Goodrive800 Pro Series Basic Rectifier Unit

Software Manual

SHENZHEN INVT ELECTRIC CO., LTD.

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1	First release.	V1.0	June 2022

Preface

Thank you for choosing INVT Goodrive800 Pro series engineering variable-frequency drive (VFD).

For ease of use, read the manual carefully before using Goodrive800 Pro series product.

As an upgrade product of Goodrive800 series engineering VFD, Goodrive800 Pro series engineering VFD inherits the high reliability feature of Goodrive800 platform but optimizes the upgrade, structure, and components, achieving unit modularization, flexible cabinet configuration, more compact structure, easier installation and maintenance, and optimum protection.

- Excellent speed and torque control performance
- Modular design, as flexible as building blocks, which makes the project integration simple and efficient
- Long-life component selection and fast fault recovery design to ensure efficient process control
- Ergonomic design to make installation and maintenance easier
- Enriched expansion capability to support various protection options

Goodrive800 Pro series engineering VFD can be widely used in:

Metallurgy: Such as high-speed wire rod and hot strip rolling equipment, wide and thick plate equipment, cold rolling equipment, pickling lines, annealing lines, galvanizing line, color coating lines, non-ferrous metal alloy manufacturing equipment, and non-ferrous metal rolling equipment.

Petroleum: All-electric oil drilling rigs, large well repair machines, large oil machinery and equipment electric-drive power transformation, oilfield water injection equipment and other heavy oil equipment.

Paper making: Paper making joint equipment, including flow box, net section, press section, drying section, sizing, hard calendering, coating, super calender, rewinder and other continuous production lines.

Port and other large lifting equipment: Such as shore-side container overhead cranes, tire-type (orbital) container gantry cranes, grab unloaders, grab gantry cranes, large shipbuilding gantry cranes, and large metallurgical casting cranes.

Others: Such as unit test benches, military equipment, oil and gas transmission, and mining transmission equipment.

Goodrive800-71 series is the basic rectifier unit of Goodrive800 Pro series. If not otherwise specified, the basic rectifier unit in this manual refers to the basic rectifier unit of Goodrive800 Pro series, that is, Goodrive800-71 series product. The rated power of a single unit is 356kW–929kW, and the max. parallel power can be 5183kW. The basic rectifier unit consists of input reactor, semi-controlled rectifier bridge and DC fuse. It is compact in structure and easy to integrate and maintain, reducing cabinet footprint.

You are reading Goodrive800 Pro Series Basic Rectifier Unit Software Manual. Read through this manual carefully before installation to ensure the product is installed and operated in a proper manner to give full play to its excellent performance and powerful functions. If you have any question about the function and performance of the product, please consult our technical support.

If the product is ultimately used for military affairs or weapon manufacture, comply with the export control regulations in the Foreign Trade Law of the People's Republic of China and complete related formalities.

To continuously improve the performance of the product to meet higher application requirements, we reserve the right to continuously improve the product and accordingly the product manual, which may be made without prior notice. We have the final interpretation of the manual content.

Contents

1 Safety precautions

1.1 Safety declaration

Read this manual carefully and follow all safety precautions before moving, installing, operating and servicing the product. Otherwise, equipment damage or physical injury or death may be caused.

We shall not be liable or responsible for any equipment damage or physical injury or death caused due to your or your customers' failure to follow the safety precautions.

1.2 Safety definition

Danger: Severe personal injury or even death can result if related requirements are not followed.

Warning: Personal injury or equipment damage can result if related requirements are not followed.

Note: Actions taken to ensure proper running.

Trained and qualified professionals: People operating the equipment must have received professional electrical and safety training and obtained the certificates, and must be familiar with all steps and requirements of equipment installing, commissioning, running and maintaining and capable to prevent any emergencies.

1.3 Warning symbols

Warnings caution you about conditions that can result in severe injury or death and/or equipment damage and advice on how to prevent dangers. The following table lists the warning symbols in this manual.

Symbol	Name	Description
	Danger	Severe personal injury or even death can result if related requirements are not followed.
	Warning	Personal injury or equipment damage can result if related requirements are not followed.
	Electrostatic sensitive	The PCBA may be damaged if related requirements are not followed.
	Hot sides	Do not touch. The basic rectifier base may become hot.
	Electric shock	As high voltage still presents in the bus capacitor after power off, wait for at least 15 minutes (depending on the warning symbols on the machine) after power off to prevent electric shock.
Note	Note	Actions taken to ensure proper running.

1.4 Safety guidelines

	• Only trained and qualified professionals are allowed to carry out related operations. • Do not perform wiring, inspection or component replacement when power supply is applied. Ensure all the input power supplies have been disconnected before

<table>
<tr><td></td><td>wiring or inspection, and wait for at least the time designated on the Goodrive800 Pro series product or until the DC bus voltage is less than 36V. The minimum waiting time is listed in the following.
<table>
<tr><th colspan="2">Rectifier unit model</th><th>Minimum waiting time</th></tr>
<tr><td>380V</td><td>>356kW</td><td>15 minutes</td></tr>
<tr><td>690V</td><td>>487kW</td><td>15 minutes</td></tr>
</table></td></tr>
<tr><td>  </td><td>• Do not refit the Goodrive800 Pro series product unless authorized; otherwise fire, electric shock or other injury may result.</td></tr>
<tr><td>  </td><td>• The base may become hot when the Goodrive800 Pro series product is running. Do not touch. Otherwise, you may get burnt.</td></tr>
<tr><td>  </td><td>• The electrical parts and components inside the Goodrive800 Pro series product are electrostatic sensitive. Take measurements to prevent electrostatic discharge when performing related operations.</td></tr>
</table>

1.4.1 Delivery and installation

<table>
<tr><td>  </td><td>• Do not install the rectifier unit on inflammables. In addition, prevent the rectifier unit from contacting or adhering to inflammables.
• Do not run the rectifier unit if it is damaged or incomplete.
• Do not contact the rectifier unit with damp objects or body parts. Otherwise, electric shock may result.</td></tr>
<tr><td>Note</td><td>• Select appropriate tools for rectifier unit delivery and installation to ensure the safe and proper running and avoid physical injury or death. To ensure personal safety, take mechanical protective measures like wearing safety shoes and working uniforms.
• Protect the rectifier unit against physical shock or vibration during the delivery and installation.
• Do not carry the rectifier unit only by its front cover as the cover may fall off.
• The installation site must be away from children and other public places.
• Prevent the screws, cables and other conductive parts from falling into the rectifier unit.
• As rectifier unit leakage current caused during running may exceed 3.5mA, ground properly and ensure the grounding resistance is less than 10Ω. The conductivity of PE grounding conductor must meet the following requirements:
<table>
<tr><th>Power cable conductor cross-sectional area S (mm²)</th><th>Grounding conductor cross-sectional area</th></tr>
<tr><td>S⩽16</td><td>S</td></tr>
<tr><td>16<S⩽35</td><td>16</td></tr>
<tr><td>35<S</td><td>S/2</td></tr>
</table>
• R, S, and T are the power input terminals, while U, V, and W are the DC bus output terminals. Connect the input power cables and output busbars properly; otherwise, the rectifier unit may be damaged.</td></tr>
</table>

1.4.2 Commissioning and running

<table>
<tr><td>  </td><td>• Cut off all power supplies connected to the rectifier unit before terminal wiring, and wait for at least the time designated on the rectifier unit after disconnecting the power supplies.
• High voltage presents inside the rectifier unit during running. Do not carry out any operation on the rectifier unit during running except for keypad setup. For</td></tr>
</table>

	products at voltage class of 4 or 6, the control terminals form extra-low voltage circuits. Therefore, you need to prevent the control terminals from connecting to accessible terminals of other devices. • Before turning on the power supply, check the cable connection status. • Prevent anyone from directly touching the energized part of the cabinet door. Pay special attention to safety when handling shields that are made of metal sheets. • Do not do any withstand voltage testing during unit connection. Disconnect the motor cable before performing any insulation and voltage withstand tests for the motor or motor cable. • Do not open the cabinet door since high voltage presents inside the Goodrive800 Pro series product during running.
Note	• Do not switch on or switch off the input power supplies of the rectifier unit frequently. • If the rectifier unit has been stored for a long time without use, perform checking and carry out pilot run for the rectifier unit before using it again. • Close the rectifier unit front cover before running; otherwise, electric shock may occur.

1.4.3 Maintenance and component replacement

	• Only trained and qualified professionals are allowed to perform maintenance, inspection, and component replacement for the rectifier unit. • Cut off all power supplies connected to the rectifier unit before terminal wiring, and wait for at least the time designated on the rectifier unit after disconnecting the power supplies. • During maintenance and component replacement, take measures to prevent screws, cables and other conductive matters from falling into the internal of the rectifier unit.
Note	• Use proper torque to tighten screws. • During maintenance and component replacement, keep the rectifier unit and its parts and components away from combustible materials and ensure they have no combustible materials adhered. • Do not carry out insulation voltage-endurance test on the rectifier unit, or measure the control circuits of the rectifier unit with a megohmmeter. • During maintenance and component replacement, take proper anti-static measures on the rectifier unit and its internal parts.

1.4.4 Disposal

	• The rectifier unit contains heavy metals. Dispose of a scrap rectifier unit as industrial waste.
	• Dispose of a scrap product separately at an appropriate collection point but not place it in the normal waste stream.

2 Quick startup

2.1 Safety notes

	Equipment can tip over if transported incorrectly or with disallowed means of transport. Serious injury, property damage, or even death may result. • Only trained and qualified professionals are allowed to carry out the operations mentioned in this chapter. Please carry out operations according to instructions presented in section 1.4.1 Delivery and installation. Ignoring these safety precautions may lead to physical injury or death, or device damage. • Ensure the rectifier unit power has been disconnected before installation. If the rectifier unit has been powered on, disconnect the rectifier unit power and wait for at least the time specified on the rectifier unit, and ensure the POWER indicator is off. You are recommended to use a multimeter to check and ensure the rectifier unit DC bus voltage is below 36V. • The equipment installation must be designed and done according to applicable local laws and regulations. We do not assume any liability whatsoever for any equipment installation which breaches local laws or regulations. If recommendations given by us are not followed, the rectifier unit may experience problems that the warranty does not cover. • Only trained and qualified professionals are allowed to carry out related operations. • Do not perform wiring, inspection or component replacement when power supply is applied. Ensure all the input power supplies have been disconnected before wiring or inspection, and wait for at least the time designated on the Goodrive800 Pro series product or until the DC bus voltage is less than 36V.

2.2 Unpacking inspection

Check the following after receiving the product.

1. the packing box is damaged or dampened.
2. Whether the model identifier on the exterior surface of the packing box is consistent with the purchased model.
3. Whether the interior surface of the packing box is abnormal, for example, in wet condition, or whether the enclosure of the VFD is damaged or cracked.
4. Whether the VFD nameplate is consistent with the model identifier on the exterior surface of the packing box.
5. Whether the accessories (including the manual, keypad, and expansion card) inside the packing box are complete.

If any problems are found, contact the local INVT dealer or office.

2.3 Checking before use

Check the following before using the product.

1. Mechanical type of the load to be driven by the VFD to verify whether the VFD will be overloaded during work. Whether the power class of the VFD needs to be increased.
2. Whether the actual running current of the motor is less than the rated current of the VFD.
3. Whether the grid voltage is within the voltage range allowed by the VFD.
4. Whether the requirements of communication method to be used is met.

2.4 Environment checking

Check the following before installing the product.

1. Whether the actual ambient temperature exceeds 40°C. If yes, the current is derated by 2% for every increase of 1°C. Do not use the VFD when the ambient temperature exceeds 50°C.
2. Whether the actual ambient temperature is lower than -10°C. If the temperature is lower than -10°C, use heating devices.
3. Whether the altitude of the application site exceeds 1000m. When the installation site altitude exceeds 1000 m, the current is derated by 1% for every increase of 100m.
4. Whether the actual environment humidity exceeds 90%, or condensation occurs. If yes, take additional protective measures.
5. Whether there is direct sunlight or biological invasion in the environment where the VFD is to be used. If yes, take additional protective measures.
6. Whether there is dust or inflammable and explosive gas in the environment where the VFD is to be used. If yes, take additional protective measures.

2.5 Checking after installation

Check the following after the rectifier installation is complete.

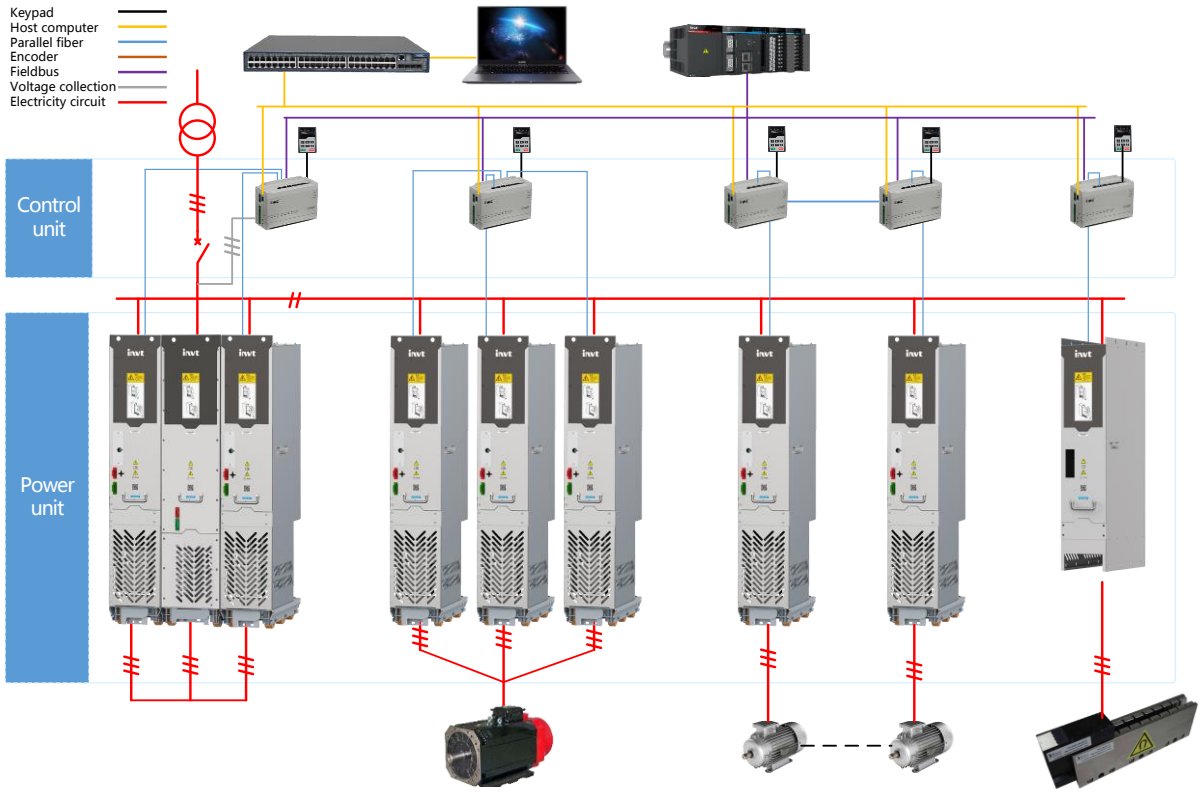
1. Whether the input power cables and motor cables meet the current-carrying capacity requirements of the actual load.
2. Whether correct accessories are selected for the VFD, the accessories are correctly and properly installed, and the installation cables meet the capacity carrying requirements of all components (including the reactor, input filter, output reactor, output filter, DC reactor, braking unit and braking resistor).
3. Whether the VFD is installed on non-flammable materials and the heat-radiating accessories (such as the reactor and braking resistor) are away from flammable materials.
4. Whether all control cables and power cables are run separately and the routing complies with EMC requirement.
5. Whether all grounding systems are properly grounded.
6. Whether all the installation clearances of the VFD meet the requirements in the manual.
7. Whether the external connection terminals of the VFD are tightly fastened and the torque is appropriate.
8. Take additional protective measure to prevent the screws, cables and other conductive parts from falling into the VFD.

3 System instruction

3.1 System topology

GD800 Pro multi-drive typical topology consists of rectifier (basic rectifier, regenerative rectifier, active rectifier), inverter and brake, as shown in the Figure 3-1. The module can be expanded through the parallel connection of control units. The control unit and PLC are connected through the bus, which realizes the centralized control and enables the host controller debugging and monitoring functions through Ethernet.

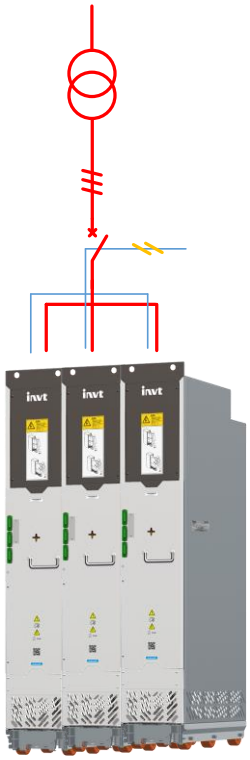
Figure 3-1 GD800 Pro multi-drive typical topology



3.2 Parallel connection

The basic rectifier contains built-in input reactor which allows parallel connection among units. A maximum of six rectifiers can be paralleled together.

Figure 3-2 Basic rectifiers in parallel



Note: Basic rectifier units of different sizes cannot be used in parallel.

4 Keypad operation guidelines

4.1 Keypad introduction

The keypad is used to control the basic rectifier, read status data, and set parameters.

Figure 4-1 Keypad diagram

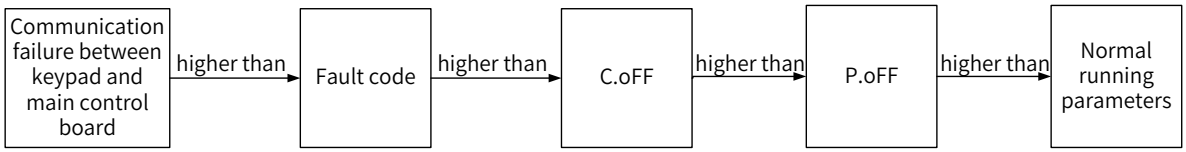
No.	Name	Description	
1	Status indicator	RUN/TUNE	Run indicator On: The basic rectifier is running. Off: The basic rectifier is stopped.
		FWD/REV	Grid phase sequence indicator Off: The grid is in positive sequence. On: The grid is in negative sequence.
		LOCAL/REMOT	Indicates whether the basic rectifier is controlled through the keypad, terminals, or communication. Off: The basic rectifier is controlled through the keypad. Blinking: The basic rectifier is controlled through terminals. On: The basic rectifier is controlled through remote communication.
		TRIP	Fault indicator On: The basic rectifier is in fault state. Off: The basic rectifier is in normal state. Blinking: The basic rectifier is in pre-alarm state.
2	Unit indicator	Unit displayed currently	
		Hz	Frequency unit
		RPM	Rotation speed unit
		A	Current unit
		%	Percentage
		V	Voltage unit

<table>
<tr><th>No.</th><th>Name</th><th colspan="3">Description</th></tr>
<tr><td>3</td><td>Digital display zone</td><td colspan="3">Five-digit LED displays various monitoring data and alarm codes such as the frequency setting and output frequency.
<table>
<tr><th>Display</th><th>Means</th><th>Display</th><th>Means</th><th>Display</th><th>Means</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>3</td><td>3</td><td>4</td><td>4</td><td>5</td><td>5</td></tr>
<tr><td>6</td><td>6</td><td>7</td><td>7</td><td>8</td><td>8</td></tr>
<tr><td>9</td><td>9</td><td>A</td><td>A</td><td>b</td><td>b</td></tr>
<tr><td>C</td><td>C</td><td>d</td><td>d</td><td>E</td><td>E</td></tr>
<tr><td>F</td><td>F</td><td>H</td><td>H</td><td>I</td><td>I</td></tr>
<tr><td>L</td><td>L</td><td>N</td><td>N</td><td>n</td><td>n</td></tr>
<tr><td>o</td><td>O</td><td>P</td><td>P</td><td>r</td><td>r</td></tr>
<tr><td>S</td><td>S</td><td>t</td><td>t</td><td>U</td><td>U</td></tr>
<tr><td>v</td><td>v</td><td>.</td><td>.</td><td>-</td><td>-</td></tr>
</table></td></tr>
<tr><td rowspan="8">4</td><td rowspan="8">Keys</td><td> 
</td><td>Programming key</td><td>Press it to enter or exit level-1 menus or delete a parameter.</td></tr>
<tr><td> 
</td><td>Confirmation key</td><td>Press it to enter menus in cascading mode or confirm the setting of a parameter.</td></tr>
<tr><td>  </td><td>UP key</td><td>Press it to increase data or move upward.</td></tr>
<tr><td>  </td><td>Down key</td><td>Press it to decrease data or move downward.</td></tr>
<tr><td> 
</td><td>Right-shifting key</td><td>Press it to select display parameters rightward in the interface for the basic rectifier in stopped or running state or to select digits to change during parameter setting.</td></tr>
<tr><td> 
</td><td>Run key</td><td>Press it to run the basic rectifier when using the keypad for control.</td></tr>
<tr><td> 
</td><td>Stop/Reset key</td><td>Press it to stop the rectifier unit that is running. The function of this key is restricted by P07.04. In fault alarm state, this key can be used for reset in any control modes.</td></tr>
<tr><td> 
</td><td>Multifunction shortcut key</td><td>The function is determined by P07.02.</td></tr>
</table>

4.2 Keypad display

The keypad displays information such as the stopped-state parameters, running-state parameters, and fault status, and allows you to modify function codes.

Figure 4-2 Keypad display priority



4.2.1 Displaying stopped-state parameters

When the rectifier unit is in stopped state, the keypad displays stopped-state parameters, as shown in Figure 4-3.

In the stopped state, various kinds of parameters can be displayed. You can determine which parameters are displayed by setting function code P07.05. For details, see the description of P07.05.

By setting P07.05, there are 15 parameters that can be selected to display: DC bus voltage (V), grid frequency (Hz), input voltage (V), input current (A), input power factor (%), active current component (%), reactive current component (%), input terminal state, output terminal state, AI1 (V), AI2 (V), AI3 (V), input apparent power (kVA), input active power (kW) and input reactive power (kVar).

You can press 》/SHIFT to shift selected parameters from left to right or press QUICK/JOG (P07.02=2) to shift selected parameters from right to left.

4.2.2 Displaying running-state parameters

After receiving a valid running command, the basic rectifier unit enters the running state, and the keypad displays running-state parameters, with the RUN/TUNE indicator on. The on/off state of the FWD/REV indicator is determined by the grid phase sequence. As shown in Figure 4-3.

In the running state, the displayed parameters are consistent with the parameters displayed in the stopped state.

4.2.3 Displaying fault information

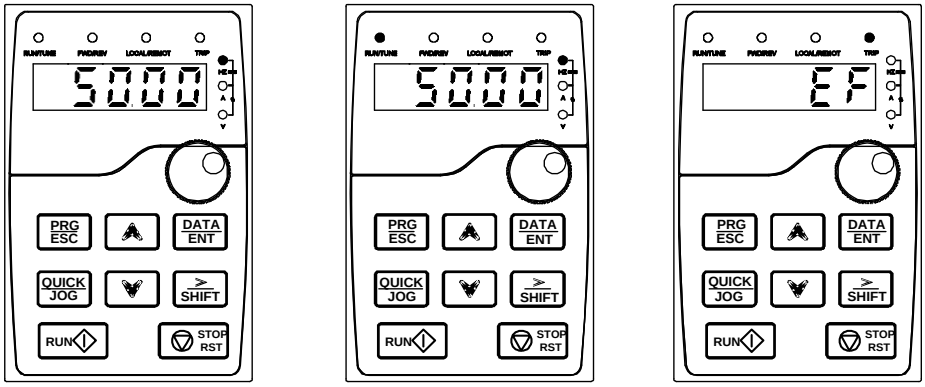
After detecting a fault signal, the basic rectifier enters the fault alarm state immediately, the fault code blinks on the keypad, and the TRIP indicator is on. You can perform fault reset by using the STOP/RST key, control terminals, or communication commands.

If the fault persists, the fault code is continuously displayed.

4.2.4 Editing function codes

You can press the PRG/ESC key to enter the editing mode in stopped, running, or fault alarm state (if a user password is used, see the description of P07.00). The editing mode contains two levels of menus in the following sequence: Function code group or function code number → Function code setting. You can press the DATA/ENT key to enter the function parameter display interface. In the function parameter display interface, you can press the DATA/ENT key to save parameter settings or press the PRG/ESC key to exit the parameter display interface.

Figure 4-3 Status display



Stopped state Running state Fault state

4.3 Operation procedure

You can operate the basic rectifier by using the keypad. For details about function code descriptions, see the function code list.

4.3.1 Modifying function codes

The basic rectifier provides three levels of menus, including:

- Function code group number (level-1 menu)
- Function code number (level-2 menu)
- Function code setting (level-3 menu)

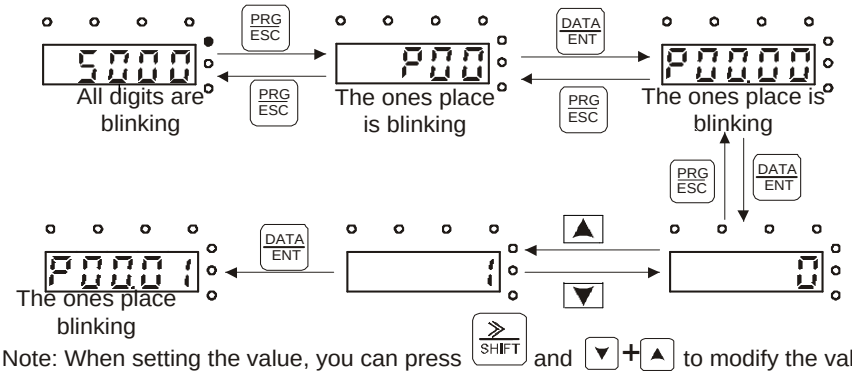
Note: When performing operations on the level-3 menu, you can press the PRG/ESC or DATA/ENT key to return to the level-2 menu. If you press the DATA/ENT key, the set value of the parameter is saved to the control board first, and then the level-2 menu is returned, displaying the next function code. If you press the PRG/ESC key, the level-2 menu is returned directly, without saving the set value of the parameter, and the current function code is displayed.

If you enter the level-3 menu but the parameter does not have a digit blinking, the parameter cannot be modified due to either of the following reasons:

1. It is read only, such as actual detection parameters and running record parameters.
2. It cannot be modified in running state and can be modified only in stopped state.

Example: Change the value of P00.01 from 0 to 1.

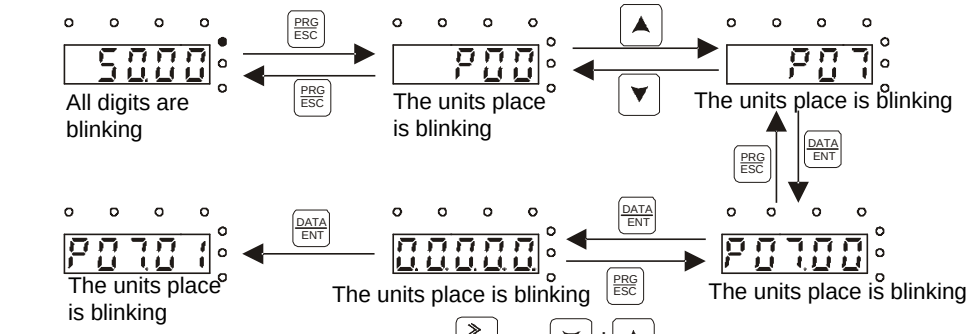
Figure 4-4 Modifying a parameter



4.3.2 Setting a password for the basic rectifier

The basic rectifier provides the user password protection function. When you set P07.00 to a non-zero value, the value is the user password. If password protection is enabled, "0.0.0.0.0" is displayed when you press the PRG/ESC key again to enter the function code editing interface. You need to enter the correct user password to enter the interface. To disable the password protection function, you need only to set P07.00 to 0.

Figure 4-5 Setting a password

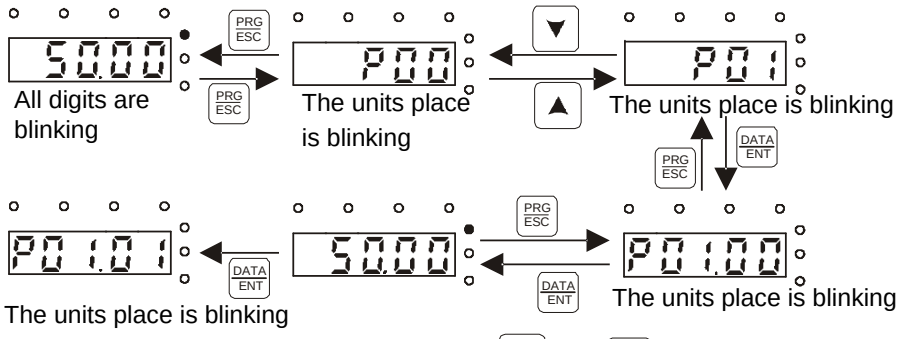


Note: When setting the value, you can press SHIFT and ▼ + ▲ to modify the value.

4.3.3 Viewing basic rectifier status

The basic rectifier provides group P01 for status viewing. You can enter group P01 for viewing.

Figure 4-6 Viewing a parameter

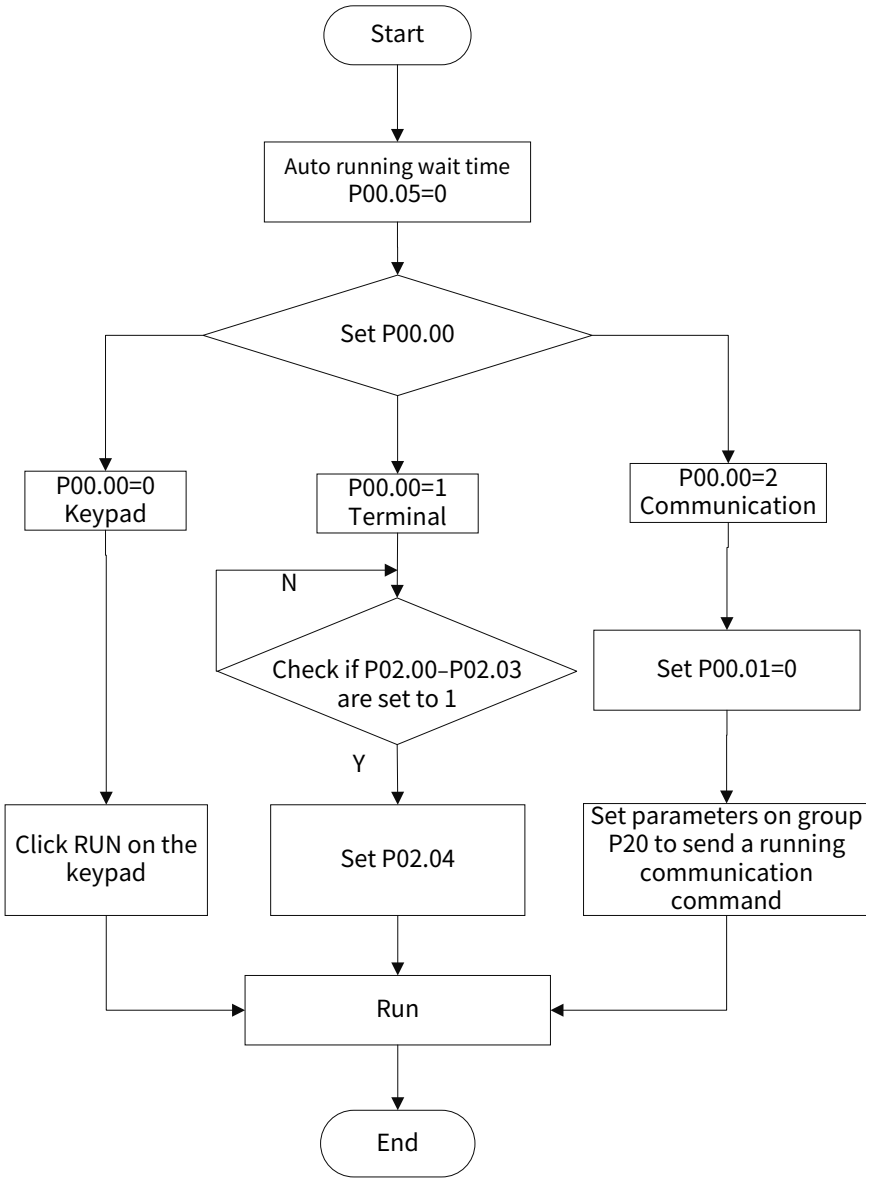


Note: When setting the value, you can press SHIFT and ▼ + ▲ to modify the value.

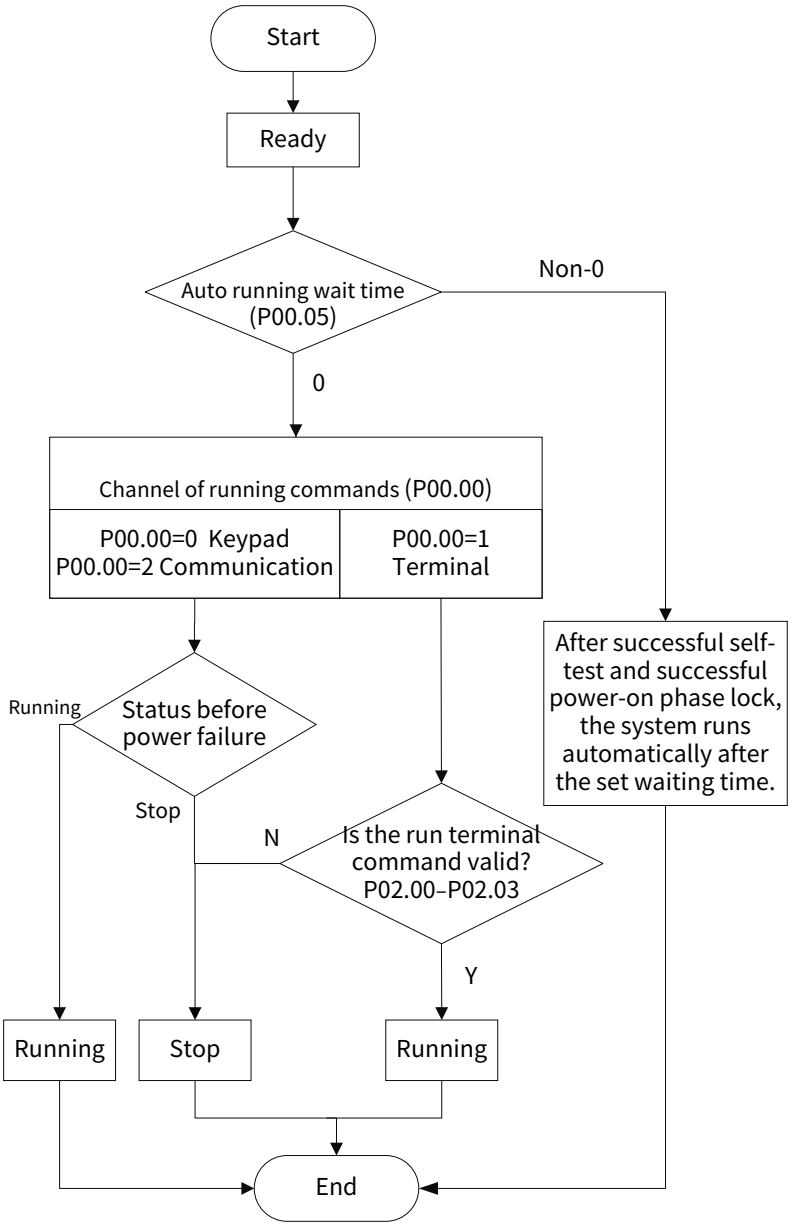
5 Function description

5.1 Common commissioning procedure

Set P00.05 to 0 before commissioning to prevent the system from auto running upon power-on. The basic rectifier provides three control modes: keypad, terminal, and communication that can be selected through P00.00. In keypad control mode (P00.00=0), use the Run key and Stop/Reset key to control the start/stop of the basic rectifier. In terminal control mode (P00.00=1), control the start/stop of the basic rectifier by setting the function code corresponding to S terminal (P02.00–P02.03) to 1 and setting P02.04. In communication control mode (P00.00=2), set P00.01 to 0 and control the start/stop of the basic rectifier through communication commands.

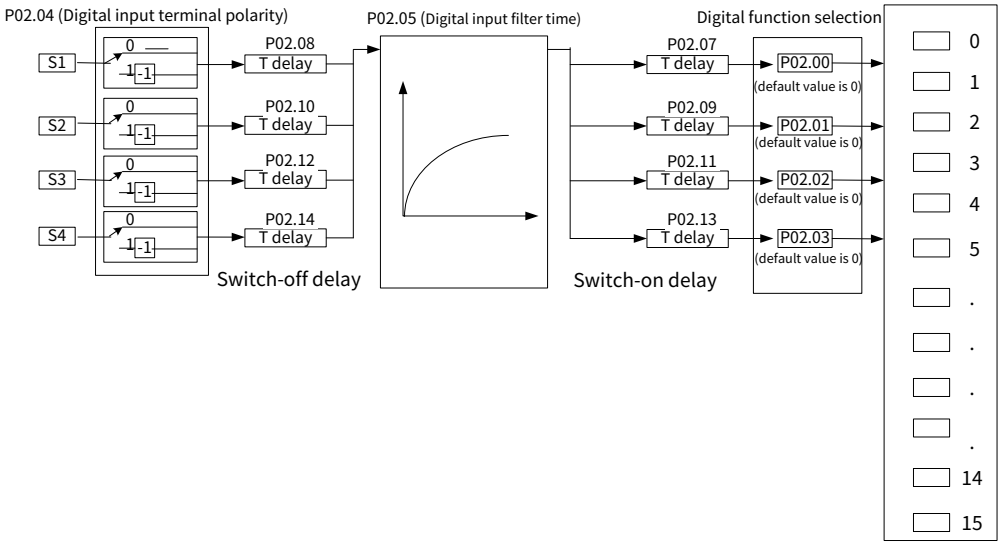


5.2 Start/stop control



5.3 Digital input

The basic rectifier unit carries four programmable digital input terminals. The functions of all the digital input terminals can be programmed through function codes.



5.3.1 Terminal functions

The function codes are used to set the input type of S1–S4 terminals.

Function code	Name	Description	Setting range	Default
P02.00	Function of S1 terminal	0: No function 1: Run 2: Reset faults 3: External fault 4: Reserved 5: Reserved 6: Reserved 7: Reserved 8: Reserved 9: Reserved 10: Switch the running command channel to keypad 11: Switch the running command channel to terminal 12: Switch the running command channel to communication 13: Reserved 14: Reserved 15: Reserved	0–15	0
P02.01	Function of S2 terminal		0–15	0
P02.02	Function of S3 terminal		0–15	0
P02.03	Function of S4 terminal		0–15	0

This parameter is used to set the corresponding function of digital multi-function input terminals.

Note: Two different multifunction input terminals cannot be configured with a same function.

Setting	Function	Description
0	No function	The SCR rectifier does not act even if with signal input. Set unused terminals to "no function" to avoid misaction.

Setting	Function	Description
1	Run	External terminals are used to control SCR rectifier running.
2	Fault reset	External fault reset function, same as the reset function of the STOP/RST key on the keypad. You can use this function to reset faults remotely.
3	External fault	After receiving the external fault signal, the SCR rectifier reports the fault and stops.
4	Reserved	Reserved
5	Reserved	Reserved
6	Reserved	Reserved
7	Reserved	Reserved
8	Reserved	Reserved
9	Reserved	Reserved
10	Switch the running command channel to keypad	When the function is enabled, the running command channel is switched to keypad. When the function is disabled, the running command channel is restored to the previous setting.
11	Switch the running command channel to terminal	When the function is enabled, the running command channel is switched to terminal. When the function is disabled, the running command channel is restored to the previous setting.
12	Switch the running command channel to communication	When the function is enabled, the running command channel is switched to communication. When the function is disabled, the running command channel is restored to the previous setting.
13	Reserved	Reserved
14	Reserved	Reserved
15	Reserved	Reserved

5.3.2 Terminal parameters

Function code	Name	Description	Setting range	Default
P02.04	Digital input terminal polarity	0x00–0xFF	0x00–0xFF	0x00

The function code is used to select input terminal polarity.

When a bit is 0, the input terminal is positive; when a bit is 1, the input terminal is negative.

BIT4	BIT3	BIT2	BIT1	BIT0
Reserved	S4	S3	S2	S1

Function code	Name	Description	Setting range	Default
P02.05	Digital input filter time	Digital input filter time	0.000–1.000	0

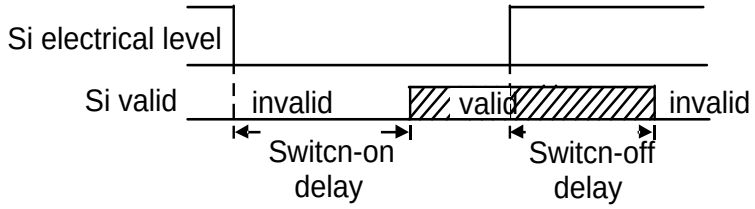
The function code is used to set the filter time for S1–S4. In strong interference cases, increase the value to avoid maloperation.

Function code	Name	Description	Setting range	Default
P02.06	Virtual input terminal setting	Specifies whether to enable the virtual input terminals in communication mode. 0: Virtual input terminals are invalid 1: MODBUS communication virtual terminals are valid 2–10: Reserved	0–10	0

Specifies whether to enable the virtual input terminals in communication mode.

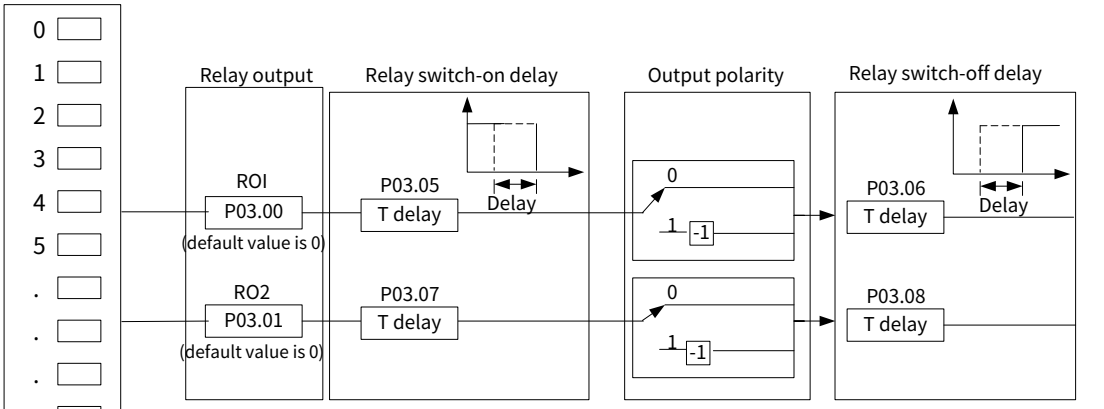
Function code	Name	Description	Setting range	Default
P02.07	S1 switch-on delay	0.000–60.000s	0.000–60.000	0.000s
P02.08	S1 switch-off delay	0.000–60.000s	0.000–60.000	0.000s
P02.09	S2 switch-on delay	0.000–60.000s	0.000–60.000	0.000s
P02.10	S2 switch-off delay	0.000–60.000s	0.000–60.000	0.000s
P02.11	S3 switch-on delay	0.000–60.000s	0.000–60.000	0.000s
P02.12	S3 switch-off delay	0.000–60.000s	0.000–60.000	0.000s
P02.13	S4 switch-on delay	0.000–60.000s	0.000–60.000	0.000s
P02.14	S4 switch-off delay	0.000–60.000s	0.000–60.000	0.000s

The function codes specify the delay time corresponding to the electrical level changes when the programmable input terminals switch on or switch off.



5.4 Digital output

The basic rectifier unit carries four groups of relay output terminals. The function of all the output terminals can be programmed through function codes,



0	Invalid	1	Ready for running	2	Running
3	Fault output	4	Reserved	5	Reserved
6	Reserved	7	Reserved	8	MODBUS communication virtual terminal output
9	Reserved	10	Reserved		

5.4.1 Terminal functions

The function codes are used to select the relay output type.

Function code	Name	Description	Setting range	Default
P03.00	RO1 output	0: No output 1: Ready for running 2: Running 3: Fault output 4: Reserved 5: Reserved 6: Reserved 7: Reserved 8: MODBUS communication virtual terminal output 9: Reserved 10: Reserved 11–31: Reserved	0–31	0
P03.01	RO2 output			

The following table lists the function code options. A same output terminal function can be repeatedly selected.

Setting	Function	Description
0	No output	The output terminal does not have any function.
1	Ready for running	The SCR rectifier is ready for running.
2	Running	Output is valid when the SCR rectifier runs.
3	Fault output	Output is valid when a fault occurred to the SCR rectifier.
4	Reserved	Reserved
5	Reserved	Reserved
6	Reserved	Reserved
7	Reserved	Reserved
8	Modbus communication virtual terminal	A signal is output based on the value set through Modbus. The value 1 indicates output is valid and 0 indicates output is invalid.

Setting	Function	Description
	output	
9	Reserved	Reserved
10	Reserved	Reserved
11–31	Reserved	Reserved

5.4.2 Terminal parameters

Function code	Name	Description	Setting range	Default
P03.04	Digital output terminal polarity	0x00–0x3F BIT0 corresponds to RO1. BIT1 corresponds to RO2. BIT2–BIT7: Reserved	0x00–0x3F	0x00

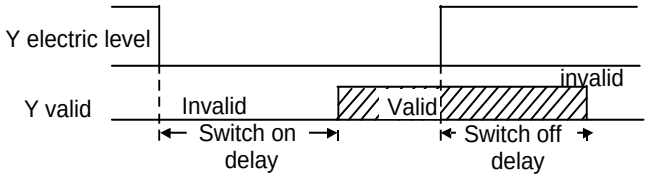
The function code is used to select output terminal polarity.

When a bit is 0, the output terminal is positive; when a bit is 1, the output terminal is negative.

BIT1	BIT0
RO2	RO1

Function code	Name	Description	Setting range	Default
P03.05	RO1 switch-on delay	0.000–60.000s	0.000–60.000	0.000s
P03.06	RO1 switch-off delay	0.000–60.000s	0.000–60.000	0.000s
P03.07	RO2 switch-on delay	0.000–60.000s	0.000–60.000	0.000s
P03.08	RO2 switch-off delay	0.000–60.000s	0.000–60.000	0.000s

The function codes specify the delay time corresponding to the electrical level changes when the programmable output terminals switch on or switch off.



5.5 HMI

Function code	Name	Description	Setting range	Default
P07.00	User password	0–65535	0–65535	0

When you set the function code to a non-zero number, password protection is enabled.

If you set the function code to 00000, the previous user password is cleared and password protection is disabled.

After the user password is set and takes effect, you cannot enter the parameter menu if you enter an incorrect password. Please remember your password and save it in a secure place.

After you exit the function code editing interface, the password protection function is enabled within 1 minute. If password protection is enabled, "0.0.0.0.0" is displayed when you press the PRG/ESC key again to enter the function code editing interface. You need to enter the correct user password to enter the interface.

Note: Restoring the default values may delete the user password. Exercise caution when using this function.

Function code	Name	Description	Setting range	Default
P07.01	Parameter copy	0: No operation 1: Upload parameters from the local address to the keypad 2: Download parameters from the keypad to the local address	0–2	0

The function code is used to set the parameter copy mode.

Note: After the operation corresponding to 1 or 2 is complete, the function code restores to 0.

Function code	Name	Description	Setting range	Default
P07.02	Function of QUICK/JOG	0: No function 1: Switch displayed function codes from right to left by Press QUICK/JOG to shift the displayed function code from right to left. 2: Switch command channels in sequence Press QUICK/ JOG to switch command channels in sequence. 3: Quick commissioning mode (based on non-factory parameter settings)	0–3	0

The function code is used to set the function of the QUICK/JOG key.

Function code	Name	Description	Setting range	Default
P07.03	Sequence of switching running-command channels by pressing QUICK/JOG	0: Keypad→Terminal→Communication 1: Keypad←→Terminal 2: Keypad←→Communication 3: Terminal←→Communication	0–3	0

When P07.02=2, set the sequence of switching running-command channels by pressing QUICK/JOG.

Function code	Name	Description	Setting range	Default
P07.04	Stop function validity of STOP/RST	0: Valid only for keypad control 1: Valid both for keypad and terminal control 2: Valid both for keypad and communication control 3: Valid for all control modes	0–3	3

Used to specify the stop function validity of STOP/RST. For fault reset, STOP/RST is valid in any conditions.

Function code	Name	Description	Setting range	Default
P07.05	Parameter selection in rectification state	0x0000–0xFFFF	0x0000–0xFFFF	0x000F
P07.06	Reserved			

There are 15 parameters that can be displayed in operation and stopping state: DC bus voltage (V), grid frequency (Hz), input voltage (V), input current (A), input power factor (%), active current component (%), reactive current component (%), input terminal state, output terminal state, AI1 (V), AI2 (V), AI3 (V), input apparent power (kVA), input active power (kW) and input reactive power (kVar).

his function code determines parameter display. The value is a 16-bit binary number. If a bit is 1, the parameter corresponding to this bit can be viewed through >>/SHIFT during running. If this bit is 0, the parameter corresponding to this bit is not displayed. When setting P02.03, convert the binary number to a hex number before the input to the function code. The content is shown in the following table.

BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT9	BIT8
Reserved	Input reactive power	Input active power	Input apparent power	AI3	AI2	AI1	Output terminal status
BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
Input terminal status	Reactive current component	Active current component	Input power factor	Input current	Input voltage	Grid frequency	DC bus voltage

Function code	Name	Description	Setting range	Default
P07.07	Factory bar code 1	0x0000–0xFFFF		
P07.08	Factory bar code 2	0x0000–0xFFFF		
P07.09	Factory bar code 3	0x0000–0xFFFF		
P07.10	Factory bar code 4	0x0000–0xFFFF		
P07.11	Factory bar code 5	0x0000–0xFFFF		
P07.12	Factory bar code 6	0x0000–0xFFFF		

The function codes are used to display the factory bar codes of devices.

Function code	Name	Description	Setting range	Default
P07.17	Accumulative electricity consumption high-order bits	0–65535kWh	0–65535	0kWh
P07.18	Accumulative electricity consumption low-order bits	0.0–999.9kWh	0.0–999.9	0.0kWh

The function codes are used to display the accumulative electricity consumption. Accumulative electricity consumption for running = P07.17*1000 + P07.18

Function code	Name	Description	Setting range	Default
P07.19	Control board	1.00–655.35	1.00–655.35	Actual

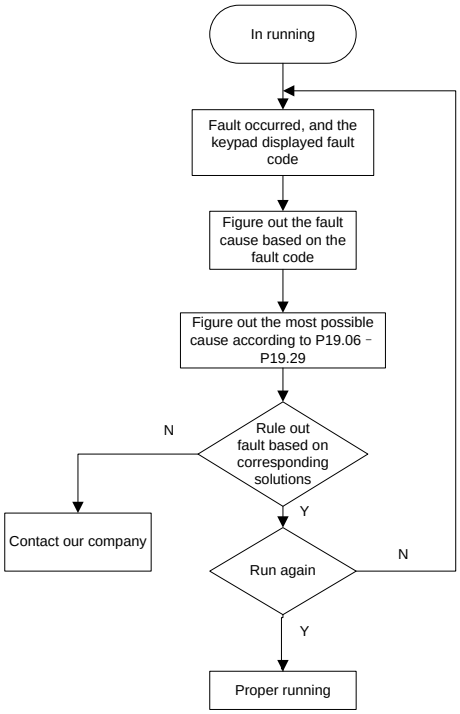
Function code	Name	Description	Setting range	Default
	software version			value

The function code displays the control board software version.

Function code	Name	Description	Setting range	Default
P07.21	Local accumulative running time	0–65535h	0–65535	Actual value

5.6 Fault handling

The following provides fault handling information.



Function code	Name	Description	Setting range	Default
P19.00	Present fault type	00: No fault 01: Input overcurrent (oC) 02: Grid undervoltage (LvI) 03: Grid overvoltage (ovI) 04: Grid phase loss (SPI) 05: Phase lock failure (PLLF) 06: DC undervoltage (Lv) 07: DC overvoltage (ov) 08: Reserved 09: Reserved 10: RS485 communication fault (E_485) 11–14: Reserved 15: Rectifier overload (oL) 16: EEPROM operation error (EEP)	0–32	0
P19.01	Last fault type			0
P19.02	2nd-last fault type			0
P19.03	3rd-last fault type			0
P19.04	4th-last fault type			0
P19.05	5th-last fault type			0

Function code	Name	Description	Setting range	Default
		17–19: Reserved 20: External fault (EF) 21: Reserved 22: Keypad or panel communication fault (PCE) (Reserved) 23: Parameter upload fault (UPE) 24: Parameter download fault (dNE) 25: Running time reached (ENd) 26–30: Reserved		

For details, see fault information.

Function code	Name	Description	Setting range	Default
P19.06	Input terminal status at present fault	0x00–0xFF	0x00–0xFF	0x00

The function code is used to record the input terminal status when the present fault occurs.

Function code	Name	Description	Setting range	Default
P19.07	Output terminal status at present fault	0x00–0xFF	0x00–0xFF	0x00

The function code is used to record the output terminal status when the present fault occurs.

Function code	Name	Description	Setting range	Default
P19.08	DC voltage at present fault	0.0–2000.0V	0.0–2000.0	0.0V

The function code is used to record the DC voltage when the present fault occurs.

Function code	Name	Description	Setting range	Default
P19.09	Grid voltage at present fault	0.0–2000.0V	0.0–2000.0	0.0V

The function code is used to record the grid voltage when the present fault occurs.

Function code	Name	Description	Setting range	Default
P19.10	Input current at present fault	0.0–6000.0A	0.0–6000.0	0.0A

The function code is used to record the input current when the present fault occurs.

Function code	Name	Description	Setting range	Default
P19.22	Input terminal status at last fault	0x00–0xFF	0x00–0xFF	0x00

Function code	Name	Description	Setting range	Default
P19.23	Output terminal status at last fault	0x00–0xFF	0x00–0xFF	0x00
P19.24	DC voltage at last fault	0.0–2000.0V	0.0–2000.0	0.0V
P19.25	Grid voltage at last fault	0.0–2000.0V	0.0–2000.0	0.0V
P19.26	Input current at last fault	0.0–6000.0A	0.0–6000.0	0.0A

The function codes are used to record display information when the last fault occurs. For details, see P19.06–P19.10.

Function code	Name	Description	Setting range	Default
P19.38	Input terminal status at 2nd-last fault	0x00–0xFF	0x00–0xFF	0x00
P19.39	Output terminal status at 2nd-last fault	0x00–0xFF	0x00–0xFF	0x00
P19.40	DC voltage at 2nd-last fault	0.0–2000.0V	0.0–2000.0	0.0V
P19.41	Grid voltage at 2nd-last fault	0.0–2000.0V	0.0–2000.0	0.0V
P19.42	Input current at 2nd-last fault	0.0–6000.0A	0.0–6000.0	0.0A

6 Fault Information

The chapter tells you how to reset faults and check faults history. A complete list of alarms and fault information as well as possible causes and corrective measures are presented in this chapter.

	Only trained and qualified professionals are allowed to carry out the operations mentioned in this chapter. Please carry out operations according to instructions presented in "Safety precautions".

6.1 Indications of alarms and faults

The fault is indicated by indicators. See "Keypad operation guidelines". When the TRIP indicator is on, the alarm or fault code displayed in the keypad indicates the basic rectifier is in exception state. This chapter covers most of the alarms and faults, and their possible causes and corrective measures. If you cannot find out the alarm or fault causes, contact local INVT office.

6.2 Fault reset

On the you can reset the basic rectifier unit through STOP/RST key on the keypad, digital inputs, or by cutting off the basic rectifier power. After faults are removed, the motor can be started again.

6.3 Fault history

The function codes from P19.00 to P19.05 record the types of the last six faults. The function codes P19.06–P19.10, P19.22–P19.26, P19.38–P19.42 record the running data of basic rectifier at the last three faults.

6.4 Faults and solutions

When a fault occurred, handle the fault as follows:

Step 1 Check whether keypad display is improper. If yes, contact the local INVT office.

Step 2 If keypad works properly, check the function codes in P19 group to confirm the corresponding fault record parameters, and determine the real state when current fault occurred through parameters.

Step 3 Check the following table to see whether the exception state exists by solution.

Step 4 Rule out the faults or ask for help from professionals.

Step 5 After confirming the fault is removed, perform fault reset, and start running.

6.4.1 Faults

Fault code	Fault type	Possible cause	Solution
oC	Input overcurrent	Exception occurred to hardware circuit; Rectifier is used in overload.	Ask for technical support; Adjust the load or select a rectifier with larger power.
LvI	Grid undervoltage	Abnormal input power outage; Input voltage detection circuit exception.	Check the input power for recovery. Ask for technical support.
ovI	Grid overvoltage	Input power exception; Interference exists;	Check the input power for recovery. Check for and remove the external

Fault code	Fault type	Possible cause	Solution
		Input voltage detection circuit exception.	interference source; Ask for technical support.
SPI	Grid phase loss	Input power cable disconnection or power exception; Power phase loss detection circuit exception; Interference exists.	Check the input power for recovery. Ask for technical support; Check for and remove the external interference source.
PLLF	Phase lock failure	Grid environment exception, such as the sudden change of grid frequency or voltage; Grid voltage sampling board circuit exception;	Check for and remove the interference source; Ask for technical support.
Lv	DC undervoltage	Input power exception; Bus voltage detection circuit exception; Interference exists.	Check the input power for recovery. Ask for technical support Check for and remove the external interference source.
ov	DC overvoltage	Input power exception; Bus voltage detection circuit exception; Interference exists.	Check the input power for recovery. Ask for technical support Check for and remove the external interference source.
ItE	Current detection fault	Hall component damage, circuit exception, or interference	Check for and remove the interference source.
E_485	RS485 communication fault	Baud rate is set improperly; Serial communication error; Long period of communication interruption.	Set a proper baud rate; Press STOP/RST for reset or ask for technical support; Check the wiring of communication interfaces.
oL	Rectifier overload	Allowed load exceeded.	Adjust the load or select a rectifier with larger power.
EEP	EEPROM operation error	Error in reading or writing control parameters; DPRAM chip damage.	Press STOP/RST for reset; Ask for technical support.
EF	External fault	SI external faulty input terminal action.	Check external device input.
dIS	Rectifier disabled	External digital terminal no action though rectifier enabling is selected in the digital output function	Press the corresponding digital terminal, enter group P5, and cancel the function.
PCE	Keypad/panel communication fault	Keypad cable connected improperly or disconnected Keypad cable too long, causing strong interference Keypad or mainboard communication circuit error.	Check the keypad cable to determine whether a fault occurs. Check for and remove the external interference source. Replace the hardware and seek maintenance services.
UPE	Parameter upload fault	Keypad cable connected improperly or disconnected; Keypad cable too long, causing	Check for and remove the external interference source. Replace the hardware and seek

Fault code	Fault type	Possible cause	Solution
		strong interference Keypad or mainboard communication circuit error.	maintenance services. Replace the hardware and seek maintenance services.
dNE	Parameter download fault	Keypad cable connected improperly or disconnected; Keypad cable too long, causing strong interference Data storage error occurred to the keypad.	Check for and remove the external interference source. Replace the hardware and seek maintenance services. Re-back up the data on the keypad.
End	Running time reached	Preset running time reached.	Change the time or ask for technical support.

7 Communication

7.1 Modbus protocol

This chapter describes the communication of the basic rectifier.

The basic rectifier provides RS485 communication interfaces and adopts the master-slave communication based on the international standard Modbus communication protocol. You can implement centralized control (setting commands for controlling the rectifier, modifying the running frequency and related function code parameters, and monitoring the working state and fault information of the rectifier) through PC/PLC, upper control computer, or other devices to meet specific application requirements.

7.1.1 Modbus protocol introduction

Modbus is a communication protocol for use with electronic controllers. By using this protocol, a controller can communicate with other devices through transmission lines. It is a general industrial standard. With this standard, control devices produced by different manufacturers can be connected to form an industrial network and be monitored in a centralized way.

The Modbus protocol provides two transmission modes, namely American Standard Code for Information Interchange (ASCII) and remote terminal units (RTU). On one Modbus network, all the device transmission modes, baud rates, data bits, check bits, end bits, and other basic parameters must be set consistently.

A Modbus network is a control network with one master and multiple slaves, that is, on one Modbus network, there is only one device serving as the master, and other devices are the slaves. The master can communicate with any single slave or with all slaves. For separate access commands, a slave needs to return a response. For broadcasted information, slaves do not need to return responses.

7.1.2 Application of Modbus

The basic rectifier uses the Modbus RTU mode and communicates through RS485 interfaces.

7.1.2.1 RS485

RS485 interfaces work in half-duplex mode and transmit data signals in the differential transmission way, which is also referred to as balanced transmission. An RS485 interface uses a twisted pair, where one wire is defined as A (+), and the other B (-). Generally, if the positive electrical level between the transmission drives A and B ranges from +2V to +6V, the logic is "1"; and if it ranges from -2V to -6V, the logic is "0".

On the rectifier terminal block, the 485+ terminal corresponds to A, and 485- corresponds to B.

The communication baud rate (P20.01) indicates the number of bits sent in a second, and the unit is bit/s (bps). A higher baud rate indicates faster transmission and poorer anti-interference capability. When a twisted pair of 0.56mm (24 AWG) is used, the maximum transmission distance varies according to the baud rate, as described in the following table.

Baud rate	Max. transmission distance	Baud rate	Max. transmission distance
2400BPS	1800m	9600BPS	800m
4800BPS	1200m	19200BPS	600m

In long-distance RS485 communication, it is recommended that you use shielded cables, and use the shielding layer as the ground wire.

When there are fewer devices and the transmission distance is short, the whole network works well without

terminal load resistors. The performance, however, degrades as the distance increases. Therefore, it is recommended that you use a 120 Ω terminal resistor when the transmission distance is long.

7.1.2.2 RTU mode

1. RTU communication frame structure

When a controller is set to use the RTU communication mode on a Modbus network, every byte (8 bits) in the message includes 2 hexadecimal characters (each includes 4 bits). Compared with the ASCII mode, the RTU mode can transmit more data with the same baud rate.

Code system

- 1 start bit
- 7 or 8 data bits; the minimum valid bit is transmitted first. Each frame domain of 8 bits includes 2 hexadecimal characters (0–9, A–F).
- 1 odd/even check bit; this bit is not provided if no check is needed.
- 1 end bit (with check performed), 2 bits (without check)

Error detection domain

- Cyclic redundancy check (CRC)

The following table describes the data format.

11-bit character frame (Bits 1 to 8 are data bits)

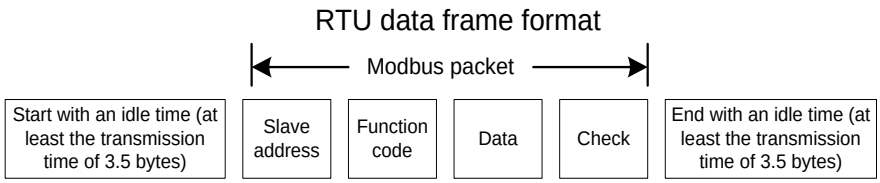
Start bit	BIT1	BIT2	BIT3	BIT4	BIT5	BIT6	BIT7	BIT8	Check bit	Stop bit

10-bit character frame (Bits 1 to 7 are data bits)

Start bit	BIT1	BIT2	BIT3	BIT4	BIT5	BIT6	BIT7	Check bit	Stop bit

In a character frame, only the data bits carry information. The start bit, check bit, and end bit are used to facilitate the transmission of the data bits to the destination device. In practical applications, you must set the data bits, parity check bits, and stop bits consistently.

In RTU mode, the transmission of a new frame always starts from an idle time (the transmission time of 3.5 bytes). On a network where the transmission rate is calculated based on the baud rate, the transmission time of 3.5 bytes can be easily obtained. After the idle time ends, the data domains are transmitted in the following sequence: slave address, operation command code, data, and CRC check character. Each byte sent in each domain includes 2 hexadecimal characters (0–9, A–F). The network devices always monitor the communication bus. After receiving the first domain (address information), each network device identifies the byte. After the last byte is sent, a similar transmission interval (with a minimum transmission time of 3.5 bytes) is used to indicate that the frame transmission ends. Then, the transmission of a new frame starts.



The information of a frame must be sent in a continuous data flow. If there is an interval greater than the transmission time of 1.5 bytes before the transmission of the entire frame is complete, the receiving device deletes the incomplete information, and mistakes the subsequent byte for the address domain of a new frame. Similarly, if the transmission interval between two frames is shorter than the transmission time of 3.5 bytes, the receiving device mistakes it for the data of the last frame. The CRC check value is incorrect due to the disorder of the frames, and thus a communication fault occurs.

The following table describes the standard structure of an RTU frame.

START (frame header)	T1-T2-T3-T4 (time gap with a min. length of 3.5 bytes)
ADDR (slave address domain)	Communication address: 0–247 (decimal system) (0 is the broadcast address)
CMD (function domain)	03H: read slave parameters 06H: write slave parameters
DATA (N-1) … DATA (0) (data domain)	Data of 2×N bytes, main content of the communication as well as the core of data exchanging.
CRC CHK LSB	Detection value: CRC (16 bits)
CRC CHK MSB	
END (frame tail)	T1-T2-T3-T4 (time gap with a min. length of 3.5 bytes)

2. RTU communication frame error check modes

During the transmission of data, errors may occur due to various factors. Without check, the data receiving device cannot identify data errors and may make an incorrect response. The incorrect response may cause severe problems. Therefore, the data must be checked.

The check is implemented as follows: The transmitter calculates the to-be-transmitted data based on a specific algorithm to obtain a result, adds the result to the rear of the message, and transmits them together. After receiving the message, the receiver calculates the data based on the same algorithm to obtain a result, and compares the result with that transmitted by the transmitter. If the results are the same, the message is correct. Otherwise, the message is considered incorrect.

The error check of a frame includes two parts, namely bit check on individual bytes (that is, odd/even check bit using the check bit in the character frame), and whole data check (CRC check).

Bit check on individual bytes (odd/even check)

You can select the bit check mode as required, or you can choose not to perform the check, which will affect the check bit setting of each byte.

Definition of even check: Before the data is transmitted, an even check bit is added to indicate whether the number of "1" in the to-be-transmitted data is odd or even. If it is even, the check bit is set to "0"; and if it is odd, the check bit is set to "1".

Definition of odd check: Before the data is transmitted, an odd check bit is added to indicate whether the number of "1" in the to-be-transmitted data is odd or even. If it is odd, the check bit is set to "0"; and if it is even, the check bit is set to "1".

For example, the data bits to be sent are "11001110", including five "1". If the even check is applied, the even check bit is set to "1"; and if the odd check is applied, the odd check bit is set to "0". During the transmission of the data, the odd/even check bit is calculated and placed in the check bit of the frame. The receiving device performs the odd/even check after receiving the data. If it finds that the odd/even parity of the data is inconsistent with the preset information, it determines that a communication error occurs.

CRC

A frame in the RTU format includes an error detection domain based on the CRC calculation. The CRC domain checks all the content of the frame. The CRC domain consists of two bytes, including 16 binary bits. It is calculated by the transmitter and added to the frame. The receiver calculates the CRC of the received frame, and compares the result with the value in the received CRC domain. If the two CRC values are not equal to each other, errors occur in the transmission.

During CRC, 0xFFFF is stored first, and then a process is invoked to process a minimum of 6 contiguous bytes in the frame based on the content in the current register. CRC is valid only for the 8-bit data in each character. It is invalid for the start, end, and check bits.

During the generation of the CRC values, the "exclusive or" (XOR) operation is performed on the each 8-bit

character and the content in the register. The result is placed in the bits from the least significant bit (LSB) to the most significant bit (MSB), and 0 is placed in the MSB. Then, LSB is detected. If LSB is 1, the XOR operation is performed on the current value in the register and the preset value. If LSB is 0, no operation is performed. This process is repeated for 8 times. After the last bit (8th bit) is detected and processed, the XOR operation is performed on the next 8-bit byte and the current content in the register. The final values in the register are the CRC values obtained after operations are performed on all the bytes in the frame.

The calculation adopts the international standard CRC check rule. You can refer to the related standard CRC algorithm to compile the CRC calculation program as required.

The following example is a simple CRC calculation function for your reference (using the C programming language):

```
unsigned int crc_cal_value(unsigned char*data_value,unsigned char data_length)
{
    int i;
    unsigned int crc_value=0xffff;
    while(data_length--)
    {
        crc_value^=*data_value++;
        for(i=0;i<8;i++)
        {
            if(crc_value&0x0001)
                crc_value=(crc_value>>1)^0xa001;
            else
                crc_value=crc_value>>1;
        }
    }
    return(crc_value);
}
```

In the ladder logic, CKSM uses the table look-up method to calculate the CRC value according to the content in the frame. The program of this method is simple, and the calculation is fast, but the ROM space occupied is large. Use this program with caution in scenarios where there are space occupation requirements on programs.

7.1.3 RTU command codes and communication data

7.1.3.1 Command code 03H, reading N words (continuously up to 16 words)

The command code 03H is used by the master to read data from the rectifier. The count of data to be read depends on the "data count" in the command. A maximum of 16 pieces of data can be read. The addresses of the read parameters must be contiguous. Each piece of data occupies 2 bytes, that is, one word. The command format is presented using the hexadecimal system (a number followed by "H" indicates a hexadecimal value). One hexadecimal value occupies one byte.

The 03H command is used to read information including the parameters and running status of the rectifier.

For example, to read two contiguous data content pieces from 0004H from the rectifier with the address of 01H (that is, to read content from data addresses 0004H and 0005H), the frame structure is as follows:

RTU master command (from the master to the rectifier)

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR (address)	01H

CMD (command code)	03H
Start address MSB	00H
Start address LSB	04H
Data count MSB	00H
Data count LSB	02H
CRC LSB	85H
CRC MSB	CAH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

The value in START and END is "T1-T2-T3-T4 (transmission time of 3.5 bytes)", indicating that the RS485 needs to stay idle for at least the transmission time of 3.5 bytes. An idle time is required to distinguish on message from another to ensure that the two messages are not regarded as one.

ADDR=01H means the command message is sent to the rectifier with the address of 01H and ADDR occupies one byte.

CMD=03H means the command message is sent to read data from the rectifier and CMD occupies one byte.

"Start address" means reading data from the address and it occupies two bytes with the MSB on the left and LSB on the right.

"Data count" indicates the count of data to be read (unit: word). "Start address" is "0004H" and "Data count" is 0002H, indicating that data is to be read from the data addresses of 0004H and 0005H.

CRC check occupies two bytes, with the LSB on the left, and MSB on the right.

RTU slave response (from the rectifier to the master)

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	01H
CMD	03H
Number of bytes	04H
MSB of data in 0004H	13H
LSB of data in 0004H	88H
MSB of data in 0005H	00H
LSB of data in 0005H	00H
CRC LSB	7EH
CRC MSB	9DH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

The definition of the response information is described as follows:

"ADDR" is "01H", indicating that the message is sent by the rectifier whose address is 01H. The ADDR information occupies one byte.

"CMD" is "03H", indicating that the message is a response of the rectifier to the 03H command of the master for reading data. The CMD information occupies one byte.

"Number of bytes" indicates the number of bytes between a byte (not included) and the CRC byte (not included). The value "04" indicates that there are four bytes of data between "Number of bytes" and "CRC LSB", that is, "MSB of data in 0004H", "LSB of data in 0004H", "MSB of data in 0005H", and "LSB of data in 0005H".

A piece of data contains two bytes, with the MSB on the left and LSB on the right. From the response, the data in 0004H is 1388H, and that in 0005H is 0000H.

CRC check occupies two bytes, with the LSB on the left, and MSB on the right.

7.1.3.2 Command code 06H, writing a word

This command is used by the master to write data to the rectifier. One command can be used to write only one piece of data. It is used to modify the parameters and running mode of the rectifier.

For example, to write 5000 (1388H) to 0004H of the rectifier whose address is 02H, the frame structure is as follows.

RTU master command (from the master to the rectifier)

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	02H
CMD	06H
MSB of data writing address	00H
LSB of data writing address	04H
MSB of to-be-written data	13H
LSB of to-be-written data	88H
CRC LSB	C5H
CRC MSB	6EH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

RTU slave response (from the rectifier to the master)

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	02H
CMD	06H
MSB of data writing address	00H
LSB of data writing address	04H
MSB of to-be-written data	13H
LSB of to-be-written data	88H
CRC LSB	C5H
CRC MSB	6EH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

Note: The sections 7.1.3.1 and 7.1.3.2 mainly describe the command formats. For the detailed application, see the examples in section 7.1.3.7.

7.1.3.3 Command code 08H, diagnosis

Sub-function code description:

Sub-function code	Description
0000	Returned data based on query information

For example, to query about the circuit detection information about the driver whose address is 01H, the query and return strings are the same, and the format is described as follows.

RTU master command

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	01H
CMD	08H
Sub-function code MSB	00H
Sub-function code LSB	00H
MSB of to-be-written data	12H
LSB of to-be-written data	ABH
CRC CHK LSB	ADH

CRC CHK MSB	14H
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

RTU slave response

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	01H
CMD	08H
Sub-function code MSB	00H
Sub-function code LSB	00H
MSB of to-be-written data	12H
LSB of to-be-written data	ABH
CRC CHK LSB	ADH
CRC CHK MSB	14H
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

7.1.3.4 Data address definition

This section describes the address definition of communication data. The addresses are used for controlling the running, obtaining the state information, and setting related function parameters of the rectifier.

1. Function code address format rules

The address of a function code consists of two bytes, with the MSB on the left and LSB on the right. The high-order byte ranges from 00 to ffH, and the low-order byte also ranges from 00 to ffH. The MSB is the hexadecimal form of the group number before the dot mark, and LSB is that of the number behind the dot mark. Take P05.06 as an example: The group number is 05, that is, the MSB of the parameter address is the hexadecimal form of 05; and the number behind the dot mark is 06, that is, the LSB is the hexadecimal form of 05. Therefore, the function code address is 0506H in the hexadecimal form. For P19.01, the parameter address is 1301H.

Function code	Name	Description	Setting range	Default	Modify
P19.01	Last fault type		0–31	0	●

Note: P29 group is the factory parameters which cannot be read or changed. Some parameters cannot be changed when the rectifier is in the running state and some parameters cannot be changed in any state. The setting range, unit and related descriptions should be paid attention to when modifying the function codes.

Besides, EEPROM is stocked frequently, which may shorten the usage time of EEPROM. For users, some functions are not necessary to be stocked on the communication mode. The needs can be met on by changing the value in RAM. Changing the MSB of the function code form 0 to 1 can also realize the function. For example, if P00.07 is not to be stored in the EEPROM, you need only to modify the value of the RAM, that is, set the address to 8007H. The address can be used only for writing data to the on-chip RAM, and it is invalid when used for reading data.

2. Addresses of other Modbus functions

In addition to modifying the parameters of the rectifier, the master can also control the rectifier, such as starting and stopping the rectifier, and monitoring the running status of the rectifier.

The following table lists other function parameters.

Function	Address	Data description	R/W
Communication-based control command	2000H	0001H: Running	W
		0005H: Stop	
		0007H: Fault reset	
	200AH	Virtual input terminal command (0x00–0xFF)	W

Function	Address	Data description	R/W
	200BH	Virtual output terminal command (0x00–0x3F)	W
Rectifier status word 1	2100H	0001H: Running	R
		0003H: Stopped	
		0004H: Faulty	
		0005H: POFF	
Rectifier status word 2	2101H	Bit0: = 0: Bus voltage not established =1: Bus voltage established Bit4: = 0: No pre-alarm upon overload =1: Overload pre-alarm	R
Rectifier fault code	2102H	See the description of fault types.	R
Rectifier identification code	010EH		R

The Read/Write (R/W) characteristics indicate whether a function code can be read and written. For example, "Communication-based control command" can be written, and therefore the command code 06H is used to control the rectifier. "R" indicates that a function code is read only, and "W" indicates that a function code is written only.

Note: Some parameters in the preceding table are valid only after they are enabled. Take the running and stop operations as examples, you need to set "Running command channel" (P00.00) to "Communication", and set "Communication mode of running commands" (P00.01) to Modbus.

The following table describes the encoding rules of device codes (corresponding to the identification code 2103H of the rectifier).

8 MSBs	Meaning	8 LSBs	Meaning
0x01	Goodrive	0x0E	Goodrive800 Pro Series Basic Rectifier Unit
		0x0F	Goodrive800 Pro Series Inverter Unit or VFD

Note: A device code consists of 16 bits, with 8 MSBs and 8 LSBs. The 8 MSBs indicate the model series, and the 8 LSBs indicate the derivative model.

7.1.3.5 Fieldbus scale

In practical applications, communication data is represented in the hexadecimal form, but hexadecimal values cannot represent decimals. For example, 50.12 Hz cannot be represented in the hexadecimal form. In such cases, multiply 50.12 by 100 to obtain an integer 5012, and then 50.12 can be represented as 1394H in the hexadecimal form (5012 in the decimal form).

In the process of multiplying a non-integer by a multiple to obtain an integer, the multiple is referred to as a fieldbus scale.

The fieldbus scale depends on the number of decimal places in the value specified in "Setting range" or "Default". If there are n decimal places in the value, the fieldbus scale m is the nth-power of 10. Take the following table as an example, m is the value of 10 to the power of n. Take the following table as an example.

Function code	Name	Description	Setting range	Default	Modify
P00.06	Delay of auto fault reset	0.0–3600.0s	0.0–3600.0	1.0s	○

If "Setting range" or "Default value" contains one decimal, the fieldbus scale is 10. If the value received by the host controller is 50, "Delay of auto fault reset" of the rectifier is 5.0 (5.0=50/10).

To set "Delay of auto fault reset" to 5.0s through Modbus communication, you need first to multiply 5.0 by 10 according to the scale to obtain an integer 50, that is, 32H in the hexadecimal form, and then send the following write command:

01	06	01 14	00 32	49 E7
VFD address	Write command	Parameter address	Parameter data	CRC

After receiving the command, the rectifier converts 50 into 5.0 based on the fieldbus scale, and then sets "Delay of auto fault reset" to 5.0s.

For another example, after the host controller sends the "Delay of auto fault reset" parameter read command, the master receives the following response from the rectifier:

01	03	02	00 32	39 91
VFD address	Read command	2-byte data	Parameter data	CRC

The parameter data is 0032H, that is, 50, and therefore 5.0 is obtained based on the fieldbus scale (50/10=5.0). In this case, the master identifies that "Delay of auto fault reset" is 5.0s.

7.1.3.6 Error message response

Operation errors may occur in communication-based control. For example, some parameters can only be read, but a write command is sent. In this case, the rectifier returns an error message response.

Error message responses are sent from the rectifier to the master. The following table lists the codes and definitions of the error message responses.

Code	Name	Meaning
01H	Invalid command	The command code received by the host controller is not allowed to be executed. The possible causes are as follows:☒ ・ The function code is applicable only on new devices and is not implemented on this device.☒ ・ The slave is in faulty state when processing this request.
02H	Invalid data address	For the rectifier, the data address in the request of the host controller is not allowed. In particular, the combination of the register address and the number of the to-be-sent bytes is invalid.
03H	Invalid data value	The received data domain contains a value that is not allowed. The value indicates the error of the remaining structure in the combined request. Note: It does not mean that the data item submitted for storage in the register includes a value unexpected by the program.
04H	Operation failure	The parameter setting is invalid in the write operation. For example, a function input terminal cannot be set repeatedly.
05H	Incorrect password	The password entered in the password verification address is different from that is specified by P07.00.
06H	Incorrect data frame	The data frame sent from the host controller is incorrect in the length, or in the RTU format, the value of the CRC check bit is inconsistent with the CRC value calculated by the lower computer.
07H	Parameter read-only	The parameter to be modified in the write operation of the host controller is a read-only parameter.
08H	Parameter cannot be modified in running	The parameter to be modified in the write operation of the host controller cannot be modified during unit running.
09H	Password protection	If the host controller does not provide the correct password to unlock the system to perform a read or write operation, the error of “system being locked” is reported.

When returning a response, the slave uses a function code domain and fault address to indicate whether it is a normal response (no error) or exception response (an error occurs). In a normal response, the slave returns the corresponding function code and data address or sub-function code. In an exception response, the slave returns a code that is equal to a normal code, but the first bit is logic 1.

For example, if the master sends a request message to a slave for reading a group of function code address data, the following code is generated:

0 0 0 0 0 0 1 1 (03H in the hexadecimal form)

In a normal response, the slave returns the same function code. In an exception response, the slave returns:

1 0 0 0 0 0 1 1 (83H in the hexadecimal form)

In addition to the modification of the code, the slave returns a byte of exception code that describes the cause of the exception. After receiving the exception response, the typical processing of the master is to send the request message again or modify the command based on the fault information.

For example, to set the "Channel of running commands" (P00.00, the parameter address is 0000H) to 03 for the rectifier whose address is 01H, the command is as follows:

01	06	00 01	00 03	98 0B
VFD address	Write command	Parameter address	Parameter data	CRC

However, the "Running command channel" ranges from 0 to 2. The value 3 is out of the setting range. In this case, the rectifier returns an error message response as shown in the following:

01	86	04	43 A3
VFD address	Exception response code	Error code	CRC

The exception response code 86H (generated based on the highest-order bit "1" of the write command 06H) indicates that it is an exception response to the write command (06H). The error code is 04H, which indicates "Operation failure".

7.1.3.7 Read/Write operation examples

For the formats of the read and write commands, see section 7.1.3.1 and 7.1.3.2.

1、 Read command 03H examples

Example 1: Read state word 1 of the rectifier whose address is 01H. According to the table of other Modbus function addresses, the parameter address of state word 1 of the rectifier is 2100H.

The read command transmitted to the rectifier is as follows:

01	03	21 00	00 01	8E 36
VFD address	Read command	Parameter address	Data quantity	CRC

Assume that the following response is returned:

01	03	02	00 03	F8 45
VFD address	Read command	Number of bytes	Data content	CRC

The data content returned by the rectifier is 0003H, which indicates that the rectifier is in the stopped state.

Example 2: View information about the rectifier whose address is 03H, including "Present fault type" (P19.00) to "5th-last fault type" (P19.05) of which the parameter addresses are 1300H to 1305H (contiguous 6 parameter addresses starting from 1300H).

The command transmitted to the rectifier is as follows:

03	03	07 1B	00 06	B5 59
VFD address	Read command	Start address	6 parameters in total	CRC

Assume that the following response is returned:

03	03	0C	00 23	00 23	00 23	00 23	00 23	00 23	5F D2
VFD address	Read command	Number of bytes	Most recent fault type	Last fault type	2nd-last fault type	3rd-last fault type	4th-last fault type	5th-last fault type	CRC

From the returned data, we can see that all the fault types are 0012H, that is, 18 in the decimal form, which means the STO fault (E- STo).

2、 Example of writing command 06H

Example 1: Set the rectifier whose address is 03H to be forward running. Refer to the table of other function parameters, the address of "Communication-based control command" is 2000H, and 0001H indicates forward running, as shown in the following table.

Function	Address	Data description	R/W
Communication-based control command	2000H	0001H: Running	R/W
		0005H: Stop	
		0007H: Fault reset	

The command transmitted from the master is as follows:

03	06	20 00	00 01	42 28
VFD address	Write command	Parameter address	Forward running	CRC

If the operation is successful, the following response is returned (same as the command sent from the master):

03	06	20 00	00 01	42 28
VFD address	Write command	Parameter address	Forward running	CRC

Note: In the preceding command description, spaces are added to a command just for explanatory purposes.

In practical applications, no space is required in the commands.

3、 Example of Modbus communication commissioning

A PC is used as the host, an RS232-RS485 converter is used for signal conversion, and the PC serial port used by the converter is COM1 (an RS232 port). The host controller commissioning software is the serial port commissioning assistant Commix, which can be downloaded from the Internet. Download a version that can automatically execute the CRC check function. The following figure shows the interface of Commix.

First, set the serial port to **COM1**. Then, set the baud rate consistently with P20.01. The data bits, check bits, and end bits must be set consistently with P20.02. If the RTU mode is selected, you need to select the hexadecimal form **Input HEX**. To set the software to automatically execute the CRC function, you need to select **ModbusRTU**, select **CRC16 (ModbusRTU)**, and set the start byte to **1**. After the auto CRC check function is enabled, do not enter CRC information in commands. Otherwise, command errors may occur due to repeated CRC check.

7.1.4 Common communication faults

Common communication faults include the following:

- No response is returned.
- The rectifier returns an exception response.

Possible causes of no response include the following:

- The serial port is set incorrectly. For example, the adapter uses the serial port COM1, but COM2 is selected for the communication.
- The setting of the baud rates, data bits, end bits, and check bits are inconsistent with those set on the rectifier.
- The positive pole (+) and negative pole (-) of the RS485 bus are connected reversely.

7.1.5 Related function codes

Function code	Name	Description	Setting range	Default	Modify
P20.00	Local communication address	1–247; 0 indicates a broadcast address	1–247	1	○
P20.01	Communication baud rate	0: 1200BPS 1: 2400BPS 2: 4800BPS 3: 9600BPS 4: 19200BPS 5: 38400BPS	0–5	4	○
P20.02	Data bit check	0: No check (N, 8, 1) for RTU 1: Even check (E, 8, 1) for RTU 2: Odd check (O, 8, 1) for RTU 3: No check (N, 8, 2) for RTU 4: Even check (E, 8, 2) for RTU 5: Odd check (O, 8, 2) for RTU	0–5	1	○

Function code	Name	Description	Setting range	Default	Modify
P20.03	Communication response delay	0–200ms	0–200	5	○
P20.04	Communication timeout time	0.0 (invalid); 0.1–60.0s	0.0–60.0s	0.0s	○
P20.05	Transmission error processing	0: Report an alarm and coast to stop 1: Keep running without reporting an alarm 2: Stop in enabled stop mode without reporting an alarm (applicable only to communication mode) 3: Stop in enabled stop mode without reporting an alarm (applicable to any mode)	0–3	0	◎
P20.06	Communication processing action	0x00–0x11 Ones place: 0: Respond to write operations 1: Not respond to write operations Tens place: 0: Reserved 1: Reserved	0x00–0x11	0x00	◎

8 Parameter list

The function parameters are divided into groups by function, and each group includes several function codes (each function code identifies a function parameter). A three-level menu style is applied to function codes. For example, "P00.07" indicates the 7th function code in the P00 group. The P29 group consist of factory function parameters, which are user inaccessible.

The function group numbers correspond to the level-1 menus, the function codes correspond to the level-2 menus, and the function parameters correspond to the level-3 menus.

The content of the function code table is as follows:

Column 1 "Function code ": Code of the function group and parameter.

Column 2 "Name": Full name of the function parameter.

Column 3 "Description": Detailed description of the function parameter.

Column 4 "Setting range": Setting range of the function parameter

Column 5 "Default": Initial value set in factory/

Column 6 "Modify": Whether the parameter can be modified, and conditions for the modification.

"○" indicates that the value of the parameter can be modified when the basic rectifier is in stopped or running state.

"◎" indicates that the value of the parameter cannot be modified when the basic rectifier is in running state.

"●" indicates that the value of the parameter is detected and recorded, and cannot be modified.

(The basic rectifier automatically checks and constrains the modification of parameters, which helps prevent incorrect modifications.)

2. The parameters adopt the decimal system (DEC). If the hexadecimal system is adopted, all bits are mutually independent on data during parameter editing, and the setting ranges at some bits can be hexadecimal (0–F).

3. "Default" indicates the factory setting of the function parameter. If the value of the parameter is detected or recorded, the value cannot be restored to the factory setting.

4. The basic rectifier better protect parameters, the basic rectifier provides the password protection function. After a password is set (that is, P07.00 is set to a non-zero value), "0. 0. 0. 0. 0." is displayed when you press the PRG/ESC key to enter the function code editing interface. You need to enter the correct user password to enter the interface. For the factory parameters, you need to enter the correct factory password to enter the interface. (You are not advised to modify the factory parameters. Incorrect parameter setting may cause operation exceptions or even damage to the basic rectifier.) If password protection is not in locked state, you can change the password any time. You can set P07.00 to 0 to cancel the user password. When P07.00 is set to a non-zero value during power-on, parameters are prevented from being modified by using the user password function.

When you modify function parameters through serial communication, the user password protection function is also applicable and compliant with the same rule.

P00 group––Basic functions

Function code	Name	Description	Setting range	Default	Modify
P00.00	Channel of running	0: Keypad (the indicator is off) 1: Terminal (the indicator blinks)	0–2	0	◎

Function code	Name	Description	Setting range	Default	Modify
	commands	2: Communication (the indicator is on)			
P00.01	Communication mode of running commands	0: Modbus 1: Reserved 2: Reserved	0–2	0	◎
P00.02	Cooling-fan running mode	0: Normal mode 1: Permanent running after power-on	0–1	0	◎
P00.03	Function parameter restore	0: No operation 1: Restore default values 2: Clear fault records 3: Clear accumulative electricity consumption	0–3	0	◎
P00.04	Function parameter property	0: Invalid 1: Read only	0–1	0	○
P00.05	Auto running wait time	Time to wait for the system to become stable (such as phase-locked loop) before automatic running. When P01.06 is set to 0.0s, automatic running is invalid.	0.0–3600.0	0.0s	◎
P00.06	Delay of auto fault reset	0.0–3600.0s	0.0–3600.0	1.0s	○
P00.07	Auto fault reset count	When P01.08 is 0, automatic fault reset is invalid.	0–10	0	○

P01 group––State monitoring group

Function code	Name	Description	Setting range	Default	Modify
P01.00	Input voltage valid value	Displays the present input voltage of the VFD. 0.0–2000V	0–2000	0.0V	●
P01.01	Input current valid value	Displays the present input current of the VFD. 0.0–6000.0A	0.0–6000.0	0.0A	●
P01.02	DC bus voltage	Displays the present DC bus voltage of the VFD. 0.0–2000V	0.0–2000	0.0V	●
P01.03	Grid frequency	Displays the present input grid frequency of the VFD. 0.00–120Hz	0.00–120	0.00Hz	●

P02 group––Input terminals

Function code	Name	Description	Setting range	Default	Modify
P02.00	Function of S1 terminal	0: No function 1: Run 2: Reset faults 3: External fault 4: Reserved 5: Reserved 6: Reserved 7: Reserved 8: Reserved 9: Reserved 10: Switch the running command channel to keypad 11: Switch the running command channel to terminal 12: Switch the running command channel to communication 13: Reserved 14: Reserved 15: Reserved	0–15	0	◎
P02.01	Function of S2 terminal			0	◎
P02.02	Function of S3 terminal			0	◎
P02.03	Function of S4 terminal			0	◎
P02.04	Digital input terminal polarity	0x00–0xFF 0 indicates positive. BIT0: S1 BIT1: S2 … BIT7: S8	0x00–0xFF	0x00	◎
P02.05	Digital input filter time	Digital input filter time	0.000–1.000	0.000s	○
P02.06	Virtual input terminal setting	Specifies whether to enable the virtual input terminals in communication mode. 0: Virtual input terminals are invalid 1: MODBUS communication virtual terminals are valid 2–10: Reserved	0–10	0	◎
P02.07	S1 switch-on delay	0.000–60.000s	0.000–60.000	0.000s	◎
P02.08	S1 switch-off delay	0.000–60.000s	0.000–60.000	0.000s	◎
P02.09	S2 switch-on delay	0.000–60.000s	0.000–60.000	0.000s	◎
P02.10	S2 switch-off delay	0.000–60.000s	0.000–60.000	0.000s	◎
P02.11	S3 switch-on delay	0.000–60.000s	0.000–60.000	0.000s	◎
P02.12	S3 switch-off delay	0.000–60.000s	0.000–60.000	0.000s	◎

Function code	Name	Description	Setting range	Default	Modify
P02.13	S4 switch-on delay	0.000–60.000s	0.000–60.000	0.000s	◎
P02.14	S4 switch-off delay	0.000–60.000s	0.000–60.000	0.000s	◎

P03 group––Output terminals

Function code	Name	Description	Setting range	Default	Modify
P03.00	RO1 output	0: No output 1: Ready for running 2: Running 3: Fault output 4: Reserved 5: Reserved 6: Reserved 7: Reserved 8: MODBUS communication virtual terminal output 9: Reserved 10: Reserved 11–31: Reserved	0–31	0	○
P03.01	RO2 output				
P03.02–P03.03	Reserved				
P03.04	Relay output terminal polarity	0x00–0x3F Bit 0 corresponds to RO1 BIT1 corresponds to RO2 BIT2–BIT7: Reserved	0x00–0x3F	0x00	○
P03.05	RO1 switch-on delay	0.000–60.000s	0.000–60.000	0.000s	○
P03.06	RO1 switch-off delay	0.000–60.000s	0.000–60.000	0.000s	○
P03.07	RO2 switch-on delay	0.000–60.000s	0.000–60.000	0.000s	○
P03.08	RO2 switch-off delay	0.000–60.000s	0.000–60.000	0.000s	○
P03.09–P03.12	Reserved				

P07 group––Human-machine interface

Function code	Name	Description	Setting range	Default	Modify
P07.00	User password	0–65535 When you set the function code to a non-zero number, password protection is enabled. The value 0 indicates password protection is	0–65535	0	○

Function code	Name	Description	Setting range	Default	Modify
		disabled. After the user password is set and takes effect, you cannot enter the parameter menu if you enter an incorrect password.			
P07.01	Parameter copy	Parameter copy mode. 0: No operation 1: Upload parameters from the local address to the keypad 2: Download parameters from the keypad to the local address **Note: After the operation corresponding to 1 or 2 is complete, the function code restores to 0.**	0–2	0	◎
P07.02	QUICK/JOG key function selection	0: No function 1: Switch displayed function codes from right to left by Press QUICK/JOG to shift the displayed function code from right to left. 2: Switch command channels in sequence Press QUICK/JOG to switch command channels in sequence. 3: Quick commissioning mode (based on non-factory parameter settings)	0–3	0	○
P07.03	Sequence of switching running-command channels by pressing QUICK/JOG	When P07.02=2, set the sequence of switching running-command channels by pressing QUICK/JOG. 0: Keypad→Terminal→Communication 1: Keypad←→Terminal 2: Keypad←→Communication 3: Terminal←→Communication	0–3	0	○
P07.04	Stop function validity of STOP/RST	Used to specify the stop function validity of STOP/RST. For fault reset, STOP/RST is valid in any conditions. 0: Valid only for keypad control 1: Valid both for keypad and terminal control 2: Valid both for keypad and communication control 3: Valid for all control modes	0–3	3	○
P07.05	Parameter selection in rectification state	0x0000–0xFFFF Bit 0: DC bus voltage (V) Bit 1: Grid frequency (Hz) Bit 2: Input voltage (V) Bit 3: Input current (A)	0x0000–0xFFFF	0x000F	○

Function code	Name	Description	Setting range	Default	Modify
		Bit 4: Input power factor Bit 5: Active current component (%) Bit 6: Reactive current component (%) (% blinking) Bit 7: Input terminal status Bit 8: Output terminal status Bit 9: AI1 (V) Bit 10: AI2 (V) (V blinking) Bit 11: AI3 (V) Bit 12: Input apparent power (kVA) Bit 13: Input active power (kW) Bit 14: Input reactive power (kVar) Bit 15: Reserved			
P07.06	Reserved				
P07.07	Factory bar code 1	0x0000–0xFFFF			●
P07.08	Factory bar code 2	0x0000–0xFFFF			●
P07.09	Factory bar code 3	0x0000–0xFFFF			●
P07.10	Factory bar code 4	0x0000–0xFFFF			●
P07.11	Factory bar code 5	0x0000–0xFFFF			●
P07.12	Factory bar code 6	0x0000–0xFFFF			●
P07.13–P07.16	Reserved				
P07.17	Accumulative electricity consumption high-order bits	The function codes are used to display the accumulative electricity consumption. Accumulative electricity consumption for running = P07.17*1000+P07.18	-32767–32767	0kWh	●
P07.18	Accumulative electricity consumption low-order bits		-999.9–999.9	0.0kWh	●
P07.19	Software version (DSP)	0.00–655.35	0.00–655.35	0.00	●
P07.20	Reserved				
P07.21	Local accumulative running time	0–65535h	0–65535	0h	●

P19 group––Fault information

Function code	Name	Description	Setting range	Default	Modify
P19.00	Present fault type	00: No fault 01: Input overcurrent (oC) 02: Grid undervoltage (LvI) 03: Grid overvoltage (ovI) 04: Grid phase loss (SPI)	0–30	0	●
P19.01	Last fault type			0	●
P19.02	2nd-last fault type			0	●

Function code	Name	Description	Setting range	Default	Modify
P19.03	3rd-last fault type	05: Phase lock failure (PLLF) 06: DC undervoltage (Lv) 07: DC overvoltage (ov) 08: Reserved 09: Reserved 10: RS485 communication fault (E_485) 11: Reserved 12: Reserved 13: Reserved 14: Reserved 15: Rectifier overload (oL) 16: EEPROM operation error (EEP) 17: Reserved 18: Reserved 19: Reserved 20: External fault (EF) 21: Reserved 22: Keypad or panel communication fault (PCE) (Reserved) 23: Parameter upload fault (UPE) 24: Parameter download fault (dNE) 25: Running time reached (ENd) 26: Reserved 27: Reserved 28: Reserved 29: Reserved 30: Reserved		0	●
P19.04	4th-last fault type			0	●
P19.05	5th-last fault type			0	●
P19.06	Input terminal status at present fault	0x00–0xFF	0x00–0xFF	0x00	●
P19.07	Output terminal status at present fault	0x00–0xFF	0x00–0xFF	0x00	●
P19.08	DC voltage at present fault	0.0–2000.0V	0.0–2000.0	0.0V	●
P19.09	Grid voltage at present fault	0.0–2000.0V	0.0–2000.0	0.0V	●
P19.10	Input current at present fault	0.0–6000.0A	0.0–6000.0	0.0A	●
P19.11–P19.21	Reserved				
P19.22	Input terminal status at last fault	0x00–0xFF	0x00–0xFF	0x00	●
P19.23	Output terminal status at last fault	0x00–0xFF	0x00–0xFF	0x00	●

Function code	Name	Description	Setting range	Default	Modify
P19.24	DC voltage at last fault	0.0–2000.0V	0.0–2000.0	0.0V	●
P19.25	Grid voltage at last fault	0.0–2000.0V	0.0–2000.0	0.0V	●
P19.26	Input current at last fault	0.0–6000.0A	0.0–6000.0	0.0A	●
P19.27–P19.37	Reserved				
P19.38	Input terminal status at 2nd-last fault	0x00–0xFF	0x00–0xFF	0x00	●
P19.39	Output terminal status at 2nd-last fault	0x00–0xFF	0x00–0xFF	0x00	●
P19.40	DC voltage at 2nd-last fault	0.0–2000.0V	0.0–2000.0	0.0V	●
P19.41	Grid voltage at 2nd-last fault	0.0–2000.0V	0.0–2000.0	0.0V	●
P19.42	Input current at 2nd-last fault	0.0–6000.0A	0.0–6000.0	0.0A	●
P19.43–P19.53	Reserved				

P20 group––Serial communication

Function code	Name	Description	Setting range	Default	Modify
P20.00	Local communication address	1–247; 0 indicates a broadcast address	1–247	1	○
P20.01	Communication baud rate	0: 1200BPS 1: 2400BPS 2: 4800BPS 3: 9600BPS 4: 19200BPS 5: 38400BPS	0–5	4	○
P20.02	Data bit check	0: No check (N, 8, 1) for RTU 1: Even check (E, 8, 1) for RTU 2: Odd check (O, 8, 1) for RTU 3: No check (N, 8, 2) for RTU 4: Even check (E, 8, 2) for RTU 5: Odd check (O, 8, 2) for RTU	0–5	1	○
P20.03	Communication response delay	0–200ms	0–200	5ms	○
P20.04	Communication timeout time	0.0 (invalid); 0.1–60.0s	0.0–60.0	0.0s	○
P20.05	Transmission error	0: Report an alarm and coast to stop 1: Keep running without reporting	0–3	0	◎

Function code	Name	Description	Setting range	Default	Modify
	processing	an alarm 2: Stop in enabled stop mode without reporting an alarm (applicable only to communication mode) 3: Stop in enabled stop mode without reporting an alarm (applicable to any mode)			
P20.06	Communication processing action	0x00–0x11 Ones place: 0: Respond to write operations 1: Not respond to write operations Tens place: 0: Reserved 1: Reserved	0x00–0x11	0x00	◎
P20.07–P20.09	Reserved				

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