set the input 1 source of terminal start/stop block 1.
b5-07	[Block 1] input 2	Used to set the input 2 source of terminal start/stop block 1.
b5-08	[Block 1] Operation command source	Used to set the operation command source of terminal start/stop block 1.
b5-09	[Block 1] reset signal source	Used to set the reset command source of terminal start/stop block 1.

Param.	Name	Function
b5-10	[Block 2] mode	Used to set the control mode of terminal start/stop block 2. 0: Level mode IN1 (1) 1: IN1 (1), IN2 (0->1) Edge trigger mode 1 2: IN1 (1), IN2 (0->1 hold) Edge trigger mode 2 3: IN1 (0->1), IN2 (0) Edge trigger mode 3 For details, see *"4.1.7.3 Terminal Start/Stop Mode: Level Mode" on page 52* and *"4.1.7.6 Terminal Start/Stop Mode: Edge Trigger Mode 3" on page 54*
b5-11	[Block 2] input 1	Used to set the input 1 source of terminal start/stop block 2.
b5-12	[Block 2] input 2	Used to set the input 2 source of terminal start/stop block 2.
b5-13	[Block 2] operation command source	Used to set the operation command source of terminal start/stop block 2.
b5-14	[Block 2] reset signal source	Used to set the reset command source of terminal start/stop block 2.

4.1.7.3 Terminal Start/Stop Mode: Level Mode

When b5-05/b5-10 is set to 0, the level mode is active.

When the level mode is active, the high/low level state of input 1 determines the status of OFF1, which is used to control start/stop of the drive, with OFF2 deactivated. When input 1 is high level, OFF1 is active. When input 1 is low level, OFF1 is inactive.

Table 4–5 Technical data

Block selection [b5-04]	Mode selection b5-05/b5-10	Block 1 input 1 [b5-06]	Block 1 input 2 [b5-07]	Block 2 input 1 [b5-11]	Block 2 input 2 [b5-12]	Output OFF1 state b5-01
0	0	0	x	x	x	0
Terminal block 1	0	1	x	x	x	1
1	0	x	x	0	x	0
Terminal block 2	0	x	x	1	x	1

For example, use DI1 to start/stop the device, as shown in *"Figure 4-2 Example of level mode" on page 52*. For parameter setting, see *"Table 4-6 Parameter setting" on page 53*.

K1	Start command
Close	Start
Open	Stop

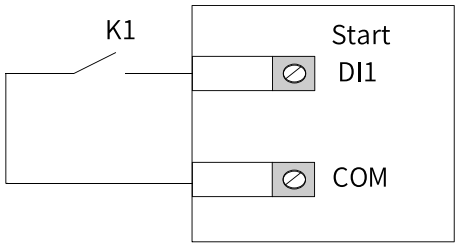


Figure 4-2 Example of level mode

Table 4–6 Parameter setting

Param.	Value	Description
b5-04	0	Used to select terminal start/stop block 1.
b5-05	0	Used to select the level mode.
b5-06	U0-02 (1002)	Used to set DI1 as the start/stop command source.

4.1.7.4 Terminal Start/Stop Mode: Edge Trigger Mode 1

When b5-05/b5-10 is set to 1, edge trigger mode 1 is active.

In edge trigger mode 1, when input 1 is high level and the rising edge of input 2 changes, OFF1 is 1. When input 1 is low level, OFF1 is 0. After OFF1 is set to 1, input 2 changes from high level to low level, and OFF1 remains at 1. In this mode, input 2 is normally connected to the momentary start button and input 1 is normally connected to the OFF switch of the NC contact.

Table 4–7 Technical data

Block selection [b5-04]	Mode selection b5-05/b5-10	Block 1 input 1 [b5-06]	Block 1 input 2 [b5-07]	Block 2 input 1 [b5-11]	Block 2 input 2 [b5-12]	Output OFF1 state b5-01
0	1	0	x	x	x	0
Terminal block 1	1	1	0→1	x	x	1
1	1	x	x	0	x	0
Terminal block 2	1	x	x	1	0→1	1

For example, use DI1/DI2 to start/stop the device, as shown in *"Figure 4-3 Example" on page 53*. For parameter setting, see *"Table 4-8 Parameter setting" on page 53*.

K1	K2	Start command
Open	Close	Stop
↑	Close	Start
Open	Open	Stop
Close	Open	Stop

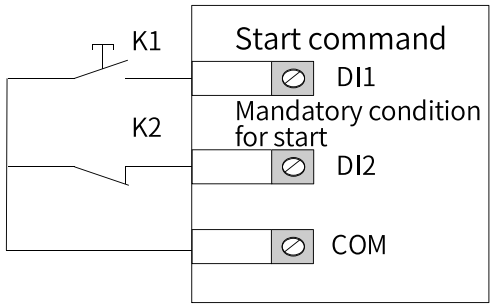


Figure 4-3 Example

Table 4–8 Parameter setting

Param.	Value	Description
b5-04	0	Used to select terminal start/stop block 1.
b5-05	1	Used to select edge trigger mode 1.
b5-06	U0-03 (1003)	Device stop through DI2
b5-07	U0-02 (1002)	Device start through DI1

4.1.7.5 Terminal Start/Stop Mode: Edge Trigger Mode 2

When b5-05/b5-10 is set to 2, edge trigger mode 2 is active.

In edge trigger mode 2, when input 1 is high level and input 2 is high level at the rising edge, OFF1 is 1. When either of inputs 1 and 2 is low level, OFF1 is 0. That is, when OFF1 is active, input 2 must be 1. Otherwise, OFF1 changes to 0. In this mode, input 2 is normally connected to the latching start switch, and input 1 is normally connected to the OFF switch of the NC contact.

Block selection [b5-04]	Mode selection b5-05/b5-10	Block 1 input 1 [b5-07]	Block 1 input 2 [b5-07]	Block 2 input 1 [b5-11]	Block 2 input 2 [b5-12]	Output OFF1 state b5-01
0 Terminal block 1	2	0	1	x	x	0
	2	x	0	x	x	0
	2	1	0→1	x	x	1
1 Terminal block 2	2	x	x	0	x	0
	2	x	x	x	0	0
	2	x	x	1	0→1	1

For example, use DI1/DI2 to start/stop the device, as shown in *"Figure 4-4 Edge trigger mode 2" on page 54*. For parameter setting, see *"Table 4-9 Parameter setting" on page 54*.

K1	K2	Start command
Open	Close	Stop
Close	Close	Start
Open	Open	Stop
Close	Open	Stop

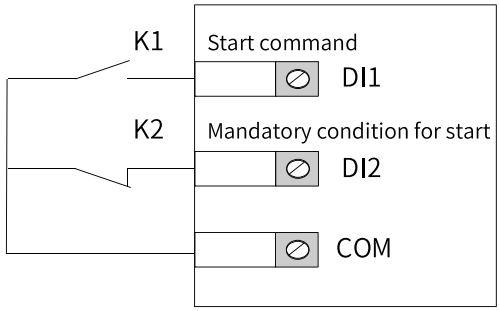


Figure 4-4 Edge trigger mode 2

Table 4–9 Parameter setting

Param.	Value	Description
b5-04	0	Used to select terminal start/stop block 1.
b5-05	2	Used to select edge trigger mode 2.
b5-06	U0-03 (1003)	Device stop through DI2
b5-07	U0-02 (1002)	Device start/stop through DI1

4.1.7.6 Terminal Start/Stop Mode: Edge Trigger Mode 3

When b5-05/b5-10 is set to 3, edge trigger mode 3 is active.

When edge trigger mode 3 is active, if input 2 is low level and input 1 is at the rising edge, the value of OFF1 is 1. When input 2 is high level, the value of OFF1 is 0. When the value of OFF1 is 1, input 1 does not need to keep high level. In this mode, input 1 is normally connected to the momentary start button, and input 2 is normally connected to the momentary stop button.

Block selection [b5-04]	Mode selection b5-05/b5-10	Block 1 input 1 [b5-06]	Block 1 input 2 [b5-06]	Block 2 input 1 [b5-11]	Block 2 input 2 [b5-12]	Output OFF1 state b5-01
0	3	x	1	x	x	0
Terminal block 1	3	0→1	0	x	x	1
1	3	x	x	x	1	0
Terminal block 2	3	x	x	0→1	0	1

For example, use DI1/DI2 to start/stop the device, as shown in *"Figure 4-5 Example of edge trigger mode 3" on page 55*. For parameter settings, see *"Table 4-10 Parameter settings" on page 55*.

K1	K2	Start command
Open	Open	Stop
↑	Open	Start
Open	Close	Stop
Close	Close	Stop

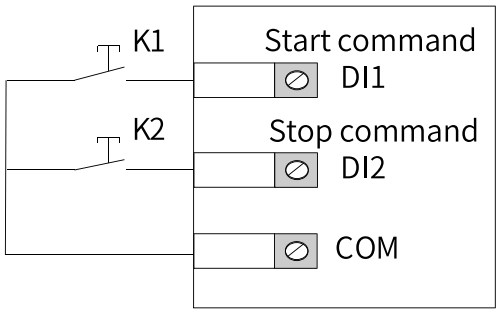


Figure 4-5 Example of edge trigger mode 3

Table 4–10 Parameter settings

Param.	Value	Description
b5-04	0	Used to select terminal start/stop block 1.
b5-05	3	Used to select edge trigger mode 3.
b5-06	U0-02 (1002)	Device start through DI1
b5-07	U0-03 (1003)	Device stop through DI2

4.2 Setpoint Channel

4.2.1 Voltage Reference

The HCU-40 supports two voltage setting channels. These two channels are completely independent of each other. The voltage setting channel can be switched online through A9-01. The voltage reference is set as a percentage. The base value of the voltage reference can be viewed through d3-00.

- 400 V device: The voltage reference base value is 600 V.
- 500 V device: The voltage reference base value is 750 V.
- 690 V device: The voltage reference base value is 1050 V.

Table 4–11 Voltage setting channel selection

Channel selection	Param.	Name	Description
A9-01 = 0 Channel 1	C0-00	[Channel 1] Voltage reference source	0: Parameter 1: Multi-reference value 1 2: Calculated based on the preset grid voltage 6: Multi-reference setting 7: Motorized potentiometer output Others: K connector
	C0-01	[Channel 1] Digital setting of the voltage	Digital setting of the voltage value
	C0-02	[Channel 1] Actual effective voltage	Actual voltage setpoint after being limited
	C0-03	[Channel 1] Voltage reference upper limit	400 V device: 510 V to 720 V 690 V device: 700 V to 1150 V
	C0-04	[Channel 1] Voltage reference lower limit	
	C0-05	[Channel 1] Voltage rise ramp setting	Voltage reference ramp
	C0-06	[Channel 1] Voltage drop ramp setting	Voltage reference ramp
A9-01 = 1 Channel 2	C2-00	[Channel 2] Voltage setting source	0: Parameter 1: Multi-reference value 1 2: Calculated based on the preset grid voltage 6: Multi-reference setting 7: Motorized potentiometer output Others: K connector
	C2-01	[Channel 2] Digital setting of the voltage	Digital setting of the DC voltage value
	C2-02	[Channel 2] Actual effective voltage	Actual voltage setpoint after being limited
	C2-03	[Channel 2] Voltage reference upper limit	400 V device: 510 V to 720 V 690 V device: 700 V to 1150 V
	C2-04	[Channel 2] Voltage reference lower limit	
	C2-05	[Channel 2] Voltage rise ramp setting	Voltage reference ramp
	C2-06	[Channel 2] Voltage drop ramp setting	Voltage reference ramp

4.2.2 Current Reference

The HCU-40 supports two current reference channels. These two channels are completely independent of each other. The current reference channels can be switched online through A9-01. The current reference is set as a percentage. The base value of the AC current reference can be viewed through d3-01. The current reference base value is related to the rated current of the device.

- In the single mode, the current reference base value (d3-01) is the same as the rated current of the device (A2-03).
- In the parallel mode, the current reference base value (d3-01) is equal to the rated current of the device (A2-03) multiplied by the number of parallel units. View the related parameters in group A15.

Table 4–12 Current reference channel selection

Channel selection	Param.	Name	Description
A9-01 = 0 Channel 1	C1-00	[Channel 1] current reference source	0: Parameter 1: Multi-reference value 1 6: Multi-reference setting 7: Motorized potentiometer output value Other: K connector
	C1-01	[Channel 1] Current digital reference	Digital reference of the current value
	C1-02	[Channel 1] Actual effective current	Actual effective current reference after being limited
	C1-03	[Channel 1] Positive current limit	Effective value of positive current reference limit in the current control mode
	C1-04	[Channel 1] Negative current limit	Effective value of negative current reference limit in the current control mode
	C1-05	[Channel 1] Current reference upper limit	Upper limit of the current reference in the current control mode
	C1-06	[Channel 1] Current reference lower limit	Lower limit of the current reference in the current control mode
A9-01 = 1 Channel 2	C3-00	[Channel 2] Current reference source	0: Parameter 1: Multi-reference value 1 6: Multi-reference value x AC current reference base value 7: Motorized potentiometer output value Other: K connector
	C3-01	[Channel 2] Digital setting of the current	Digital setting of the current value
	C3-02	[Channel 2] Actual effective current	Actual effective current reference after being limited
	C3-03	[Channel 2] Positive current limit	Effective value of positive current reference limit in the current control mode
	C3-04	[Channel 2] Negative current limit	Effective value of negative current reference limit in the current control mode
	C3-05	[Channel 2] Current reference upper limit	Upper limit of the current reference in the current control mode
	C3-06	[Channel 2] Current reference lower limit	Lower limit of the current reference in the current control mode

4.2.3 Motorized Potentiometer

The motorized potentiometer functions are shown in *"Figure 4-6 Motorized potentiometer functions" on page 58*.

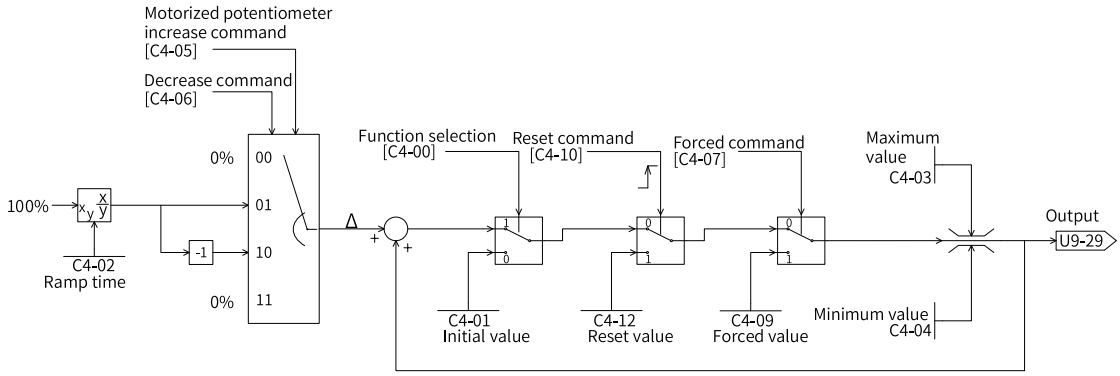


Figure 4-6 Motorized potentiometer functions

When the local control is active through SOP-20-880, you can use SOP-20-880 to increase or decrease the motorized potentiometer.

For details on motorized potentiometer function parameters, see the following table.

Parameter	Name	Function description	Setpoint
C4-00	Motorized potentiometer function	0: Inhibited 1: Non-retentive upon power failure 2: Retentive upon power failure	-
C4-01	Initial value of motorized potentiometer	Indicates the initial value after power-on of the motorized potentiometer when C4-00 is set to 1.	-600.0% to +600.0%
C4-02	Ramp time of motorized potentiometer	Defines the time for increasing from 0% to 100% (or time for decreasing from 100% to 0%).	0.1s to 3000.0s
C4-03	Maximum value of motorized potentiometer	Upper output limit	-600.0% to +600.0%
C4-04	Minimum value of motorized potentiometer	Lower output limit	-600.0% to +600.0%

Parameter	Name	Function description	Setpoint
C4-05	Value increase source of motorized potentiometer	Used to set the decreasing command source of the motorized potentiometer.	0: 0 1: 1 2: DI1 3: DI2 4: DI3 5: DI4 6: DI5 7: DI6 8: DIL 9: HDI1 10: HDI2 Others: B connector
C4-06	Value decrease source of motorized potentiometer		
C4-07	Motorized potentiometer forcing source	Used to set the force command source of the motorized potentiometer.	Same as C4-05
C4-08	Source of motorized potentiometer force value	Defines the source of the force value.	0: 0 1: 100% 2: Parameter Other: K connector
C4-09	Force value setting of motorized potentiometer	Defines the force value of digital setting.	-600.0% to +600.0%
C4-10	Source of reset command of motorized potentiometer	Used to set the reset command source of the motorized potentiometer.	Same as C4-05
C4-11	Source of motorized potentiometer reset value	Defines the source of the reset value.	0: 0 1: 100% 2: Parameter Other: K connector
C4-12	Reset value of motorized potentiometer	Reset value of digital setting	-600.0% to +600.0%

4.2.4 Multi-reference Setting

In the multi-reference mode, you need to set the multi-reference selection as required. Configure the parameters as follows.

Table 4–13 Parameter setting

Param.	Name	Setpoint
C6-01	Multi-reference selection 1	0: 0 1: 1 2: DI1 3: DI2 4: DI3 5: DI4 6: DI5 7: DI6 8: DIL 9: HDI1 10: HDI2 Others: B connector
C6-02	Multi-reference selection 2	Same as C6-01
C6-03	Multi-reference selection 3	Same as C6-01
C6-04	Multi-reference selection 4	Same as C6-01
C6-05	Multi-reference 1	-600.0% to +600.0%
C6-06	Multi-reference 2	-600.0% to +600.0%
C6-07	Multi-reference 3	-600.0% to +600.0%
C6-08	Multi-reference 4	-600.0% to +600.0%
C6-09	Multi-reference 5	-600.0% to +600.0%
C6-10	Multi-reference 6	-600.0% to +600.0%
C6-11	Multi-reference 7	-600.0% to +600.0%
C6-12	Multi-reference 8	-600.0% to +600.0%
C6-13	Multi-reference 9	-600.0% to +600.0%
C6-14	Multi-reference 10	-600.0% to +600.0%
C6-15	Multi-reference 11	-600.0% to +600.0%
C6-16	Multi-reference 12	-600.0% to +600.0%
C6-17	Multi-reference 13	-300.0% to +300.0%
C6-18	Multi-reference 14	-300.0% to +300.0%
C6-19	Multi-reference 15	-300.0% to +300.0%
C6-20	Multi-reference 16	-300.0% to +300.0%

The HCU-40 supports 16 multi-references. Select the multi-reference through C6-01 to C6-04. 0000 (binary) to 1111 (binary) correspond to multi-reference setpoints 1 to 16 respectively. You can view the multi-reference setpoints through C6-00.

Table 4–14 Parameters related to multi-reference setpoints

[C6-01]	[C6-02]	[C6-03]	[C6-04]	U9-30 Effective multi-reference value	Connector
0	0	0	0	C6-05	U9-31
1	0	0	0	C6-06	U9-32
0	1	0	0	C6-07	U9-33
1	1	0	0	C6-08	U9-34
0	0	1	0	C6-09	U9-35
1	0	1	0	C6-10	U9-36
0	1	1	0	C6-11	U9-37
1	1	1	0	C6-12	U9-38

[C6-01]	[C6-02]	[C6-03]	[C6-04]	U9-30 Effective multi-reference value	Connector
0	0	0	1	C6-13	U9-39
1	0	0	1	C6-14	U9-40
0	1	0	1	C6-15	U9-41
1	1	0	1	C6-16	U9-42
0	0	1	1	C6-17	U9-43
1	0	1	1	C6-18	U9-44
0	1	1	1	C6-19	U9-45
1	1	1	1	C6-20	U9-46

5 Self-test and Auto-tuning

5.1 Phase Sequence Self-test

During on-site application or production assembly, the three-phase AC voltage sampling RST and three-phase current sampling RST are often incorrectly mapped. As a result, overcurrent or overvoltage occurs upon startup of the active rectifier, making it difficult to quickly and accurately troubleshoot the problem. In this case, start phase sequence self-test. The software detects the sampling relationship between the three-phase power supply voltage and three-phase current, and automatically adjusts the corresponding relationship to reduce commissioning time and difficulty.

Three different self-test modes can be set through b7-02, as shown below.

- If phase sequence self-test has been performed and the wiring is not changed, self-test is not necessary. In this case, set b7-02 to 0.
- If phase sequence self-test is not performed or the correctness of wiring cannot be verified, set b7-02 to 1 to perform self-test once before operation.
- If wiring needs to be changed frequently during use of the active rectifier, set b7-02 to 2 to perform self-test every time before operation.

Param.	Setpoint	Description
b7-02	0	No self-test
	1	Self-test performed only once
	2	Self-test performed continuously

During phase sequence self-test, the state machine is S9 (Pre-operational detection). A single-shot self-test lasts about 8 seconds. The self-test results can be viewed through d1-00. After self-test is done, normal operation applies. In this case, the state machine enters S12 (Operational).

5.2 Capacitor Auto-tuning

In multi-drive applications with a common DC bus, the power and quantity of drives are variable. The active rectifier operates in voltage mode, regulating the common DC bus voltage to the setpoint. The regulator parameters of the outer voltage loop are directly related to the capacitance on the DC bus.

The software detects the total capacitance on the DC bus (including the rated capacity configured by the rectifier and the capacitance of other drives) and automatically adjusts the regulator parameters of the voltage loop to improve the dynamic response performance.

Three different auto-tuning modes can be set through b7-08:

- If capacitor auto-tuning is performed and the rear load capacitance does not change, set b7-08 to 0. In this case, capacitor auto-tuning is not required.
- If capacitor auto-tuning is not performed or the rear load capacitance is uncertain, b7-08 is set to 1 to enable capacitor auto-tuning before initial operation.
- If the downstream load capacitance may change during operation, set b7-08 to 2 to enable capacitor auto-tuning every time before operation.

If the load changes slowly and fast dynamic response is not required, set b7-08 to 0 to skip capacitor auto-tuning.

The rated capacity of the DC bus of the active rectifier can be viewed in d2-00, and the capacitor auto-tuning result can be viewed in d2-01.

If the total capacitance in the DC bus is known, you can manually set d2-01 based on the total capacitance on the DC bus without capacitor auto-tuning.

Param.	Value range	Description
b7-08	0	Not perform auto-tuning
	1	Perform auto-tuning once
	2	Perform auto-tuning each time before operation

If the auto-tuned capacitance deviates greatly from the actual bus capacitance, you can switch the auto-tuning scheme by setting E0-45 to 1 [New scheme] and perform auto-tuning again to improve the auto-tuning accuracy.

Note

- The active rectifier can be configured with an inverter with rated power not higher than 4 x rectifier power.
- The capacitance d2-01 auto-tuned or manually set must be within the range of 0.5 to 10 x rated capacitance d2-00 of the active rectifier. If this range is exceeded, F87-3 (DC bus capacitance out of range) can be triggered. If the total capacitance on the DC bus exceeds 10 x rated capacitance, capacitor auto-tuning is not required. The capacitance set manually (d2-01) cannot exceed 10 x rated capacitance.
- The capacitor auto-tuning function is active only in the voltage mode.

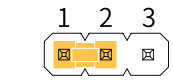
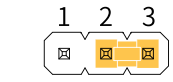
6 Control Interface

The HCU-40 controller is equipped with seven DIs (DI1 to DI6, DIL), two HDIs, three ROs, two HDOs, two AIs, and two AOs as standard. You can set related parameters in group F.

6.1 Digital Input (DI)

The HCU-40 controller is equipped with seven DI signals as standard. The two HDIs can be configured as DI signals.

Before using the DI terminal, configure DI internal/external power supplies and jumper J16 as required, as shown in the following table.

Diagram	Description
	Shorting DGND and DICOM allows DIs to be powered up by 24 VDC internal power supply.
	Disconnecting DGND from DICOM allows DIs to be powered up by an external power supply.

Forced DI function

The DI input status supports the forced function. F0-02 is used to select the DI to be set forcedly, and F0-03 is used to set the forced DI status. One bit corresponds to the status of one DI. bit0 to bit5 correspond to DI1 to DI6, and bit6, bit7, and bit8 correspond to DIL, HDI1, and HDI2 respectively. For details on the forced DI status, see the following table.

Table 6–1 Forced DI status

F0-02		DI1 (U0-02)	DI2 (U0-03)	DI3 (U0-04)	DI4 (U0-05)	DI5 (U0-06)	DI6 (U0-07)	DIL U0-08	HDI1 (U0-09)	HDI2 (U0-10)
bit0	0	Hardware DI1	x	x	x	x	x	x	x	x
	1	F0-03 (bit0)	x	x	x	x	x	x	x	x
bit1	0	x	Hardware DI2	x	x	x	x	x	x	x
	1	x	F0-03 (bit1)	x	x	x	x	x	x	x
bit2	0	x	x	Hardware DI3	x	x	x	x	x	x
	1	x	x	F0-03 (bit2)	x	x	x	x	x	x

F0-02		DI1 (U0-02)	DI2 (U0-03)	DI3 (U0-04)	DI4 (U0-05)	DI5 (U0-06)	DI6 (U0-07)	DIL U0-08	HDI1 (U0-09)	HDI2 (U0-10)
bit3	0	x	x	x	Hardware DI4	x	x	x	x	x
	1	x	x	x	F0-03 (bit3)	x	x	x	x	x
bit4	0	x	x	x	x	Hardware DI5	x	x	x	x
	1	x	x	x	x	F0-03 (bit4)	x	x	x	x
bit5	0	x	x	x	x	x	Hardware DI6	x	x	x
	1	x	x	x	x	x	F0-03 (bit5)	x	x	x
bit6	0	x	x	x	x	x	x	Hardware DIL	x	x
	1	x	x	x	x	x	x	F0-03 (bit6)	x	x
bit7	0	x	x	x	x	x	x	x	Hardware HDI1	x
	1	x	x	x	x	x	x	x	F0-03 (bit7)	x
bit8	0	x	x	x	x	x	x	x	x	Hardware HDI2
	1	x	x	x	x	x	x	x	x	F0-03 (bit8)
bit9 to bit15	x	x	x	x	x	x	x	x	x	x

DI delay

Each DI of HCU-40 supports settings of switch-on delay time and switch-off delay time, which support DI filtering, as shown in Figure 4-11. When the hold time of the DI signal state is shorter than the set time, the DI state remains in the original state. Set the switch-on delay time and switch-off delay time for each DI through F0-04 to F0-21.

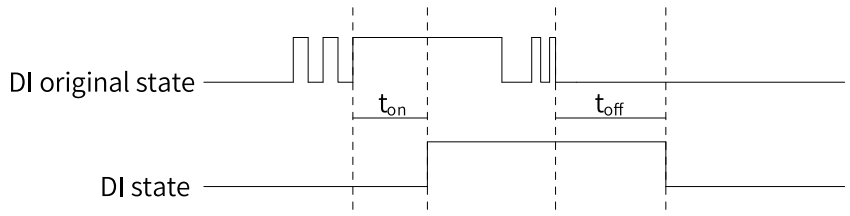


Figure 6-1 DI delay

DI connector

When DI is used for drive control or other related operations, associate corresponding parameters with the DI connector. Two groups of bit connectors are available for DI status.

Table 6–2 DI connector parameter

Param.	Description	Param.	Description
U0-02	DI1 status	U0-12	DI1 status inverted
U0-03	DI2 status	U0-13	DI2 status inverted
U0-04	DI3 status	U0-14	DI3 status inverted
U0-05	DI4 status	U0-15	DI4 status inverted
U0-06	DI5 status	U0-16	DI5 status inverted
U0-07	DI6 status	U0-17	DI6 status inverted
U0-08	DIL status	U0-18	DIL status inverted
U0-09	HDI1 status	U0-19	HDI1 status inverted
U0-10	HDI2 status	U0-20	HDI2 status inverted

Note

In HCU-40 controller, DI3 is set as the feedback signal source of the main circuit breaker forcibly. Low level indicates that the main breaker is disconnected, and high level indicates that the main breaker is closed. HDI1 is set as the reactor overtemperature detection signal forcibly. In this case, low level indicates that the reactor is overheated, and high level indicates that the reactor temperature is normal.

6.2 Digital Output (DO)

The HCU-40 supports three ROs and two HDOs that used as DOs, each of which can be set with switch-on delay and switch-off delay. The ROs and HDOs support positive and negative logic processing functions through F1-17 settings. When the negative logic is valid, logic 0 indicates that output (normally open) is valid and logic 1 indicates that output (normally open) is invalid.

F1-00 indicates the status of the DO source signal, and F1-01 indicates the status after the delay logic and negative logic processing.

Note

In the HCU-40 controller, the RO1 signal is forcibly used for the main circuit breaker control and the RO3 power for the auxiliary contactor control and the signal source cannot be set.

6.3 Analog Input (AI)

The HCU-40 supports two AI inputs (current signal input or voltage signal input).

Before using AI, check whether the external signal is a current signal or a voltage signal and then set jumpers J14 and J15 properly. Then, set F2-04 and F2-05 properly.

Table 6–3 Jumper J14: Current or voltage signal input selection for AI1

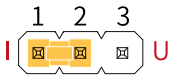
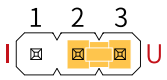
Diagram	Description
	AI1 current signal input applied if 1 and 2 are shorted
	AI1 voltage signal input applied if 2 and 3 are shorted

Table 6–4 Jumper J15: Current and voltage signal selection for AI2

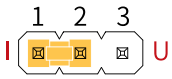
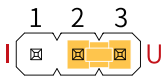
Diagram	Description
	AI2 current signal input applied if 1 and 2 are shorted
	AI2 voltage signal input applied if 2 and 3 are shorted

Table 6–5 AI parameter setting

Param.	Name	Description
F2-00	AI1 input value	Displays the input value of AI1.
F2-01	AI1 input scaling	Displays the corresponding percentage of AI1 input.
F2-02	AI2 input value	Displays the input value of AI2.
F2-03	AI2 input scaling	Displays the corresponding percentage of AI2 input.
F2-04	AI1 type	Used to set the input signal type of AI1. Perform the jumper settings and cable connection properly at the HCU end. For details, see *HCU Control Unit Hardware Guide*. 0: –10 V to +10 V 1: 0 V to 10 V 2: -20 mA to +20 mA 3: 0 mA to 20 mA 4: 4 mA to 20 mA
F2-05	AI2 type	Used to set the input signal type of AI2. Perform the jumper settings and cable connection properly at the HCU end. For details, see *HCU Control Unit Hardware Guide*. 0: –10 V to +10 V 1: 0 V to 10 V 2: -20 mA to +20 mA 3: 0 mA to 20 mA 4: 4 mA to 20 mA

Param.	Name	Description
F2-06	Minimum input value of AI1 curve	Used to calibrate AI1.
F2-07	Minimum input scaling of AI1 curve	
F2-08	Max. input value of AI1 curve	
F2-09	Max. input scaling of AI1 curve	
F2-10	Minimum input value of AI2 curve	Used to calibrate AI2.
F2-11	Minimum input scaling of AI2 curve	
F2-12	Max. input value of AI2 curve	
F2-13	Max. input scaling of AI2 curve	
F2-14	Selection when AI value lower than the set minimum input	Ones-: Selection when AI1 value < minimum input value 0: Minimum input scaling applied 1: 0.0% applied Tens-: Selection when AI2 value < minimum input value 0: Minimum input scaling applied 1: 0.0% applied
F2-15	AI1 filter time	Defines the AI filter time.
F2-16	AI2 filter time	
F2-17	AI1 denoising threshold	Defines the denoising threshold. When the AI input fluctuation is lower than the threshold, the AI input scaling remains unchanged.
F2-18	AI2 denoising threshold	
F2-19	Zero-crossing threshold of AI setting	When the AI input value is lower than the threshold, the AI input value is 0.
F2-20	AI1 selection	Used to enable or disable AI1. When this parameter is disabled, AI1 is set to 0 forcibly.
F2-21	AI2	Used to enable or disable AI2. When this parameter is disabled, AI2 is set to 0 forcibly.
F2-22	AI1 open circuit monitoring threshold	0 mA to 4.000 mA
F2-23	AI2 open circuit monitoring threshold	0 mA to 4.000 mA
F2-24	AI1 open circuit monitoring delay	0s to 1.000s
F2-25	AI2 open circuit monitoring delay	0s to 1.000s
F2-26	AI open circuit monitoring	Used to enable or disable open circuit monitoring, which is active only when upon current signal input. When the AI input value keeps lower than the set value for the set time, open circuit occurs on AI.

6.4 Analog Output (AO)

The HCU-40 supports two AOs with voltage and current signal types. Before using AOs, set J18 to J19 properly.

Table 6–6 Jumper J18: AO1 current and voltage signal selection

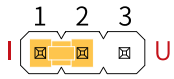
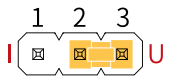
Diagram	Description
	Current signal applies if pins 1 and 2 are shorted.
	Voltage signal applies if pins 2 and 3 are shorted.

Table 6–7 Jumper J19: AO2 current and voltage signal selection

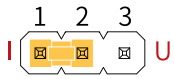
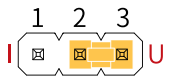
Diagram	Description
	Current signal applies if pins 1 and 2 are shorted.
	Voltage signal applies if pins 2 and 3 are shorted.

Table 6–8 AO parameter setting

Param.	Name	Description
F3-00	AO1 output value	Displays the AO1 output value.
F3-01	AO1 output scaling	Displays the AO1 output percentage.
F3-02	AO2 output value	Displays the AO2 output value.
F3-03	AO2 output scaling	Displays the AO2 output percentage.
F3-04	AO1 signal source	Defines the signal source of AO1 output.
F3-05	AO2 signal source	Defines the signal source of AO2 output.
F3-06	AO1	Defines the signal type of AO1 output. For proper wiring mode, see *HCU Control Unit Hardware Guide*. 0: 0 V to 10 V 1: 0 mA to 20 mA 2: 4 mA to 20 mA
F3-07	AO2 type	Defines the signal type of AO2 output. For proper wiring mode, see *HCU Control Unit Hardware Guide*. 0: 0 V to 10 V 1: 0 mA to 20 mA 2: 4 mA to 20 mA
F3-08	Minimum output scaling of AO1 curve	Defines the AO1 scaling factor.
F3-09	Minimum output value of AO1 curve	
F3-10	Maximum output scaling of AO1 curve	
F3-11	Maximum output value of AO1 curve	

Param.	Name	Description
F3-12	Minimum output scaling of AO2 curve	Defines the AO2 scaling factor.
F3-13	Minimum output value of AO2 curve	
F3-14	Maximum output scaling of AO2 curve	
F3-15	Maximum output value of AO2 curve	

6.5 High-Speed Digital Input (HDI)

The HCU-40 control module supports two HDI signals. For details, see *HCU Control Unit Hardware Guide*.

Note

- The HDI can be used as a DI. When it is set as a DI, see *"6.1 Digital Input (DI)" on page 64* for related parameter setting.
- HDI1 is used as the DI forcibly and HDI1 is used for detecting the reactor overtemperature signal.

6.6 High-speed Digital Output (HDO)

The HCU-40 controller supports two HDO signals. For details, see *HCU Control Unit Hardware Guide*.

Note

HDO can be used as a DO. When it is set as a DO, see for related parameter settings in *"6.2 Digital Output (DO)" on page 66*.

6.7 Input/Output Function Module (HIO)

- The parameter group n7/n8/n9 indicates HIO module selection and status.
- The parameter group n23/n26/n29 indicates DIO, RO, AI, and AO configurations of HIO-10 module.
- The parameter group n24/n27/n30 indicates DIO and RO configurations of HIO-20 module.
- The parameter group n25/n28/n31 indicates DI, DIO, RO, AI, and AO configurations of HIO-30 module.

For details, see the following table.

Param.	Description
n7-02	0: Disable 1: HIO-10 module, n23 active, n24 and n25 hidden 2: HIO-20 module, n24 active, n23 and n25 hidden 3: HIO-30 module, n25 active, n23 and n24 hidden
n8-02	0: Disable 1: HIO-10 module, n26 active, n27 and n28 hidden 2: HIO-20 module, n27 active, n26 and n28 hidden 3: HIO-30 module, n28 active, n26 and n27 hidden
n9-02	0: Disable 1: HIO-10 module, n29 active, n30 and n31 hidden 2: HIO-20 module, n30 active, n29 and n31 hidden 3: HIO-30 module, n31 active, n29 and n30 hidden

The following table describes the parameters of HIO-10 module.

Param.	Description
n7-00 (n8-00 and n9-00)	Used to set the expansion slot where the HIO module is located.
n7-02 (n8-02 and n9-02)	Module type selection 0: Disable 1: HIO-10 2: HIO-20 3: HIO-30
n7-01 (n8-01 and n9-01)	Displays the HIO module online state.
n7-10 (n8-10 and n9-10)	Displays DIO module configuration state.
n7-11 to n7-14 (n8-11 to n8-14, and n9-11 to n9-14)	Displays the input and output states of DI, DIO, and RO.
n7-15 (n8-15 and n9-15)	Displays the AI input state, including AI disconnection and AI limit violation.
n7-20 to n7-25 (n8-20 to n8-25, and n9-20 to n9-25)	Displays the AI input value and AI input scaling.
n7-30 to n7-35 (n8-30 to n8-35, and n9-30 to n9-35)	Displays the AO output scaling and actual AO output value.
n23-00 (n26-00 and n29-00)	Used to set the DI/DIO input filter time.
n23-09 to n23-15 (n26-09 to n26-15, and n29-09 to n29-15)	Used to set the DIO positive/negative logic, signal source, switch-on time, and switch-off time.
n23-20 to n23-23 (n26-20 to n26-23, and n29-20 to n29-23)	Used to set the RO positive/negative logic, signal source, ON delay, and OFF delay.
n23-35 to n23-37 (n26-35 to n26-37, and n29-35 to n29-37)	Used to set the action when AI value is lower than minimum input value, AI disconnection monitoring, and AI zero-crossing threshold.
n23-40 to n23-59 (n26-40 to n26-59, and n29-40 to n29-59)	Used to set AI enable state, AI type[<1>], AI curve parameters, AI filter time, AI denoising threshold, and AI disconnection monitoring threshold and delay.
n23-70 to n23-85 (n26-70 to n26-85, and n29-70 to n29-85)	Used to set the AO signal source, AO type[<1>], and AO curve parameters.

Note

<1>: The function selection of AI type and AO type is consistent with the hardware DIP switch (jumper).

6.7.1 DI or DIO

Before using the DIOs, see *HIO-10 I/O Function Module User Guide* for HIO power supply selection and peripheral circuit wiring.

Take the HIO-10 as an example. When n7-00 and n7-02 are both set to 1, configure DIO1 and DIO2 as DIs or DOs through n23-10 and n23-13. The following figure shows the DIO software functions of HIO. When DI is selected through n23-10/n23-13, the DI signals will be processed with input filter, switch-on delay, switch-off delay, and positive/negative logic processing. When B connector is selected through n23-10/n23-13, configure the DIO as DO and set n23-10/n23-13 as the DO signal source of DIO1/DIO2. The DO signal will be processed with switch-on delay, switch-off delay, and positive/negative logic processing. When B connector is of low level, the output is low level. When B connector is of high level, the output is high level.

The HIO-30 module provides six DIs. Signal processing of DIs is the same as that of DIO used as a DI.

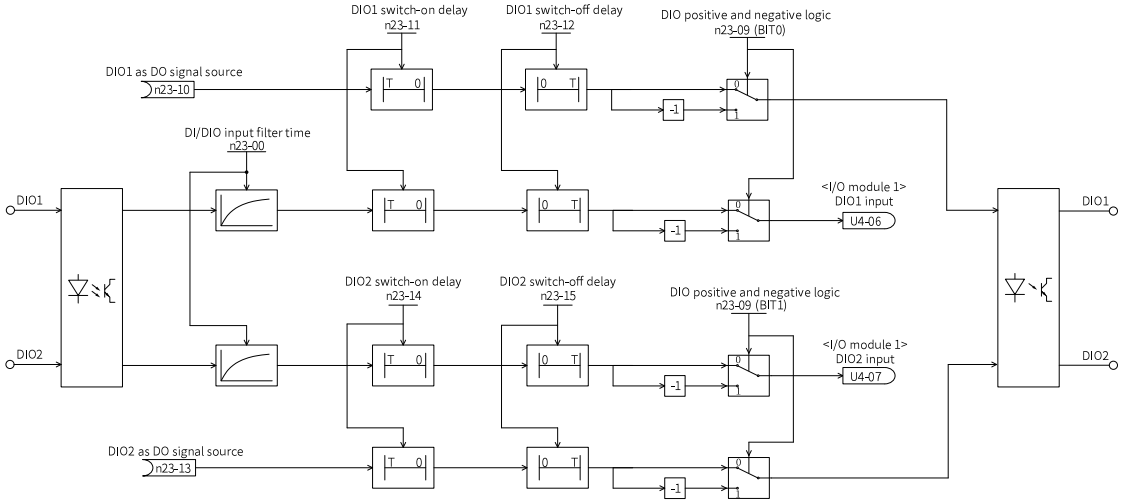


Figure 6-2 DIO software functions of HIO

For DIO function parameters, see the following table.

Param.	Name	Description
n7-10/n8-10/n9-10	Configuration for DIO used as output	The HIO module provides a maximum of six DIOs. DIO1 to DOI6 correspond to bit00 to bit05 of n7-10 respectively. 0: DIO used as DI 1: DIO used as DO
n7-11/n8-11/n9-11	Original status of DI/DIO input	Displays the original status of the DI or DIO that used as DI. bit0 to bit5 display the original status of the DIO that used as DI. bit8 to bit13 display the original status of DI.

Param.	Name	Description
n7-12/n8-12/n9-12	Final status of DI/DIO input	Displays the final input status of the DI or DIO that used as DI after being filtered, delayed, and processed with the positive and negative logic. bit0 to bit5 display the final status of the DIO that used as DI. bit8 to bit13 display the final status of the DI input.
n7-13/n8-13/n9-13	RO/DIO output setting state	Displays the setting status of the RO or DIO that used as DO output. bit0 to bit5 display the setting status of the DIO that used as DO. bit8 to bit13 display the setting status of the RO.
n7-14/n8-14/n9-14	Final status of RO/DIO output	Displays the final status of the RO or DIO that used as DO after being delayed and processed with the positive and negative logic. bit0 to bit5 display the final status of the DIO that used as DO. bit8 to bit13 display the final status of the RO.
n23-10/n26-10/n29-10	DIO1 as DO signal source	DIO1 is used as a DI by default. When n23-10 is configured as B connector, DIO1 is used as a DO. 0: Used as DI Others: B connector
n23-13/n26-13/n29-13	DIO2 as DO signal source	DIO2 is used as a DI by default. When n23-13 is configured as B connector, DIO1 is used as a DO. 0: Used as DI Others: B connector
n23-00/n26-00/n29-00	Filter time of DI/DIO input	0.000s to 1.000s
n23-11/n26-11/n29-11	DIO1 switch-on delay	0.00s to 360.00s
n23-14/n26-14/n29-14	DIO2 switch-on delay	0.00s to 360.00s
n23-12/n26-12/n29-12	DIO1 switch-off delay	0.00s to 360.00s

Param.	Name	Description
n23-15/n26-15/n29-15	DIO2 switch-off delay	0.00s to 360.00s
n23-09/n26-09/n29-09	DIO positive/negative logic	bit0: DIO1 positive and negative logic 0: Logic 1 corresponds to high level. 1: Logic 1 corresponds to low level. bit1: DIO2 positive and negative logic 0: Logic 1 corresponds to high level. 1: Logic 1 corresponds to low level. bit2: DIO3 positive and negative logic 0: Logic 1 corresponds to high level. 1: Logic 1 corresponds to low level. bit3: DIO4 positive and negative logic 0: Logic 1 corresponds to high level. 1: Logic 1 corresponds to low level. bit4: DIO5 positive and negative logic 0: Logic 1 corresponds to high level. 1: Logic 1 corresponds to low level. bit5: DIO6 positive and negative logic 0: Logic 1 corresponds to high level. 1: Logic 1 corresponds to low level.

The following table describes parameters of the DI/DIO connector.

Param.	Description	Param.	Description	Param.	Description
U4-55	<I/O module 1> DI1 input	U4-67	<I/O module 2> DI1 input	U4-79	<I/O module 3> DI1 input
U4-56	<I/O module 1> DI2 input	U4-68	<I/O module 2> DI2 input	U4-80	<I/O module 3> DI2 input
U4-57	<I/O module 1> DI3 input	U4-69	<I/O module 2> DI3 input	U4-81	<I/O module 3> DI3 input
U4-58	<I/O module 1> DI4 input	U4-70	<I/O module 2> DI4 input	U4-82	<I/O module 3> DI4 input
U4-59	<I/O module 1> DI5 input	U4-71	<I/O module 2> DI5 input	U4-83	<I/O module 3> DI5 input
U4-60	<I/O module 1> DI6 input	U4-72	<I/O module 2> DI6 input	U4-84	<I/O module 3> DI6 input
U4-61	<I/O module 1> DIO1 input	U4-73	<I/O module 2> DIO1 input	U4-85	<I/O module 3> DIO1 input
U4-62	<I/O module 1> DIO2 input	U4-74	<I/O module 2> DIO2 input	U4-86	<I/O module 3> DIO2 input
U4-63	<I/O module 1> DIO3 input	U4-75	<I/O module 2> DIO3 input	U4-87	<I/O module 3> DIO3 input
U4-64	<I/O module 1> DIO4 input	U4-76	<I/O module 2> DIO4 input	U4-88	<I/O module 3> DIO4 input
U4-65	<I/O module 1> DIO5 input	U4-77	<I/O module 2> DIO5 input	U4-89	<I/O module 3> DIO5 input
U4-66	<I/O module 1> DIO6 input	U4-78	<I/O module 2> DIO6 input	U4-90	<I/O module 3> DIO6 input

Note

For the DIO and DI configuration of HIO-20 and HIO-30 modules, see the configuration of HIO-10 modules above.

6.7.2 Analog Input (AI)

For example, an HIO-10 module supports two AIs with current and voltage signals. Before use, check whether the external signal is a current signal or a voltage signal, and select proper DIP switch based on the signal type. For details, see *HIO-10 I/O Function Module User Guide*. When n7-00 and n7-02 are both set to 1, set n23-41 or n23-51 properly to implement AI functions shown in the following figure.

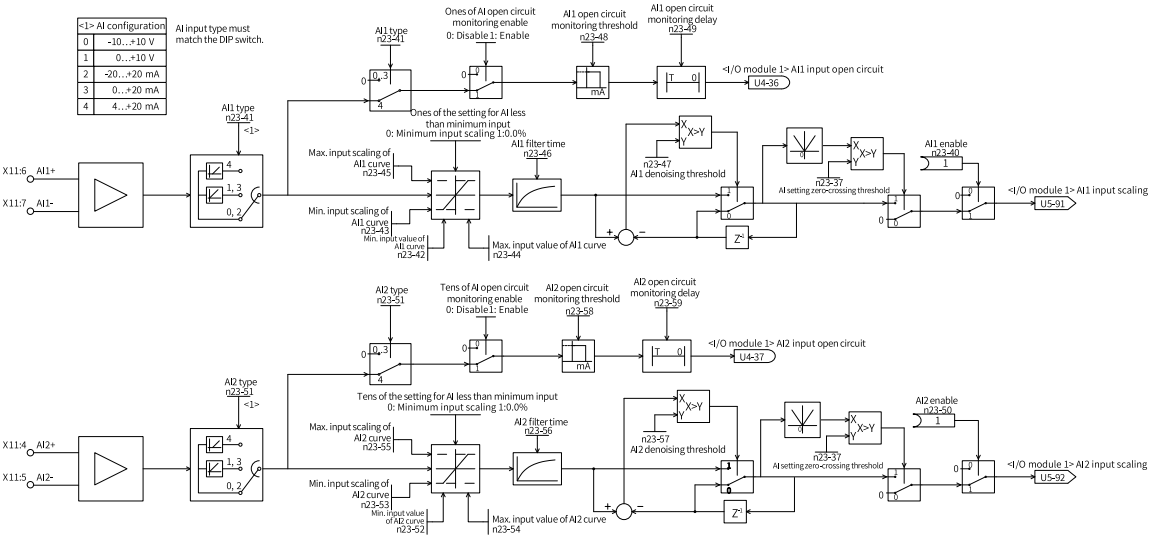


Figure 6-3 AI software function of HIO module

For AI function parameters, see the following table.

Param.	Name	Description
n7-20/n8-20/n9-20	AI1 input value	Displays AI1 input value in V or mA according to the selection of n23-41.
n7-21/n8-21/n9-21	AI1 input scaling	Displays the percentage corresponding to AI1 input, which is the final output after AI module processing.
n7-22/n8-22/n9-22	AI2 input value	Displays AI2 input value in V or mA according to the selection of n23-51.
n7-23/n8-23/n9-23	AI2 input scaling	Displays the percentage corresponding to AI2 input, which is the final output after AI module processing.

Param.	Name	Description
n23-41/n26-41/n29-41	AI1 type	Used to set the input signal type for AI1 or AI2. The AI DIP switch must be set properly based on the signal type. For details, see *HIO-10 I/O Function Module User Guide*. 0: –10 V to +10 V 1: 0 V to 10 V 2: -20 mA to +20 mA 3: 0 mA to 20 mA 4: 4 mA to 20 mA
n23-51/n26-51/n29-51	AI2 type	
n23-42/n26-42/n29-42	Min. input value of AI1 curve	Used to calibrate AI1. n23-42 and n23-44 also limit the range of AI1 input (the unit is V or mA according to n23-41). Within the value range, the output percentage is converted linearly. When the input value is lower than the value of n23-42, the default output is n23-43, or the output can be set to 0.0% through the tens of n23-35.
n23-43/n26-43/n29-43	Min. input scaling of AI1 curve	
n23-44/n26-44/n29-44	Max. input value of AI1 curve	
n23-45/n26-45/n29-45	Max. input scaling of AI1 curve	
n23-52/n26-52/n29-52	Min. input value of AI2 curve	Used to calibrate AI2. n23-52 and n23-54 also limit the range of AI2 input (the unit is V or mA according to n23-51). Within the value range, the output percentage is converted linearly. When the input value is lower than the value of n23-52, the default output is n23-53, or the output can be set to 0.0% through the tens of n23-35.
n23-53/n26-53/n29-53	Min. input scaling of AI2 curve	
n23-54/n26-54/n29-54	Max. input value of AI2 curve	
n23-55/n26-55/n29-55	Max. input scaling of AI2 curve	
n23-35/n26-35/n29-35	Selection when AI value < minimum input value	Ones: Selection when AI1 value lower than the minimum input value 0: Minimum input scaling 1: 0.0% Tens: Selection when AI2 value lower than minimum input value 0: Minimum input scaling 1: 0.0%
n23-46/n26-46/n29-46	AI1 filter time	Defines the AI filter time, which can remove interference and generate a delay effect.
n23-56/n26-56/n29-56	AI2 filter time	
n23-47/n26-47/n29-47	AI1 denoising threshold	Defines the denoising threshold. When the AI input fluctuation is lower than the threshold, the AI input scaling remains unchanged.
n23-57/n26-57/n29-57	AI2 denoising threshold	
n23-37/n26-37/n29-37	AI zero-crossing threshold	When the AI input value is lower than the threshold, the AI value is 0.
n23-40/n26-40/n29-40	AI1 enable	Used to enable or disable AI1. AI1 is forced to be 0 when disabled.
n23-50/n26-50/n29-50	AI2 enable	Used to enable or disable AI2. AI2 is forced to be 0 when disabled.

Param.	Name	Description
n23-36/n26-36/n29-36	AI disconnection monitoring enable	Used to enable or disable disconnection monitoring, which is active only when current signal (4 mA to 20 mA) applies. When the AI input value is lower than the open circuit threshold for a period of time longer than the open circuit delay, AI is disconnected. Ones: AI1 disconnection monitoring 0: Disable 1: Enable Tens: AI2 disconnection monitoring 0: Disable 1: Enable Hundreds: AI3 disconnection monitoring 0: Disable 1: Enable
n23-48/n26-48/n29-48	AI1 disconnection monitoring threshold	0.000 mA to 4.000 mA
n23-58/n26-58/n29-58	AI2 disconnection monitoring threshold	0.000 mA to 4.000 mA
n23-49/n26-49/n29-49	AI1 disconnection monitoring delay	0.00s to 10.00s
n23-59/n26-59/n29-59	AI2 disconnection monitoring delay	0.00s to 10.00s

For AI connector parameters, see the following table.

Param.	Description	Parameter	Description
U4-91	<I/O module 1> AI1 input disconnected	U5-91	<I/O module 1> AI1 input scaling
U4-92	<I/O module 1> AI2 input disconnected	U5-92	<I/O module 1> AI2 input scaling
U4-93	<I/O module 1> AI3 input disconnected	U5-93	<I/O module 1> AI3 input scaling
U4-94	<I/O module 2> AI1 input disconnected	U5-94	<I/O module 2> AI1 input scaling
U4-95	<I/O module 2> AI2 input disconnected	U5-95	<I/O module 2> AI2 input scaling
U4-96	<I/O module 2> AI3 input disconnected	U5-96	<I/O module 2> AI3 input scaling
U4-97	<I/O module 3> AI1 input disconnected	U5-97	<I/O module 3> AI1 input scaling
U4-98	<I/O module 3> AI2 input disconnected	U5-98	<I/O module 3> AI2 input scaling
U4-99	<I/O module 3> AI3 input disconnected	U5-99	<I/O module 3> AI3 input scaling

Note

For the AI configuration of HIO-30, see the AI configuration of HIO-10.

6.7.3 Analog Output (AO)

For example, a HIO-10 module supports two AOs with current and voltage signals. Before using AOs, configure the hardware jumpers properly. For details, see *HIO-10 I/O Function Module User Guide*. When n7-00 and n7-02 are both set to 1, set n23-71 or n23-81 properly to implement AO functions shown in the following figure.

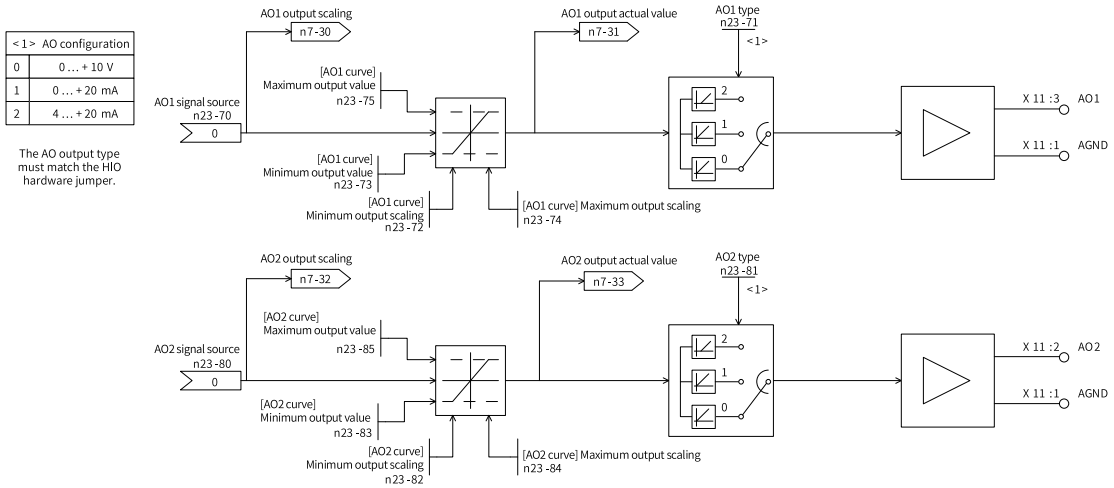


Figure 6-4 AO software functions of HIO

For AO function parameters, see the following table.

Param.	Name	Description
n7-30/n8-30/n9-30	AO1 output scaling	Displays the AO1 output value in V or mA according to the setting of n23-71.
n7-31/n8-31/n9-31	AO1 actual output value	Displays the AO1 output percentage, corresponding to n23-70.
n7-32/n8-32/n9-32	AO2 output scaling	Displays the AO2 output value in V or mA according to the setting of n23-81.
n7-33/n8-33/n9-33	AO2 actual output value	Displays the AO2 output percentage, corresponding to n23-80.
n23-70/n26-70/n29-70	AO1 signal source	Used to set the signal source of AO1 output.
n23-80/n26-80/n29-80	AO2 signal source	Used to set the signal source of AO2 output.
n23-71/n26-71/n29-71	AO1 type	Select proper wiring mode based on the signal type of AO1 or AO2 output. For details, see *HIO-10 I/O Function Module User Guide*. 0: 0 V to 10 V 1: 0 mA to 20 mA 2: 4 mA to 20 mA
n23-81/n26-81/n29-81	AO2 type	
n23-73/n26-73/n29-73	Minimum output value of AO1 curve	Used to set the calibration factor of AO1. n23-73 and n23-75 limit the range of the AO1 output percentage. Within the range, the output value is converted linearly (the unit is V or mA, depending on the setting of n23-71).
n23-72/n26-72/n29-72	Minimum output scaling of AO1 curve	
n23-75/n26-75/n29-75	Maximum output value of AO1 curve	
n23-74/n26-74/n29-74	Maximum output scaling of AO1 curve	

Param.	Name	Description
n23-83/n26-83/n29-83	Minimum output value of AO2 curve	Used to set the calibration factor of AO2. n23-83 and n23-85 limit the range of the AO2 output percentage. Within the range, the output value is converted linearly (the unit is V or mA, depending on the setting of n23-81).
n23-82/n26-82/n29-82	Minimum output scaling of AO2 curve	
n23-85/n26-85/n29-85	Maximum output value of AO2 curve	
n23-84/n26-84/n29-84	Maximum output scaling of AO2 curve	

Note

For AO configurations of the HIO-30 module, see the preceding AO configurations of the HIO-10 module.

6.7.4 Relay Output (RO)

For example, the HIO-10 supports one RO. The following figure shows how RO functions are implemented.

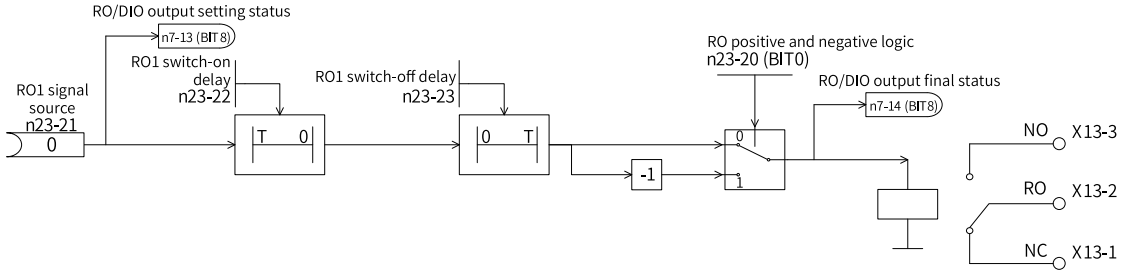


Figure 6-5 RO software function diagram

For RO function parameters, see the following table.

Parameter	Name	Description
n7-13/n8-13/n9-13	Setting status of RO/DIO output	Displays the setting status of the RO or DIO used as a DO. Bit0 to bit5 display the setting status of the DIO used as a DO. Bit8 to bit13 display the setting status of the RO output.
n7-14/n8-14/n9-14	Final status of RO/DIO output	Displays the final status of the RO or DIO used as a DO after the delay logic and positive and negative logic processing. Bit0 to bit5 display the final status of the DIO used as a DO. Bit8 to bit13 display the final status of the RO output.
n23-21/n26-21/n29-21	RO1 signal source	0: Low level 1: High level Other: B connector
n23-22/n26-22/n29-22	RO1 switch-on delay	0.00s to 360.00s

Parameter	Name	Description
n23-23/n26-23/n29-23	RO1 switch-off delay	0.00s to 360.00s
n23-20/n26-20/n29-20	RO positive and negative logic	Bit0: RO1 positive and negative logic 0: High level output for logic 1 1: Low level output for logic 1 Bit1: RO2 positive and negative logic 0: High level output for logic 1 1: Low level output for logic 1 Bit2: RO3 positive and negative logic 0: High level output for logic 1 1: Low level output for logic 1 Bit3: RO4 positive and negative logic 0: High level output for logic 1 1: Low level output for logic 1

Note

For the RO configuration of HIO-20 and HIO-30 modules, see the configuration of HIO-10 module RO above.

7 Control Performance

7.1 Operation Mode

E0-01 (Active rectifier mode) is used to select whether the active rectifier works in the voltage mode or current mode.

Voltage mode

Set E0-01 to 0 to make the active rectifier operate in the voltage mode. In this mode, the DC bus voltage output is controlled to the set voltage. Within the rated power range, a programmable constant DC voltage source can be provided for the downstream load.

- Rectification and regenerative mode
  Set E0-03 (Operation mode) to 0 to make the active rectifier operate in the four-quadrant mode, which allows energy to flow in both rectification and regenerative directions. This mode is the most commonly used mode of the active rectifier.
- Rectification mode
  Set E0-03 (Operation mode) to 1 make the active rectifier operate in the rectification mode, which only allows energy to flow from the three-phase AC power supply to the active rectifier. This mode is used when energy regeneration is not allowed by the three-phase AC power supply.

Current mode

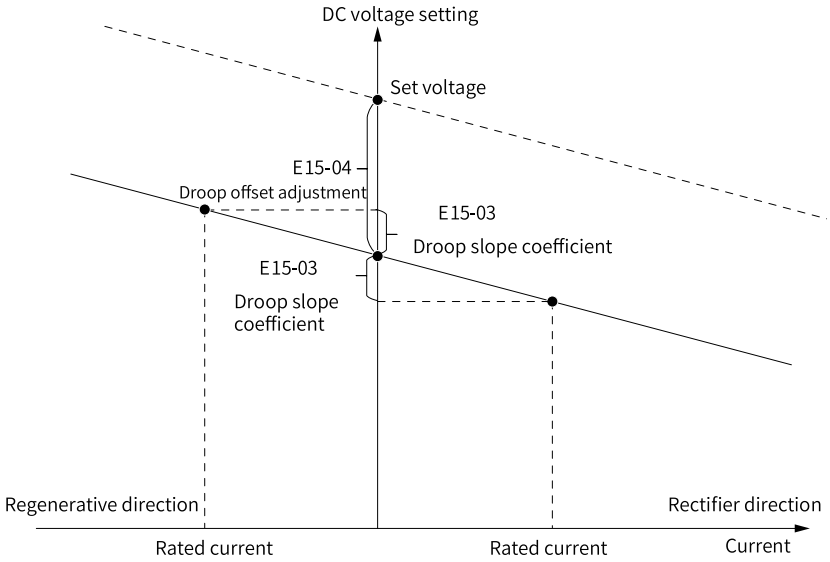
Set E0-01 to 1 to make the active rectifier operate in the current mode. In this mode, the RMS value of the input three-phase AC current is controlled to the active setpoint. A programmable constant current source can be provided for the downstream load within the rated power range.

- Active current setting
  Set the current in group C1 or group C3. When a positive number is set, the active rectifier absorbs the active current from the three-phase AC power supply and charges the downstream DC load, or tests the rectification output characteristics of the three-phase AC power supply. When a negative value is set, the active current is fed back by the active rectifier to the three-phase AC power supply and discharges the downstream DC load, or tests the regenerative output characteristics of the three-phase AC power supply.
- Reactive current setting
  Set E0-07 to 100% to represent the per-unit current base value (d3-01). The active rectifier absorbs 90° of the capacitive reactive current of the leading-phase three-phase AC power supply, performing capacitive reactive compensation on the AC power supply.

7.2 DC Droop Control

When two or more active rectifiers are connected in parallel on the DC side and operate in the voltage mode, or when the active rectifier is connected in parallel with other DC voltage sources, the droop control function on the DC side must be enabled. In the droop function, power-sharing between active rectifiers is supported through the built-in algorithm and low-speed communication between nodes.

The droop function on the DC side is enabled through E15-00. After the droop function on the DC side is enabled, the voltage reference on the DC side is adjusted based on the active current droop. E15-03 is used to set the DC droop slope coefficient (10.0 V by default). It means that when the active current reaches the rated current, the DC voltage reference is reduced to 10.0 V. E15-04 is used to shift the DC droop curve up and down, and can be used to adjust the power of multiple DC networking devices.



Param.	Name	Description
E15-00	Droop control enable selection	0: Inactive 1: Active Other: B connector
E15-03	Droop slope coefficient	-20.0 V to +20.0 V
E15-04	Droop offset adjustment value	-20.0 V to +20.0 V
E15-05	Droop adjustment limit	0.0 V to 30.0 V

Power-sharing function

The active power may be unevenly shared when DC droop control is performed by multiple active rectifiers. The active rectifier supports the built-in power-sharing function. You can set E15-10 to 1 to enable DC droop power-sharing control, and adjust the droop shifting value of each droop node through the built-in algorithm, and then execute the power-sharing function. The target of power-sharing control is set according to E15-13. The default value is 5.0%, that is, the power deviation between active rectifiers does not exceed 5.0% after power-sharing control is enabled.

After the power-sharing function is enabled, each droop node asserts its own droop status word U16-00 and per-unit power value U16-01. Each droop node shall receive the status words and per-unit power values from all other participating droop nodes. Set E15-11 (Power-sharing configuration of droop reception node) to enable the droop nodes received by this node, and configure the data of the enabled reception nodes through E15-19 to E15-26.

Param.	Name	Remarks
E15-10	Power-sharing control enable of droop node	0: Inactive 1: Active Other: B connector
E15-11	Power-sharing configuration of droop receiving node	0 to 1111
E15-13	Power-sharing threshold of droop node	0.0 to 50.0
E15-14	Communication heartbeat error detection of droop receiving node	0: Disable 1: Active
E15-18	Automatic configuration of droop receiving node	0: Inactive 1: Configure reception node 1 2: Configure reception node 1/2 3: Configure reception nodes 1/2/3 3: Configure the reception node 1/2/3/4
E15-19	Status word of droop node 1	The corresponding connector needs to be configured to match the communication between the nodes.
E15-20	Power per-unit value of droop node 1	The corresponding connector needs to be configured to match the communication between the nodes.
E15-21	Status word of droop node 2	The corresponding connector needs to be configured to match the communication between the nodes.
E15-22	Power per-unit value of droop node 2	The corresponding connector needs to be configured to match the communication between the nodes.
E15-23	Status word of droop node 3	The corresponding connector needs to be configured to match the communication between the nodes.
E15-24	Power per-unit value of droop node 3	The corresponding connector needs to be configured to match the communication between the nodes.
E15-25	Status word of droop node 4	The corresponding connector needs to be configured to match the communication between the nodes.
E15-26	Power per-unit value of droop node 4	The corresponding connector needs to be configured to match the communication between the nodes.

Note

- The power sharing function of the droop node is used. InoLink communication for each droop node can be connected and configured for inter-node communication.
- During commissioning, limit the positive and negative current to avoid improper parameter setting, which may result in no droop or improper droop parameters, and full-power circulation connected directly in parallel by multiple groups of voltage sources.

7.3 High/Low-Voltage Ride-Through Function

7.3.1 Low Voltage Ride-Through Function

When the grid low voltage ride-through (LVRT) function is enabled, the MD880 active rectifier module supports low voltage ride-through function according to DL_T1648-2016 upon grid faults or disturbances that cause a drop in the grid voltage.

The low voltage ride-through function is enabled via E16-00, which is divided into three zones via E16-09 and E16-10, namely, instantaneous low voltage ride-through zone, short-term low voltage ride-through zone, and zero voltage ride-through zone.

- The continuous low voltage ride-through zone applies for values greater than E16-09 and less than or equal to E16-08.
- The short-term low voltage ride-through zone applies when for values less than or equal to E16-09 and greater than or equal to E16-10, with a grid low voltage protection time of 5 seconds.
- The instantaneous low voltage ride-through zone applies for values lower than E16-10, with a grid low voltage protection time of 0.5 seconds. E16-11 is the zero voltage ride-through point (zero voltage ride-through belongs to the instantaneous low voltage ride-through category). When E16-03 is enabled, the active rectifier will switch to an uncontrolled rectifier mode.

When the grid voltage drops, the fault protection time is updated based on the specific ride-through zone, and current limiting is applied according to different ride-through intervals (E16-13 and E16-14) to prevent overcurrent.

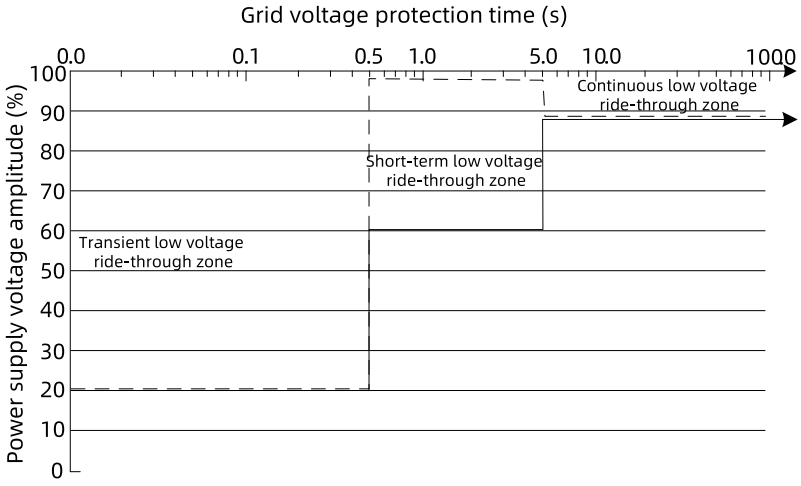


Figure 7-1 Low voltage ride-through zone

Table 7–1 Parameters related to low voltage ride-through function

Param.	Name	Description
E16-00	Grid low voltage ride-through function enable	0: Inactive 1: Active
E16-01	Grid low voltage ride-through voltage class	380 V to 690 V Defines the low voltage ride-through voltage base value of the grid. The model voltage class applies by default.
E16-03	Grid zero voltage ride-through pulse blocking enable	0: Inactive 1: Active
E16-08	Grid fault ride-through voltage point	0% to 100%, default 85% Grid fault ride-through fault masking voltage value
E16-09	Grid short-term low voltage ride-through voltage point	0% to 100%, default 80%
E16-10	Grid instantaneous low voltage ride-through voltage point	0% to 100%, default 60%

Param.	Name	Description
E16-11	Grid zero voltage ride-through voltage point	0% to 100%, default 20%
E16-12	Grid low voltage ride-through hysteresis	5% to 20% Note: To prevent repeated triggering of the ride-through mode due to grid fluctuation near the ride-through point, you can set the low voltage ride-through hysteresis through E16-12. When the voltage recovered is higher than the hysteresis, the grid voltage is recovered, and the active rectifier reverts to the normal operation mode.
E16-13	Grid low voltage ride-through short-term current limiting	0.0% to 100.0% Note: Under heavy duty conditions, when the grid voltage drops, the grid current may reach the limit. The current limiting is used to prevent AC drive damage due to overcurrent during recovery. The downstream inverter Vdcmin function is used to keep DC bus voltage stable after current limiting is activated.
E16-14	Grid low voltage ride-through instantaneous current limiting	0.0% to 100.0% Note: Under heavy duty conditions, when the grid voltage drops, the grid current may reach the limit. The current limiting is used to prevent AC drive damage due to overcurrent during recovery. The downstream inverter Vdcmin function is used to keep DC bus voltage stable after current limiting is activated.

7.3.2 High Voltage Ride-Through Function (Bus Voltage Adaptive Function)

When a fault or disturbance in the external power grid causes the incoming voltage of the MD880 rectifier module to rise, the modulation index of the active rectifier will increase. When the modulation index of the active rectifier reaches its limit, control instability errors can occur. By enabling the bus voltage adaptive function via E16-05, the optimal modulation index can be automatically matched to stabilize the control performance, allowing the MD880 active rectifier to ride through upon grid voltage rise.

- When the grid voltage is greater than E16-20 (Grid high voltage ride-through point 1) and lower than E16-21 (Grid high voltage ride-through point 2), the fault protection time is 5 seconds.
- When the grid voltage is greater than E16-21 (High voltage ride-through voltage point 2), the fault protection time is 0.5 seconds.

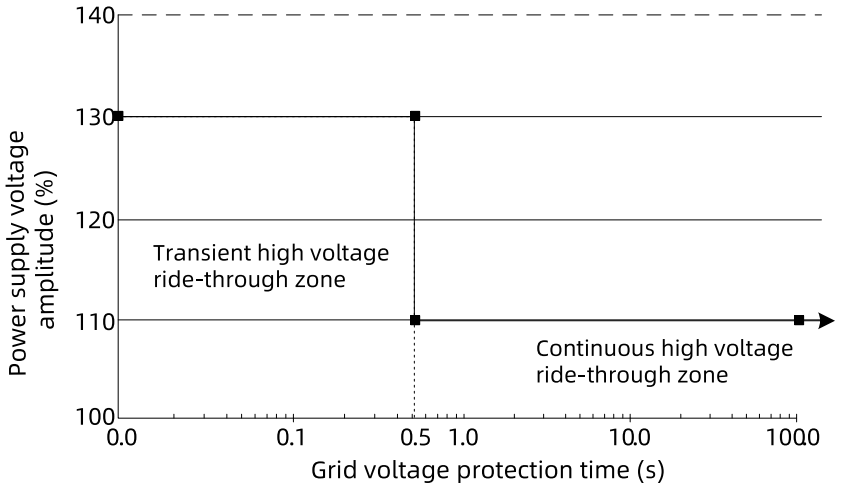


Figure 7-2 High voltage ride-through zone

Table 7–2 Parameters related to high voltage ride-through function

Param.	Name	Description
E16-05	Enable adaptive bus voltage	0: Inactive 1: Active
E16-15	Maximum adaptive bus voltage	110% to 120%, default value 110%
E16-19	Maximum adaptive reactive current	0% to 50%, default value 25%
E16-20	Grid high voltage ride-through voltage point 1	110% to 130%, default value 110%
E16-21	Grid high voltage ride-through voltage point 2	110% to 130%, default value 120%

Note

- When adaptive bus voltage is enabled, if the bus voltage reference (C0-01) is greater than the adaptive bus voltage, the bus voltage of C0-01 is used as the reference voltage.
- When the inverter is used together with the downstream of -7 model, the DC bus overvoltage threshold of the inverter may be lower than that of the active rectifier. A sudden rise of grid voltage can trigger an overvoltage fault on the inverter side. In this case, enable the Vdcmax function to ride through transient DC bus voltage surges caused by grid voltage rise.

8 Function Application

8.1 Synchronous Voltage Detection Module

The HCU-40 controller supports one group of HSVM-10 synchronous voltage detection modules for grid voltage detection on the AC side, which is configured in group n19.

The synchronous voltage sampling module, configured in group n19, is a mandatory sampling module for the active rectifier to detect the AC voltage on the filter capacitor in the active rectifier. It is used for the basic control function of active rectifier. The active rectifier must be configured correctly before start. If the module is not configured or is offline, F80-4 is reported after start.

The parameters of the synchronous voltage sampling module are shown in the following table.

Param.	Meaning	Description
n19-00	Expansion slot selection	0: Disable 1: Expansion slot 1_1 2: Expansion slot 1_2 3: Expansion slot 1_3 4: Extension slot 2_1 5: Expansion slot 2_2 6: Expansion slot 2_3 7: Extension slot 3_1
n19-01	Module type selection	1: HSVM-10
n19-02	Module status	0: Offline 1: Online
n19-10	[HSVM-10] voltage sampling frequency	0: 40 K sampling frequency 1: 80 K sampling frequency 2: 160 K sampling frequency 3: 320 K sampling frequency
n19-11	[HSVM-10] voltage sampling delay	0: Inactive 1: Active
n19-15	[HSVM-10] module Usr sampling AD value	AD value of SR line voltage sampling
n19-16	[HSVM-10] module Ust sampling AD value	AD value of ST line voltage sampling

The HSVM-10 real-time sampling data is also displayed in group U6, as shown in the following table.

Param.	Meaning	Description
U6-47	[HSVM-10] module Usr sampling AD value	AD value of SR line voltage sampling (filter capacitor) for AC voltage sampling
U6-48	[HSVM-10] module Ust sampling AD value	AD value of ST line voltage sampling (filter capacitor) for AC voltage sampling
U6-68	RS line voltage	The RS line voltage per-unit value (instantaneous value) is derived from the HSVM-10 sampling result.

Param.	Meaning	Description
U6-69	ST line voltage	The ST line voltage per-unit value (instantaneous value) is derived from the HSVM-10 sampling result.
U6-70	TR line voltage	The TR line voltage per-unit value (instantaneous value) is derived from the HSVM-10 sampling result.

8.2 Communication Module

8.2.1 Fieldbus Adapter

Fieldbus adapters are used for communication between the fieldbus and drive. Currently, three fieldbus adapters are supported, with two used independently and the remaining one used for redundancy. Set a redundant adapter for fieldbus adapter A/B. That allows the system to automatically switch to redundant adapter C for data exchange when the fieldbus adapter fails to function due to an exception.

Each fieldbus adapter supports a maximum of 16 pieces of 16-bit process data. The following figure shows how the bus adapter works.

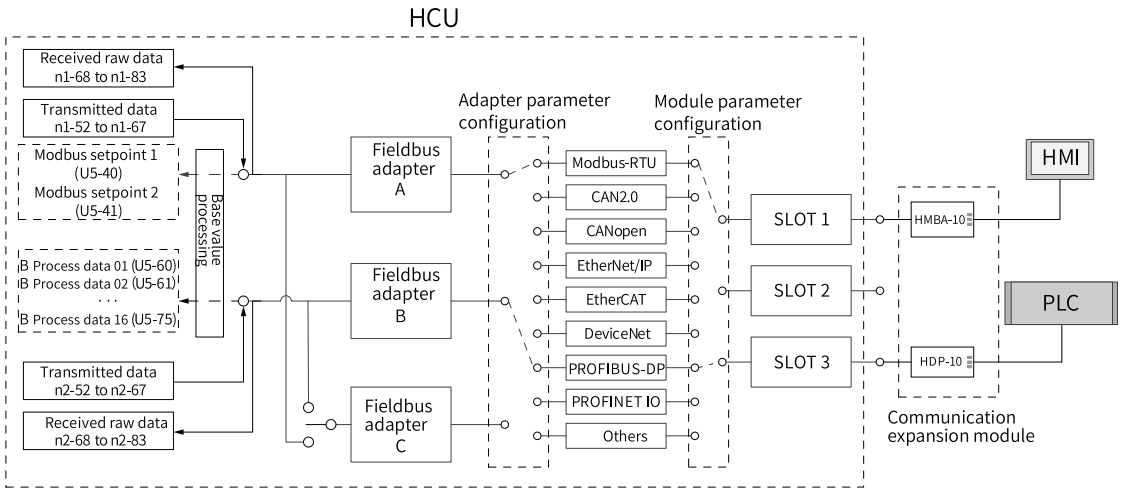


Figure 8-1 Fieldbus adapter working principle

Fieldbus adapters support nine communication modules, including the following:

Modbus RTU fieldbus module, CAN2.0 fieldbus module, CANopen fieldbus module, Ethernet/IP industrial Ethernet module, EtherCAT industrial EtherCAT module, DeviceNet fieldbus module, PROFIBUS-DP fieldbus module, PROFINET IO industrial Ethernet module, and other customized communication modules.

Table 8–1 Parameters of fieldbus adapter

No.	Fieldbus adapter A	Fieldbus adapter B	Description
1	n1-00	n2-00	Used to select the required bus protocol type. The value 0 indicates that no fieldbus is selected.
2	n1-01	n2-01	Used to detect communication timeout. The value 0.00 indicates that communication timeout detection is disabled.

No.	Fieldbus adapter A	Fieldbus adapter B	Description
3	n1-02	n2-02	Indicates the communication fault detection switch. 0 indicates that communication faults are detected, and 1 indicates that communication faults are not detected.
4	n1-03	n2-03	Used for communication CRC error verification. 0 indicates that CRC fault detection is disabled.
5	n1-04 to n1-19	n2-04 to n2-19	Defines the source of data sent by the drive.
6	n1-20 to n1-35	n2-20 to n2-35	Defines the base value of data sent by the drive. Actual data sent = Original data sent x Base value of data sent/4096. When this parameter is set to 0, the base value is 4096.
7	n1-52 to n1-67	n2-52 to n2-67	Displays the process data actually sent by the drive.
8	n1-36 to n1-51	n2-36 to n2-51	Defines the base value of data received by the drive. Data received = Original data received × Base value of data received/4096. When this parameter is set to 0, the base value is 4096.
9	n1-68 to n1-83	n2-68 to n2-83	Displays the original process data received by the drive.
10	n1-90	n2-90	Used to set whether to store parameters to EEPROM when writing parameters.
11	n1-91	n2-91	Used to set whether to upload the current fault information of devices to the host controller.
12	U5-44 to U5-59	U5-60 to U5-75	Displays the process data received by the drive after base value conversion.
13	U2-00 to U2-15	U2-16 to U2-31	Displays the status of 16 bits of process data PZD1 after base value conversion.

No.	Fieldbus adapter C	Description
1	n3-00	Used to select the redundant bus adapter for fieldbus adapters A and B. The value 0 indicates that no redundant bus adapter is used.
2	n3-03	Used to set whether to store parameters written through bus adapter C email data to EEPROM.

Fieldbus adapters support the email data and process data.

Email data is transmitted aperiodically and used for parameter read/write, start/stop, fault reset, status monitoring, and command transmission.

Process data is generally used for command setting, status interaction, voltage reference, and current reference, which is exchanged periodically.

8.2.2 Process Data Configuration

The HCU-40 supports two independent fieldbus adapters, each of which supports transmission and reception of up to 16 process data. The source of process data sent can be set independently. You can also set different base values for each data and perform per-unit value calculation.

Process data received by the drive

View the original data received by the bus adapter through n1-68 to n1-83 (or n2-68 to n2-83).

View the received data after base value conversion through U5-44 to U5-59 (or U5-60 to U5-75). For calculation methods of base value conversion, see *"8.2.3 Communication Base Value" on page 90*.

PZD1 of the process data after base value conversion is divided into 16 bits. You can view the status of each bit through U2-00 to U2-15 (or U2-16 to U2-31). You can use word-to-bit function blocks (L0-00, L0-01, L0-02) to divide other process data into bits if necessary.

Configure control channels and related parameters for the received process data. For details, see section "Setpoint Channels".

Note

In PROFIBUS-DP communication, set the check bit of PZD1 to 1 (bit10 of PZD1 by default, which can be modified or disabled through n16-10). Otherwise, all the received process data is inactive. U5-44 to U5-59 (or U5-60 to U5-75) keep the data of the previous cycle, but n1-68 to n1-83 (or n2 2-83) display the original data received.

Process data sent or uploaded by the drive

Set the source of the data sent or uploaded by the drive through n1-04 to n1-19 (or n2-04 to n2-19).

To send data consisting of bits, use group L0 (bit-to-word function block) to generate the expected data (U5-86 to U5-89). Then, associate n1-04 to n1-19 (or n2-04 to n2-19) with U5-86 to U5-89.

You can set an independent base value for each process data through n1-20 to n1-35 (n2-20 to n2-35). The data (n1-04 to n1-19, or n2-04 to n2-19) received by the host controller or PLC is converted from the base value. For calculation methods of base value conversion, see *"4.2.1 Voltage Reference" on page 55*.

Use n1-52 to n1-67 (n2-52 to n2-67) to view the data finally sent.

View the data that needs to be received by PLC, such as grid voltage, grid current, grid frequency, and bus voltage through the connector in group U.

8.2.3 Communication Base Value

The HCU-40 control module sets the current reference and voltage reference in the form of percentages. The base value of the percentage can be viewed in group d3. The value 100% corresponds to the base value of group d3.

In the HCU-40 control module, the value 4096 corresponds to 100%, that is, 4096 corresponds to the per-unit base value displayed in group d3. The communication base value in the HCU-40 control module is 0 by default. The value 0 indicates that base value conversion is not performed during data reception and transmission.

Table 8–2 Per-unit base value

Param.	Name
d3-00	Base value of per-unit voltage
d3-01	Base value of per-unit current
d3-02	Base value of per-unit power

Generally, base value conversion is not performed on the data comprised of bits. The communication base value is set to 0 generally.

Suppose that the voltage is set through communication, the expected voltage reference is 720 V, the data sent through communication is 7200, the per-unit base value of d3-00 is 600 V, and voltage reference is set through PZD2 of process data, then set the following parameters.

- Voltage reference source (C0-00) = U5-45 (PZD2 of bus adapter A)
- Communication base value of process data input 2 (n1-37) = (7200 x 600)/720 = 6000

The calculation formula for the communication base value is as follows.

$$\text{Communication base value} = \frac{\text{Per unit base value x Sent data}}{\text{Target setpoint}}$$

8.2.4 Communication Expansion Module

Table 8–3 Communication expansion module

No.	Expansion module	Description
1	Modbus-RTU module	Used for the Modbus communication protocol, which is a standard communication protocol. For details, see the communication expansion module user guide. Parameters of this module are in group n10.
2	CAN2.0 module	Used by the CAN2.0 communication protocol, which is a custom protocol of Inovance. For details, see the communication extension card user guide. The CAN2.0 expansion module supports seven communication speeds. Parameters of this module are in group n11.
3	CANopen module	Used for the CANopen communication protocol. For details, see the communication expansion module user guide. The CANopen expansion module supports seven communication speeds. Parameters of this module are in group n12.
4	Ethernet module	Used for the Ethernet communication protocol. For details, see the communication expansion module user guide. The Ethernet communication expansion module supports automatic IP address assignment. Parameters of this module are in group n13.
5	EtherCAT Module	Used for the EtherCAT communication protocol. For details, see related user guides. Parameters of this module are in group n14.
6	DeviceNet Module	Used for the DeviceNet communication protocol. For details, see related user guides. Parameters of this module are in group n15.
7	PROFIBUS-DP module	Used for the PROFIBU-DP communication protocol. For details, see related user guides. Parameters of this module are in group n16.
8	PROFINET I/O module	used for the PROFINET communication protocol. For details, see related user guides. Parameters of this module are in group n17.
9	Custom communication module	Used for custom communication protocols for various application scenarios. For details, see related user guides. Parameters of this module are in group n18.

8.2.5 InoLink Communication Network

InoLink is used for master-slave communication among multiple devices. In a network system, the logical master sends data (control bit and reference value) to the logical slave through master/slave communication.

- Currently, each InoLink node supports transmission of up to eight pieces of 16-bit data and reception of up to eight pieces of 16-bit data.

- The InoLink communication network supports a maximum of 16 communication nodes. A network node in the network corresponds to a drive. The network must contain a communication node with address 1. The addresses of other nodes must be different. The maximum node address is 16.
- The baud rate of InoLink communication is 5 Mbps, and data is exchanged once every 2 ms.

If no data is received from another node within 2s, the node reports an offline fault. If the non-master node does not receive data from node 1 within 2s, the node reports a master offline fault. If the addresses of two nodes in the network are the same, the newly set node reports an address conflict fault.

Table 8–4 InoLink communication parameters

No.	InoLink communication parameters	Description
1	n0-00	Used to enable InoLink communication nodes. InoLink is used for master and slave communication between multiple drive units and supports networking of up to 16 controllers. You can configure the InoLink communication network through n0-02 to n0-19 and configure the data sent and received through n0-20 to n0-77. The received data can be monitored through U5-32 to U5-39.
2	n0-01	Displays the current InoLink state. Options: 0: Disable 1: Node address conflict - Conflicting nodes exist in the current network. 2: Baud rate mismatch 3: Bus disconnected or faulty 4: Communication normal 5: Listen-only mode - The listen-only mode applies when n0-02 is set to 0. 6: Unreliable communication (excessive CRC errors) 7: Excessive data interaction volume - Reduce the amount of data interaction in the network or extend the InoLink data interaction cycle via n0-08. 8: Waiting
3	n0-02	Used to set the addresses of Inolink communication nodes. Note: A maximum of 16 nodes are supported. Set the controller with node address 1 as the communication master. One master must be present in a network and the node addresses of all controllers cannot come into conflict with each other. • When the node address is set to 0, the listen-only mode applies. In this case, no data is sent to the network. • F83-1 (InoLink: Address conflict) is triggered if the same node address exists in the same InoLink network.

No.	InoLink communication parameters	Description
4	n0-03	Defines the InoLink fault mode. Options: • Standard mode: If a controller receives no data from any other controller, it reports F83-2 communication offline fault (the master does not report this fault). If the controller receives no data within 2s, it reports F83-3 receiver offline fault. If a new controller is numbered the same as an existing controller in the network, the controller reports F83-1 address conflict fault. • No fault prompt mode - No fault prompt is reported.
5	n0-04	Defines the restart judgment time of the InoLink node. When Inolink is enabled and no node data is received within the time set by this parameter, F83-2 (InoLink communication offline fault) is triggered.
6	n0-06	Defines the InoLink communication mode. Options: • 1 [Standard mode] - The baud rate is 5 M. The data transmission bit width is 16-bit. The total number of nodes is 16. The number of process data interactions is 8. The data interaction cycle is 2 ms. • 2 [Custom mode] - Configured by n0-08. Note: When the controller is in the listen-only mode and the node is offline, the actual effective communication mode is switched cyclically between the standard and custom modes. Check the actual communication mode of InoLink through n0-07.
7	n0-07	Used to check the actual effective communication mode of InoLink. Options: • 0 [Standard mode] - The baud rate is 5 M. The data transmission bit width is 16-bit. The total number of nodes is 16. The number of process data interactions is 8. The data interaction cycle is 2 ms. • 1 [Custom mode] - Configured by n0-08.
8	n0-08	Used to set the InoLink communication custom mode configuration, which is active only when n0-07 is 1.
9	n0-09	Displays the actual effective baud rate of InoLink network.
10	n0-10	Displays InoLink data transmission bit width. The standard mode is 16-bit, and the custom mode is 8-bit.
11	n0-16	Displays the total number of InoLink nodes.
12	n0-17	Displays the current number of InoLink process data interactions.
13	n0-18	Displays the current InoLink data interaction cycle.

No.	InoLink communication parameters	Description
14	n0-19	Used to set auxiliary InoLink functions. Options: Ones - Synchronized time base: Enables synchronization of multiple HCU task cycles, used for high-precision synchronous control applications.
15	n0-27 to n0-20	Used to select the data to be sent by this node.
16	n0-40, n0-42, n0-44, n0-46, n0-48, n0-50, n0-52, and n0-54	Used to set the logical master for nodes. The logical master is the node that sends data to the other nodes.
17	n0-41, n0-43, n0-45, n0-47, n0-49, n0-51, n0-53, and n0-55	Used to set which piece of data sent from the logical master site will be used by the receiving node. The received data will be multiplied by the proportion of received data before being displayed in U5-32 to U5-39. Each bit of InoLink.PZD1 can be monitored through U2-32 to U2-47.
18	n0-77 to n0-70	Used to set the proportional factor of the received data. The data used by nodes is the data sent from the logical master multiplied by the proportional factor.

8.2.6 Fieldbus Adapter Slot Configuration

Configure expansion module slots properly before using an expansion module. That is, you need to set the slot number properly. The following figure takes the PROFIBUS-DP module as an example to show the configuration of expansion module slot.

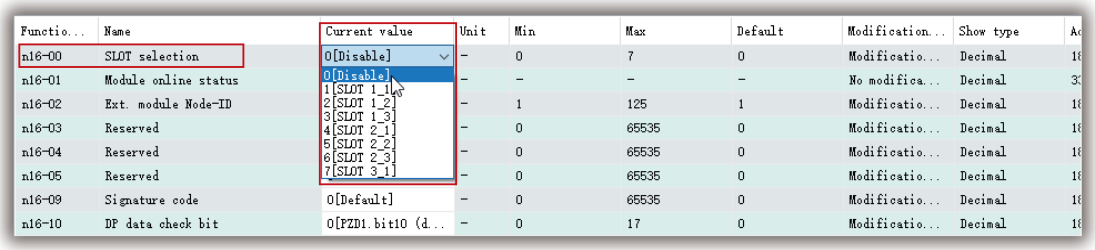


Figure 8-2 PROFIBUS-DP module slot configuration

When the PROFIBUS-DP module is installed to SLOT3, set n16-00 to 7 and select expansion module slot 3_1.

The HCU provides three slots. The following figure shows the definition of expansion slots.

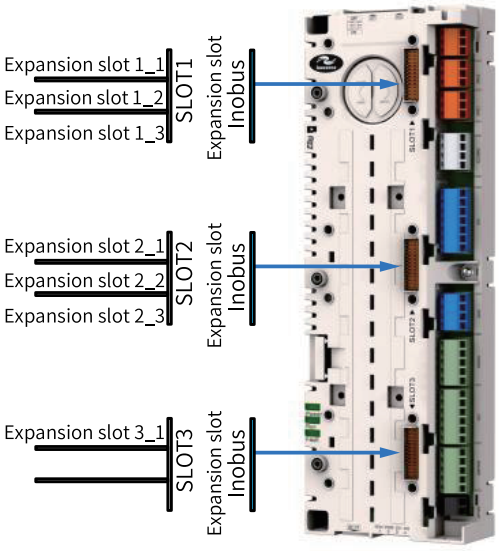


Figure 8-3 Definition of expansion module slot

When the communication expansion module is directly inserted into the slot on the HCU, for example, the SLOT2 can be set to expansion slot 2_1, expansion slot 2_2, and expansion slots 2_3.

The SLOT1 and SLOT2 can be expanded into three slots (1 x HOFM + 3 x HSED) by installing the HOFM module + HSED function module. Note that the parameter configuration does not come into conflict with the expansion slot selection of the other two expansion modules (if any). Take SLOT2 as an example. The topology is as follows.

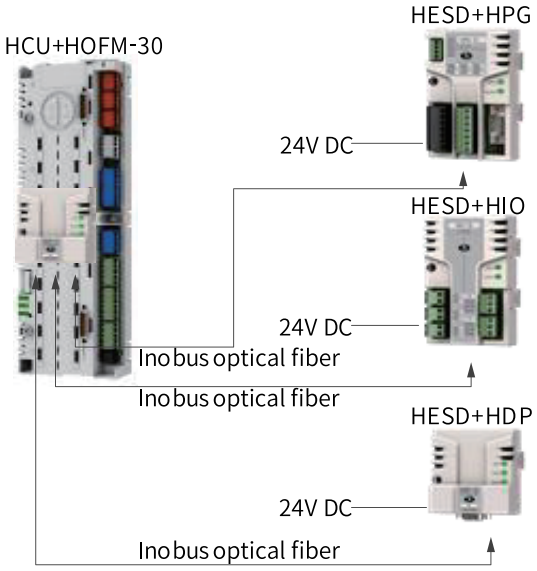


Figure 8-4 SLOT2 topology

When installing function modules to the three slots, observe the following principles.

- Each slot supports three expansion slots, but only one of the three expansion slots is allowed to connect communication expansion modules. The other two slots can connect non-communication expansion modules. For example, the HIO module.
- Do not connect the optical fiber expansion module HOFM in the HSED function module.

- The HDP-10 module can be installed into any slot in theory. Due to the size of the PROFIBUS-DP bus terminal, when the HDP-10 module is installed in the SLOT1 (or SLOT2), the SLOT2 (or SLOT3) cannot be installed with other expansion modules. Therefore, it is recommended that HDP-10 be installed in SLOT3.

8.2.7 Application Case of the Fieldbus Adapter

Description of requirements

The host controller uses PROFIBUS-DP network to control the start/stop control word and read the operation status and monitoring data of the device, as described below.

Control word sent by the host controller (process data 1 sent by the host controller):

bit	Meaning	Description
0	OFF1	0: Device stopped 1: Device started
1	OFF2	0: Emergency stop, startup not allowed 1: Startup allowed
2 to 6	Reserved	-
7	Reset	0→1: Fault reset
8 to 9	Reserved	-
10	PLC control	Constant 1 1: Communication data valid
11 to 15	Reserved	-

Status word read by the host controller (process data 1 received):

bit	Description
0	1: Ready to switch on
1	1: Ready to run
2	1: Soft startup completed
3	1: Startup completed
4	1: Device fault occurred
5	1: Device alarm occurred
6 to 8	Reserved
9	1: Communication data valid
10 to 15	Reserved

Fault status word read by the host controller (process data 2 received):

bit	Description
0	1: Grid abnormal
1	1: Overcurrent
2	1: Bus overvoltage
3	1: Bus undervoltage
4	1: Device overload
5 to 8	Reserved
9	1: Device module overtemperature
10	1: Excessive leakage current
11 to 14	Reserved
15	1: IGBT module drive error

Monitoring data read by the host controller:

Data	Name	Scaling
Process data 3 received	Bus voltage	6000→600.0 V
Process data 4 received	Grid frequency	5000→50.00 Hz
Process data 4 received	Grid voltage	3800→380.0 V
Process data 5 received	Grid current	50→50 A

Configuration procedure

1. Install the HDP-10 module properly with power off. Switch on the HCU-40 control power supply, and check whether the HDP-10 is installed properly through group A2.

A2-24	SLOT 1_1 module type	0[No ext. module]
A2-25	SLOT 1_1 software version	0.00
A2-26	SLOT 1_2 module type	0[No ext. module]
A2-27	SLOT 1_2 software version	0.00
A2-28	SLOT 1_3 module type	0[No ext. module]
A2-29	SLOT 1_3 software version	0.00
A2-30	SLOT 2_1 module type	0[No ext. module]
A2-31	SLOT 2_1 software version	0.00
A2-32	SLOT 2_2 module type	0[No ext. module]
A2-33	SLOT 2_2 software version	0.00
A2-34	SLOT 2_3 module type	0[No ext. module]
A2-35	SLOT 2_3 software version	0.00
A2-36	SLOT 3_1 module type	112[Profibus-DP]
A2-37	SLOT 3_1 software version	3.24

2. Configure the PROFIBUS-DP expansion slot and set the communication address properly.

n16-00	SLOT selection	7[SLOT 3_1]
n16-01	Module online status	1[Online]
n16-02	Ext. module Node-ID	1

3. Configure the bus adapter. Assume that PROFIBUS-DP is connected to bus adapter A and set the communication disconnection detection time properly.

n1-00	[FBA-A] Bus type	7[Profibus-DP]	-
n1-01	[FBA-A] Comm. wire breakag...	0.50	s

4. Configure the process data received by the host controller (HCU-40 outputs process data).

- Use bit-to-word Function 1 to generate device status word.

L0-10	[B2W 1] Bit00 selection	U1-00[Ready to switch on]
L0-11	[B2W 1] Bit01 selection	U1-01[Ready for operation]
L0-12	[B2W 1] Bit02 selection	U1-09[Pre-charge completed]
L0-13	[B2W 1] Bit03 selection	U1-12[Startup completed]
L0-14	[B2W 1] Bit04 selection	U1-14[Fault activated]
L0-15	[B2W 1] Bit05 selection	U1-15[Warning/Limit activa...
L0-16	[B2W 1] Bit06 selection	0[Disable]
L0-17	[B2W 1] Bit07 selection	0[Disable]
L0-18	[B2W 1] Bit08 selection	0[Disable]
L0-19	[B2W 1] Bit09 selection	U0-01[Logic 1]
L0-20	[B2W 1] Bit10 selection	0[Disable]
L0-21	[B2W 1] Bit11 selection	0[Disable]
L0-22	[B2W 1] Bit12 selection	0[Disable]
L0-23	[B2W 1] Bit13 selection	0[Disable]
L0-24	[B2W 1] Bit14 selection	0[Disable]
L0-25	[B2W 1] Bit15 selection	0[Disable]

- Use bit-to-word Function 2 to generate fault status word.

L0-26	[B2W 2] Bit00 selection	U3-73[Grid abnormal]
L0-27	[B2W 2] Bit01 selection	U3-50[Overcurrent]
L0-28	[B2W 2] Bit02 selection	U3-51[Overvoltage(HVS)]
L0-29	[B2W 2] Bit03 selection	U3-52[Undervoltage(HVS)]
L0-30	[B2W 2] Bit04 selection	U3-56[Drive overload]
L0-31	[B2W 2] Bit05 selection	0[Disable]
L0-32	[B2W 2] Bit06 selection	0[Disable]
L0-33	[B2W 2] Bit07 selection	0[Disable]
L0-34	[B2W 2] Bit08 selection	0[Disable]
L0-35	[B2W 2] Bit09 selection	U3-58[Module overtemperature]
L0-36	[B2W 2] Bit10 selection	U3-65[Excessive leakage current]
L0-37	[B2W 2] Bit11 selection	0[Disable]
L0-38	[B2W 2] Bit12 selection	0[Disable]
L0-39	[B2W 2] Bit13 selection	0[Disable]
L0-40	[B2W 2] Bit14 selection	0[Disable]
L0-41	[B2W 2] Bit15 selection	0[Disable]

- Configure the host controller to read data.

n1-04	Process data output 1	U5-86[[B2W 1] Output]
n1-05	Process data output 2	U5-87[[B2W 2] Output]
n1-06	Process data output 3	U5-02[DC link voltage]
n1-07	Process data output 4	U5-04[Grid frequency]
n1-08	Process data output 5	U5-03[Grid voltage]
n1-09	Process data output 6	U5-05[Grid current]
n1-10	Process data output 7	0[0]
n1-11	Process data output 8	0[0]

5. Configure the host controller to send control word.

A9-00	CMS selection source	0[CMS-1]
b0-00	Enable default config.	0[Disable]
b1-00	[CH-1] control source	1[Custom start/stop (group b1)]
b1-01	[CH-1] custom OFF1 source	U2-00[FBA-A.PZD1.0]
b1-02	[CH-1] custom OFF2 source	U2-01[FBA-A.PZD1.1]
b1-03	[CH-1] custom operation command source	1[Allow operation]
b1-04	[CH-1] custom reset signal source	U2-07[FBA-A.PZD1.7]

6. Power off and on the HCU-40 control power supply again.
7. Check whether the data received and sent by HCU-40 is normal. The output process data of HCU-40 corresponds to the data received by the host controller, and the input process data corresponds to the process data sent by the host controller.

n1-52	[Process data output 1] Data display	0x0230
n1-53	[Process data output 2] Data display	0x0000
n1-54	[Process data output 3] Data display	0x0000
n1-55	[Process data output 4] Data display	0x0000
n1-56	[Process data output 5] Data display	0x0000
n1-57	[Process data output 6] Data display	0x0000
n1-68	[Process data input 1] Data display	0x0000

Note

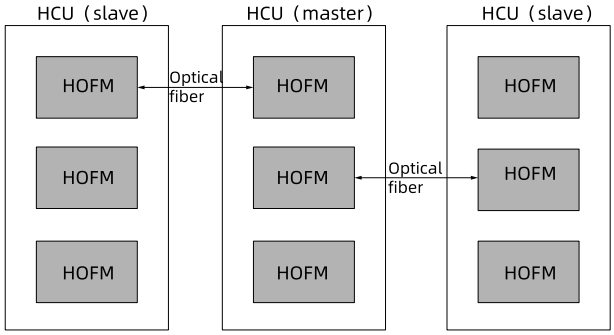
In PROFIBUS-DP communication, set the check bit of PZD1 to 1 (bit10 of PZD1 by default, which can be modified or disabled through n16-10). Otherwise, all the received process data is considered invalid. U5-44 to U5-59 (or U5-60 to U5-75) keep the data of check bit 1, but n1-68 to n1-83 (or n2-68 to n2-83) display the original data received.

8.2.8 Carrier Synchronization Communication Network

8.2.8.1 Carrier Synchronization Communication

HCU-40 carrier synchronization communication is used for carrier-level high-speed communication between multiple AFE control devices during synchronized operation, and currently supports master-slave parallel control.

Carrier synchronization communication uses optical fiber to implement link connection between multiple controllers. Star topology is used, where one master can be connected to up to three slaves, and among the two controllers connected, only one can be the master and the other the slave.



The following shows the related parameter configuration.

Table 8–5 Basic parameter setting

Param.	Name	Description
n40-00/n40-01/n40-02	Carrier synchronization communication module slot selection for modules 1/2/3	Defines the slot position where the carrier synchronization communication module 1/2/3 is located.
n40-03	Carrier synchronization master-slave setting	Defines whether the current controller is on the master side in the carrier synchronization communication. In the carrier synchronization communication system, when a master-slave architecture is used for networking, if the system detects multiple masters or a missing master in the network, a carrier synchronization networking error alarm can be triggered (alarm code A203-2/A203-3/A203-4).
n40-04	Carrier synchronization signal source (slave)	Defines the source of the master synchronization signal in slave mode. Set a synchronization communication signal source for the carrier synchronization module in the slave for real-time communication.

Param.	Name	Description
n40-05/n40-06/n40-07	Carrier synchronization communication module 1/2/3 real-time data mode enable	Used to enable real-time data for the carrier synchronization communication module. Real-time data transmission can only be performed when this parameter is enabled.
n40-08	Carrier synchronization communication module real-time data mode	0: Master-slave parallel mode
n40-09	Carrier synchronization communication module transmission error detection enable	Used to enable transmission error detection for the carrier synchronization communication module. After n40-09 is enabled, when the drive is in the operation state, if an error is detected in the data transmitted during carrier synchronization communication, the corresponding fault (F205-3, F206-3, F207-3) can be triggered. When the drive is in the stopped state, if an error in the carrier synchronization communication transmission data is detected, the corresponding alarm (A205-3, A206-3, A207-3) can be triggered.
n40-10	Carrier synchronization communication module reception error detection enable	Used to enable reception error detection for the carrier synchronization communication module. After n40-10 is enabled, when the drive is in the operation state, if an error is detected in the data received during carrier synchronization communication, the corresponding fault (F205-11, F206-11,F207-11) can be triggered. When the drive is in the operation state, if an error is detected in the data received during carrier synchronization communication, the corresponding alarm (A205-11, A206-11, A207-11) can be triggered.

Carrier synchronization communication data is divided into real-time data and non-real-time data.

- Real-time data: Refers to data transmitted at fixed moments within each carrier cycle.
- Non-real-time data: Refers to data exchanged asynchronously outside real-time communication. Master-slave communication is achieved through non-real-time data.

Param.	Name	Description
n40-35/n40-43/n40-51	Carrier synchronization communication module 1/2/3 non-real-time data transmission 1	Defines the non-real-time data transmitted by carrier synchronization module 1/2/3. Related connectors: U27-24 to U27-47 Carrier synchronization communication module 1/2/3 non-real-time data transmission U27-72 to U27-95 Carrier synchronization communication module 1/2/3 non-real-time data reception
n40-36/n40-44/n40-52	Carrier synchronization communication module 1/2/3 non-real-time data transmission 2	
n40-37/n40-45/n40-53	Carrier synchronization communication module 1/2/3 non-real-time data transmission 3	
n40-38/n40-46/n40-54	Carrier synchronization communication module 1/2/3 non-real-time data transmission 4	
n40-39/n40-47/n40-55	Carrier synchronization communication module 1/2/3 non-real-time data transmission 5	
n40-40/n40-48/n40-56	Carrier synchronization communication module 1/2/3 non-real-time data transmission 6	
n40-41/n40-49/n40-57	Carrier synchronization communication module 1/2/3 non-real-time data transmission 7	
n40-42/n40-50/n40-58	Carrier synchronization communication module 1/2/3 non-real-time data transmission 8	

8.2.8.2 Master-Slave Parallel Control

A master-slave control architecture based on carrier synchronization can achieve stable parallel operation of multiple AFEs. In parallel control mode, one AFE acts as the master and operates in the voltage mode to establish and support the DC bus voltage. The remaining AFEs act as slaves and operate in the current mode to receive current distribution commands from the master.

For stable parallel operation of AFEs, the following configurations must be set.

1. Set the active rectification mode configuration (E0-01) for the AFE master to voltage mode, and set the active rectification mode configuration (E0-01) for the slave to current mode.
2. Configure the carrier synchronization communication setting parameters in group n40. See details in *"8.2.8.1 Carrier Synchronization Communication" on page 99*.

Table 8–6 Parameters related to parallel operation of master and slave

Param.	Name	Description
C0-00	[Channel 1] voltage reference source	Defines voltage reference source of [channel 1]. In the voltage mode, select the DC bus voltage reference source.
C1-00	Current reference source (Current reference for carrier synchronization 1 to 3)	Set the current reference source (Current reference for carrier synchronization 1 to 3), which must be consistent with the carrier synchronization signal source defined by n40-09.

Param.	Name	Description
E0-01	Active rectification mode	Set the active rectification mode: set the active rectification mode (E0-01) for the master to voltage mode, and set the active rectification mode (E0-01) for the slaves to current mode.
E7-37	Detection threshold for excessive bus voltage deviation	Defines the threshold for excessive bus voltage deviation in master-slave mode for the master.
E7-38	Detection time for excessive bus voltage deviation	Defines the detection time for excessive bus voltage deviation in master-slave mode for the master.
E7-39	Master-slave operation error detection time	Defines the master-slave operation error detection time in the master-slave mode for the master.



In master-slave parallel mode, all power units must be uniform. The master operates in voltage mode and the slave operates in current mode, with the actual effective carrier frequency (A4-01) kept consistent.

Carrier synchronization master-slave parallel application example

This section takes dual AFE master-slave parallel control as an example. The following shows the related parameter configuration.

Table 8–7 Master

Param.	Name	Value
C0-00	[Channel 1] voltage reference source	2 [Calculated based on preset incoming line voltage]
E0-01	Active rectification mode	0 [Voltage mode]
E7-37	Detection threshold for excessive bus voltage deviation	5.0
E7-38	Detection time for excessive bus voltage deviation	0.01
E7-39	Master-slave operation error detection time	0.01
n40-00	Carrier synchronization communication module 1 slot selection	1 [Expansion slot 1_1]
n40-03	Carrier synchronization master-slave setting	1 [Master]
n40-05	Carrier synchronization communication module 1 real-time data mode enable	1 [Enable]

Table 8–8 Slave 1

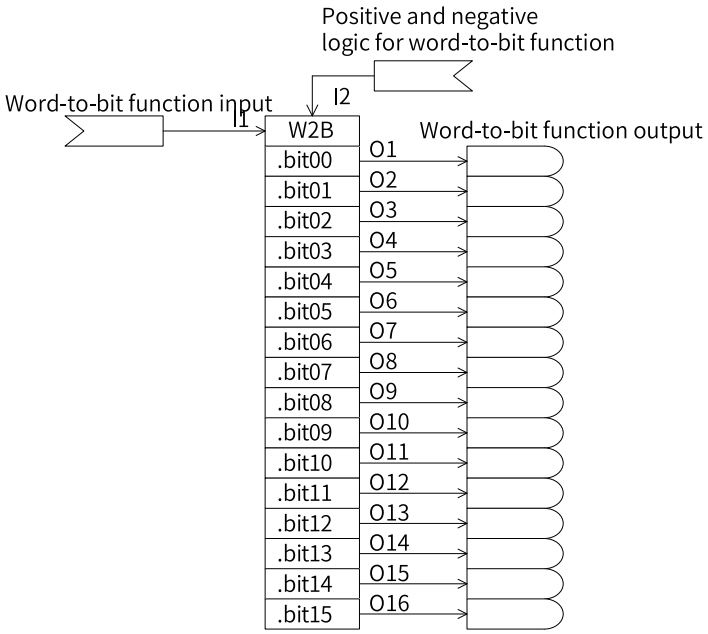
Param.	Name	Value
C1-00	[Channel 1] current reference source	2 [Carrier synchronization 1 current reference]
E0-01	Active rectification mode	1 [Current mode]
n40-00	Carrier synchronization communication module 1 slot selection	1 [Expansion slot 1_1]

Param.	Name	Value
n40-03	Carrier synchronization master-slave setting	1 [Slave]
n40-05	Carrier synchronization communication module 1 real-time data mode enable	1 [Enable]

8.3 Word-to-Bit Function

8.3.1 Word-to-Bit Block (1 to 4)

Diagram



Operation

When input I1 is Word, the outputs O1 to O16 correspond to bit0 to bit15 of input I1; when input I1 is DWord, the outputs O1 to O16 correspond to high-order 16 bits (bit0 to bit15) of input I1; I2 bit=0, not inverted; I2 bit=1, inverted.

Connection

Input I1: signed number

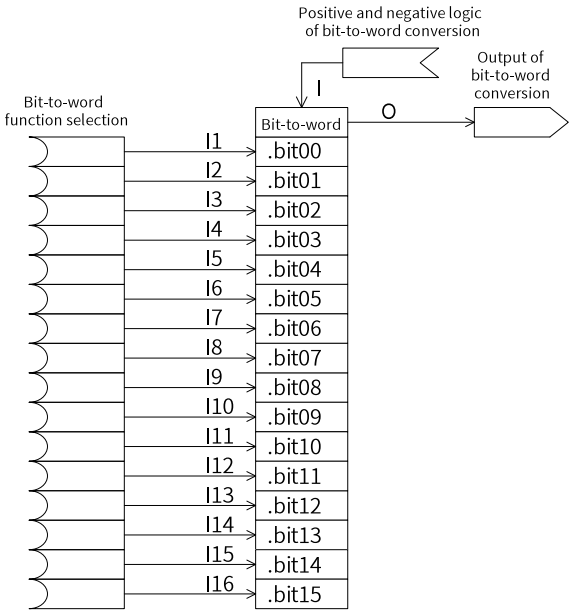
Input I2: unsigned number

Output O1 to O16: binary number

Word-to-bit block		1	2	3	4
Input	I1	L0-00	L0-01	L0-02	L0-03
	I2	L0-74	L0-75	L0-76	L0-77
Output	O1 (bit00)	U2-48	U2-64	U2-80	U4-39
	O2 (bit01)	U2-49	U2-65	U2-81	U4-40
	O3 (bit02)	U2-50	U2-66	U2-82	U4-41
	O4 (bit03)	U2-51	U2-67	U2-83	U4-42
	O5 (bit04)	U2-52	U2-68	U2-84	U4-43
	O6 (bit05)	U2-53	U2-69	U2-85	U4-44
	O7 (bit06)	U2-54	U2-70	U2-86	U4-45
	O8 (bit07)	U2-55	U2-71	U2-87	U4-46
	O9 (bit08)	U2-56	U2-72	U2-88	U4-47
	O10 (bit09)	U2-57	U2-73	U2-89	U4-48
	O11 (bit10)	U2-58	U2-74	U2-90	U4-49
	O12 (bit11)	U2-59	U2-75	U2-91	U4-50
	O13 (bit12)	U2-60	U2-76	U2-92	U4-51
	O14 (bit13)	U2-61	U2-77	U2-93	U4-52
	O15 (bit14)	U2-62	U2-78	U2-94	U4-53
	O16 (bit15)	U2-63	U2-79	U2-95	U4-54

8.3.2 Bit-to-Word Block (1 to 4)

Diagram



Operation

bit0 to bit15 of the output O correspond to inputs I1 to I16. When the input bit is zero, inversion is not applied. When the input bit is 1, inversion is applied.

Connection

Input I: unsigned number

Input I1 to I16: binary number

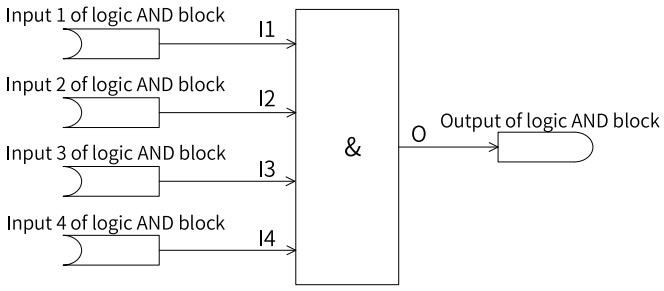
Output O: signed number

bit-to-word block		1	2	3	4
Input	I1 (bit00)	L0-10	L0-26	L0-42	L0-58
	I2 (bit01)	L0-11	L0-27	L0-43	L0-59
	I3 (bit02)	L0-12	L0-28	L0-44	L0-60
	I4 (bit03)	L0-13	L0-29	L0-45	L0-61
	I5 (bit04)	L0-14	L0-30	L0-46	L0-62
	I6 (bit05)	L0-15	L0-31	L0-47	L0-63
	I7 (bit06)	L0-16	L0-32	L0-48	L0-64
	I8 (bit07)	L0-17	L0-33	L0-49	L0-65
	I9 (bit08)	L0-18	L0-34	L0-50	L0-66
	I10 (bit09)	L0-19	L0-35	L0-51	L0-67
	I11 (bit 10)	L0-20	L0-36	L0-52	L0-68
	I12 (bit 11)	L0-21	L0-37	L0-53	L0-69
	I13 (bit 12)	L0-22	L0-38	L0-54	L0-70
	I14 (bit 13)	L0-23	L0-39	L0-55	L0-71
	I15 (bit 14)	L0-24	L0-40	L0-56	L0-72
	I16 (bit15)	L0-25	L0-41	L0-57	L0-73
	I	L0-78	L0-79	L0-80	L0-81
Output	O	U5-86	U5-87	U5-88	U5-89

8.4 Logic Operation Function

8.4.1 Logic AND Block (A to D)

Diagram



Operation

O=I1&I2&I3&I4

Only when I1, I2, I3, and I4 are all true, the output (O) will be true; Otherwise, the output (O) is false. The output of the truth table is:

Input				Output
I1	I2	I3	I4	O
0	×	×	×	0
×	0	×	×	0
×	×	0	×	0
×	×	×	0	0
1	1	1	1	1

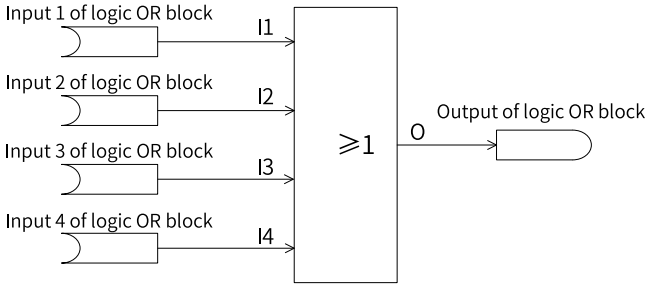
Connection Input I1, I2, I3, and I4: binary number

Output O: binary number

Logic AND module	Input				Output
	I1	I2	I3	I4	O
A	L2-00	L2-01	L2-02	L2-03	U3-00
B	L2-04	L2-05	L2-06	L2-07	U3-01
C	L2-08	L2-09	L2-10	L2-11	U3-02
D	L2-12	L2-13	L2-14	L2-15	U3-03

8.4.2 Logic OR Block (A to D)

Diagram



Operation

O=I1|I2|I3|I4

If any one of the inputs I1, I1, I2, I3, and I4 is true, the output is true. The output of the truth table is:

Input				Output
I1	I2	I3	I4	O
0	0	0	0	0
1	×	×	×	1
×	1	×	×	1
×	×	1	×	1
×	×	×	1	1

Connection

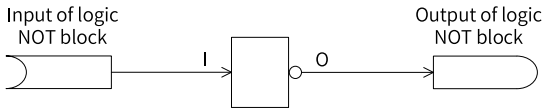
Input I1, I2, I3, and I4: binary number

Output O: binary number

Logic OR module	Input				Output
	I1	I2	I3	I4	O
A	L2-24	L2-25	L2-26	L2-27	U3-12
B	L2-28	L2-29	L2-30	L2-31	U3-13
C	L2-32	L2-33	L2-34	L2-35	U3-14
D	L2-36	L2-37	L2-38	L2-39	U3-15

8.4.3 Logic NOT Block (A to H)

Diagram



Operation

$$O=\bar{I}$$

Input	Output
I	O
0	1
1	0

Connection

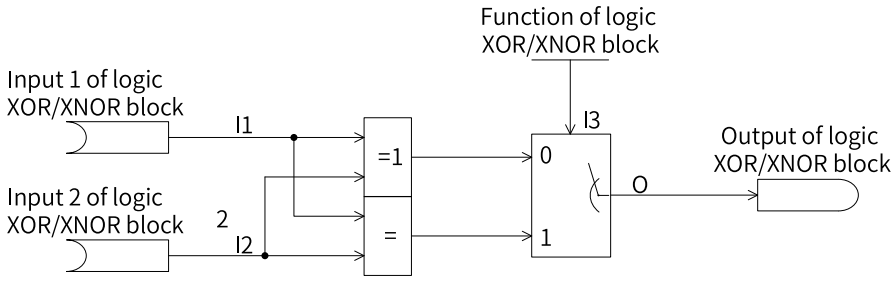
Input I1: binary number

Output O: binary number

Logic NOT module	Input	Output
	I	O
A	L2-16	U3-04
B	L2-17	U3-05
C	L2-18	U3-06
D	L2-19	U3-07
E	L2-20	U3-08
F	L2-21	U3-09
G	L2-22	U3-10
H	L2-23	U3-11

8.4.4 Logic XOR/XNOR Block (A to D)

Diagram



Operation

When I3 for enabling the logic XOR/XNOR block is set to 0, the logic XOR block is enabled, as shown in $O=\bar{I1}I2+I1\bar{I2}$.

When I1 and I2 are the same, the output (O) is 0. When I1 and I2 are different, the output (O) is 1. The output of the truth table is as follows.

Input		Output
I1	I2	O
0	0	0
1	0	1
0	1	1
1	1	0

When I3 for enabling the logic XOR/XNOR block is set to 1, the logic XNOR block is enabled, as shown in $O=I1I2+\bar{I1}\bar{I2}$.

When I1 and I2 are the same, the output (O) is 1. When I1 and I2 are different, the output (O) is 0. The output of the truth table is as follows.

Input		Output
I1	I2	O
0	0	1
1	0	0
0	1	0
1	1	1

Connection

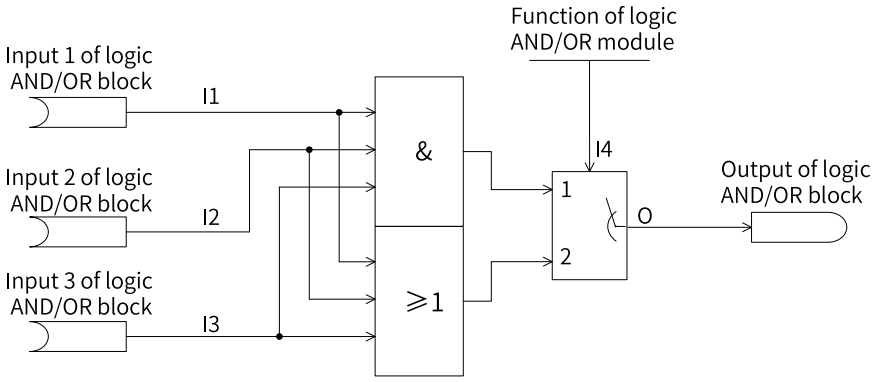
Input I1, I2, and I3: binary number

Output O: binary number

Logic XOR/XNOR block	Input			Output
	I1	I2	I3	O
A	L2-41	L2-42	L2-40	U4-00
B	L2-44	L2-45	L2-43	U4-01
C	L2-47	L2-48	L2-46	U4-02
D	L2-50	L2-51	L2-49	U4-03

8.4.5 Logic AND/OR Block (A to H)

Diagram



Operation

When I4 for enabling logic AND/OR block is set to 1, the logic AND block is active, as shown in O=I1&I2&I3
.

Only when I1, I2, and I3 are all true, the output (O) will be true; Otherwise, the output (O) is false. The output of the truth table is as follows.

Input			Output
I1	I2	I3	O
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0
1	0	1	0
0	1	1	0
1	1	1	1

When I4 for enabling the logic AND/OR block is set to 2, the logic OR block is enabled, as shown in O=I1|I2|I3
.

If any one of the inputs I1, I2, and I3 is true, the output is true. The output of the truth table is as follows.

Input			Output
I1	I2	I3	O
0	0	0	0
1	0	0	1
0	1	0	1
1	1	0	1
0	0	1	1
1	0	1	1
0	1	1	1
1	1	1	1

Connection

Input I1, I2, I3, and I4: binary number

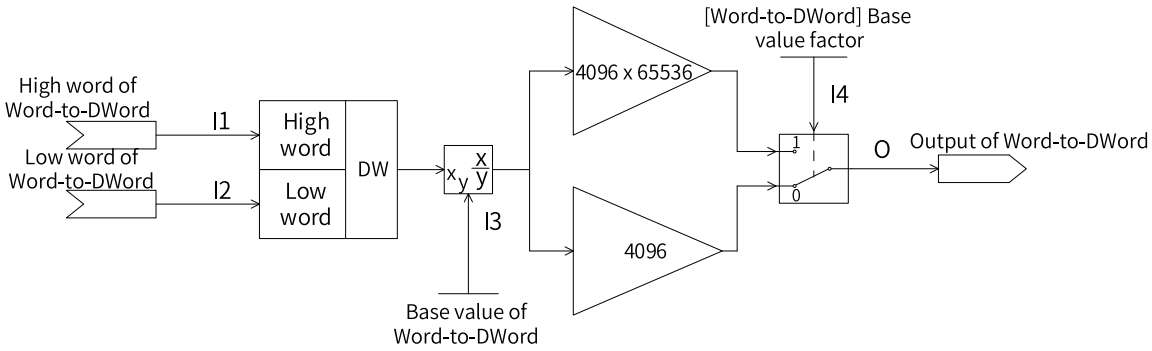
Output O: binary number

Logic AND/OR block	Input				Output
	I1	I2	I3	I4	O
A	L2-61	L2-62	L2-63	L2-60	U4-31
B	L2-65	L2-66	L2-67	L2-64	U4-32
C	L2-69	L2-70	L2-71	L2-68	U4-33
D	L2-73	L2-74	L2-75	L2-72	U4-34
E	L2-77	L2-78	L2-79	L2-76	U4-35
F	L2-81	L2-82	L2-83	L2-80	U4-36
G	L2-85	L2-86	L2-87	L2-84	U4-37
H	L2-89	L2-90	L2-91	L2-88	U4-38

8.5 Word-to-DWord Function

8.5.1 Word-to-DWord Conversion (1 to 5)

Diagram



Operation

$$O=\begin{cases}\frac{I1\times 65536+I2}{I3}\times 4096\times 65536, I4=1\\ \frac{I1\times 65536+I2}{I3}\times 4096, I4=0\end{cases}$$

The output value is the result of double word with I1 as high-order 16 bits and I2 as low-order 16 bits divided by base value I3 then multiplied by base value factor (base value factor depends on I4); when the input is double-word, high-order 16 bits applies.

When I3 is 0, the output equals the input without base value conversion.

Connection

Input I1 and I2: signed number

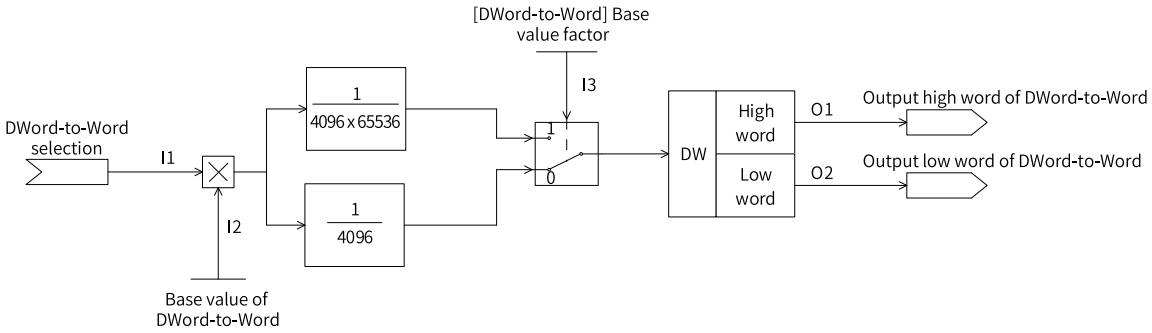
Input I3: unsigned number

Output O: signed number

Word-to-DWord	Input				Output
	I1	I2	I3	I4	O
1	L3-01	L3-02	L3-03	L3-00 (bit 0)	U9-47
2	L3-04	L3-05	L3-06	L3-00 (bit 1)	U9-48
3	L3-07	L3-08	L3-09	L3-00 (bit 2)	U9-49
4	L3-10	L3-11	L3-12	L3-00 (bit 3)	U9-13
5	L3-13	L3-14	L3-15	L3-00 (bit4)	U9-14

8.5.2 DWord-to-Word Conversion (1 to 5)

Diagram



Operation

$$O1=\begin{cases}\left(\frac{I1\cdot I2}{4096\times 65536}>>16\right)\&0xFFFF, I3=1\\ \left(\frac{I1\cdot I2}{4096}>>16\right)\&0xFFFF, I3=0\end{cases}$$

$$O2=\begin{cases}\left(\frac{I1\cdot I2}{4096\times 65536}\right)\&0xFFFF, I3=1\\ \left(\frac{I1\cdot I2}{4096}\right)\&0xFFFF, I3=0\end{cases}$$

The output high words are the high-order 16 bits of I1 multiplied by base value I2 then divided by base value factor (base value factor depends on I3). The output low words are the low-order 16 bits of I1 multiplied by base value I2 then divided by base value factor (base value factor depends on I3).

When I2 is set to 0, the output high/low word is directly used as the input high/low word without base value conversion.

Connection

Input I1: signed number

Input I2: unsigned number

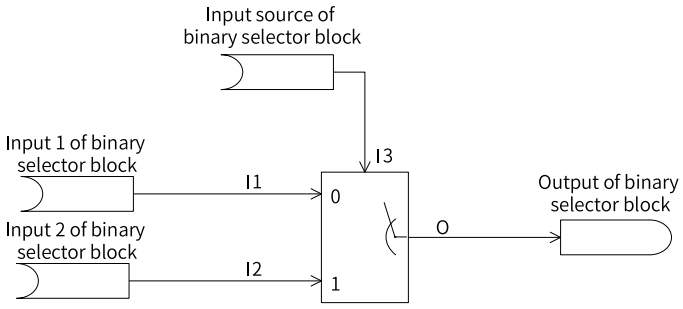
Output O1 and O2: signed number

DWord-to-Word conversion	Input			Output	
	I1	I2	I3	O1	O2
1	L3-26	L3-27	L3-25 (bit 0)	U5-76	U5-77
2	L3-28	L3-29	L3-25 (bit 1)	U5-78	U5-79
3	L3-30	L3-31	L3-25 (bit 2)	U5-80	U5-81
4	L3-32	L3-33	L3-25 (bit 3)	U5-82	U5-83
5	L3-34	L3-35	L3-25 (bit 4)	U5-84	U5-85

8.6 Switch Function Block

8.6.1 Binary Selector Block (1 to 8)

Diagram



Operation

$$O=\begin{cases} I1, I3=0 \\ I2, I3=1 \end{cases}$$

When I3 (binary selector block) is set to 0, the output O equals I1 (bit). When I3 (binary selector block) is set to 1, the output O equals I2 (bit).

Connection

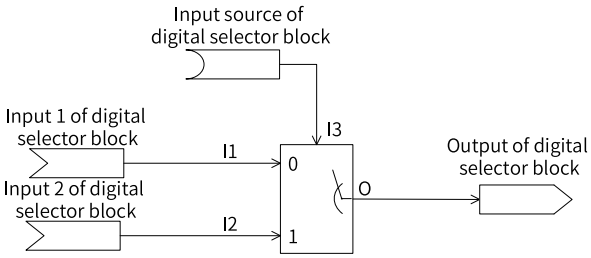
Input I1, I2, and I3: binary number

Output O: binary number

Binary selector block	Input			Output
	I1	I2	I3	O
1	L5-01	L5-02	L5-00	U4-04
2	L5-04	L5-05	L5-03	U4-05
3	L5-07	L5-08	L5-06	U4-06
4	L5-10	L5-11	L5-09	U4-07
5	L5-13	L5-14	L5-12	U3-24
6	L5-16	L5-17	L5-15	U3-25
7	L5-19	L5-20	L5-18	U3-26
8	L5-22	L5-23	L5-21	U3-27

8.6.2 Digital Selector Block (1 to 16)

Diagram



Operation

$$O=\begin{cases} I1, I3=0 \\ I2, I3=1 \end{cases}$$

When I3 (digital selector block) is set to 0, the output O equals I1 (word). When I3 (digital selector block) is set to 1, the output O equals I2 (word).

Connection

Input I1 and I2: signed number

Input I3: binary number

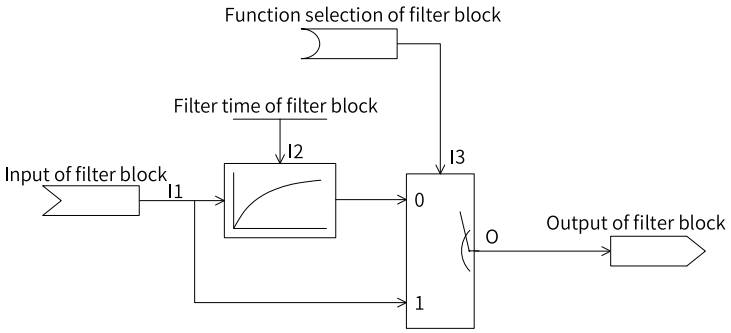
Output O: signed number

Digital selector block	Input			Output
	I1	I2	I3	O
1	L5-31	L5-32	L5-30	U9-56
2	L5-34	L5-35	L5-33	U9-57
3	L5-37	L5-38	L5-36	U9-58
4	L5-40	L5-41	L5-39	U9-59
5	L5-43	L5-44	L5-42	U9-60
6	L5-46	L5-47	L5-45	U9-61
7	L5-49	L5-50	L5-48	U9-62
8	L5-52	L5-53	L5-51	U9-63
9	L5-55	L5-56	L5-54	U9-64
10	L5-58	L5-59	L5-57	U9-65
11	L5-61	L5-62	L5-60	U9-66
12	L5-64	L5-65	L5-63	U9-67
13	L5-67	L5-68	L5-66	U9-15
14	L5-70	L5-71	L5-69	U9-16
15	L5-73	L5-74	L5-72	U9-17
16	L5-76	L5-77	L5-75	U9-18

8.7 Control Function Block

8.7.1 Filter Block (A to D)

Diagram



Operation

When the filter block function selection I3 is set to 0, the output O equals I1. When the filter block function selection I3 is set to 1, the output O equals I1.

Connection

Input I1: signed number

Input I2: unsigned number

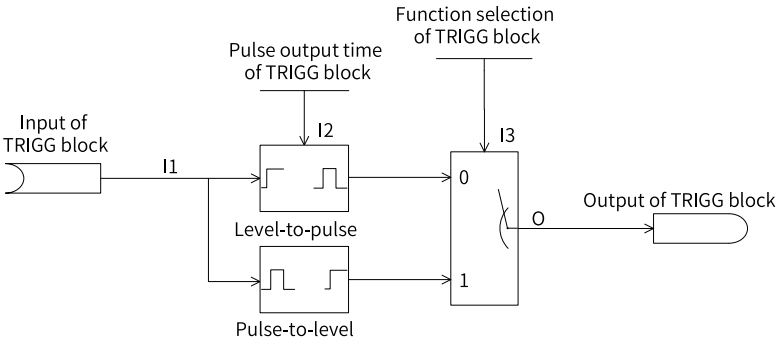
Input I3: binary number

Output O: signed number

Filter block	Input			Output
	I1	I2	I3	O
A	L6-01	L6-02	L6-00	U9-69
B	L6-04	L6-05	L6-03	U9-70
C	L6-07	L6-08	L6-06	U9-71
D	L6-10	L6-11	L6-09	U9-72

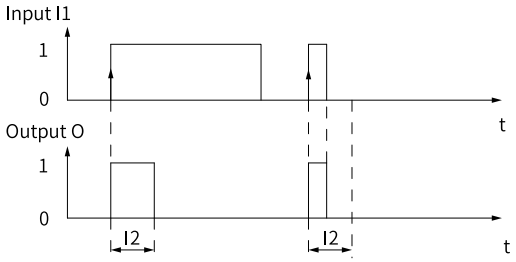
8.7.2 Level-to-Pulse Block (A to D)

Diagram

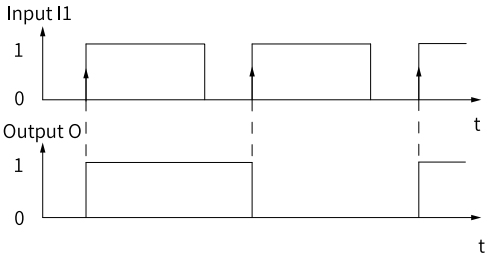


Operation

When I3 for enabling level-to-pulse block is set to 0, level-to-pulse conversion is active. In this case, the output is set to 1 within the pulse output time l2 on the rising edge of input l1. If input I1 is 0, the output is 0 immediately regardless of whether the pulse duration is reached.



When l3 for enabling level-to-pulse block is set to 1, pulse-to-level conversion is active. In this case, the output is set to 1 on the first rising edge of input I1, and set to 0 on the second rising edge of input I1, and so on. For odd number of pulses, the output is high level. For even number of pulses, the output is low level.



Connection

Input I1 and I3: binary number

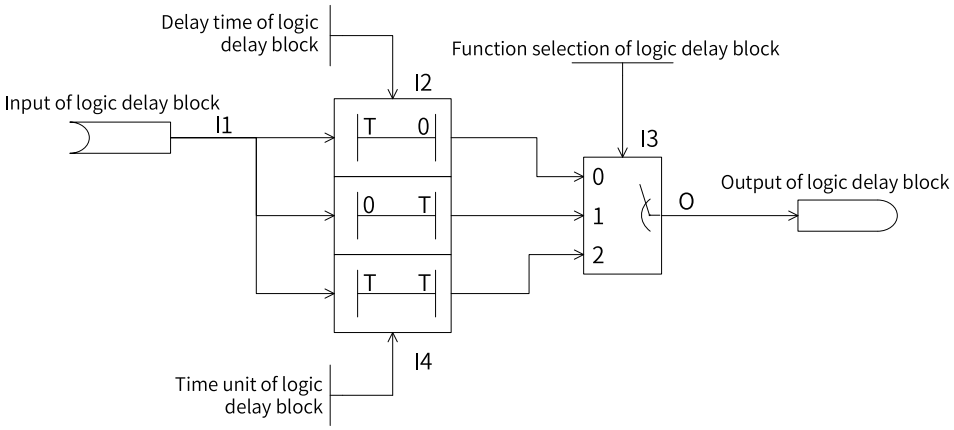
Input I2: unsigned number

Output O: binary number

Level-to-pulse block	Input			Output
	I1	I2	I3	O
A	L6-13	L6-14	L6-12	U4-08
B	L6-16	L6-17	L6-15	U4-09
C	L6-19	L6-20	L6-18	U4-10
D	L6-22	L6-23	L6-21	U4-11

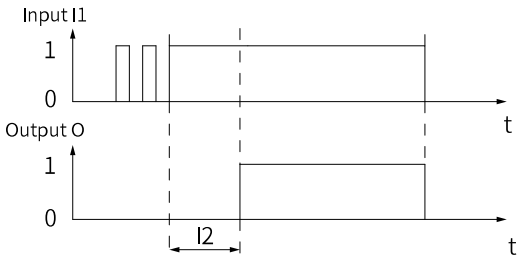
8.7.3 Logic Delay Block (A to H)

Diagram

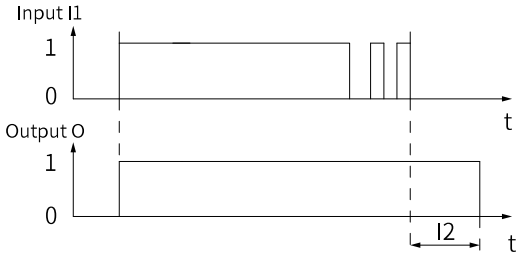


Operation

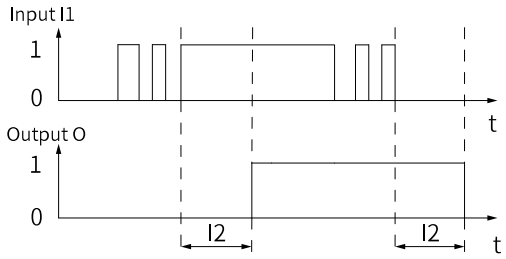
When I3 for enabling the logic delay block is set to 0, the switch-on delay applies upon 0→1, and the delay time is determined by the l2 delay time and the l4 time unit. Switch-on delay can filter out high-level pulses shorter than I2 time, as shown in the following figure.



When I3 for enabling the logic delay block is set to 1, the switch-on delay applies upon 1→0, and the delay time is determined by l2 delay time and the l4 time unit. Switch-off delay can filter out low-level pulses shorter than I2 time, as shown in the following figure.



When I3 for enabling the logic delay block is set to 2, the switch-on delay applies upon 0→1 and 1→0. The delay time is determined by the l2 delay time and the l4 time unit. Both switch-on delay and switch-off delay have filtering effect, as shown in the following figure.



Connection

Input I1: binary number

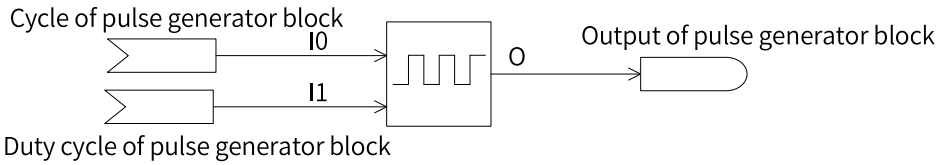
Input I2 and I3: unsigned number

Output O: binary number

Logic delay block	Input				Output
	I1	I2	I3	I4	O
A	L6-24	L6-26	L6-25	L6-27	U3-16
B	L6-28	L6-30	L6-29	L6-31	U3-17
C	L6-32	L6-34	L6-33	L6-35	U3-18
D	L6-36	L6-38	L6-37	L6-39	U3-19
E	L6-40	L6-41	L6-42	L6-43	U3-20
F	L6-44	L6-45	L6-46	L6-47	U3-21
G	L6-48	L6-49	L6-50	L6-51	U3-22
H	L6-52	L6-53	L6-54	L6-55	U3-23

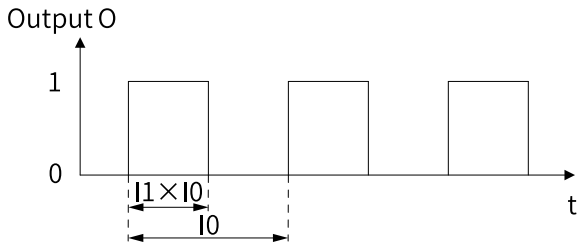
8.7.4 Pulse Generator Block (1 to 3)

Diagram



Operation

When the cycle input of the pulse generator block is 0, the block output keeps low level. If the input I0 is not 0, the block outputs square-wave signal. I1 duty cycle can be set.



Connection

Input I0 and I1: unsigned number

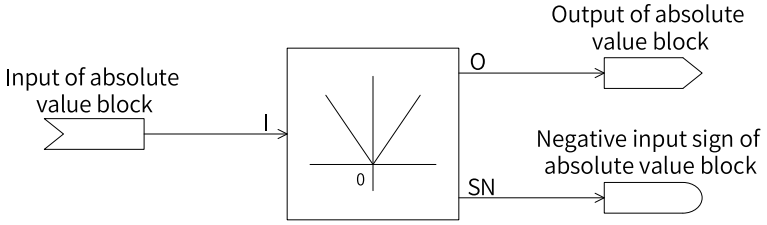
Output O: binary number

Pulse generator block	Input		Output
	I0	I1	O
A	L6-56	L6-57	U2-96
B	L6-58	L6-59	U2-97
C	L6-60	L6-61	U2-98

8.8 Arithmetic Function Block

8.8.1 Absolute Value Block (A to D)

Diagram



Operation

$O=|I|$

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

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

Connection

Input I: signed number

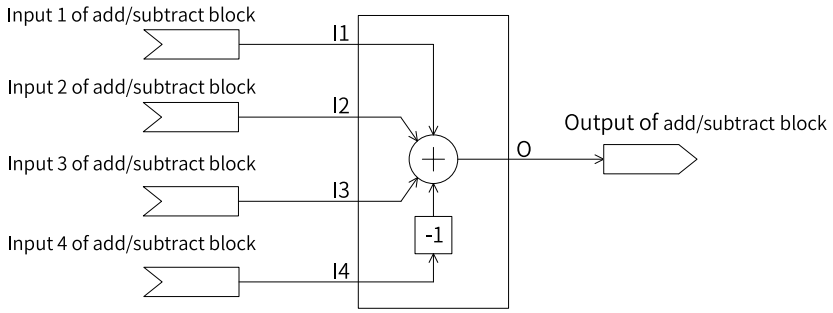
Output O: signed number

Output SN: binary number

Absolute value block	Input	Output	
	I	SN	O
A	L7-00	U4-12	U9-73
B	L7-01	U4-13	U9-74
C	L7-02	U4-14	U9-75
D	L7-03	U4-15	U9-76

8.8.2 Add/Subtract Block (A to D)

Diagram



Operation

O=I1+I2+I3-I4

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

Connection

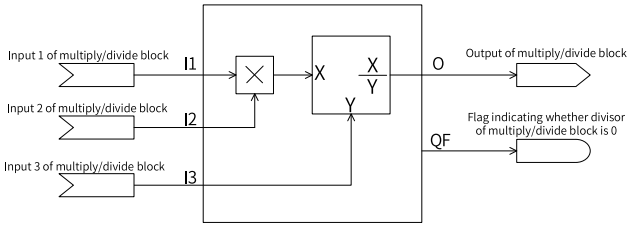
Input I1, I2, I3, and I4: signed number

Output O: signed number

Add/Subtract block	Input				Output
	I1	I2	I3	I4	O
A	L7-04	L7-05	L7-06	L7-07	U9-77
B	L7-08	L7-09	L7-10	L7-11	U9-78
C	L7-12	L7-13	L7-14	L7-15	U9-79
D	L7-16	L7-17	L7-18	L7-19	U9-80

8.8.3 Multiply/Divide Block (A to D)

Diagram



Operation

$$O=(I1 \cdot I2)/I3$$

$$QF=\begin{cases}1, I3=0\\0, I3\neq 0\end{cases}$$

Connection

Input I1, I2 and I3: signed number

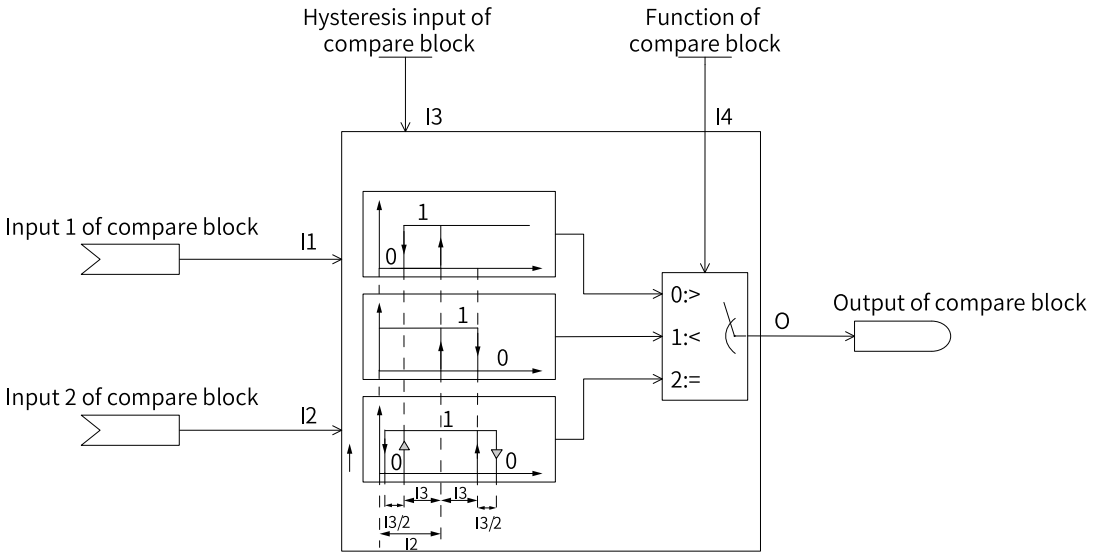
Output O: signed number

Output QF: binary number

Multiply/Divide block	Input			Output	
	I1	I2	I3	QF	O
A	L7-20	L7-21	L7-22	U4-16	U9-81
B	L7-23	L7-24	L7-25	U4-17	U9-82
C	L7-26	L7-27	L7-28	U4-18	U9-83
D	L7-29	L7-30	L7-31	U4-19	U9-84

8.8.4 Compare Block (A to E)

Diagram



Operation

When I4 (Compare block function) is set to 0, before I1 increases from 0 to I2 in the forward direction, the output O keeps low level. When I1 increases to a value higher than I2, the output O changes from low level to high level. When I1 keeps increasing, the output O keeps high level. If I1 decreases, as long as I1 is higher than I2-I3, the output O keeps high level. Only when I1 is lower than I2-I3, the output O changes from high level to low level.

When l4 (Compare block function) is set to 1, before I1 increases from 0 to I2+I3 in the forward direction, the output O keeps high level. When I1 increases to a value higher than I2+I3, the output O changes from high level to low level. When I1 keeps increasing, the output O keeps low level. If I1 decreases, as long as I1 is higher than I2, the output O keeps low level. Only when I1 is lower than I2, the output O changes from low level to high level.

When l4 (Compare block function) is set to 2, before I1 increases from 0 to I2-I3 in the forward direction, the output O keeps low level. When I1 increases to a value between the range of I2-I3 to I2 +I3, the output O changes from low level to high level. When I1 increases to a value higher than I2 +1.5×I3, the output O changes from high level to low level. If I1 decreases, as long as I1 is lower than I2+I3, the output O keeps low level. When I1 decreases to a value between the range of I2-1.5×I3 to I2+I3, the output O changes from low level to high level. Only when I1 is lower than I2-1.5×I3, the output O changes from high level to low level.

Hysteresis input I3 suppresses frequent on-off switching.

Connection

Input I1 and I2: signed number

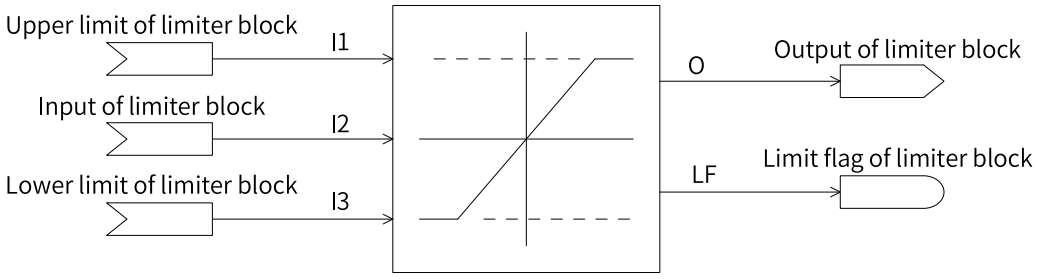
Input I3 and I4: unsigned number

Input O: binary number

Compare block	Input				Output
	I1	I2	I3	I4	O
A	L7-33	L7-34	L7-35	L7-32	U4-20
B	L7-37	L7-38	L7-39	L7-36	U4-21
C	L7-41	L7-42	L7-43	L7-40	U4-22
D	L7-45	L7-46	L7-47	L7-44	U4-23
E	L7-49	L7-50	L7-51	L7-48	U4-24

8.8.5 Limiter Block (A to D)

Diagram



Operation

$$O=\begin{cases} I1, & I2>I1 \\ I2, & I3\leqslant I2\leqslant I1 \\ I3, & I2<I3 \end{cases}$$

$$LF=\begin{cases}1.\ I2 > I1 \text{ or } I2 < I3\\ 0.\ I3 \leqslant I2 \leqslant I1\end{cases}$$

When input I2 is higher than the upper limit I1, the output O is equal to I1. When input I2 is lower than the lower limit I3, the output O is equal to I3. When input l2 is within the range of the lower limit to the upper limit, the output is equal to the input. When input I2 is higher than the upper limit I1 or lower than the lower limit I3, the limit flag position is set to 1.

Connection

Input I1, I2, and I3: signed number

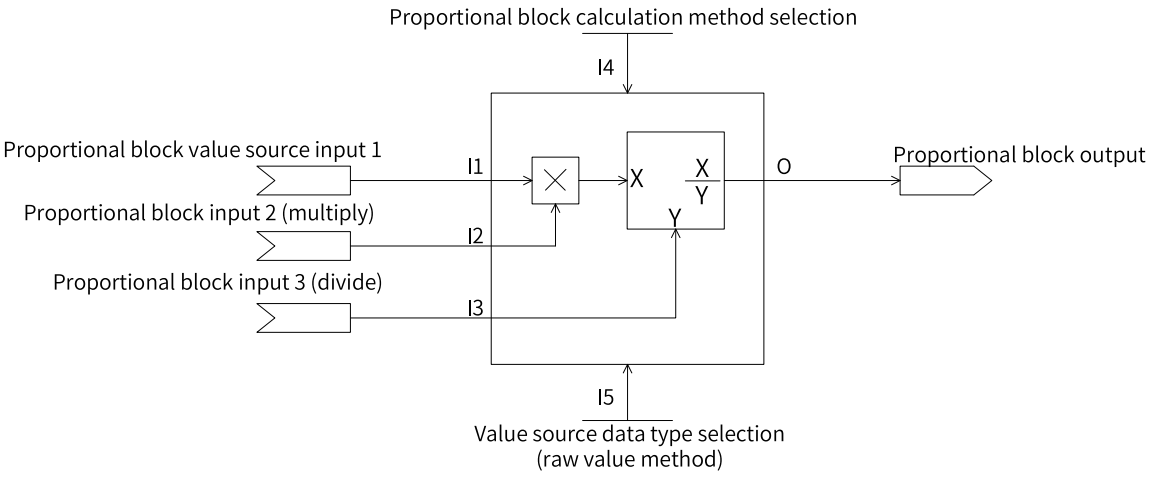
Output O: signed number

Output LF: binary number

Limiter block	Input			Output	
	I1	I2	I3	LF	O
A	L7-61	L7-60	L7-62	U4-25	U9-19
B	L7-64	L7-63	L7-65	U4-26	U9-20
C	L7-67	L7-66	L7-68	U4-27	U9-21
D	L7-70	L7-69	L7-71	U4-28	U9-22

8.8.6 Proportional Block (1 to 15)

Diagram



Operation

The operation of proportional block is similar to that of multiply/divide block. You can select the calculation method and data type for I1 as needed. According to *"3.4.2 Representation of Per-Unit Values" on page 24*, 4096 corresponds to 100% for Word connectors, and 4096 x 65536 corresponds to 100% for DWord connectors. Proportional blocks 1 to 10 are used for Word connector operation, and proportional blocks 11 to 15 are used for DWord connector operation.

Connection

Input I1, I3, I4, and I5: Unsigned number

Input I2: Signed number

Output O: signed number

Proportional block	Input					Output
	I1	I2	I3	I4	I5	O
1	L11-02	L11-03	L11-04	L11-00 (bit0)	L11-01 (bit0)	U15-10
2	L11-05	L11-06	L11-07	L11-00 (bit1)	L11-01 (bit1)	U15-11
3	L11-08	L11-09	L11-10	L11-00 (bit2)	L11-01 (bit2)	U15-12
4	L11-11	L11-12	L11-13	L11-00 (bit3)	L11-01 (bit3)	U15-13
5	L11-14	L11-15	L11-16	L11-00 (bit4)	L11-01 (bit4)	U15-14
6	L11-17	L11-18	L11-19	L11-00 (bit5)	L11-01 (bit5)	U15-15
7	L11-20	L11-21	L11-22	L11-00 (bit6)	L11-01 (bit6)	U15-16
8	L11-23	L11-24	L11-25	L11-00 (bit7)	L11-01 (bit7)	U15-17
9	L11-26	L11-27	L11-28	L11-00 (bit8)	L11-01 (bit8)	U15-18
10	L11-29	L11-30	L11-31	L11-00 (bit9)	L11-01 (bit9)	U15-19
11	L11-32	L11-33	L11-34	L11-00 (bit10)	L11-01 (bit10)	U19-95
12	L11-35	L11-36	L11-37	L11-00 (bit11)	L11-01 (bit11)	U19-96
13	L11-38	L11-39	L11-40	L11-00 (bit12)	L11-01 (bit12)	U19-97
14	L11-41	L11-42	L11-43	L11-00 (bit13)	L11-01 (bit13)	U19-98
15	L11-44	L11-45	L11-46	L11-00 (bit14)	L11-01 (bit14)	U19-99

Example:

- The Word connector (U7-85) uses proportional block 1 for multiply/divide operation.
  The input 1 of proportional block 1 is sourced from the connector (U7-85). Set input 2 of proportional block 1 (Multiply) and input 3 of proportional block 1 (Divide) to 1.

Param.	Name	Setpoint
L11-02	Value source input 1 of proportional block 1	U7-85 (Output of constant setpoint 1)
L11-03	Input 2 of proportional block 1 (Multiply)	1
L11-04	Input 3 of proportional block 1 (Divide)	1

The following table shows the output value of the proportional block when different calculation methods and data types are selected for constant setpoint 1 (word) ±10.0%.

[L9-00]	[L11-00] bit0	[L11-01] bit0	[U15-10]
10.0	0 (Original value)	0 (Signed number)	10%
	0	1 (Unsigned number)	10%
	1 (Per-unit value)	-	10%
-10.0	0	0	-10%
	0	1	800%<1>
	1	-	-10%

Note

If -10.0% is treated as an unsigned number, the output value can reach the positive limit as a result.

- The DWord connector (U9-51) uses proportional block 11 for multiply/divide operations. Input 1 of proportional block 11 is sourced from the value of connector U9-51. Set input 2 of proportional block 11 (multiply) and input 3 of proportional block 11 (divide) to 1.

Param.	Name	Setpoint
L11-32	Value source input 1 of proportional block 11	U9-51 (Output of constant setpoint 6)
L11-33	Input 2 of proportional block 11 (Multiply)	1
L11-34	Input 3 of proportional block 11 (Divide)	1

The following table shows the output value of the proportional block when different calculation methods and data types are selected for constant setpoint 6 (double word) ±10.0%.

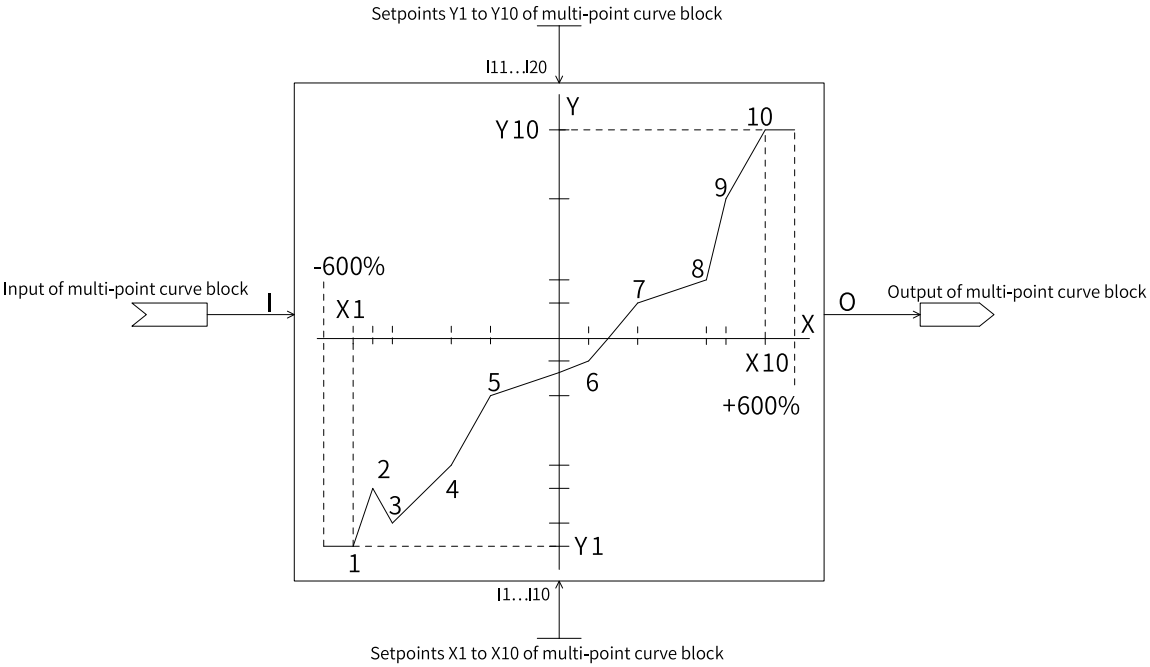
[L9-05]	[L11-00] bit10	[L11-01] bit10	[U19-95]
10.00%	0 (Original value)	0 (Signed number)	10%
	0	1 (Unsigned number)	10%
	1 (Per-unit value)	-	10%
-10.00%	0	0	-10%
	0	1	800%<1>
	1	-	-10

Note

If -10.0% is treated as an unsigned number, the output value can reach the positive limit as a result.

8.9 Multi-Point Curve Block

Diagram



Operation

The coordinate is valid only when the condition "X1 < X2 <‥" ‧ is satisfied. When the input is outside the active coordinate point, the output is equal to the Y-coordinate value of adjacent valid coordinate point. When the input is within the valid coordinate point, the corresponding Y-coordinate value is calculated based on the curve.

Connection

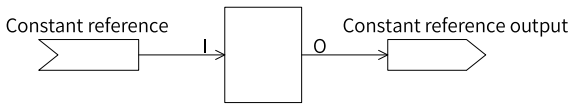
Input I, I1 to I20: signed number

Output O: signed number

Multi-point curve block		A	B
Input	I	L8-00	L8-21
	I1 (X1)	L8-01	L8-22
	I2 (X2)	L8-03	L8-24
	I3 (X3)	L8-05	L8-26
	I4 (X4)	L8-07	L8-28
	I5 (X5)	L8-09	L8-30
	I6 (X6)	L8-11	L8-32
	I7 (X7)	L8-13	L8-34
	I8 (X8)	L8-15	L8-36
	I9 (X9)	L8-17	L8-38
	I10 (X10)	L8-19	L8-40
	I11 (Y1)	L8-02	L8-23
	I12 (Y2)	L8-04	L8-25
	I13 (Y3)	L8-06	L8-27
	I14 (Y4)	L8-08	L8-29
	I15 (Y5)	L8-10	L8-31
	I16 (Y6)	L8-12	L8-33
	I17 (Y7)	L8-14	L8-35
	I18 (Y8)	L8-16	L8-37
	I19 (Y9)	L8-18	L8-39
	I20 (Y10)	L8-20	L8-41
Output	O	U9-85	U9-86

8.10 Constant Setting Block

Diagram



Operation

O = I

The output O equals the input I. Each of constant setting blocks 1 to 5 has one decimal point, while constant setting blocks 6 to 10 have higher accuracy with two decimal points for each block.

Connection

Input I: signed number

Output O: signed number

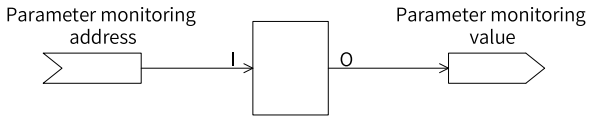
Constant setting block	Input	Output
	I	O
1	L9-00	U7-85
2	L9-01	U7-86

Constant setting block	Input	Output
	I	O
3	L9-02	U7-87
4	L9-03	U7-88
5	L9-04	U7-89
6	L9-05	U9-51
7	L9-06	U9-52
8	L9-07	U9-53
9	L9-08	U9-54
10	L9-09	U9-55

8.11 Parameter Monitoring and Modification

8.11.1 Parameter Monitoring (1 to 10)

Diagram



Operation

The parameter monitoring block output O corresponds to the setpoint of parameter address I. Parameter monitoring blocks 1 to 4 can be used for monitoring parameters with setpoints ranging from 0 to 65535, and parameter monitoring blocks 5 to 10 can be used for monitoring parameters with setpoints ranging from -32768 to 32767.

Connection

Input I: unsigned number

Output O: Blocks 1 to 4 are unsigned values, and blocks 5 to 10 are signed values.

Parameter monitoring block	Input	Output
	I	O
1	L10-00	U7-65
2	L10-01	U7-66
3	L10-02	U7-67
4	L10-03	U7-68
5	L10-04	U7-69
6	L10-05	U7-70
7	L10-06	U7-71
8	L10-07	U7-72
9	L10-08	U7-73
10	L10-09	U7-74

Example:

Use parameter monitoring blocks 1 and 5 to monitor the setpoint of L9-00 (Constant setpoint 1).

Set block 1 and block 5 to 3429, which is the address of L9-00.

Param.	Name	Setpoint
L10-00	Parameter address 1 for parameter monitoring	3429
L10-04	Parameter address 5 for parameter monitoring	3429

The following table shows the output values of parameter monitoring blocks 1 and 5 for constant setpoint 1 (L9-00) ±10.0%.

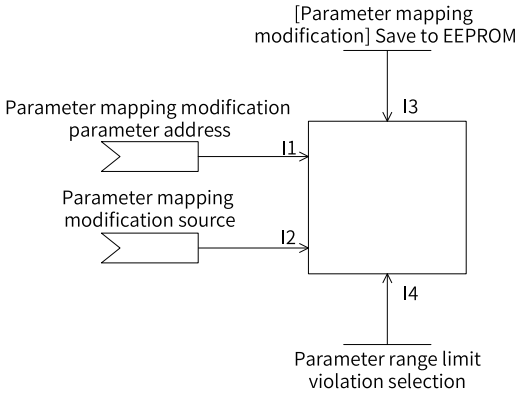
[L9-00]	[U7-65]	[U7-69]
10.0	100	100
-10.0	65436<1>	-100

Note

<1>: The output data types of parameter monitoring blocks 1 to 4 are 16-bit unsigned numbers. The 16-bit unsigned number that corresponds to the complement of –100 is 65436. Therefore, parameter monitoring blocks 5 to 10 are used to monitor signed parameter values.

8.11.2 Parameter Mapping (1 to 16)

Diagram



Operation

Write the modified value of I2 to the parameter addressed by I1. You can set whether to save the modified parameter addressed by I1 through I3, and set whether to perform limiting action through I4 when the modified value of I2 exceeds the upper/lower limit of the parameter addressed by I1.

Connection

Input I1, I2, I3, and I4: Unsigned number

Parameter mapping module	Input			Output
	I1	I2	I3	I4
1	L10-18	L10-19	L10-16 (bit0)	L10-17 (bit0)
2	L10-20	L10-21	L10-16 (bit1)	L10-17 (bit1)

Parameter mapping module	Input			Output
	I1	I2	I3	I4
3	L10-22	L10-23	L10-16 (bit2)	L10-17 (bit2)
4	L10-24	L10-25	L10-16 (bit3)	L10-17 (bit3)
5	L10-26	L10-27	L10-16 (bit4)	L10-17 (bit4)
6	L10-28	L10-29	L10-16 (bit5)	L10-17 (bit5)
7	L10-30	L10-31	L10-16 (bit6)	L10-17 (bit6)
8	L10-32	L10-33	L10-16 (bit7)	L10-17 (bit7)
9	L10-34	L10-35	L10-16 (bit8)	L10-17 (bit8)
10	L10-36	L10-37	L10-16 (bit9)	L10-17 (bit9)
11	L10-38	L10-39	L10-16 (bit10)	L10-17 (bit10)
12	L10-40	L10-41	L10-16 (bit11)	L10-17 (bit11)
13	L10-42	L10-43	L10-16 (bit12)	L10-17 (bit12)
14	L10-44	L10-45	L10-16 (bit13)	L10-17 (bit13)
15	L10-46	L10-47	L10-16 (bit14)	L10-17 (bit14)
16	L10-48	L10-49	L10-16 (bit15)	L10-17 (bit15)

Example:

Use connector U7-85 (Output of constant setpoint 1) to modify C6-05 (Multi-reference setpoint 1) through parameter mapping module 1.

Set L10-18 to 191 (address of C6-05) and L10-19 to U7-85 (output of constant setpoint 1).

Param.	Name	Value
L10-18	Address 1 of the parameter for modifying parameter mapping	191
L10-19	Parameter mapping modification value source 1	U7-85 [Output of constant setpoint 1]

The following table lists the setpoints of C6-05 for L9-00±10.0% and L9-00±150.0%.

[L9-00]	[L10-17] bit0	[C6-05]
10.0	-	41.0 [1]
-10.0	-	-41.0
150.0	0 (No action)	Inactive
	1 (Limited to upper or lower limit)	600.0 <2>
-150.0	0 (No action)	Inactive
	1 (Limited to upper or lower limit)	-600.0 <2>

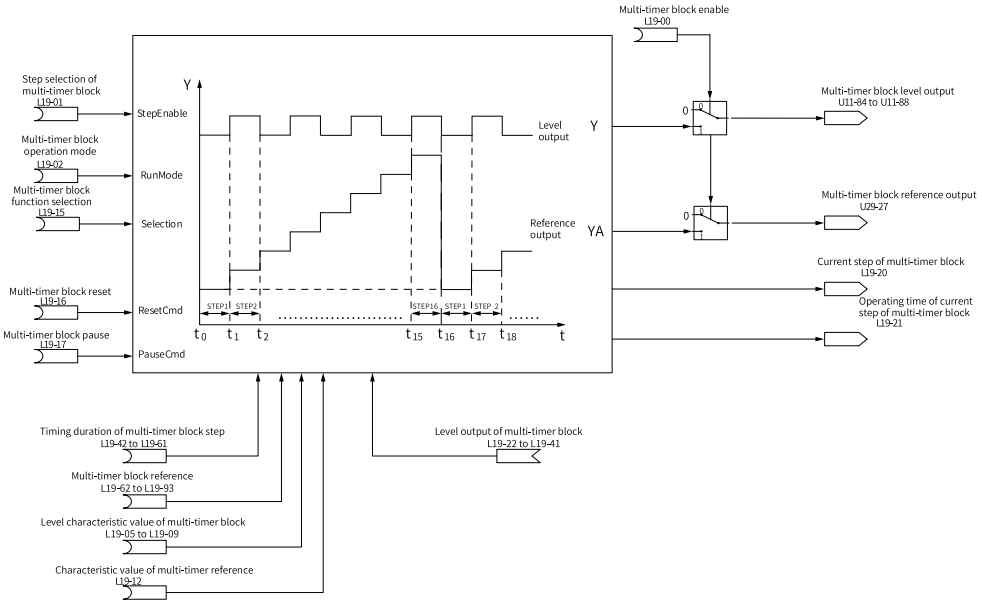
Note

- <1>: According to *"3.4.2 Representation of Per-Unit Values" on page 24*, for word connectors, 4096 corresponds to 100%. [U7-85] is 10.00%; the 10% per-unit value corresponds to the original value 410, and C6-05 has a decimal place, so [C6-05] is 41.0.
- <2>: The original value corresponding to ±150.0% per-unit value exceeds the upper/lower limit of C6-05. When the modification range exceeds the limit, C6-05 is limited to the maximum/minimum value.

8.12 Multi-Timer Block

8.12.1 Function of the Multi-timer Block

The multi-timer block can be used to implement simple PLC operation logic, achieving process sequence control through segmented parameter configuration (such as time interval, current/ voltage setting, and switch status).



See the following figure.

STEP1: Output current runs at 50% output for 30s

STEP2: Output current runs at 100% output for 15s

STEP3: Stop for 15s

STEP4: Output current runs at 10% output for 30s

STEP5: Output current runs at 30% output for 100s

...

Up to 16 steps are supported. Run from STEP1 to STEP16 and then run from STEP1 again, and repeat this process.

8.12.2 Description of Multi-timer Block Parameters

STEP setting of multi-timer block

Parameters related to STEP selection of the multi-timer block are shown below.

Param.	Name	Value range	Default
L19-01	STEP selection of multi-timer block	bit0 to bit15: STEP1 to STEP16 0: Disable 1: Enable	0xFFFF

The start and end steps are defined as follows.

Start step: Based on the setting of L19-01, the searching process starts from STEP1. The first enabled step searched is used as the start step.

End step: Based on the setting of L19-01, the searching process starts from STEP16 and ends if the first enabled step is detected.

Example 1: If L19-01 = 0xFFFF, then the start step is SETP1 and the end step is SETP16.

Example 2: If L19-01 = 0x3FFC, then the start step is SETP3 and the end step is SETP14.

Example 3: If L19-01 = 0x0001, then the start step is SETP1 and the end step is SETP1.

The multi-timer block executes in sequence from the start step to the end step, which forms a complete cycle. Non-enabled steps between the start step and end step are skipped directly.

Operation mode of multi-timer block

Parameters related to the operation mode of the multi-timer block are as follows.

Four modes of operation are available for the multi-timer block, which can be configured through L19-02.

Param.	Name	Value range	Default
L19-02	Operation mode of multi-timer block	0: Keeping STEP1 output after operating for one cycle After sequentially executing from the start step to the end step, the system remains at STEP1, even if STEP1 is not enabled. The five level signals are outputted according to the STEP1 values defined by L19-22...L19-41. The setpoints are outputted according to the STEP1 values defined by L19-62...L19-93. 1: Keeping STEP16 output after operating for one cycle After sequentially executing from the start step to the end step, the system remains at STEP16, even if STEP16 is not enabled. The five level signals are outputted according to the STEP16 values defined by L19-22...L19-41. The setpoints are outputted according to the STEP16 values defined by L19-62... L19-93. 2: Operating cyclically Operate cyclically and repeatedly from the start step to the end step. The five level signals are outputted according to the values defined by L19-22...L19-41. The setpoints are outputted according to the values defined by L19-62...L19-93. 3: Outputting specified feature values after operating for one cycle After one cycle of operation from the start step to the end step, the five level signals are outputted according to the values defined by L19-05...L19-09. The setpoints are outputted according to the values defined by L19-12.	2: Operating cyclically

Multi-timer block time setting

Each STEP time of the multi-timer block can be set separately. The timer parameters of a multi-timer block are as follows.

<table>
<tr><th>Param.</th><th>Name</th><th>Value range</th><th>Default</th></tr>
<tr><td>L19-42</td><td>Timer unit in STEP1 to STEP4 of multi-timer block</td><td>
<table>
<tr><th>Bit</th><th>Name</th><th>Value range</th></tr>
<tr><td>Ones</td><td>STEP1 timer unit selection</td><td rowspan="4">0: 0.01s
1: 0.1s
2: 1s
3: 1 min</td></tr>
<tr><td>Tens</td><td>STEP2 timer unit selection</td></tr>
<tr><td>Hundreds</td><td>STEP3 timer unit selection</td></tr>
<tr><td>Thou-
sands</td><td>STEP4 timer unit selection</td></tr>
</table>
</td><td>0</td></tr>
<tr><td>L19-43</td><td>Timer unit in STEP5 to STEP8 of multi-timer block</td><td>
<table>
<tr><th>Bit</th><th>Name</th><th>Value range</th></tr>
<tr><td>Ones</td><td>STEP5 timer unit selection</td><td rowspan="4">0: 0.01s
1: 0.1s
2: 1s
3: 1 min</td></tr>
<tr><td>Tens</td><td>STEP6 timer unit selection</td></tr>
<tr><td>Hundreds</td><td>STEP7 timer unit selection</td></tr>
<tr><td>Thou-
sands</td><td>STEP8 timer unit selection</td></tr>
</table>
</td><td>0</td></tr>
<tr><td>L19-44</td><td>Timer unit in STEP9 to STEP12 of multi-timer block</td><td>
<table>
<tr><th>Bit</th><th>Name</th><th>Value range</th></tr>
<tr><td>Ones</td><td>STEP9 timer unit selection</td><td rowspan="4">0: 0.01s
1: 0.1s
2: 1s
3: 1 min</td></tr>
<tr><td>Tens</td><td>STEP10 timer unit selection</td></tr>
<tr><td>Hundreds</td><td>STEP11 timer unit selection</td></tr>
<tr><td>Thou-
sands</td><td>STEP12 timer unit selection</td></tr>
</table>
</td><td>0</td></tr>
<tr><td>L19-45</td><td>Timer unit in STEP13 to STEP16 of multi-timer block</td><td>
<table>
<tr><th>Bit</th><th>Name</th><th>Value range</th></tr>
<tr><td>Ones</td><td>STEP13 timer unit selection</td><td rowspan="4">0: 0.01s
1: 0.1s
2: 1s
3: 1 min</td></tr>
<tr><td>Tens</td><td>STEP14 timer unit selection</td></tr>
<tr><td>Hun-
dreds</td><td>STEP15 timer unit selection</td></tr>
<tr><td>Thou-
sands</td><td>STEP16 timer unit selection</td></tr>
</table>
</td><td>0</td></tr>
<tr><td>L19-46 to L19-61</td><td>Timer time of STEP 1 to STEP16 of multi-timer block</td><td>0 to 65535</td><td>0</td></tr>
</table>

Take STEP1 as an example, to achieve a timing of 10s in STEP1, set L19-46 to 1000 when the ones of L19-42 is set to 0 (time unit: 0.01s).

Multi-timer block level output setting

Parameters related to level output of the multi-timer block are shown below.

Param.	Name	Value range	Default
L19-05	Characteristic value of level output 1	0: Low level 1: High level Other: B connector	0: Low level
L19-06	Characteristic value of level output 2	0: Low level 1: High level Other: B connector	0: Low level
L19-07	Characteristic value of level output 3	0: Low level 1: High level Other: B connector	0: Low level
L19-08	Characteristic value of level output 4	0: Low level 1: High level Other: B connector	0: Low level
L19-09	Characteristic value of level output 5	0: Low level 1: High level Other: B connector	0: Low level
L19-22	Multi-timer block level output 1	bit0 to bit15: STEP1 level to STEP16 level 0: Low level 1: High level	0x0000
L19-23	Multi-timer block level output 2	Same as above	0x0000
L19-24	Multi-timer block level output 3	Same as above	0x0000
L19-25	Multi-timer block level output 4	Same as above	0x0000
L19-26 to L19-41	Multi-timer block level output 5 - STEP1 to STEP16	0: Low level 1: High level Other: B connector	0: Low level

Application example of multi-timer block level output:

The multi-timer block has five level output signals, each corresponding to a connector. The following parameters apply to cyclic operation of the multi-timer block.

Table 8–9 Parameter configuration for multi-timer block level output

Param.	Name	Value range
L19-00	Multi-timer block enable	1 [Enable]
L19-01	STEP selection of multi-timer block	0xFFFF
L19-02	Operation mode of multi-timer block	2 [Operating cyclically]
L19-22	Multi-timer block level output 1	0xAAAA
L19-23	Multi-timer block level output 2	0xAAAA
L19-24	Multi-timer block level output 3	0xAAAA
L19-25	Multi-timer block level output 4	0xAAAA
L19-26 to L19-41	Multi-timer block level output 5 - STEP1 to STEP16	STEP1 is low level, STEP2 is high level, and STEP3 is low level... STEP16 is high level.

The following figure shows the level output after preceding configurations are done.

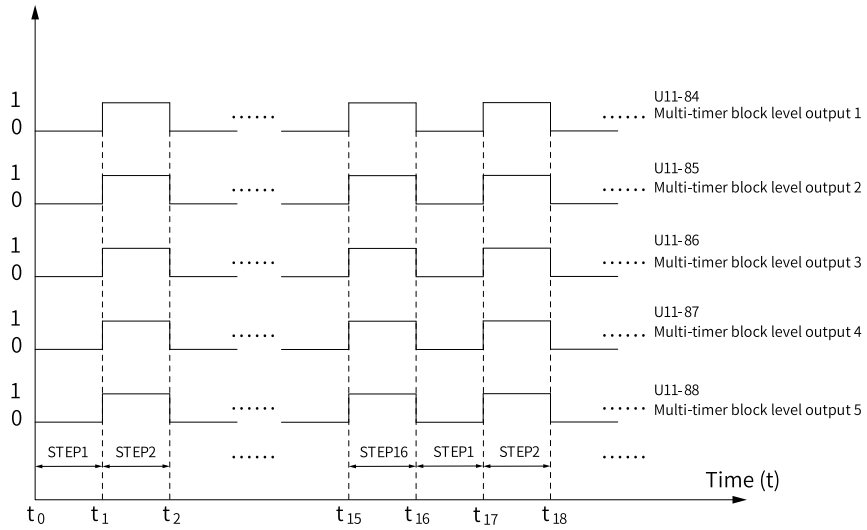


Figure 8-5 Multi-timer block level output

Multi-timer block reference output setting

Multi-timer block reference parameters are shown below.

Param.	Name	Value range	Default
L19-12	Characteristic value of reference output	-600.0 % to +600.0%	0.0%
L19-62	Multi-timer block STEP1 reference selection	0: Set by L19-63 Other: K connector	0: Set by L19-63
L19-63	Multi-timer block STEP1 reference	-600.0 % to +600.0%	0.0%
L19-64	Multi-timer block STEP2 reference selection	0: Set by L19-65 Other: K connector	0: Set by L19-65
L19-65	Multi-timer block STEP2 reference	-600.0 % to +600.0%	0.0%
L19-66	Multi-timer block STEP3 reference selection	0: Set by L19-67 Other: K connector	0: Set by L19-67
L19-67	Multi-timer block STEP3 reference	-600.0 % to +600.0%	0.0%
L19-68	Multi-timer block STEP4 reference selection	0: Set by L19-69 Other: K connector	0: Set by L19-69
L19-69	Multi-timer block STEP4 reference	-600.0 % to +600.0%	0.0%
L19-70	Multi-timer block STEP5 reference selection	0: Set by L19-71 Other: K connector	0: Set by L19-71
L19-71	Multi-timer block STEP5 reference	-600.0 % to +600.0%	0.0%
L19-72	Multi-timer block STEP6 reference selection	0: Set by L19-73 Other: K connector	0: Set by L19-73
L19-73	Multi-timer block STEP6 reference	-600.0 % to +600.0%	0.0%
L19-74	Multi-timer block STEP7 reference selection	0: Set by L19-75 Other: K connector	0: Set by L19-75
L19-75	Multi-timer block STEP7 reference	-600.0 % to +600.0%	0.0%
L19-76	Multi-timer block STEP8 reference selection	0: Set by L19-77 Other: K connector	0: Set by L19-77
L19-77	Multi-timer block STEP8 reference	-600.0 % to +600.0%	0.0%

Param.	Name	Value range	Default
L19-78	Multi-timer block STEP9 reference selection	0: Set by L19-79 Other: K connector	0: Set by L19-79
L19-79	Multi-timer block STEP9 reference	-600.0 % to +600.0%	0.0%
L19-80	Multi-timer block STEP10 reference selection	0: Set by L19-81 Other: K connector	0: Set by L19-81
L19-81	Multi-timer block STEP10 reference	-600.0 % to +600.0%	0.0%
L19-82	Multi-timer block STEP11 reference selection	0: Set by L19-83 Other: K connector	0: Set by L19-83
L19-83	Multi-timer block STEP11 reference	-600.0 % to +600.0%	0.0%
L19-84	Multi-timer block STEP12 reference selection	0: Set by L19-85 Other: K connector	0: Set by L19-85
L19-85	Multi-timer block STEP12 reference	-600.0 % to +600.0%	0.0%
L19-86	Multi-timer block STEP13 reference selection	0: Set by L19-87 Other: K connector	0: Set by L19-87
L19-87	Multi-timer block STEP13 reference	-300.00 % to +300.00%	0.0%
L19-88	Multi-timer block STEP14 reference selection	0: Set by L19-89 Other: K connector	0: Set by L19-89
L19-89	Multi-timer block STEP14 reference	-300.00 % to +300.00%	0.0%
L19-90	Multi-timer block STEP15 reference selection	0: Set by L19-91 Other: K connector	0: Set by L19-91
L19-91	Multi-timer block STEP15 reference	-300.00 % to +300.00%	0.0%
L19-92	Multi-timer block STEP16 reference selection	0: Set by L19-93 Other: K connector	0: Set by L19-93
L19-93	Multi-timer block STEP16 reference	-300.00 % to +300.00%	0.0%

The reference of the multi-timer block corresponds to connector U29-27. The reference of each STEP can be set through parameters. The following diagram applies to cyclic operation of multi-timer block.

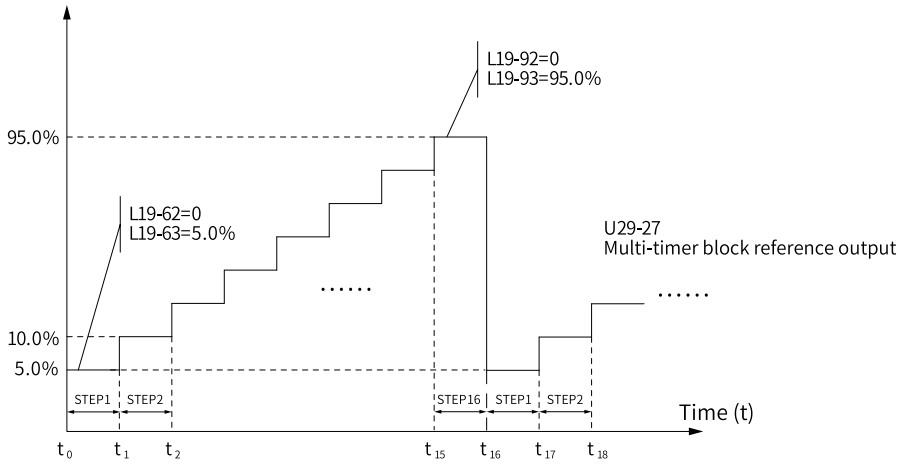


Figure 8-6 Multi-timer block reference output

Retention function setting of multi-timer block

Parameters related to retention function of the multi-timer block are shown below.

Param.	Name	Value range	Default
L19-15	Multi-timer block function selection	0: Neither the STEP nor operating time retentive before power failure 1: Only the STEP retentive before power failure 2: Only the operating time retentive before power failure 3: Both the STEP and operating time retentive before power failure	0: Neither the STEP nor operating time retentive before power failure

The retention function upon power failure is used to record the STEP and operating time upon power failure, allowing the device to continue operating at the retentive values. You can set the retention mode upon power failure through L19-15.

Setting the reset and pause functions of the multi-timer block

Parameters related to reset and pause functions of the multi-timer block are shown below.

Param.	Name	Value range	Default
L19-16	Multi-timer block reset enable	0: Inactive 1: Enable Other: B connector	0: Inactive
L19-17	Multi-timer block pause enable	0: Inactive 1: Active Other: B connector	0: Inactive

The reset command of the multi-timer block is rising edge-triggered. When a reset command is generated, the operation starts from the start step immediately. The reset command of the multi-timer block is configured through L19-16.

The pause command of the multi-timer block is level-triggered. When the pause command is active, the timer stops, and therefore the operation stops at the current step. The pause command of the multi-timer block is configured through L19-17.

Note: The priority of the reset command is higher than the pause command.

Multi-timer block output connector

Table 8–10 Multi-timer block output connector table

Param.	Name	Description
U11-84	Multi-timer block level output 1	After the multi-timer block is enabled, view the output levels of the multi-timer block through connectors U11-84 to U11-88.
U11-85	Multi-timer block level output 2	
U11-86	Multi-timer block level output 3	
U11-87	Multi-timer block level output 4	
U11-88	Multi-timer block level output 5	
U29-27	Multi-timer block setpoint output	After the multi-timer block is enabled, you can view the reference output of the multi-timer block through U29-27.

8.12.3 Application Case of Multi-timer Block

You can implement the following logic through the multi-timer block.

Step 1: Keep U29-27 [Multi-timer block reference output] outputting 100% and U11-84 [Multi-timer block level output 1] outputting 1 for 30s.

Step 2: Keep U29-27 [Multi-timer block reference output] outputting 0% and U11-84 [Multi-timer block level output 1] outputting 0 for 15s.

Step 3: Keep U29-27 [Multi-timer block reference output] outputting 20% and U11-84 [Multi-timer block level output 1] outputting 1 for 100s.

Step 4: Keep U29-27 [Multi-timer block reference output] outputting 0% and U11-84 [Multi-timer block level output 1] outputting 0 for 30s.

Repeat steps 1 to 4.

For parameter configuration, see the following table.

Param.	Name	Value range
L19-00	Multi-timer block enable	1 [Enable]
L19-01	STEP selection of multi-timer block	0x000F
L19-02	Operation mode of multi-timer block	2 [Operating cyclically]
L19-15	Multi-timer block function selection	0 [STEP and operating time non-retentive before power failure]
L19-16	Multi-timer block reset enable	0 [Inactive]
L19-17	Multi-timer block pause enable	0 [Inactive]
L19-22	Multi-timer block level output 1	0x0005
L19-42	Timer unit in STEP1 to STEP4 of multi-timer block	2222
L19-46	Timer time of multi-timer block STEP1	30
L19-47	Timer time of multi-timer block STEP2	15
L19-48	Timer time of multi-timer block STEP3	100
L19-49	Timer time of multi-timer block STEP4	30
L19-62	Multi-timer block STEP1 reference selection	0
L19-63	Multi-timer block STEP1 reference	100.0%

Param.	Name	Value range
L19-66	Multi-timer block STEP3 reference selection	0
L19-67	Multi-timer block STEP3 reference	20.0%

8.13 General Timer and Counter

The HCU-40 has two groups of real-time timers and two groups of edge counters, which can be used to monitor the operation duration and actions of key vulnerable components, and trigger preventive maintenance prompts accordingly.

- Real-time timer: Enables timing of digital signals in the continuous high/low state (For example, the operating time of the fan and cumulative operating time of the IGBT).
- Edge counter: Enables the counting of digital signals when they jump from 0 → 1/1 → 0 (for example, ON/OFF count of the relay, and start/stop count of the fan).

Table 8–11 Timer/Counter reset mode

Param.	Name	Value	Remarks
L20-02	Timer (Counter) reset	0: No operation 1: Clear real-time timer 1 2: Clear real-time timer 2 5: Clear edge counter 1 6: Clear edge counter 2 101: Clear all real-time timers 102: Clear all edge counters 103: Clear all timers (counters)	Timer/Counter reset: Clears the actual values of L20-06/20/34/49. Operation: 1. Set the clear mode corresponding to L20-02. 2. Check that L20-03 is set to 1.
L20-03	Acknowledgment for resetting the timer (counter)	0: Cancel 1: OK	Used to confirm the reset action.

Table 8–12 Timer-related parameters

Param.	Name	Value	Remarks
L20-05	[Real-time timer 1] monitoring signal	0: Disable 101: DC bus powered on 102: IGBT operating 103: Control module powered on 104: Fan operating Other: B connector	The selected monitoring signal is timed according to the monitor level set by L20-08/22.
L20-19	[Real-time timer 2] monitoring signal		
L20-07	[Real-time timer 1] timing threshold	0 to 4294967295	When the actual value (L20-06/20) reaches the set threshold, the pre-alarm action defined by L20-14/28 is triggered. When the timing threshold is 0, the alarm action is inactive.
L20-21	[Real-time timer 2] timing threshold	0.00s to 42949672.95s	

<table>
<tr><th>Param.</th><th>Name</th><th>Value</th><th>Remarks</th></tr>
<tr><td>L20-08</td><td>[Real-time timer 1] function selection</td><td rowspan="2">Ones: Timing mode
0: Cyclic timing
1: Continuous timing
Tens: Monitoring level
0: Low level
1: High level
Hundreds-: Storage mode of actual values
0: Non-retentive upon power failure
1: Retentive upon power failure</td><td rowspan="2">• Cyclic timing: When the actual value (L20-06/20) is higher than or equal to the timing threshold defined by (L20-07/21), the actual value is cleared and cyclic timing applies. Continuous timing: When the actual value (L20-06/20) is higher than or equal to the timing threshold defined by L20-07/21, the actual value is not cleared and timing continues.
• Low level: When the monitoring signal (L20-05/19) is low level, the timer starts and stops at high level. High level: When the monitoring signal (L20-05/19) is high level, the timer starts and stops at low level.
• Non-retentive upon power failure: When the HCU is powered off, the actual values of L20-06/20 are cleared. Retentive upon power failure: The actual value (L20-06/20) is saved upon power failure of HCU.</td></tr>
<tr><td>L20-22</td><td>[Real-time timer 2] function selection</td></tr>
<tr><td>L20-09</td><td>[Real-time timer 1] hold time of cyclic timing state setting</td><td rowspan="4">0 to 4294967295</td><td rowspan="2">When L20-08/22 is set to "cyclic timing", the real-time timer status setting remains at the set time whenever the actual value (L20-06/20) reaches the timing threshold defined by L20-07/21.</td></tr>
<tr><td>L20-23</td><td>[Real-time timer 2] hold time of cyclic timing status setting</td></tr>
<tr><td>L20-10</td><td>[Real-time timer 1] cyclic timing alarm/minor fault hold time</td><td rowspan="2">When L20-08/22 is set to "cyclic timing" and L20-14/28 (Alarm action) is set to "alarm/minor fault", automatic reset applies when the alarm/minor fault A118-1/119-1 that triggered when the actual value (L20-06/20) reaches the value defined by L20-07/21 lasts for the time set by this parameter.</td></tr>
<tr><td>L20-24</td><td>[Real-time timer 2] cyclic timing alarm/minor fault hold time</td></tr>
</table>

Param.	Name	Value	Remarks
L20-14	[Real-time timer 1] pre-alarm action	0: Coast to stop 1: Active 2: Stop based on the set stop mode 3: Operating at limited current 4: Operating at limited speed 5: Operating at limited torque 6: Display alarms only 7: Ignore	Used to set the pre-alarm action.
L20-28	[Real-time timer 2] pre-alarm action		

Table 8–13 Counter-related parameters

Param.	Name	Value	Remarks
L20-33	[Edge counter 1] monitoring signal	0: Disable 101: DC bus powered on 102: IGBT operating 103: Control module powered on 104: Fan operating Other: B connector	The selected monitoring signal is counted according to the counting edge set by L20-36/51.
L20-48	[Edge counter 2] monitoring signal		
L20-35	[Edge Counter 1] Counter threshold	0 to 4294967295	When the actual value (L20-34/49) reaches the set threshold, the pre-alarm action defined by L20-43/58 is triggered. When the counter threshold is the default value 0, the pre-alarm action is inactive.
L20-50	[Edge counter 2] counter threshold		

Param.	Name	Value	Remarks
L20-36	[Edge counter 1] function selection	Ones-: Counting mode 0: Cyclic counting 1: Continuous counting Tens-: Counting edge 0: Falling edge 1: Rising edge 2: Falling edge or rising edge Hundreds-: Storage mode of actual values 0: Non-retentive upon power failure 1: Retentive upon power failure	• Cyclic counting: When the actual value (L20-34/49) is higher than or equal to the counting threshold defined by L20-35/50, the actual value is cleared and cyclic counting applies. Cyclic counting: When the actual value (L20-34/49) is higher than or equal to the counting threshold defined by L20-35/50, the actual value is cleared and counting continues. • Rising edge: Captures monitoring signals (L20-33/48) to generate rising edge signal count. Falling edge: Capture monitoring signals (L20-33/48) to generate falling edge signal count. Rising edge or falling edge: Captures monitoring signals (L20-33/48) to generate falling edge and rising edge signal count. • Non-retentive upon power failure: When the HCU is powered off, the actual values of L20-34/49 are cleared. Retentive upon power failure: The actual value (L20-34/49) is saved upon power failure of HCU.
L20-51	[Edge counter 2] function selection		
L20-37	[Edge counter 1] hold time of cyclic counting status setting	0 to 4294967295	When L20-36/51 is set to "Cyclic timing", the edge counter status setting remains at the set time whenever the actual value (L20-34/49) reaches the timing threshold defined by L20-35/50.
L20-52	[Edge counter 2] hold time of cyclic counting status setting		
L20-38	[Edge counter 1] cyclic counting alarm/minor fault hold time		When L20-36/51 is set to "cyclic count" and L20-43/58 (Pre-alarm action) is set to" alarm/minor fault", automatic reset applies when the alarm/minor fault A122-1/123-1 that triggered when the actual value (L20-34/49) reaches the value defined by L20-35/50 lasts for the time set by this parameter.
L20-53	[Edge counter 2] cyclic counting alarm/minor fault hold time		

Param.	Name	Value	Remarks
L20-39	[Edge counter 1] proportional coefficient numerator	1 to 4294967295	L20-34/49 Proportional conversion of actual values
L20-54	[Edge counter 2] proportional coefficient numerator		
L20-40	[Edge counter 1] proportional coefficient denominator		
L20-55	[Edge counter 2] proportional coefficient denominator		
L20-43	[Edge counter 1] pre-alarm action	0: Coast to stop 1: Active 2: Stop based on the set stop mode 3: Operating at limited current 4: Operating at limited speed 5: Operating at limited torque 6: Display alarms only 7: Ignore	Used to set the pre-alarm action.
L20-58	[Edge counter 2] pre-alarm action		

Table 8–14 Timer/Counter status display

Timer/Counter	Param.	Name	Description
Real-time timer	L20-00	Real-time timer status word	When the actual value (L20-06/20) is higher than or equal to the timing threshold defined by 20-07/21, the corresponding bit of the status word is set (bit0: Real-time timer 1 status bit; bit1: Real-time timer 2 status bit).
	L20-06	[Real-time timer 1] actual value	Cumulative timer value in units of 1s
	L20-20	[Real-time timer 2] actual value	Cumulative timer value in units of 0.01s
	U20-34	Real-time timer 1 status	The real-time timer 1/2 state is set when the actual value (L20-06/20) is higher than or equal to L20-07/21.
	U20-35	Real-time timer 2 status	
	U20-42	Real-time timer 1 pre-alarm action trigger	Pre-alarm action trigger flag
	U20-43	Real-time timer 2 pre-alarm action trigger	
Edge counter	L20-01	Edge counter status word	When the actual value (L20-34/49) is higher than or equal to the timer threshold (L20-35/50), the corresponding bit of the status word is set (bit0: Edge counter 1 status bit; bit1: Edge counter 2 status bit).
	L20-34	[Edge counter 1] actual value	Cumulative count value
	L20-49	[Edge counter 2] actual value	
	U20-38	Edge counter 1 status	The edge counter 1/2 state is set when the actual value (L20-34/49) is higher than or equal to the timer threshold (L20-35/50).
	U20-39	Edge counter 2 status	
	U20-46	Pre-alarm action of edge counter 1 triggered	Pre-alarm action trigger flag
	U20-47	Pre-alarm action of edge counter 2 triggered	

Typical applications

Scenario 1: Monitoring the cumulative operating time of the fan

Logic: The cumulative operating time of the fan reaches 50,000 hours, and an alarm is triggered to remind users of fan maintenance.

Parameter setting:

Param.	Value	Remarks
L20-05 [Real-time timer 1] monitoring signal	104	Used as the fan start/stop signal. The fan operates at high level and stops at low level.
L20-07 [Real-time timer 1] timer threshold	180000000s	Converted to hours: 180000000/ 3600 = 50000 hours
L20-08 [Real-time timer 1] function selection	111	Timing mode: Continuous timing Monitoring level: High level Storage mode of actual values: Retentive upon power failure
L20-14 [Real-time timer 1] pre-alarm action	6	Displaying the alarm only

Status display for 500 hours of cumulative operating time of the fan:

Param.	Displayed value	Remarks
L20-00 Real-time timer status word	0x01	L20-06 ≥ 180000000 (cumulative operating time of the fan reaching 50000 hours) The HCU-40 reports A118-1 based on the pre-alarm action configuration.
U20-34 Real-time timer 1 status	1	
U20-42 Real-time timer 1 pre-alarm action triggered	1	

Scenario 2: Monitoring of cumulative relay action count

Logic: A fault that cause stop can be reported when the relay action count exceeds 50000, reminding users of the risk of relay fault.

Parameter setting:

Param.	Value	Remarks
L20-33 [Edge counter 1] monitoring signal	10	RO1 edge signal
L20-35 [Edge counter 1] timer threshold	50000	-
L20-36 [Edge counter 1] function selection	111	Counting mode: Keep counting Counting edge: Rising edge Storage mode of actual values: Retentive upon power failure
L20-39 [Edge counter 1] proportional coefficient numerator	1	L20-34 = L20-34 x L20-39/L20-40
L20-40 [Edge counter 1] proportional coefficient denominator	1	
L20-43 [Edge counter 1] pre-alarm action	0	Coast to stop

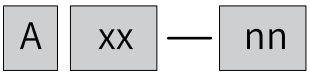
Display when relay action count exceeding 50000:

Param.	Displayed value	Remarks
L20-01 Edge counter status word	0x01	L20-34 ≥ 50000 (relay action count exceeding 50000) HCU-40 reports F122-1 based on the pre-alarm action configuration.
U20-38 Edge counter 1 status	1	
U20-46 Edge counter 1 pre-alarm action triggered	1	

9 Parameter List

9.1 Function Parameter Categories

Parameters of the HCU-40 controller are grouped by function and displayed in three levels of menus, as shown below.



- A represents the level 1 menu, which is represented by one letter and corresponds to a group of complete functions.
- XX represents the level 2 menu, which uses one or two digits. The level 1 and level 2 menus combined represent a specific set of functions.
- nn represents the number of the level 3 menu, which is represented by two digits, which can be combined with the level 1 or level 2 menus to indicate a specific parameter.

The separator "-" is used between level 2 and level 3 menus. For LED display, the separator "." is also used. Axx-nn and Axx.nn represent the same parameter.

The following table describes the level 1 and level 2 menus.

Level 1 menu	Name	Level 2 menu	Name	Remarks
A	System	A0	Status monitoring	Common monitoring variables
		A1	Faults and alarms	Displays the current fault or alarm.
		A2	Drive information	Displays the basic information of the drive and status of the expansion module.
		A4	Power unit control	Related parameters of the power module
		A8	Environment setting	Parameter recovery, application macro setting
		A9	Data set selection	Reference channel switchover
		A10	SOP-20/relay communication	Related parameters of SOP-20-880 (InoDriveStudio)
		A12	Trigger oscilloscope	Related parameters of InoDriveStudio trigger oscilloscope
		A13	Black box custom channel	Data that needs to be recorded upon custom faults
		A15	Parallel parameter	Parameters related to multi-module parallel operation
		A16	Log parameter	Parameters related to custom log functions
b	Control channel	b0	Default configuration parameter	Default control mode
		b1	Channel 1 custom control word setting	Custom start/stop control word setting of channel 1
		b2	Channel 1 other control word setting	Other control word setting of channel 1
		b3	Channel 2 custom control word setting	Custom start/stop control word setting of channel 2
		b4	Channel 2 other control word setting	Other control word setting of channel 2
		b5	Terminal start/stop module	Parameters related to terminal control module
		b6	Auxiliary control word setting	Auxiliary control parameter setting
		b7	Auto-tuning/Self-test	Parameters related to auto-tuning and self-test
C	Setpoint channel	C0	Channel 1 voltage reference	Defines the voltage reference source of channel 1.
		C1	Channel 1 current reference	Defines the current reference source of channel 1.
		C2	Channel 2 voltage reference	Defines voltage reference source of channel 2.
		C3	Channel 2 current reference	Defines the current reference source of channel 2.
		C4	Motorized potentiometer	Parameters related to UP/DOWN motorized potentiometer
		C6	Multi-reference setting	Setting of 16 multi-references
d	Rating system	d0	Basic grid parameters	Including rated grid voltage/frequency
		d1	Grid auto-tuning parameters	Basic parameters for auto-tuning
		d2	Additional auto-tuning parameters	Auto-tuned additional parameters
		d3	Base value information	Displaying per-unit base values

Level 1 menu	Name	Level 2 menu	Name	Remarks
E	Rectifier control	E0	Control parameter setting	Parameters for control performance adjustment
E	Rectifier control	E4	Auxiliary parameter setting	Parameters related to auxiliary control
		E6	Limit setting	Parameters related to output limiting
		E7	Fault protection parameter setting	Parameters related to fault protection
		E8	Fault protection enable selection	Parameters related to fault protection enable
		E15	Droop control setting	Parameters related to communication control
		E16	Grid fault ride-through setting	Parameters related to grid fault ride-through
F	Input/Output	F0	DI	-
		F1	DO	-
		F2	AI	-
		F3	AO	-
		F4	HDI	-
		F5	HDO	-
		F6	AI/AO calibration parameters	-
H	Protection and auxiliary	H0	Troubleshooting	Parameters related to faults
		H1	Fault level change	
		H2	Latest fault code log	Related log of faults, minor faults, and alarms
		H3	Last fault code log	
		H4	2nd to last fault code log	
		H5	3rd to last fault code log	
		H6	4th to last fault code log	
		H7	Latest minor fault code log	
		H8	Latest alarm code log	
		H10	Custom fault word	Custom fault flag combination
		H11	Custom error setting	Custom fault and alarm source

Level 1 menu	Name	Level 2 menu	Name	Remarks
L	Application function	L0	Word-to-bit function	Function blocks of word-to-bit and bit-to-word conversion
		L2	Logical operation function	Logic AND, NOT, OR, XOR, XNOR function blocks
		L3	Word-to-DWord function	Function blocks of word-to-DWord and DWord-to-word
		L5	Switch function block	Function blocks of binary selector and digital selector
		L6	Control function block	Function blocks for filter, level-to-pulse conversion, logic delay, and pulse generator
		L7	Arithmetic function block	Function blocks for absolute value, add/ subtract, multiply/divide, comparison, and multi-point curves
		L8	Multi-point curve module	Function block of multi-point curve
		L9	Constant setting module	Constant setting function block
		L10	Parameter monitoring and modification	Function blocks of parameter monitoring and mapping modification
		L11	Arithmetic function block 2	Proportional function block
		L18	Statistics function	Function block for statistics of relay service life
		L19	Multi-timer module	-
		L20	General timer and counter	-
n	Bus adapter and expansion module	n0	Inolink communication	Peer-to-peer communication between HCUs for load distribution or master-slave control
		n1	Fieldbus adapter A	Configuration and view of fieldbus adapter process data
		n2	Fieldbus adapter B	
		n3	Fieldbus adapter C	
		n7	HIO module 1 configuration	Parameters related to the expansion I/O module
		n8	HIO module 2 configuration	
		n9	HIO module 3 configuration	
		n10	Modbus RTU module	Parameters related to the communication module
		n11	CAN2.0 module	
		n12	CANopen module	
		n13	Ethernet module	
		n14	EtherCAT module	
		n15	HDVN module	

Level 1 menu	Name	Level 2 menu	Name	Remarks
n	Bus adapter and expansion module	n16	PROFIBUS-DP module	Parameters related to the communication module
		n17	PROFIBUS-IO module	
		n18	User-defined communication module	
		n19	Synchronous voltage detection module	Used to set HSVM-related parameters.
		n23	HIO module 1 parameter setting (HIO-10)	Parameter configuration of HIO module 1 in group n7. When n7-02 is set to HIO-10, n23 is active. When n7-02 is set to HIO-20, n24 is active. When n7-02 is set to HIO-30, n25 is active.
		n24	HIO module 1 parameter setting (HIO-20)	
		n25	HIO module 1 parameter settings (HIO-30)	
		n26	HIO module 2 parameter setting (HIO-10)	Parameter configuration of HIO module 2 in group n8. When n8-02 is set to HIO-10, n26 is active. When n8-02 is set to HIO-20, n27 is active. When n8-02 is set to HIO-30, n28 is active.
		n27	HIO module 2 parameter setting (HIO-20)	
		n28	HIO module 2 parameter setting (HIO-30)	
		n29	HIO module 3 parameter setting (HIO-10)	Parameter configuration of HIO module 2 in group n9. When n9-02 is set to HIO-10, n29 is active. When n9-02 is set to HIO-20, n30 is active. When n9-02 is set to HIO-30, n31 is active.
		n30	HIO module 3 parameter setting (HIO-20)	
		n31	HIO module 3 parameter setting (HIO-30)	
		n37	Custom communication module 2	Parameters related to the communication module
		n40	Carrier synchronization setting	
		n41	EtherNet/IP module	
		n53	DWord input of fieldbus adapter A expansion process data	Configuration and view of fieldbus adapter extension process data
		n54	DWord output of fieldbus adapter A extension process data	

Level 1 menu	Name	Level 2 menu	Name	Remarks
n	Bus adapter and expansion module	n55	DWord input of fieldbus adapter B extension process data	Configuration and view of fieldbus adapter extension process data
		n56	DWord output of fieldbus adapter B extension process data	
		n57	Expansion process data of fieldbus adapter A	
		n58	Expansion process data of fieldbus adapter B	
U	Connector	U0	Bit connector 1	B connector, value range 0 to 1
		U1	Bit connector 2	
		U2	Bit connector 3	
		U3	Bit connector 4	
		U4	Bit connector 5	
		U5	Word connector 1	K connector, 16-bit word type
		U6	Word connector 2	
		U7	Word connector 3	
		U8	Word connector 4	
		U9	DWord connector 1	DWord connector, 32-bit DWord type
		U10	Bit connector	B connector, value range 0 to 1
		U11	Bit connector	
		U13	Bit connector	
		U14	Bit connector	
		U15	Word connector 5	K connector, 16-bit word type
		U16	Word connector 6	
		U17	Word connector 7	
		U18	Word connector 8	
		U19	DWord connector 2	DWord connector, 32-bit DWord type
		U20	Word connector	B connector, value range of 0 to 1
		U27	Word connector	K connector, 16-bit word type
		U28	Bit connector 12	B connector, value range 0 to 1
		U29	DWord connector 3	DWord connector, 32-bit DWord type
		U39	DWord connector 4	

9.2 List of Function Parameters

For complete information on parameters, see MD880(LC)-40 Series Active Rectifier Parameter Guide.

10 Connector Resource

10.1 Common Connector

The connector refers specifically to group U, which are used to save and display status or variables during system operation. According to the data type, connectors can be divided into digital type (corresponding to U0.00–U4.99) and analog type (corresponding to U5.00–U9.99), also called bit connector (B connector) and word connector (K connector).

Analog connectors (also called word connector or K connector) can be divided into word (16-bit, occupying one storage address, corresponding to U5.00 to U8.99) and double-word (32-bit, occupying two storage addresses, corresponding to U9.00 to U9.99) types according to the data type. The DWord connector can represent more valid digits to improve the value precision.

Analog connectors can be divided into three types by unit: the per-unit value, the actual value, and the unit-less value.

- The per-unit value is expressed as a percentage to a certain reference value and can be used to represent voltage, current, and power.
- The actual value is displayed in V, A, and kW.
- The unit-less value usually refers to the data received through communication or the value of certain options.

For representation of the per-unit value system, the following rules are used:

- Corresponding to word connector: 0x1000 (decimal 4096) represents 100%. You can choose the actual value (Value) or per-unit value (Percent) for display. The conversion relationship is as follows: Percent = Value/4096.
- Corresponding to DWord connector: 0x1000 0000 (4096 x 65536) represents 100%. You can choose the actual value (Value) or per-unit value (Percent) for display. The conversion relationship is as follows: Percent = Value/4096/65536.
- The value ranges of per-unit values that can be represented by the word and DWord connectors are the same, both of which are -800.00% to +799.99%.
- The word and DWord connectors can be converted mutually. When assigning a word connector value to a DWord connector, the low word is 0 and the high word is the value of the word connector. When assigning a DWord connector value to a word connector, the low word is aborted, and the high word is directly assigned to the word connector, which is equivalent to a decrease in the number of valid digits of the value, but the range of values has not changed.

10.1.1 Common Monitoring Values

Param.	Name	Description
U5-02	Bus voltage	Actual value (unit: V)
U5-03	Grid voltage	Actual value (unit: V)
U5-04	Grid frequency	Unit: Hz
U5-05	Grid current	Actual value (unit: A)
U5-06	Power	Actual value (unit: kVA)
U5-07	Power factor	Actual value
U5-08	Three-phase unbalance factor	Actual value (unit: %)

Param.	Name	Description
U5-09	Maximum temperature of power unit	Actual value (unit: ℃)
U5-11	Detected temperature of the module	Actual value (unit: ℃)
U5-16	Active power	Actual value (unit: kW)
U5-17	Active current	Actual value (unit: A)
U6-01	Actual effective current reference	Actual value (unit: A)
U6-02	Actual effective voltage reference (before ramp)	Actual value (unit: V)
U6-05	Input current scaling	Percentage (unit: %)
U6-07	Actual effective current reference (per-unit value)	Per-unit value (The value 4096 represents 100%.)
U6-08	Actual effective voltage reference (per-unit value)	Per-unit value (The value 4096 represents 100%.)

10.1.2 Common Status Connector

Param.	Name	Description
U1-00	Ready to switch on	1: No system fault or emergency stop
U1-01	Ready to run	1: OFF1 signal available, soft start applied on the device
U1-02	Started	1: OFF1 signal available, soft start applied on the device and the device operating normally
U1-03	OFF1 active	1: OFF1 set to 1
U1-04	OFF2 inactive	1: OFF2 set to 1
U1-05	Startup lockout	1: OFF2 is set to 0, or OFF2 is in S4 and OFF1 is set to 1.
U1-06	Not started	1: The device is not started.
U1-07	Waiting for soft start	Reserved
U1-08	Soft start in progress	1: Soft start in progress, state machine being S6
U1-09	Soft start completed	1: Soft start completed
U1-10	Auxiliary contactor control command	1: Control signal of auxiliary contactor activated
U1-11	Main circuit breaker control command	1: Control signal of main circuit breaker activated
U1-12	Startup completed	1: Startup completed
U1-13	Startup not completed	1: Startup not completed
U1-14	Fault activation	1: Current fault activated
U1-15	Alarm/Minor fault activation	1: Current alarm/minor fault activated
U1-16	OFF2 activation	1: OFF2 set to 0
U1-17	Auto-tuning in progress	1: Parameter auto-tuning in progress
U1-18	Self-test in progress	1: Self-test in progress
U1-19	No fault	1: No fault activated
U1-20	No alarm/minor fault	1: No alarm or minor fault activated
U1-21	Feedback status of auxiliary contactor	1: Auxiliary circuit breaker feedback signal activated
U1-22	Main circuit breaker feedback state	1: Main circuit breaker feedback signal activated
U1-25	In operation	1: Device in normal operation
U1-27	Fault reset command status	1: Fault reset command activated

Param.	Name	Description
U1-28	Effective terminal start/stop module	0: Terminal start/stop module 1 1: Terminal start/stop module 2
U1-29	Terminal start/stop module OFF1 status	1: OFF1 output value of selected terminal start/stop module being 1
U1-30	[Module 1] OFF1 status	1: OFF1 output value of terminal start/stop module 1 being 1
U1-31	[Module 2] OFF1 status	1: OFF1 output value of terminal start/stop module 2 being 1
U1-32	Default configuration status	0: Inactive 1: Active
U1-78	Remote control permission	0: Local control 1: Remote control

10.1.3 Common Status Word Connector

Param.	Name	Description
U5-00	Current state machine	Indicates the state machine of the current system.
U8-07	Control word 1	A word that formed by bit0 to bit15 of control word 1
U8-08	Control word 2	A word that formed by bit0 to bit15 of control word 2
U8-09	Status word 1	A word that formed by bit0 to bit15 of status word 1
U8-10	Status word 2	A word that formed by bit0 to bit15 of status word 2

10.1.4 Fault Status Bit Connector

Param.	Name	Description
U3-40	Hardware fault	0: No fault 1: Fault occurred
U3-41	SD card fault	Same as above
U3-42	Low RTC battery voltage	Same as above
U3-43	Local control fault	Same as above
U3-44	Drive communication fault	Same as above
U3-45	Expansion module offline	Same as above
U3-46	Expansion module slot address conflict	Same as above
U3-47	Bus adapter fault	Same as above
U3-49	IGBT drive fault	Same as above
U3-50	Overcurrent fault	Same as above
U3-51	Overvoltage fault	Same as above
U3-52	Undervoltage fault	Same as above
U3-56	Drive overload	Same as above
U3-57	Ground fault	Same as above
U3-58	Module overtemperature	Same as above
U3-59	Module temperature too low	Same as above
U3-60	Ambient temperature too high	Same as above
U3-61	Parameters set incorrectly	Same as above
U3-62	External fault activated	Same as above
U3-63	External alarm activated	Same as above

Param.	Name	Description
U3-64	EEPROM power failure	Same as above
U3-65	Excessive leakage current	Same as above
U3-66	Master-slave communication fault (InoLink & optical fiber synchronization)	Same as above
U3-67	Incorrect model parameter	Same as above
U3-68	Rectifier self-test error	Same as above
U3-69	Soft start error	Same as above
U3-70	External hardware fault	Same as above
U3-71	Reactor temperature error	Same as above
U3-72	Module connection error	Same as above
U3-73	Power grid error	Same as above
U3-74	Input current unbalance	Same as above
U3-75	Parameter auto-tuning error	Same as above
U3-76	Bus adapter alarm	Same as above
U3-77	Internal fault	Same as above
U3-78	Exception	Same as above
U3-79	24 V voltage too low	Same as above
U3-80	Parallel operation alarm	Same as above
U3-81	Parallel operation fault	Same as above
U3-82	Current unbalance alarm in parallel mode	Same as above
U3-88	Module pre-overtemperature	Same as above

10.1.5 I/O Bit Connector

Param.	Name	Description
U0-00	Logic 0	Constant 0
U0-01	Logic 1	Constant 1
U0-02	DI1	DI state State after delay and forced processing
U0-03	DI2	
U0-04	DI3	
U0-05	DI4	
U0-06	DI5	
U0-07	DI6	
U0-08	DIL	
U0-09	HDI1	
U0-10	HDI2	
U0-12	DI1 inverted	All DI states inverted State inverted after delay and forced processing
U0-13	DI2 inverted	
U0-14	DI3 inverted	
U0-15	DI4 inverted	
U0-16	DI5 inverted	
U0-17	DI6 inverted	
U0-18	DIL inverted	
U0-19	HDI1 inverted	
U0-20	HDI2 inverted	
U0-21	RO1	0: NO contact open 1: NO contact closed

Param.	Name	Description
U0-22	RO2	0: NO contact open 1: NO contact closed
U0-23	RO3	0: NO contact open 1: NO contact closed
U0-24	HDO1	0: Open 1: Closed
U0-25	HDO2	0: Open 1: Closed

10.1.6 Connectors Related to Application Function

Param.	Name	Description
U2-48 U2-63	Output of word-to-bit function 1	Output values of the 16 bits that correspond to the word selected by L0-00
U2-64 U2-79	Output of word-to-bit function 2	Output values of the 16 bits that correspond to the word selected by L0-01
U2-80 U2-95	Output of word-to-bit function 3	Output values of the 16 bits that correspond to the word selected by L0-02
U2-96	Output of pulse generator block 1	Output value of pulse generator block in group L6
U2-97	Output of pulse generator block 2	
U2-98	Output of pulse generator block 3	
U3-00	Output of logic AND block A	Output value of each of the logic AND blocks in group L2
U3-01	Output of logic AND block B	
U3-02	Output of logic AND block C	
U3-03	Output of logic AND block D	
U3-04	Output of logic NOT block A	Output value of each of the logic NOT blocks in group L2
U3-05	Output of Logic NOT block B	
U3-06	Output of logic NOT block C	
U3-07	Output of logic NOT block D	
U3-08	Output of logic NOT block E	
U3-09	Output of logic NOT block F	
U3-10	Output of logic NOT block G	
U3-11	Output of logic NOT block H	
U3-12	Output of logic OR block A	Output value of each of the logic OR blocks in group L2
U3-13	Output of logic OR block B	
U3-14	Output of logic OR block C	
U3-15	Output of logic OR block D	

Param.	Name	Description
U3-16	Output of logic delay block A	Output value of each of the logic delay blocks in group L6
U3-17	Output of logic delay block B	
U3-18	Output of logic delay block C	
U3-19	Output of logic delay block D	
U3-20	Output of logic delay block E	
U3-21	Output of logic delay block F	
U3-22	Output of logic delay block G	
U3-23	Output of logic delay block H	
U4-00	Output of logic XOR/XNOR block A	Output value of each of the logic XOR/XNOR blocks in group L2
U4-01	Output of logic XOR\XNOR block B	
U4-02	Output of logic XOR\XNOR block C	
U4-03	Output of logic XOR\XNOR block D	
U4-31	Output of logic AND/OR block A	Output value of each of the logic AND/OR blocks in group L2
U4-32	Output of logic AND/OR block B	
U4-33	Output of logic AND/OR block C	
U4-34	Output of logic AND/OR block D	
U4-35	Output of logic AND/OR block E	
U4-36	Output of logic AND/OR block F	
U4-37	Output of logic AND/OR block G	
U4-38	Output of logic AND/OR block H	
U4-04	Output of binary selector block 1	Output value of each of the binary selector blocks in group L5
U4-05	Output of binary selector block 2	
U4-06	Output of binary selector block 3	
U4-07	Output of binary selector block 4	
U3-24	Output of binary selector block 5	
U3-25	Output of binary selector block 6	
U3-26	Output of binary selector block 7	
U3-27	Output of binary selector block 8	
U4-08	Output of level-to-pulse block A	Output value of each of the level-to-pulse blocks in group L6
U4-09	Output of level-to-pulse block B	
U4-10	Output of level-to-pulse block C	
U4-11	Output of level-to-pulse block D	
U4-12	Negative number input flag of absolute value block A	Negative input flag of each of the absolute value blocks in group L7
U4-13	Negative number input flag of absolute value block B	
U4-14	Negative number input flag of absolute value block C	
U4-15	Negative number input flag of absolute value block D	

Param.	Name	Description
U4-16	Divide-by-zero flag of multiply/ divide block A	Divide-by-zero flag of each of the multiply/divide blocks in group L7
U4-17	Divide-by-zero flag of multiply/ divide block B	
U4-18	Divide-by-zero flag of multiply/ divide block C	
U4-19	Divide-by-zero flag of multiply/ divide block D	
U4-20	Output of compare block A	Output value of each of the compare blocks in group L7
U4-21	Output of compare block B	
U4-22	Output of compare block C	
U4-23	Output of compare block D	
U4-24	Output of compare block E	
U5-76	High word of the output of DWord-to-word 1	Output values of L3-26 and L3-27
U5-77	Low word of the output of DWord-to-word 1	
U5-78	High word of the output of DWord-to-word 2	Output values of L3-28 and L3-29
U5-79	Low word of the output of DWord-to-word 2	
U5-80	High word of the output of DWord-to-word 3	Output values of L3-30 and L3-31
U5-81	Low word of the output of DWord-to-word 3	
U5-82	High word of the output of DWord-to-word 4	Output values of L3-32 and L3-33
U5-83	Low word of the output of DWord-to-word 4	
U5-84	High word of the output of DWord-to-word 5	Output values of L3-34 and L3-35
U5-85	Low word of the output of DWord-to-word 5	
U5-86	Output of bit-to-word function 1	Bit-to-word output values of L0-03 to L0-18
U5-87	Output of bit-to-word function 2	Bit-to-word output values of L0-19 to L0-34
U5-88	Output of bit-to-word function 3	Bit-to-word output values of L0-35 to L0-50
U5-89	Output of bit-to-word function 4	Bit-to-word output values of L0-51 to L0-66
U9-47	Output of word-to-DWord 1	Output values of L3-01, L3-02, and L3-03
U9-48	Output of word-to-DWord 2	Output values of L3-04, L3-05, and L3-06
U9-49	Output of word-to-DWord 3	Output values of L3-07, L3-08, and L3-09
U9-13	Output of word-to-DWord 4	Output values of L3-10, L3-11, and L3-12
U9-14	Output of word-to-DWord 5	Output values of L3-13, L3-14, and L3-15

Param.	Name	Description
U9-56	Output of digital selector block 1	Output value of each of the digital selector blocks in group L5
U9-57	Output of digital selector block 2	
U9-58	Output of digital selector block 3	
U9-59	Output of digital selector block 4	
U9-60	Output of digital selector block 5	
U9-61	Output of digital selector block 6	
U9-62	Output of digital selector block 7	
U9-63	Output of digital selector block 8	
U9-64	Output of digital selector block 9	
U9-65	Output of digital selector block 10	
U9-66	Output of digital selector block 11	
U9-67	Output of digital selector block 12	
U9-15	Output of digital selector block 13	
U9-16	Output of digital selector block 14	
U9-17	Output of digital selector block 15	
U9-18	Output of digital selector block 16	
U9-69	Output of filter block A	Output value of each of the filter blocks in group L6
U9-70	Output of filter block B	
U9-71	Output of filter block C	
U9-72	Output of filter block D	
U9-73	Output of absolute value block A	Output value of each of the absolute value blocks in group L7
U9-74	Output of absolute value block B	
U9-75	Output of absolute value block C	
U9-76	Output of absolute value block D	
U9-77	Output of add/subtract block A	Output value of each of the add/subtract blocks in group L7
U9-78	Output of add/subtract block B	
U9-79	Output of add/subtract block C	
U9-80	Output of add/subtract block D	
U9-81	Output of multiply/divide block A	Output value of each of the multiply/divide blocks in group L7
U9-82	Output of multiply/divide block B	
U9-83	Output of multiply/divide block C	
U9-84	Output of multiply/divide block D	
U9-85	Output of multi-point curve block A	Output value of each of the multi-point curve blocks in group L7
U9-86	Output of multi-point curve block B	

10.1.7 Word Connectors of Communication Data

Param.	Name	Description
U5-32	PZD1 of InoLink	InoLink 8-word data received
U5-33	PZD2 of InoLink	
U5-34	PZD3 of InoLink	
U5-35	PZD4 of InoLink	
U5-36	PZD5 of InoLink	
U5-37	PZD6 of InoLink	
U5-38	PZD7 of InoLink	
U5-39	PZD8 of InoLink	
U5-40	Reference 1 set via Modbus communication	Communication address: 34320
U5-41	Reference 2 set via Modbus communication	Communication address: 34321
U5-44	PZD1 of bus adapter A	16-word process data received by bus adapter A
U5-45	PZD2 of bus adapter A	
U5-46	PZD3 of bus adapter A	
U5-47	PZD4 of bus adapter A	
U5-48	PZD5 of bus adapter A	
U5-49	PZD6 of bus adapter A	
U5-50	PZD7 of bus adapter A	
U5-51	PZD8 of bus adapter A	
U5-52	PZD9 of bus adapter A	
U5-53	PZD10 of bus adapter A	
U5-54	PZD11 of bus adapter A	
U5-55	PZD12 of bus adapter A	
U5-56	PZD13 of bus adapter A	
U5-57	PZD14 of bus adapter A	
U5-58	PZD15 of bus adapter A	
U5-59	PZD16 of bus adapter A	
U5-60	PZD1 of bus adapter B	16-word process data received by bus adapter B
U5-61	PZD2 of bus adapter B	
U5-62	PZD3 of bus adapter B	
U5-63	PZD4 of bus adapter B	
U5-64	PZD5 of bus adapter B	
U5-65	PZD6 of bus adapter B	
U5-66	PZD7 of bus adapter B	
U5-67	PZD8 of bus adapter B	
U5-68	PZD9 of bus adapter B	
U5-69	PZD10 of bus adapter B	
U5-70	PZD11 of bus adapter B	
U5-71	PZD12 of bus adapter B	
U5-72	PZD13 of bus adapter B	
U5-73	PZD14 of bus adapter B	
U5-74	PZD15 of bus adapter B	
U5-75	PZD16 of bus adapter B	

Param.	Name	Description
U29-70	PZD1+PZD2 input data (after base value conversion) of adapter A	DWord process data received by bus adapter A
U29-71	PZD2+PZD3 input data (after base value conversion) of adapter A	
U29-72	PZD3+PZD4 input data (after base value conversion) of adapter A	
U29-73	PZD4+PZD5 input data (after base value conversion) of adapter A	
U29-74	PZD5+PZD6 input data (after base value conversion) of adapter A	
U29-75	PZD6+PZD7 input data (after base value conversion) of adapter A	
U29-76	PZD7+PZD8 input data (after base value conversion) of adapter A	
U29-77	PZD8+PZD9 input data (after base value conversion) of adapter A	
U29-78	PZD9+PZD10 input data (after base value conversion) of adapter A	
U29-79	PZD10+PZD11 input data (after base value conversion) of adapter A	
U29-80	PZD11+PZD12 input data (after base value conversion) of adapter A	
U29-81	PZD12+PZD13 input data (after base value conversion) of adapter A	
U29-82	PZD13+PZD14 input data (after base value conversion) of adapter A	
U29-83	PZD14+PZD15 input data (after base value conversion) of adapter A	
U29-84	PZD15+PZD16 input data (after base value conversion) of adapter A	

Param.	Name	Description
U29-85	PZD1+PZD2 input data (after base value conversion) of adapter B	DWord process data received by bus adapter B
U29-86	PZD2+PZD3 input data (after base value conversion) of adapter B	
U29-87	PZD3+PZD4 input data (after base value conversion) of adapter B	
U29-88	PZD4+PZD5 input data (after base value conversion) of adapter B	
U29-89	PZD5+PZD6 input data (after base value conversion) of adapter B	
U29-90	PZD6+PZD7 input data (after base value conversion) of adapter B	
U29-91	PZD7+PZD8 input data (after base value conversion) of adapter B	
U29-92	PZD8+PZD9 input data (after base value conversion) of adapter B	
U29-93	PZD9+PZD10 input data (after base value conversion) of adapter B	
U29-94	PZD10+PZD11 input data (after base value conversion) of adapter B	
U29-95	PZD11+PZD12 input data (after base value conversion) of adapter B	
U29-96	PZD12+PZD13 input data (after base value conversion) of adapter B	
U29-97	PZD13+PZD14 input data (after base value conversion) of adapter B	
U29-98	PZD14+PZD15 input data (after base value conversion) of adapter B	
U29-99	PZD15+PZD16 input data (after base value conversion) of adapter B	

Param.	Name	Description
U39-00	PZD17+PZD18 input data (after base value conversion) of adapter B	Extended DWord process data received by bus adapter A
U39-01	PZD18+PZD19 input data (after base value conversion) of adapter A	
U39-02	PZD19+PZD20 input data (after base value conversion) of adapter A	
U39-03	PZD20+PZD21 input data (after base value conversion) of adapter A	
U39-04	PZD21+PZD22 input data (after base value conversion) of adapter A	
U39-05	PZD22+PZD23 input data (after base value conversion) of adapter A	
U39-06	PZD23+PZD24 input data (after base value conversion) of adapter A	
U39-07	PZD24+PZD25 input data (after base value conversion) of adapter A	
U39-08	PZD25+PZD26 input data (after base value conversion) of adapter A	Extended DWord process data received by bus adapter A
U39-09	PZD26+PZD27 input data (after base value conversion) of adapter A	
U39-10	PZD27+PZD28 input data (after base value conversion) of adapter A	
U39-11	PZD28+PZD29 input data (after base value conversion) of adapter A	
U39-12	PZD29+PZD30 input data (after base value conversion) of adapter A	
U39-13	PZD30+PZD31 input data (after base value conversion) of adapter A	
U39-14	PZD31+PZD32 input data (after base value conversion) of adapter A	

Param.	Name	Description
U39-15	PZD17+PZD18 input data (after base value conversion) of adapter B	Extended DWord process data received by bus adapter B
U39-16	PZD18+PZD19 input data (after base value conversion) of adapter B	
U39-17	PZD19+PZD20 input data (after base value conversion) of adapter B	
U39-18	PZD20+PZD21 input data (after base value conversion) of adapter B	
U39-19	PZD21+PZD22 input data (after base value conversion) of adapter B	
U39-20	PZD22+PZD23 input data (after base value conversion) of adapter B	
U39-21	PZD23+PZD24 input data (after base value conversion) of adapter B	
U39-22	PZD24+PZD25 input data (after base value conversion) of adapter B	
U39-23	PZD25+PZD26 input data (after base value conversion) of adapter B	
U39-24	PZD26+PZD27 input data (after base value conversion) of adapter B	
U39-25	PZD27+PZD28 input data (after base value conversion) of adapter B	
U39-26	PZD28+PZD29 input data (after base value conversion) of adapter B	
U39-27	PZD29+PZD30 input data (after base value conversion) of adapter B	
U39-28	PZD30+PZD31 input data (after base value conversion) of adapter B	
U39-29	PZD31+PZD32 input data (after base value conversion) of adapter B	

10.2 List of Connectors

For complete information on parameters, see MD880(LC)-40 Series Active Rectifier Parameter Guide.

11 Troubleshooting

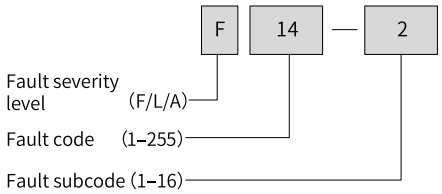
11.1 Fault Severity Level and Display

11.1.1 Fault Severity Levels

Faults are divided into three types depending on the degree of severity.

- Fault: Used to indicate that a major fault or error has occurred and the device stops running immediately.
- Minor fault (Limit): The system is faulty and allows switch-on without triggering IGBT.
- Alarm: Indicates that an alarm has occurred, which does not affect the operation state. You can handle alarms as needed.

A fault code is represented in three segments, as shown in the following figure. F indicates a fault, L indicates a minor fault, and A indicates an alarm.



11.1.2 Viewing Fault Information

Faults are represented by fault codes and fault subcodes, which indicate the classification of faults. Fault subcodes are used to locate specific faults. For example, in F15-2, the fault code 15 indicates an external fault; the fault subcode 2 indicates external fault 2.

Active fault

The HCU-40 can record up to six faults that occur at the same time. When more than six faults occur at the same time, the subsequent faults will not be recorded. Faults activated currently can be viewed through parameters in group A1.

Active fault		Active minor fault		Active alarm	
Fault code	Subcode	Fault code	Subcode	Fault code	Subcode
A1-00	A1-01	A1-12	A1-13	A1-24	A1-25
A1-02	A1-03	A1-14	A1-15	A1-26	A1-27
A1-04	A1-05	A1-16	A1-17	A1-28	A1-29
A1-06	A1-07	A1-18	A1-19	A1-30	A1-31
A1-08	A1-09	A1-20	A1-21	A1-32	A1-33
A1-10	A1-11	A1-22	A1-23	A1-34	A1-35

Fault log

The HCU-40 can record the latest five faults, the latest minor fault, and the latest alarm.

Last fault		2nd to last fault		3rd to last fault		4th to last fault	
Fault code	Subcode	Fault code	Subcode	Fault code	Subcode	Fault code	Subcode
H2-00	H2-01	H3-00	H3-01	H4-00	H4-01	H5-00	H5-01
H2-02	H2-03	H3-02	H3-03	H4-02	H4-03	H5-02	H5-03
H2-04	H2-05	H3-04	H3-05	H4-04	H4-05	H5-04	H5-05
H2-06	H2-07	H3-06	H3-07	H4-06	H4-07	H5-06	H5-07
H2-08	H2-09	H3-08	H3-09	H4-08	H4-09	H5-08	H5-09
H2-10	H2-11	H3-10	H3-11	H4-10	H4-11	H5-10	H5-11

5th to last fault		Last minor fault		Last alarm	
Fault code	Subcode	Fault code	Subcode	Fault code	Subcode
H6-00	H6-01	H7-00	H7-01	H8-00	H8-01
H6-02	H6-03	H7-02	H7-03	H8-02	H8-03
H6-04	H6-05	H7-04	H7-05	H8-04	H8-05
H6-06	H6-07	H7-06	H7-07	H8-06	H8-07
H6-08	H6-09	H7-08	H7-09	H8-08	H8-09
H6-10	H6-11	H7-10	H7-11	H8-10	H8-11

Fault data log

When a fault occurs, the HCU-40 records not only the fault code and subcode, but also the time upon fault occurrence. The data of the latest three faults can be recorded, which are recorded in group H1.

Fault data log	Last fault data	2nd to last fault data	3rd to last fault	4th to last fault	5th to last fault
Bus voltage upon fault	H2-12	H3-12	H4-12	H5-12	H6-12
Power grid voltage upon fault	H2-13	H3-13	H4-13	H5-13	H6-13
Module current upon fault	H2-14	H3-14	H4-14	H5-14	H6-14
Power grid frequency upon fault	H2-15	H3-15	H4-15	H5-15	H6-15
Fault control word 1	H2-26	H3-26	H4-26	H5-26	H6-26
Fault control word 2	H2-27	H3-27	H4-27	H5-27	H6-27
Fault status word	H2-28	H3-28	H4-28	H5-28	H6-28
Fault state machine	H2-29	H3-29	H4-29	H5-29	H6-29
Moment upon fault occurrence	H2-30	H3-30	H4-30	H5-30	H6-30
Date of fault occurrence	H2-31	H3-31	H4-31	H5-31	H6-31

Viewing faults through SOP-20-880

SOP-20-880 allows you to view the fault information through previous parameters or the fault menu.

Function	Key	Description
Viewing active fault	Key operations	Go to “Menu > Fault Records > Faults”.
Viewing active minor faults	Key operations	Go to “Menu > Fault Records > Limited Faults”.
Viewing active alarms	Key operations	Go to “Menu > Fault Records > Alarms”.
Viewing the help information of the fault		Select a fault and press the help key to display the help information of the fault.
Viewing previous faults	Key operations	Go to “Menu > Fault Records > History Faults”.

It is recommended to view the fault information by the fault menu. All recorded faults and the related help information can be viewed.

Viewing faults through InoDriveStudio

When using InoDriveStudio, you can view the fault on the "Fault alarm table" interface.

On the "Fault alarm table" interface, you can view the fault descriptions, fault causes and solutions, and data recorded when the fault occurs.

11.1.3 Fault Reset Methods

HCU supports five fault reset methods, including reset through SOP-20-880, reset through InoDriveStudio, reset through the control channel, reset through parameter setting, and reset at next power-on.

Method	Description
Reset through SOP-20-880	After connection is done, press the STOP key in any interface to reset the fault.
Reset through InoDriveStudio	After connecting InoDriveStudio, click the Reset button in the "Control panel" to reset the fault.
Reset through the control channel	Set parameters to reset the fault.
Reset through parameter setting	Set H0-07 to 1 and set the fault reset time properly to allow fault reset.
Reset at next power-on	Power on the HCU-40 control circuit again after power-off to reset the fault.

Note

- The reset commands of SOP-20-880 and InoDriveStudio are always active after being connected, regardless of the control source.
- The rising edge of the reset signal triggers a reset.
- When the default configuration is enabled, the reset command corresponding to other control words in the control channel is still active.
- When the default configuration is disabled, the corresponding reset command in the control channel is active.

11.1.4 Fault Severity Level Change and Automatic Reset

Fault severity change

Faults are classified into faults, minor faults, and alarms, which is further divided into seven levels to fit different fault conditions. Up to 10 fault levels can be set, as shown below.

Param.	Parameter value
Fault codes 1 to 10 for changing fault severity level in H0-33	Fault display code
Fault codes 1 to 10 for changing fault severity level in H0-34	0: Switch-off 1: Reserved 2: Stop 3: Reserved 4: Reserved 5: Reserved 6: Display alarm only 7: Ignore

Fault severity	Definition	Remarks
0: Switch-off	Block output and switch off	Fault
1: Reserved	-	
2: Stop	Operation is not permitted when conditions are not met.	Minor fault
3: Reserved	-	
4: Reserved		
5: Reserved		
6: Display alarm only	Display alarm only	Warning
7: Ignore	No alert	No error

Note

- Fault code: a code that is displayed when the system is faulty. For example, the fault code of external fault F15-1 is 15.
- Different faults must be set with a fault severity level within the permissible range. When the fault severity level is set, the system automatically determines whether the fault severity level is valid.

Reset automatically

In certain applications, a limited number of automatic fault resets can be set to ensure continuous application when a fault occurs. The system allows you to set the fault reset interval (Tr), fault reset count (ResetNum), reset time of fault reset count (Ts), and a maximum of three non-resettable fault codes.

- Tr: The reset command ResetCmd is generated every Tr time upon fault.
- ResetNum indicates the number of automatic resets. The remaining number of automatic resets is ResetNum-1 for each reset command ResetCmd. When the remaining number of automatic resets is 0, the automatic fault reset function is deactivated.
- Ts indicates the time for resetting the number of fault resets. After the Ts time elapses, the remaining number of fault resets are restored to the number of resets set previously (RestNum).

Non-resettable fault code: When the non-resettable fault code is included in the current system fault list, the system will not generate an automatic reset command, which means the fault can only be reset manually. See the following table for detailed setting.

Param.	Function	Value range	Remarks
H0-07	Automatic fault reset function	0: Inactive 1: Active	Enable
H0-08	Reset time of fault reset count	0.0 to 3600.0s	Ts
H0-09	Fault reset time interval	0.0s to 600.0s	Tr
H0-10	Fault reset count	0 to 5	ResetNum
H0-11	Non-resettable fault code 1	Fault display code	-
H0-12	Non-resettable fault code 2	Fault display code	-
H0-13	Non-resettable fault code 3	Fault display code	-

Note

- Enable signal: Active when the automatic fault reset function is activated and the number of fault resets (ResetNum) is not 0.
- If the fault reset interval time exceeds the reset time for fault reset count, this function is inactive.
- When automatic fault reset and automatic restart are enabled, ensure that unexpected equipment operation will not cause personal injury or mechanical damage. This function is strictly prohibited for vertical lifting applications; otherwise, heavy loads may fall out of control.
- Contact Inovance technical support if you need to enable the automatic restart function.

11.2 Troubleshooting

"System initialization" of state machine

Symptom	Solution
After the control power supply of HCU-40 is switched on, the state machine (A0-00) is always set to "0: system initializing".	Check whether the 24 VDC power supply voltage of HCU-40 is excessively low.
	Check whether the 24 VDC and 15 VDC power detection circuits of HCU-40 are faulty.
	Check whether EEPROM of HCU-40 functions improperly.
	Contact Inovance for technical support.

"Startup lockout" of state machine

Symptom	Solution
The HCU-40 state machine (A0-00) is always set to "4 Startup lockout" after the HCU-40 control is powered on.	If HCU-40 reports alarm A63-4, check whether OFF2 is set to 0, which should be 1 normally.
	If OFF2 is set to 1, check whether OFF1 is set to 1. When the drive enters "4 Startup lockout", you need to deactivate the OFF1 command to exit the "4 Startup lockout" state.
	Contact Inovance for technical support.

Parameter setting error

If there is a conflict between custom parameters, HCU-40 limits the setpoints internally to ensure normal operation. An alarm 46-1 is also reported, indicating that the parameter inputted is incorrect. The operation state of the system may be different than expected.

Find out the cause of the parameter setting error through U8-44. When no error occurs, U8-44 is set to 0. See details of U8-44 in the following table.

Fault information	Description
0	No parameter setting error
2	Conflict between min. and max. values of motorized potentiometer
20	Conflict between min. and max. input values of AI1 curve
21	Conflict between min. and max. input values of AI2 curve
22	Conflict between min. and max. output ratios of AO1 curve
23	Conflict between min. and max. output ratios of AO2 curve
24	Conflict between min. and max. input frequencies of HDI1 curve
25	Conflict between min. and max. input frequencies of HDI2 curve
26	Conflict between min. and max. output ratios of HDO1 curve
27	Conflict between min. and max. output ratios of HDO2 curve
28	Slot number of the communication card selected for fieldbus adapter A not set
29	Slot number of the communication card selected for fieldbus adapter B not set
31	Fault reset interval time exceeding the time for resetting the fault count
34	Fault handling level setting conflict
36	Incremental setting not applied to X points of multi-point curve module A
37	Incremental setting not applied to X points of multi-point curve module B
39	Number of trigger oscilloscope channels (A12.20) exceeding 8 during carrier cycle
45	Start/Stop control word being bus adapter but PROFIBUS-DP data check bit (N16.10) not being bit10
46	Parallel function enabled (A15.00) but the number of unit modules enabled being 0
47	I/O expansion module 1 parameter setting conflict (The minimum input of AI curve is larger than the maximum input value or the minimum output scaling of AO curve is larger than the maximum output scaling.)
48	I/O expansion module 2 parameter setting conflict (The minimum input of AI curve is larger than the maximum input value or the minimum output scaling of AO curve is larger than the maximum output scaling.)
49	I/O expansion module 3 parameter setting conflict (The minimum input of AI curve is larger than the maximum input value or the minimum output scaling of AO curve is larger than the maximum output scaling.)
77	Conflict between upper and lower limits of limiter module A
78	Conflict between upper and lower limits of limiter module B
79	Conflict between upper and lower limits of limiter module C
80	Conflict between upper and lower limits of limiter module D
88	Parameter setting error of the droop function reception node (reception node enabled but reception data of the node not configured)
97	Excessive new InoLink data exchange
110	Conflict between the setting of n54-00 or n54-47 (adjacent PZD DWord output enabled)
111	Conflict between the setting of n56-00 or n56-47 (adjacent PZD DWord output enabled)

Fault information	Description
112	Process data output setting of n1-04 to n1-19/n57-05 to n57-20 not matching the active process data displayed by n1-84/n57-87
113	Process data output setting of n2-04 to n2-19/n58-05 to n58-20 not matching the active process data displayed by n2-84/n58-87

11.3 Custom External Faults and Alarms

11.3.1 External Faults

H0-00 and H0-01 provide two custom sources for triggering custom faults and blocking drive output upon fault. You can select a B connector from U0-00 to U4-99 as the source for triggering custom faults. The value 0 indicates no custom fault occurred, and the value 1 indicates that an external fault (F15-1 or F15-2) is triggered.

Param.	Name	Description
H0-00	Source of external fault 1	When the parameter is active, external fault 1 is triggered.
H0-01	Source of external fault 2	When the parameter is active, external fault 2 is triggered.

11.3.2 External Alarms

H0-02 and H0-03 provide two sources for triggering custom external alarms. Such alarms are used for alarm purpose only, which do not affect operation of the drive. You can select a B connector from U0-00 to U4-99 as the source for triggering custom alarms. The value 0 indicates no custom alarms occurred, and the value 1 indicates that an external alarm (A63-1 or A63-2) is triggered.

Param.	Name	Description
H0-02	Source of external alarm 1	When the parameter is active, external alarm 1 is triggered.
H0-03	Source of external alarm 2	When the parameter is active, external alarm 2 is triggered.

11.4 List of Fault Codes

For complete information on faults, sees MD880(LC)-40 Series Active Rectifier Parameter Guide.

11.5 Fault Description

For complete information on fault codes, see MD880(LC)-40 Series Active Rectifier Parameter Guide.

12 Service and Support

12.1 Service and Support

Should you encounter a safety accident during the use or operation of the product, or face challenges in operating and maintaining the equipment, which remain unresolved after the relevant documentation is consulted, we provide multiple channels to ensure prompt resolution:

- Channel #1: Contact service@inovance.com.
- Channel #2: Visit https://www.inovance.com/global to access document downloads, after-sales support, spare parts ordering, repair applications, and authenticity verification services.
- Channel #3: Download My Inovance app (https://zshc-eu.inovance.com/download-pc/) where you can access products info and documentation, and query product parameters.

We are committed to providing you with quick and professional technical support, and we look forward to your satisfaction and trust.

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