USFULL®

User's Manual

FU9000SI Series
Auto Solar Pump Drive

V 2.1 501010208 www.usfull.com

Thank you for selecting the FU9000SI series Solar Pump Inverter developed by USFULL.

Engineered with maximum power point tracking (MPPT) , this dual-input solar drive system supports both DC photovoltaic arrays and AC grid power inputs, providing uninterrupted operation for single-phase and three-phase water pumps across agricultural applications.

The hybrid architecture prioritizes solar energy utilization with seamless AC backup, while IP20 protection and mobile app integration enable real-time monitoring and dry-run protection control. Adaptive algorithms ensure stable performance across 200-900VDC voltage variations, coupled with multi-safeguards against over-voltage and phase imbalance.

Announcement
♦ To illustrate the details of the product, the illustrations in this manual sometimes show the state of the cover or safety cover removed. When using this product, be sure to install the casing or cover according to the regulations, and operate in accordance with the contents of the manual. ♦ The illustrations in this manual are for illustration only and may be different from the products you ordered. ♦ The company is committed to the continuous improvement of products, and product functions will be continuously upgraded. The information provided is subject to change without notice. ♦ If you have any problems during use, please contact with local agent or USFULL.

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Chapter 1 Safety Information and Precautions

Please read this manual carefully and follow all safety precautions before moving, installing, operating and servicing the solar pump inverter. If ignored, physical injury or death may occur, or damage may occur to the devices.

If any physical injury or death or damage to the devices occurs for ignoring to the safety precautions in the manual, USFULL will not be responsible for any damages and we are not legally bound in any manner.

In this manual, the notices are graded based on the degree of danger:

DANGER: Indicates that failure to comply with the notice will result in severe personal injury or even death.

WARNING: Indicates that failure to comply with the notice will result in personal injury or property damage.

NOTE: Physical hurt may occur if not follow related requirements.

QUALIFIED ELECTRICIANS: People working on the device should take part in professional electrical and safety training, receive the certification and be familiar with all steps and requirements of installation, commissioning, operating, and maintaining the device to avoid any emergency.

1.1 Warning Symbols

Symbols	Name	Instruction	Abbreviation
 DANGER	Danger	Serious Physical injury or even death ma occur if related requirements are not followed.	
 WARNING	Warning	Physical injury or damage to the devices may occur if related requirements are not followed.	
 DO NOT	Electrostatic discharge	Damage to the PCBA board may occur if not related requirements are not followed.	
 HOT SIDES	Hot sides	Sides of the device may become hot. Do not touch.	
Note	Note	Physical hurt may occur if related requirements are not followed.	Note

1.2 Safety Guidelines

• Only qualified electricians are allowed to operate on the inverter.

• Do not carry out any wiring and inspection or changing components when the power supply is applied. Ensure all input power supply is disconnected before wiring and checking and always wait for at least the time designated on the inverter or until the DC bus voltage is less than 36V. The waiting time list is as follows.

Solar Pump Inverter Model		Minimum Waiting Time
1PH 220V	0.75kW-22kW	5 minutes
3PH 220V	0.75kW-55kW	5 minutes
3PH 380V	0.75kW-630kW	5 minutes

• Do not refit the inverter unauthorized; otherwise, fire, electric shock or other injury may occur.

• The base of the radiator may become hot during running. Do not touch to avoid hurt.

• The electrical parts and components inside the inverter are electrostatic. Take measurements to avoid electrostatic discharge during related operation.

1.2.1 Delivery and Installation

• Please install the inverter on fire-retardant material and keep the inverter away from combustible materials.

• Connect the braking optional parts according to the wiring diagram.

• Do not operate on the inverter if there is any damage or components loss to the inverter.

• Do not touch the inverter with wet items or body; otherwise, electric shock may occur.

• Fire Hazard. Suitable for mounting on concrete or other non-combustible surface only.

Note:

• Select appropriate moving and installing tools to ensure a safe and normal running of the inverter and avoid physical injury or death. For physical safety, the erector should take some mechanical protective measurements, such as, wearing exposure shoes and working uniforms.

• Ensure to avoid physical shock or vibration during delivery and installation.

•Do not carry the inverter by its cover. The cover may fall off.

• Install away from children and other public places.

• The leakage current of the inverter may be above 3.5mA during operation. Ground with proper techniques and ensure the grounding resistor is less than 10 Ω . The conductivity of grounding conductor is the same as that of the phase conductor. For models higher than 30kW, the cross sectional area of the grounding conductor can be slightly less than the recommended area.

• R, S, and T are the input terminals of the power supply, while U, V, and W are the motor terminals. Please connect the input power cables and motor cables with proper techniques; otherwise, the damage to the inverter may occur.

1.2.2 Commissioning and operation

	• Disconnect all power supplies applied to the inverter before the terminal wiring and wait for at least the designated time after disconnecting the power supply. • High voltage is present inside the inverter during running. Do not carry out any operation except for the keypad setting. • The inverter may start up by itself when P01.21=1. Do not get close to the inverter and motor. • The inverter cannot be used as "Emergency-stop device". • The inverter cannot be used to break the motor suddenly. A mechanical braking device should be provided.

Note:

• Do not switch on or off the input power supply of the inverter frequently.

• For inverters that have been stored for a long time, check and fix the capacitance and try to run it again before utilization.

• Cover the front board before running; otherwise, electric shock may occur.

1.2.3 Maintenance and component replacement

	• Only qualified electricians are allowed to perform the maintenance, inspection, and components replacement of the inverter. • Disconnect all power supplies to the inverter before the terminal wiring. Wait for at least the time designated on the inverter after disconnection. • Take measures to avoid screws, cables and other conductive matters to fall into the inverter during maintenance and component replacement.

Note:

• Please select proper torque to tighten screws.

• Keep the inverter, parts, and components away from combustible materials during maintenance and component replacement.

• Do not carry out any isolation and pressure test on the inverter and do not measure the control circuit of the inverter by megameter.

1.2.4 What to do after scrapping

	• There are heavy metals in the inverter. Treat it as industrial effluent.
	• When the life cycle ends, the product should enter the recycling system. Dispose of it separately at an appropriate collection point instead of placing it in the normal waste stream.

1.3 Safety Information and Precautions

Warnings

Use Stage	Safety Grade	Precautions
Before Installation	 DANGER	• Do not install the equipment if you find water seepage, component missing or damage upon unpacking. Do not install the equipment if the packing list does not conform to the product you received.
	 WARNING	• Handle the equipment with care during transportation to prevent installation damage to the equipment. • Do not use the equipment with damaged or missing components. Failure to comply will result in personal injury. • Do not touch the components with your hands. Failure to comply will result in static electricity damage.
During Installation	 DANGER	• Install the equipment on incombustible objects such as metal, and keep it away from combustible materials. Failure to comply may result in a fire. • Do not loosen the fixed screws of the components, especially during the screws with red mark.
	 WARNING	• Do not drop wire end or screw into the inverter. Failure to comply will result in damage to the inverter. • Install the inverter in places free of vibration and direct sunlight. Arrange the installation positions properly when two inverters are laid in the same cabinet to ensure the cooling effect.
Use Stage	Safety Grade	Precautions
At Wiring	 DANGER	• Wiring must be performed only by qualified personnel under instructions described in this manual. Failure to comply may result in unexpected accidents. • A circuit breaker must be used to isolate the power supply and the inverter. Failure to comply may result in a fire. • Ensure that the power supply is cut off before wiring. Failure to comply may result in electric shock. • Tie the inverter to ground properly by standard. Failure to comply may

		result in electric shock.
	 WARNING	• Never connect the power cables to the output terminals (U, V, W) of the inverter. Pay attention to the marks of the wiring terminals and ensure correct wiring. Failure to comply will result in damage to the inverter. • Never connect the braking resistor between the DC bus terminals (+) and (-). Failure to comply may result in a fire. • Use wire sizes recommended in the manual. Failure to comply may result in accidents. • Use a shielded cable for the encoder, and ensure that the shielding layer is reliably grounded.
Before Power-on	 DANGER	• Check that the following requirements are met: – The voltage class of the power supply is consistent with the rated voltage class of the inverter. – (+) and (-) are DC power supply input terminals. R, S and T (L, N) are AC power supply input terminals and output terminals (U, V, W) are properly connected. – No short-circuit exists in the peripheral circuit before the wiring is secured. Failure to comply will result in damage to the inverter power-on. • Do not perform the voltage resistance test on any part of the inverter because such test has been done in the factory. Failure to comply will result in accidents.
	 WARNING	• Cover the inverter properly before power-on to prevent electric shock. • AIl peripheral devices must be connected properly under the instructions described in this manual. Failure to comply will result in accidents.
Use Stage	Safety Grade	Precautions
After Power-on	 DANGER	• Do not open the inverter's cover after power-on. Failure to comply may result in electric shock. • Do not touch any I/O terminal of the inverter. Failure to comply may result in electric shock.
	 WARNING	• Do not touch the running. Failure to comply will result in accidents. • Do not change the default settings of the inverter. Failure to comply will result in damage to the inverter.

During Operation	 DANGER	• Do not touch the fan or the discharging resistor to check the temperature. Failure to comply will result in personal burnt. • Signal detection must be performed only by qualified personnel during operation. Failure to comply will result in personal injury or damage to the inverter.
	WARNING 	• Avoid objects falling into the inverter when it is running. Failure to comply will result in damage to the inverter. • Do not start/stop the inverter by turning the contactor ON/OFF. Failure to comply will result in damage to the inverter.
During Maintenance	 DANGER	• Repair or maintenance of the inverter may be performed only by qualified personnel. Failure to comply will result in personal injury or damage to the inverter. • Do not repair or maintain the inverter at power-on. Failure to comply will result in electric shock. • Repair or maintain the inverter only ten minutes after the inverter is powered off. This allows for the residual voltage in the capacitor to discharge to a safe value. Failure to comply will result in personal injury. • Ensure that the inverter is disconnected from all power supplies before starting repair or maintenance on the inverter. • Set and check the parameters again after the inverter is replaced. • All the pluggable components must be plugged or removed only after power-off. • The rotating motor generally feeds back power to the inverter. As a result, the inverter is still charged even if the motor stops, and the power supply is cut off. Thus ensure that the inverter is disconnected from the motor before starting repair or maintenance on the inverter.

◆ Approvals

Certification marks on the product nameplate indicate compliance with the corresponding certificates and standards.

Certification	Mark	Directives		Standard
CE	CE	EMC directives	2014/30/EU	EN 61800-3
		LVD directives	2014/35/EU	EN 61800-5-1
CB	CB	-	-	IEC 62109-1

Note:

1. The above EMC directives are complied with only when the EMC electric installation requirements are strictly observed.
2. Machines and devices used in combination with this drive must also be CE certified and marked. The integrator who integrates the drive with the CE mark into other devices has the responsibility of ensuring compliance with CE standards and verifying that conditions meet European standards.
3. The installer of the drive is responsible for complying with all relevant regulations for wiring, circuit fuse protection, earthing, accident prevention and electromagnetic (EMC regulations). In particular fault discrimination for preventing fire risk and solid earthing practices must be adhered to for electrical safety (also for good EMC practice).
4. For more information on certification, consult our distributors or USFULL.

Chapter 2 Product Overview

2.1 Unpacking Inspection

Check as follows after receiving products:

1. Check that there are no damage and humidification to the package. If not, please contact with local agents or USFULL offices.
2. Check the information on the type designation label on the outside of the package to verify that the drive is of the correct type. If not, please contact with local dealers or USFULL offices.
3. Check that there are no signs of water in the package and no signs of damage or breach to the AC drive. If not, please contact with local dealers or USFULL offices.
4. Check the information on the type designation label on the outside of the package to verify that the nameplate is of the correct type. If not, please contact with local dealers or USFULL offices.
5. Check to ensure the accessories (including user's manual and control keypad) inside the device is complete. If not, please contact with local dealers or USFULL offices.

2.2 Nameplate

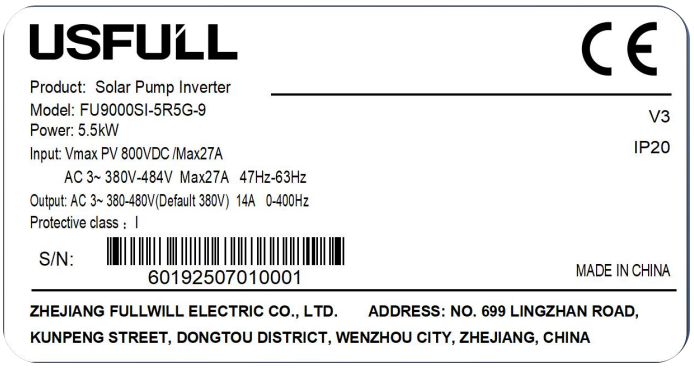


Figure 2-1 Nameplate

Note: This is the example of FU9000SI standard products are marked according to the reality.

2.3 Type Designation Key

The type designation contains information on the inverter. The user can find the type designation on the type designation label attached to the inverter or the simple nameplate.

FU9000SI – 5R5G – 9

① ② ③

Key	Sign	Description	Remarks
Model	①	Series inverter	FU9000SI
Rated power	②	Power range + Load type	5R5G—5.5kW G—General type
Voltage degree	③	Voltage degree	9: AC 3PH 380V ~ 480V 4: AC 3PH 380V ~ 480V) S2: AC 1PH to 3PH 220V ~ 240V SS2: AC 1PH 220V ~ 240V

2.4 Product Specifications

Model	-SS2	-S2	-4	-9
AC Input Voltage (V)	1PH 220V ~ 264V		3PH 380V ~ 484V	
AC Output Voltage (V)	1PH/3PH 220V ~ 240V		3PH 380V ~ 480V	
Max. DC Voltage (V)	450	450	800	800
Start-up Voltage (V)	200	200	300	300
Lowest Working Voltage (V)	150	150	250	250
Recommended DC Input Voltage Range (V)	200 ~ 450	200 ~ 450	300 ~ 750	300 ~ 750
Recommended MPP Voltage (V)	330	330	550	550

2.5 Rated Specifications

Series	Model	Rated Output Power (kW)	Rated Input Current (A)	Rated Output Current (A)
-SS2 (0.75kW ~ 4kW)	FU9000SI-0R7G-SS2	0.75	13.5	7.2
	FU9000SI-1R5G-SS2	1.5	18	10.2
	FU9000SI-2R2G-SS2	2.2	26	14
	FU9000SI-004G-SS2	4	42	23
	FU9000SI-5R5G-SS2	5.5	60	30
-4&-9 (0.75kW ~ 630kW)	FU9000SI-0R7G-9	0.75	4.5	2.5
	FU9000SI-1R5G-9	1.5	6.5	4.2
	FU9000SI-2R2G-9	2.2	7.8	5.5
	FU9000SI-004G-9	4	16	9.5
	FU9000SI-5R5G-9	5.5	27	14
	FU9000SI-7R5G-9	7.5	32	18.5
	FU9000SI-011G-9	11	38	25
	FU9000SI-015G-9	15	45	32
	FU9000SI-018G-9	18.5	51	38
	FU9000SI-022G-9	22	75	45
	FU9000SI-030G-9	30	90	60
	FU9000SI-037G-9	37	110	75
	FU9000SI-045G-9	45	125	92
	FU9000SI-055G-9	55	150	115
	FU9000SI-075G-9	75	185	150
	FU9000SI-090G-9	90	190	180
	FU9000SI-110G-9	110	225	215
	FU9000SI-132G-9	132	256	253

Series	Model	Rated Output Power (kW)	Rated Input Current (A)	Rated Output Current (A)
-4&-9 (0.75kW ~ 630kW)	FU9000SI-160G-9	160	307	304
	FU9000SI-185G-9	185	345	340
	FU9000SI-200G-9	200	385	377
	FU9000SI-220G-9	220	430	426
	FU9000SI-250G-9	250	468	465
	FU9000SI-280G-9	280	525	520
	FU9000SI-315G-9	315	590	585
	FU9000SI-355G-9	350	665	650
	FU9000SI-400G-9	400	785	725
	FU9000SI-450G-9	450	883	820
	FU9000SI-500G-9	500	920	860
	FU9000SI-630G-9	630	1210	1200

Chapter 3 Installation Guidelines

The chapter describes the mechanical installation and electric installation.

- Only qualified electricians are allowed to carry out what described in this chapter. Please operate as the instructions in safety precautions. Ignoring these may cause physical injury or death or damage to the devices.
- Ensure the power supply of the inverter is disconnected during the operation. Wait for at least the time designated after the disconnection if the power supply is applied.
- The installation and design of the inverter should be complied with the requirement of the local laws and regulations in the installation site. If the installation infringes the requirement, our company will exempt from any responsibility. Additionally, if users do not comply with the suggestion, some damage beyond the assured maintenance range may occur.

3.1 Mechanical Installation

3.1.1 Installation Environment

The installation environment is the safeguard for a full performance and long-term stable functions of the inverter. Check the installation environment as follows:

Environment	Conditions
Installation site	Indoor, conditioned
IP grade	IP20
Pollution degree	Min. PD2
Overvoltage category	Ⅱ(PV) Ⅲ(AC)
Environment temperature	• -10℃ ~ +50℃. The temperature change rate is less than 0.5℃/minute. • If the ambient temperature of the inverter is above 40℃, derate 2% for every additional 1℃. • It is not recommended to use inverter if ambient temperature is above 50℃. • To ensure reliability, do not use the inverter if the ambient temperature changes frequently. • Provide cooling fan or air conditioner to control the internal ambient temperature below the required one if the inverter is used in a close space such as in the control cabinet. • When the temperature is too low, if the inverter needs to restart to run after a long stop, it is necessary to provide an external heating device to increase the internal temperature, otherwise damage to the devices may occur.
Humidity	RH ≤ 90%. No condensation is allowed. Wet location: no.
Storage temperature	-40℃ ~ +70℃. The temperature change rate is less than 1℃/minute.

Environment	Conditions
Running environment condition	The installation site should meet the following requirements. • Away from electromagnetic radiation sources. • Away from oil mist, corrosive gases and combustible gases. • Ensure foreign object like metal powder, dust, oil and water will not fall into the inverter (do not install the inverter onto combustible object like wood). • Away from radioactive substance and combustible objects. • Away from harmful gases and liquids. • Low salt content. • No direct sunlight.
Altitude	• Below 1000m. • If the sea level is above 1000m, please derate 1% for every additional 100m.
Vibration	≤ 5.8m/s² (0.6g)
Installation direction	The inverter should be installed on an upright position to ensure sufficient cooling effect.

Note:

1. FU9000SI series inverters should be installed in a clean and ventilated environment according to enclosure classification.
2. Cooling air must be clean, free from corrosive materials and electrically conductive dust.
3. When the photovoltaic array is exposed to light, it supplies a d.c. voltage to the PCE.

3.1.2 Installation Direction

The inverter may be installed on the wall or in a cabinet.

The inverter needs be installed in the vertical position. Check the installation site according to the requirements below. See “Appendix D Dimension Drawings” for frame details.

3.1.3 Installation Mode

1. Installation Mode

Wall for the solar pump inverters (3PH 380V ＜400kW, 3PH 220V ≤55kW，and 1PH ≤22kW)

Standing installation for the solar pump inverters (3PH 380V 400kW to 630kW)

(1) Locate the position of the installation hole.
(2) Fix the screw or nut on the located position.
(3) Put the inverter against the wall.
(4) Tighten up the screws.

2. Installation Clearance Requirements

The clearance that needs to be reserved varies with the power class of the FU9000SI, as shown in the following figure.

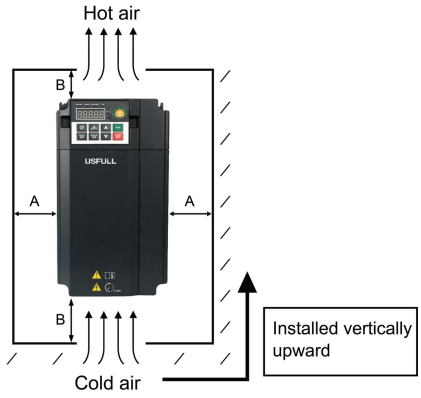


Figure 3-1

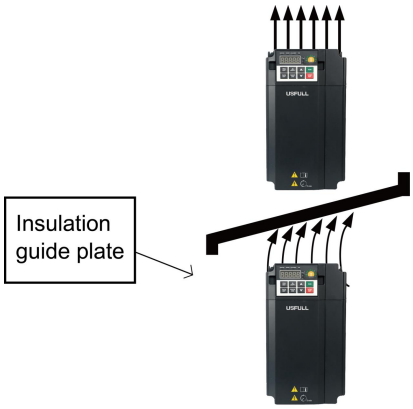


Figure 3-2

Figure 3-1 Different Power Level Installation Specification Requirements

Figure 3-2 Installation of Insulation Guide Plate

Installation clearance requirements on the FU9000SI series inverters of different power classes:

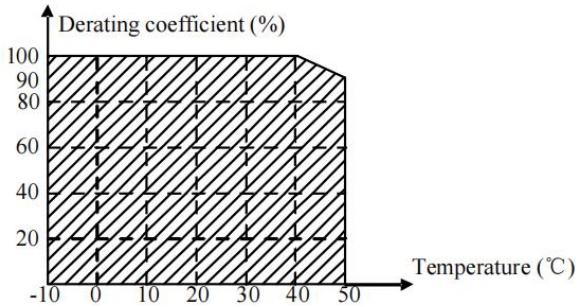
Power Class	Clearance Requirements	
0.75 ~ 18.5kW	A ≥ 10mm	B ≥ 100mm
22 ~ 37kW	A ≥ 50mm	B ≥ 200mm
45 ~ 630kW	A ≥ 50mm	B ≥ 300mm

If multiple solar pump inverters are connected together, install them side by side. If one row of solar pump inverters need to be installed above another row, install an insulation guide plate to prevent solar pump inverters in the lower row from heating those in the upper row and causing faults.

3.2 Derating

The solar pump inverter can be run at above the rated ambient temperature, altitude, and default carrier frequency by derating drive load capacity.

3.2.1 Ambient Temperature Derating



In the rated ambient temperature range 40°C ~ 50°C, the rated output current is decreased by 1% for every additional 1°C. Refer to the following figure for the actual derating.

3.2.2 Altitude Derating

The output power must be derated if the installation altitude exceeds 1000m because the cooling effect available from ambient air reduces. When the installation altitude exceeds 1000m, derate 1% for every increase of 100m. Max. altitude is 3000m.

3.2.3 Carrier Frequency Derating

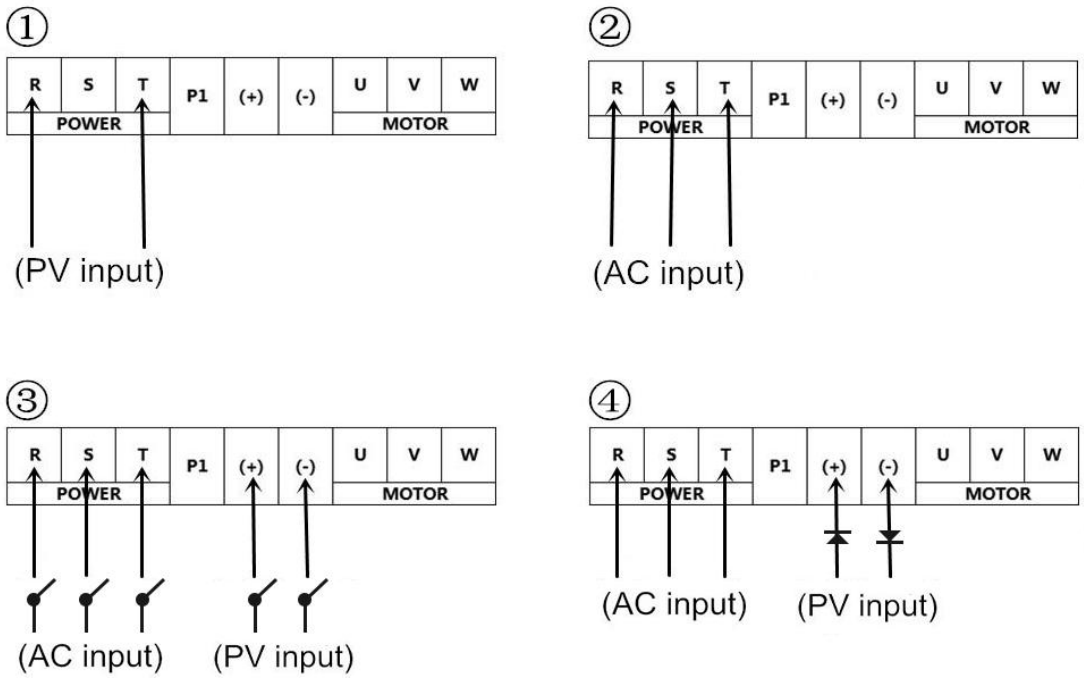
FU9000SI series solar pump inverter has different power levels corresponding to different carrier frequency ranges. The rated power of the solar pump inverter is based on the factory carrier frequency, so if it is above the factory value, the solar pump inverter needs to be derated by 10% for every additional 1kHz carrier frequency.

3.3 Standard Wiring

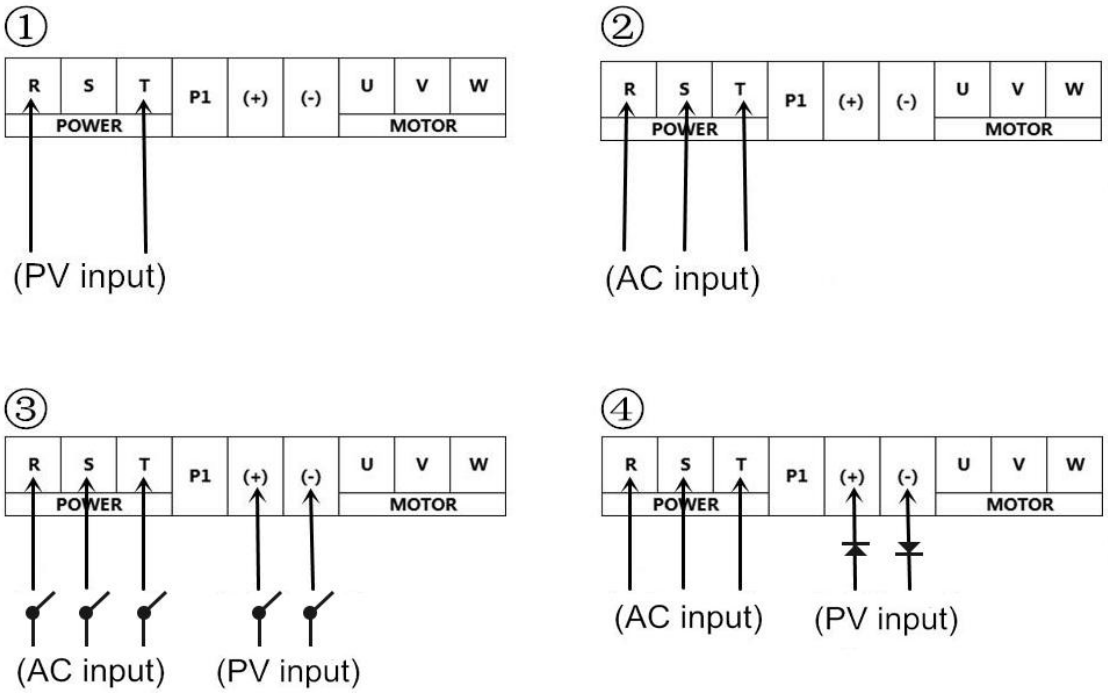
3.3.1 Terminals of Main Circuit

Terminal	Name	Function
R, S, T	AC input	3PH/1PH AC input terminals, connected to the grid. **Note:** Use the screws equipped with the inverter for wiring.
(+), (-)	PV input	Solar cell panel input terminals
U, V, W	Inverter output	3PH/1PH AC output terminals, connected to the pump motor. **Note:** 1PH motors must connect to terminals U and W.
⏚	Safety grounding	Safety protection grounding terminal. Each inverter must be grounded.

380V 0.75kW ~ 37kW Connection Instruction



380V 45kW ~ 630kW Connection Instruction



PV input please follow diagram ①.

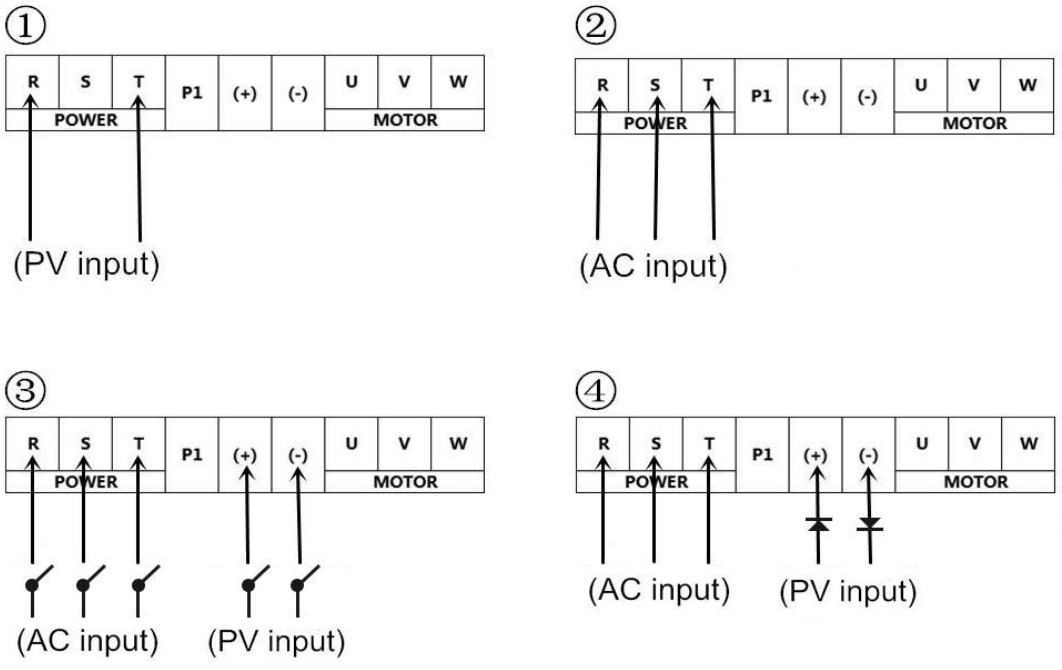
AC input please follow diagram ②.

If there are 2 input ways, please follow ③.

Please use breaker/switch to choose input source in ③.

If need same time input, please add anti-reverse diode as ④.

220V Connection Instruction



PV input please follow diagram ①.
AC input please follow diagram ②.

If there are 2 input ways, please follow ③.
Please use breaker/switch to choose input source in ③.
If need same time input, please add anti-reverse diode as ④.

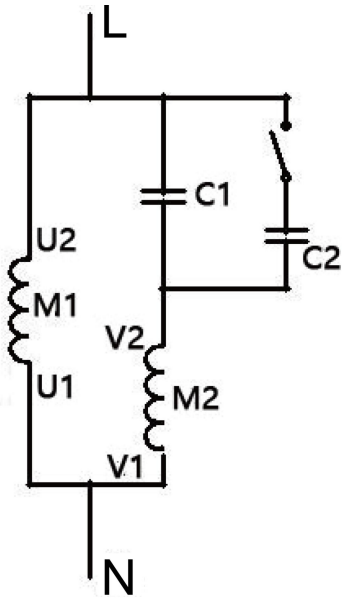
Note:
• It is not recommended to use asymmetrically motor cables. If there is a symmetrically grounding conductor in the motor cable in addition to the conductive shield, connect the grounding conductor to the grounding terminal at the inverter and motor ends.
• Route the motor cable, input power cable and control cables separately.

Wiring of main circuit terminals
1. Connect the ground wire of the input power cable to the ground terminal (⏚) of the inverter, connect the 3PH input cable to the terminals R, S, and T, and fasten them up.
2. Connect the grounding wire of the motor cable to the ground terminal of the inverter, and connect the 3PH motor cable to the terminals U, V, and W, and fasten them up.
3. Connect the braking resistor and other accessories that are equipped with cables to the specified positions.
4. Fasten all the cables outside of the inverter mechanically, if possible.

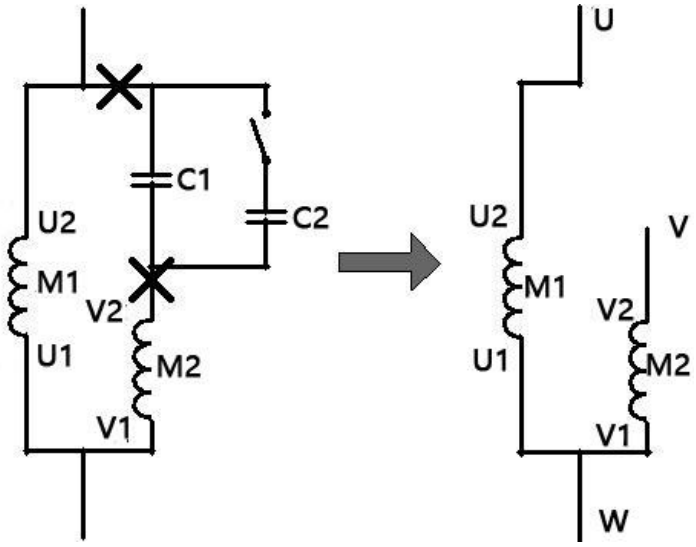
Description for -SS2 single-phase output models:

Generally, the output terminals U and W of the inverter connect to the phase cables of the single-phase motor.

If the single-phase pump cannot be started, the two-phase control method must be used, and the start-up and running capacitors (if any) of the motor must be removed. The figure below shows the internal wiring of the common single-phase motor. In the figure, M1, M2, C1, and C2 indicate the running winding, start-up winding, running capacitor, and start-up capacitor. When the motor speed exceeds 75% of the rated speed, the start-up capacitor is switched off.



Internal wiring of the single-phase motor winding after removing the starting and running capacitor:



U1 and V1 are the common terminals of the winding. Connect them to the output terminal W of the inverter. Connect U2 to the output terminal U of the inverter. Connect V2 to the output terminal V of the inverter.

Note: Use the screws equipped with the inverter.

3.3.2 Terminals of Control Circuit

Type	Terminal	Name	Function Description
Supply power	+24V	24V power supply	It provides the power of 24V±10% and the max. current of 200mA. It functions as the working power supply of digital input and output or externally connects to the sensor power supply.
	COM	Common terminal	
Input digital	S1 - COM	Forced switch to mains	Terminal feature parameters: 1. Internal impedance: 3.3kΩ 2. Acceptable voltage input: 12 ~ 24V 3. Max. input frequency:1kHz S1: Forcible switch to mains. (Switching-on indicates switching to mains, and switching-off indicates input controlled by the keypad.) S2: It connects to the high-water switch of the normally open contact by default. S3: It connects to the low-water switch of the normally closed contact. S4: A high electrical level corresponds to single phase algorithm. A low electrical level corresponds to two phase algorithm.
	S2 - COM	Full-water alarm	
	S3 - COM	Empty-water alarm	
	S4 - COM	Single/Two phase algorithm switching	
Communication	RS485+	485 Communication	485 communication terminals, using the Modbus protocol.
	RS485-		
Output digital	422TX+ 422TX- 422RX+ 422RX-	422 Communication	Communication terminals special for the boost module.
Output relay	RO1A (ROA)	Normally open contact of relay 1	1. Contact capacity: 3A/AC250V, 1A/DC30V 2. They cannot be used for high frequency switch output. During the application of auto mains & PV switching, the AC input contactor coil is controlled by the normally closed contact of the relay.
	RO1B (ROB)	Normally closed contact of relay 1	
	RO1C (ROC)	Common terminal of relay 1	

3.3.3 Standard Wiring

The figure 3-7 below shows the standard wiring of inverter.

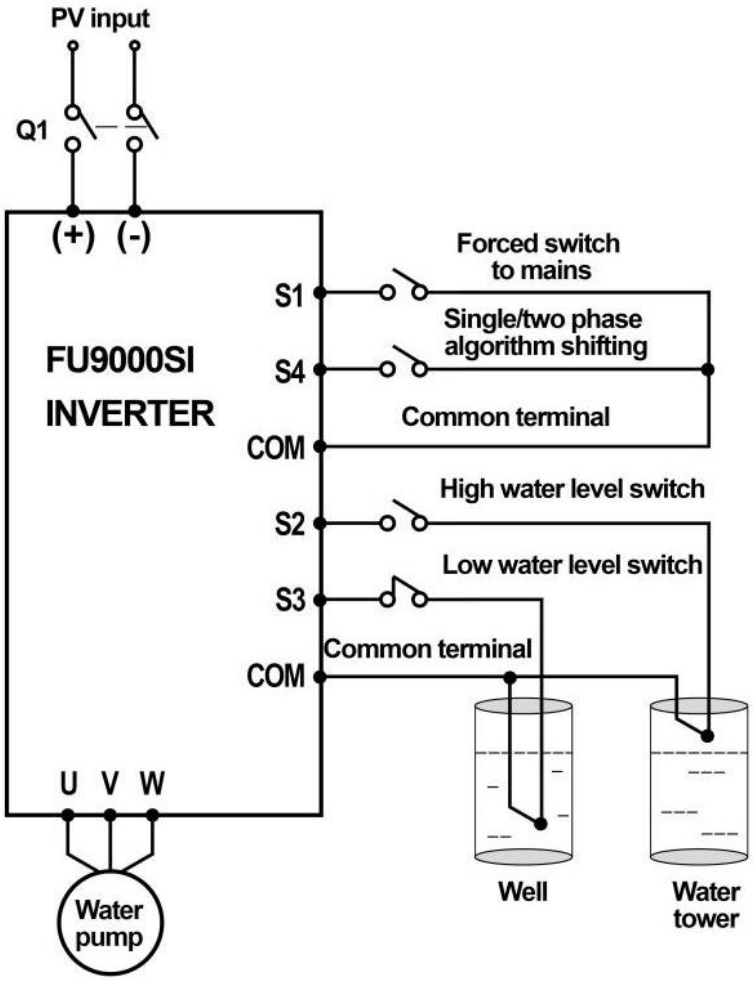


Figure 3-7 Standard wiring diagram

⚠	• The DC breaker Q1 must be installed as the protection switch for PV input. • In parallel connection, the PV combiner box must be used. • When the distance between the PV input component and inverter exceeds 10m, Type-II surge protection devices must be configured at the DC side. • When the distance between the pump and inverter exceeds 50m, it is recommended to configure output reactors for the output reactor model selection. • The inverter automatically runs after being powered on. If parameters need to be set, follow the parameter setting instructions in Group P15. • Before connecting the braking resistor cable, remove the yellow labels of P1, (+), and (-) from the terminal blocks. Otherwise, poor connection may occur.

3.4 Wiring protection

3.4.1 Protect the inverter and input power cable when a short circuit occurs

Protect the inverter and input power cable in short circuit situations and against thermal overload. Arrange the protection according to the following guidelines.

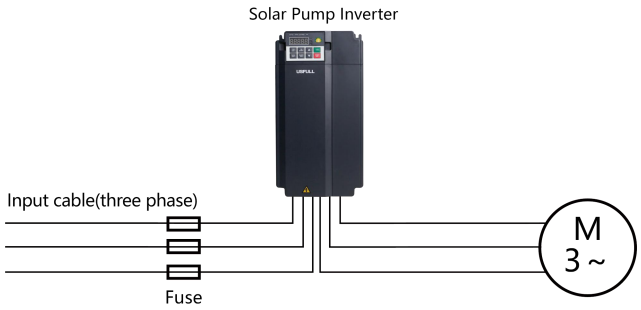


Figure 3-8 Fuse configuration

Note: Select the fuse as the manual indicated. The fuse will protect the input power cable from damage in short-circuit situations. It will protect the surrounding devices when the internal of the inverter is short circuited.

3.4.2 Protect the motor and motor cables

If the motor cable is selected based on the rated current of the inverter, the inverter can protetc the motor cable and motor when a short circuit occurs. The inverter provided the motor thermal overload protection function, which can protect the motor, and lock the output and cut off the current when necessary.

	• If the inverter is connected to multiple motors, a separate thermal overload switch or a circuit breaker must be used for protecting each cable and motor. These devices may require a separate fuse to cut off the short-circuit current.

3.4.3 Establish a bypass connection

It is necessary to set power frequency and variable frequency conversion circuits for the assurance of continuous normal work of the inverter if faults occur in some significant situations.
In some special situations, for example, if it is only used in soft start, the inverter can be converted into power frequency running after starting and some corresponding bypass should be added.

	• Never connect the supply power to the inverter output terminals U, V, and W. Power line voltage applied to the output can result in permanent damage to the inverter.

If frequent shifting is required, employ mechanically connected switches or contactors to ensure that the motor terminals are not simultaneously connected to the input power cable and output terminal of the inverter.

Chapter 4 Keypad Operation Procedure

4.1 Operation Panel

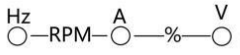
You can modify the parameters, monitor the working status and start or stop the FU9000SI by operating the operation panel, as shown in the following:

Figure 4-1 Diagram of the operation panel

Note: The keypads of inverters can be used as external keypads.

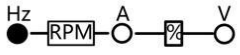
Table 3-1 Description of status indicator

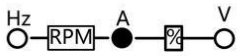
Indicator	Indication
RUN/TUNE	Indicator ON: RUNNING status
	Indicator OFF: STOP status
	Indicator Flashing Slowly: Auto-tuning status
FWD/REV	Indicator ON: Forward motor rotation
	Indicator OFF: Reverse motor rotation
LOCAL/REMOT	Indicator ON: Under terminal control
	Indicator OFF: Under operating panel control
	Indicator Flashing: Under serial communication control
TRIP	Indicator Flashing Quickly: A fault condition

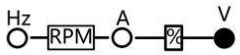


: Unit Indicators

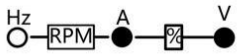
● : Indicators on ○ : Indicators off


Hz: Unit of frequency


A: Unit of current


V: Unit of voltage


RPM: Unit of rotation speed


%: Unit of perentage

Digital Display

The 5-digit LED display is able to display the following range of information:

• Setting frequency

• Output frequency

• Monitoring data

• Fault codes

Table 3-2 Description of keys on the operation panel

Key	Name	Function
PRG ESC	Programme	Enter or exit Level I menu.
DATA ENT	Confirm	Enter the menu interfaces level by level, and confirm the parameter setting.
▲	Increase	Increase data or function code.
▼	Decrease	Decrease data or function code.
SHIFT	Shift	Moving right to select the displayed parameters in turn in the stop or running state, and select the digit to be modified when modifying parameters.
RUN	Run	Start the inverter in the operation panel control mode.
STOP RST	Stop/Reset	- Stop the inverter when it is in the running state. - Perform the reset operation when in the fault state. The functions of this key are limited by function code P07.02.
QUICK JOG	Multi-function	Function selection according to P7.01, can be defined as command source or direction.

4.2 Keypad Displaying

The keypad displaying state of FU9000SI series inverters is divided into stopping state parameter, running state parameter, function code parameter editing state and fault alarm state and so on.

4.2.1 Displayed State of Stopping Parameters

When the inverter is in the stopping state, the keypad will display stopping parameters.

In the stopping state, various kinds of parameters can be displayed. Select the parameters to be displayed or not by P07.07.

In the stopping state, there are 4 parameters that can be displayed. They are: set frequency, bus voltage, input terminals state, and output terminals state.

>>/SHIFT can shift the parameters from left to right. QUICK/JOG (P07.02 = 2) can shift the parameters from right to left.

4.2.2 Displayed State of Running Parameters

After the inverter receives valid running commands, the inverter will enter into the running state and the keypad will display the running parameters. RUN/TUNE LED on the keypad is on, while the FWD/REV is determined by the current running direction.

In the running state, there are 6 parameters that can be displayed. They are: running frequency, set frequency, bus voltage, output voltage, output current, and rotating speed. >>/SHIFT can shift the parameters from left to right. QUICK/JOG (P07.02 = 2) can shift the parameters from right to left.

4.2.3 Displayed State of Faults

If the inverter detects the fault signal, it will enter into the fault pre-alarm displaying state. The keypad will display the fault code by flicking. The TRIP LED on the keypad is on, and the fault reset can be operated by the STOP/RST on the keypad, control terminals or communication commands.

4.2.4 Displayed State of Function Codes Editing

In the state of stopping, running or fault, press PRG/ESC to enter into the editing state (If there is a password, see P07.00). The editing state is displayed on two classes of menu, and the order is: function code group/function code number → function code parameter, press DATA/ENT into the displayed state of function parameter. On this state, press DATA/ENT to save the parameters or press PRG/ESC to escape.

4.3 Keypad Operation

Operate the inverter via operation panel. See the detailed structure description of function codes in the brief diagram of function codes.

4.3.1 How to Modify the Function Codes of the Inverter

The inverter has three levels menu, which are:

1. Group number of function code (first-level menu)
2. Tab of function code (second-level menu)
3. Set value of function code (third-level menu)

Remarks:

Press both the PRG/ESC and the DATA/ENT can return to the second-level menu from the third-level menu. The difference is: pressing DATA/ENT will save the set parameters into the control panel, and then return to the second-level menu with shifting to the next function code automatically; while pressing PRG/ESC will directly return to the second-level menu without saving the parameters, and keep staying at the current function code.

Under the third-level menu, if the parameter has no flickering bit, it means the function code cannot be modified. The possible reasons could be:

1. This function code is not modifiable parameter, such as actual detected parameter, operation records and so on.
2. This function code is not modifiable in running state, but modifiable in stop state.

Example: Set function code P00.00 from 0 to 1.

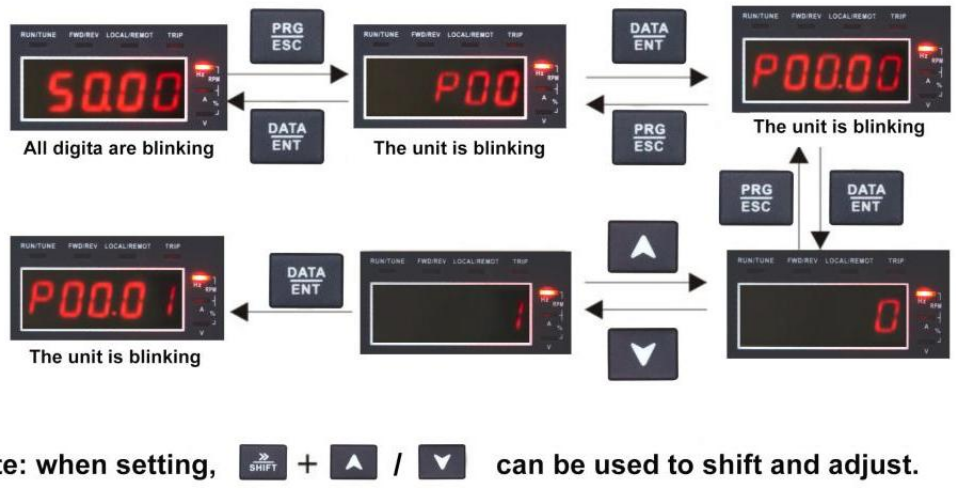


Figure 4-2 Sketch map of modifying parameters

4.3.2 How to Set the Password of the Inverter

FU9000SI series inverters provide password protection function to users. Set P07.00 to gain the password and the password protection becomes valid instantly after quitting from the function code editing state. Press PRG/ESC again to the function code editing state, "0.0.0.0.0" will be displayed.

Unless using the correct password, the operators cannot enter it. Set P07.00 to 0 to cancel password protection function.

The password protection becomes effective instantly after retreating from the function code editing state. Press PRG/ESC again to the function code editing state, "0.0.0.0.0" will be displayed. Unless using the correct password, the operators cannot enter it.

4.3.3 How to Watch the Inverter State Through Function Codes

FU9000SI series inverters provide Group P17 as the state inspection group. Users can enter into P17 directly to watch the state.

Note: For safe operation, comply with the following

1. Control Adjustments
• All parameter adjustments must be performed by qualified personnel.
• Changes to torque/frequency settings may cause motor overload or equipment damage.
2. Equipment Interconnection
• Non-compliant accessories void warranty and safety certification.
3. Surface Temperature Warning
• External surfaces may exceed 65°C during operation.
• Maintain ≥30cm clearance from flammable materials.
• Use thermal gloves when servicing.
4. Non-Specified Use Prohibition
• Any modification or use outside manufacturer specifications compromises protection features may cause fire or electric shock.

Chapter 5 Commissioning Guidelines

⚠	• Disconnect all power supplies applied to the inverter before the terminal wiring and wait for at least the designated time after disconnecting the power supply. • High voltage is present inside the inverter during running. Do not carry out any operation except for the keypad setting. • The inverter automatically runs once power on. If parameters need to be set, follow the guidelines in this chapter.

5.1 Inspection before Operation

Before powering on the inverter, ensure that:

1. The inverter is grounded reliably.
2. The wiring is correct and reliable.
3. The AC/DC breaker is selected correctly.
4. The PV input voltage is in the allowed range of the inverter.
5. The type, voltage, and power of the motor match those of the inverter.

5.2 Trial Run

Close the DC breaker. The inverter automatically runs with a delay of 5s. Check the water yield of the pump. If the water yield is normal, the trial run is successful. If the water yield is below the normal value, exchange any two motor cables, connect the cables, and perform trial run again.

5.3 Advanced Settings

Note: The default settings of the inverter for the water pump can apply to most conditions and the advanced settings are not required in most cases.

5.3.1 PI Adjustment to the Water Yield

If the user requires large or low water yield, it is necessary to adjust PI (P15.06 ~ P15.10) properly. The bigger PI parameters, the stronger the effect is, but the frequency fluctuation of the motor is bigger. In reserve, the lower the water yield is, the more stable the motor frequency is.

5.3.2 Special Settings for Single Phase Motors

1. When single phase motor is in bad running performance, the user can adjust P04 V/F curve settings: set P04.00 = 1 and set P04.03 ~ P04.08 to appropriate values according to commissioning conditions; increase the voltage if motor cannot start and decrease the voltage if the current is high.
2. When the light is normal and the system starts slowly, increase P15.28 initial voltage differential value appropriately.
3. For single phase motors with two-phase control (capacitor-removing):

① The max. voltage needs to be less than 1/1.6 of the bus voltage. It is recommended to set the rated voltage P02.04 less than 200V, or limit the max. voltage output by multi-dot V/F curve.

② P04.35 can be used to change the output currents of the main and secondary windings. It is recommended that qualified engineers perform adjustment since the voltage adjustment is associated with motor design parameters. Otherwise, the motor performance may be impacted.

Chapter 6 Function Parameters

The symbols in the function code table are described as follows:

"☆": The parameter can be modified when the inverter is in either stop or running state.

"★": The parameter cannot be modified when the inverter is in the running state.

"●": The parameter is the actually measured value and cannot be modified.

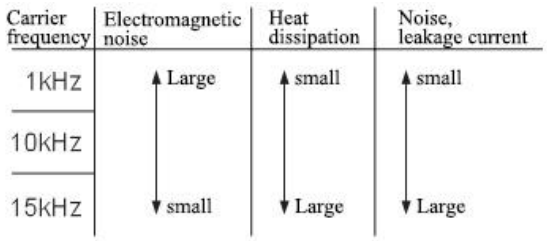
"*": The parameter is factory parameter and can be set only by the manufacturer.

Note: The inverter automatically checks and constrains the modification of parameters, which helps prevent incorrect modifications.

Function Code	Name	Setting Range	Default	Change
Group P0: Standard Function Parameters				
P00.00	Speed control mode	0: SVC 0 No need to install encoders. Suitable in applications which need low frequency, big torque for high accuracy of rotating speed and torque control. Relative to mode 1, it is more suitable for the applications which need small power. 1: SVC 1 1 is suitable in high performance cases with the advantage of high accuracy of rotating speed and torque. It does not need to install pulse encoder. 2: SVPWM control 2 is suitable in applications which do not need high control accuracy, such as the load of fan and pump, and suitable when one inverter drives multiple motors.	2	★
P00.01	Run command channel	Select the run command channel of the inverter. The control command of the inverter includes: start, stop, forward/reverse, fault reset, rotating and jogging. 0: Keypad running command channel (LOCAL/REMOT off) Carry out command control by RUN, STOP/RST on keypad. Set multi-function key QUICK/JOG to FWD/REV shifting function (P07.02 = 3) to change running direction; press RUN and STOP/RST simultaneously in running state to make the inverter coast to stop. 1: Terminal running command channel (LOCAL/REMOT flickering) Carry out the running command control by the forward rotation, reverse rotation and forward jogging and reverse jogging of the multi-function terminals. 2: Communication running command channel (LOCAL/REMOT on) The running command is controlled by the upper monitor via communication.	1	☆

Function Code	Name	Setting Range	Default	Change
P00.03	Max. output frequency	Setting range: P00.04 ~ 400.00Hz This parameter is used to set the max. output frequency of the inverter. Users need to pay attention to this parameter because it is the foundation of the frequency setting and the speed of acceleration and deceleration.	50.00Hz	★
P00.06	A Frequency command selection	0: Keypad digital setting The purpose of keypad setting frequency is achieved by modifying the value of P00.10 "keypad setting frequency". 1: Analog AI1 setting (corresponding to keypad analog potentiometer) 2: Analog AI2 setting (corresponding to terminal AI2) 3: Analog AI3 setting (corresponding to terminal AI3) The frequency is set by the analog input terminal. USFULL inverter is equipped with 3 analog input terminals as standard: • AI1 is adjusted by analog potentiometer. • AI2 is optional for voltage and current (0 ~ 10V/0 ~ 20mA), which can be switched by jumper. • AI3 is voltage input (-10 ~ +10V). **Note:** When analog AI2 selects 0 ~ 20mA input, the voltage corresponding to 20mA is 10V. The analog input setting of 100.0% corresponds to the max. output frequency (P00.03), and -100.0% corresponds to reverse max. output frequency (P00.03). 4: High-speed pulse HDI setting The frequency is set by the high-speed pulse terminal. USFULL is equipped with one high-speed pulse input as standard. The pulse frequency range is 0.00 ~ 50.00kHz. 100.0% of the high-speed pulse input setting corresponds to the max. output frequency (P00.03), and -100.0% corresponds to the reverse max. output frequency (P00.03). **Note:** The pulse setting can only be input through the multi-function input terminal HDI. Set P05.00 (HDI input type selection) to "high-speed pulse input" and P05.49 (HDI high-speed pulse input function selection) to "frequency setting input". 5: Simple PLC program setting When P00.06 = 5 or P00.07 = 5, the inverter runs in simple PLC program mode. It is necessary to set the parameters of the "Simple PLC and Multi-speed Control Group" of Group P10 to determine the operating frequency, operating direction, acceleration and deceleration time, and duration of the corresponding segment. Please refer to Group P10.	0	☆

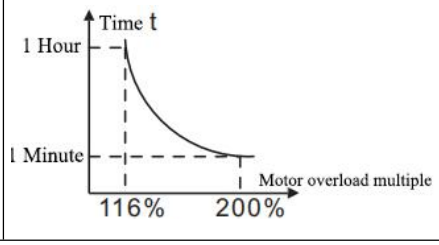
Function Code	Name	Setting Range	Default	Change
P00.06	A Frequency command selection	6: Multi-speed operation setting When P00.06 or P00.07 = 6, the inverter runs in multi-speed mode. The current running segment is selected by setting the multi-speed terminal combination in Group P05, and the current segment running frequency is determined by the parameters in Group P10. When P00.06 or P00.07 ≠ 6, the multi-speed setting has priority, but the setting segment can only be 1 ~ 15 segments. When P00.06 or P00.07 = 6, the setting segment is 0 ~ 15. 7: PID control setting When P00.06 or P00.07 = 7, the inverter operation mode is process PID control. At this time, it is necessary to set Group P9 "PID Control Group". The inverter operating frequency is the frequency value after PID action. For the meaning of PID given source, given amount, feedback source, etc., please refer to the introduction of Group P9 "PID Function". 8: Modbus communication setting The frequency is set by Modbus communication. Refer to the function introduction of Group P14. 9 ~ 11: Reserved **Note:** A frequency and B frequency cannot be set to same frequency setting mode.	0	☆
P00.10	Keypad setting frequency	Setting range: 0.00Hz ~ P00.03 (max. output frequency) When the A and B frequency commands are selected as “keypad setting”, the function code value is the initial value of the frequency digital setting of the inverter.	50.00Hz	☆
P00.11	Acceleration (ACC) time 1	Setting range of P00.11 and P00.12: 0.0 ~ 3600.0s Acceleration (ACC) time means the time needed if the inverter speeds up from 0Hz to the max. output frequency (P00.03). Deceleration (DEC) time means the time needed if the inverter speeds down from the max. output frequency to 0Hz (P00.03). FU9000SI series inverters have four groups of ACC/DEC time which can be selected by P5. The factory default ACC/DEC time of the inverter is the first group.	Model dependent	☆
P00.12	Deceleration (DEC) time 1		Model dependent	☆

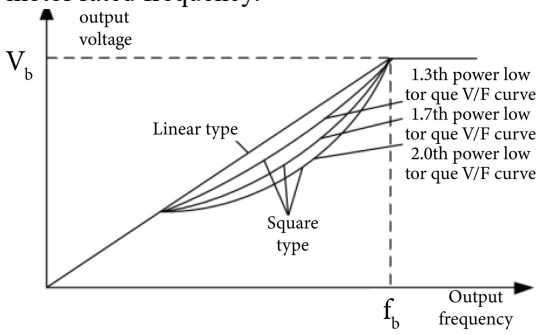
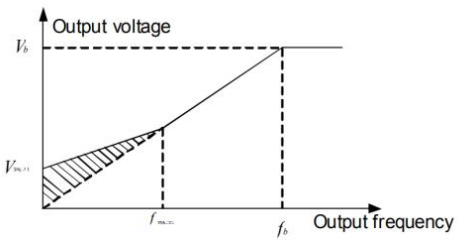
<table>
<tr><th>Function Code</th><th>Name</th><th>Setting Range</th><th>Default</th><th>Change</th></tr>
<tr><td>P00.13</td><td>Running direction selection</td><td>0: Runs at the default direction. The inverter runs in the forward direction. FWD/REV indicator is off.
1: Runs at the opposite direction. The inverter runs in the reverse direction. FWD/REV indicator is on.
Modify the function code to shift the rotation direction of the motor. This effect equals to the shifting the rotation direction by adjusting either two of the motor lines (U, V and W). The motor rotation direction can be changed by QUICK/JOG on keypad. Refer to parameter P07.02.
Note: When the function parameter comes back to the default value, the motor’s running direction will come back to the factory default state, too. In pump application scenarios, the inverter cannot run in the reverse direction. This function code cannot be modified.
2: Forbid to run in reverse direction: It can be used in some special cases if the reverse running is disabled.</td><td>0</td><td>☆</td></tr>
<tr><td>P00.14</td><td>Carrier frequency setting</td><td> 

The relationship between the model and the carrier frequency:
<table>
<tr><th>Model</th><th>Carrier Frequency Factory Value</th></tr>
<tr><td>0.75 ~ 11kW</td><td>8kHz</td></tr>
<tr><td>15kW</td><td>4kHz</td></tr>
</table>
Advantages of high carrier frequency: ideal current waveform, less current harmonics, and low motor noise.
Disadvantages of high carrier frequency: increased switching loss, increased inverter temperature rise, affected inverter output capacity, and the inverter needs to be derated at high carrier frequency; at the same time, inverter leakage current increases, and the electromagnetic interference to outside world increases.
Using a low carrier frequency is the opposite of the above situation. Too low a carrier frequency will cause unstable low-frequency operation, reduced torque, and even oscillation.
When the inverter leaves the factory, the manufacturer has set the carrier frequency reasonably. Under normal circumstances, the user does not need to change this parameter.
When the user uses a carrier frequency exceeding the default, it needs to be derated. For every 1kHz carrier frequency increase, the derate is 20%. Setting range: 1.0 ~ 15.0kHz</td><td>Model dependent</td><td>☆</td></tr>
</table>

Function Code	Name	Setting Range	Default	Change
P00.15	Motor parameter auto-tuning	0: No operation 1: Rotation auto-tuning Comprehensive motor parameter auto-tuning. It is recommended to use rotation auto-tuning when high control accuracy is needed. 2: Static auto-tuning 1 It is suitable in the cases when the motor cannot decouple form the load. Auto-tuning for motor parameter will impact control accuracy. 3: Static auto-tuning 2 (No auto-tuning for non-load current and mutual inductance.)	0	★
P00.18	Function restore parameter	0: No operation 1: Restore the default value 2: Clear fault records **Note:** The function code will restore to 0 after finishing operation of the selected function code. Restoring to the default value will cancel the user password. Use this function with caution.	0	★
Group P1: Start and Stop Control				
P01.08	Stop mode	0: Decelerate to stop After the stop command becomes valid, the inverter decelerates to reduce the output frequency during the set time. When the frequency decreases to 0Hz, the inverter stops. 1: Coast to stop After the stop command becomes valid, the inverter ceases the output immediately. The load coasts to stop due to mechanical inertia.	0	☆
P01.18	Operation protection	0: The terminal running command is invalid when powering on. 1: The terminal running command is valid when powering on.	1	☆
P01.21	Restart after power off	0: Disabled 1: Enabled	1	☆

Function Code	Name	Setting Range		Default	Change
Group P2: Motor 1 Parameters					
P02.00	Motor type	0: Asynchronous motor 1: Reserved		0	★
P02.01	Rated power of asynchronous motor	Set the parameter of the asynchronous motor. To ensure the controlling performance, set the P02.01 ~ P02.05 according to the nameplate of the asynchronous motor. FU9000SI series inverters provide the function of parameter auto-tuning. Correct parameter auto-tuning comes from the correct setting of the motor nameplate. To ensure the controlling performance, please configure the motor according to the standard principles. If the gap between the motor and the standard one is huge, the features of the inverter will decrease. **Note:** Resetting the rated power (P02.01) of the motor can initialize the motor parameters P02.02 ~ P02.10.	0.1~3000.0kW	Model dependent	★
P02.02	Rated frequency of asynchronous motor		0.01Hz~P00.03	50.00Hz	★
P02.03	Rated rotating speed of asynchronous motor		1~36000RPM	Model dependent	★
P02.04	Rated voltage of asynchronous motor		0~1200V	Model dependent	★
P02.05	Rated current of asynchronous motor		0.8~6000.0A	Model dependent	★
P02.06	Static resistor of asynchronous motor	After the motor parameter auto-tuning finishes, the set values of P02.06 ~ P02.10 will be updated automatically. These parameters are basic parameters controlled by vectors which directly impact the features. **Note:** Users cannot modify the parameters freely.	0.001~65.535Ω	Model dependent	☆
P02.07	Rotor resistor of asynchronous motor		0.001~65.535Ω	Model dependent	☆
P02.08	Leakage inductance of asynchronous motor		0.1~6553.5mH	Model dependent	☆
P02.09	Mutual inductance of asynchronous motor		0.1~6553.5mH	Model dependent	☆
P02.10	Non-load current of asynchronous motor		0.1~6553.5A	Model dependent	☆

Function Code	Name	Setting Range		Default	Change
P02.15	Rated power of synchronous motor	Used to set synchronous motor parameters. To ensure the control performance, set P02.15 ~ P02.19 correctly according to the information on the nameplate of the asynchronous motor. The inverter provides parameter auto-tuning function. Whether parameter auto-tuning can be performed properly depends on the settings of the motor nameplate parameters. In addition, you need to configure a motor according to the standard motor configuration of the inverter. If the power of the motor is greatly different from that of the standard motor configuration, the control performance of the inverter degrades significantly. **Note:** Resetting rated power of the motor (P02.15) can initialize the parameters P02.02 ~ P02.10.	0.1~3000.0kW	Model depended	★
P02.16	Rated frequency of synchronous motor		0.01~400.00Hz	50.00Hz	★
P02.17	Number of pole pairs of synchronous motor		1~50	2	★
P02.18	Rated voltage of synchronous motor		0~1200V	Model depended	★
P02.19	Rated current of synchronous motor		0.8~6000.0A	Model depended	★
P02.20	Stator resistance of synchronous motor	After motor parameter auto-tuning is properly performed, the values of P02.20 ~ P02.23 are automatically updated. These parameters are the benchmark parameters for high-performance vector control, directly affecting the control performance. **Note:** Do not modify these parameters unless it is necessary.	0.001~65.535Ω	Model depended	☆
P02.21	Direct-axis inductance of synchronous motor		0.01~655.35mH	Model depended	☆
P02.22	Quadrature-axis inductance of synchronous motor		0.01~655.35mH	Model depended	☆
P02.23	Counter-emf of synchronous motor		0~10000	300	☆
P02.27	Motor overload protection factor	Setting range: 20.0 ~ 120.0% Motor overload multiple M=Iout/(In*K) (A smaller value of K indicates a bigger value of M.) In: Rated current of the motor Iout: Output current of the inverter K: Motor overload protection factor • M=116% → The motor is protected for 1h when overloaded. • M=200% → The motor is protected for 60s when overloaded. • M≥400% → It is immediately protected. 		100.0%	☆

Function Code	Name	Setting Range	Default	Change
Group P4: V/F Control				
P04.00	V/F curve setting	These function codes define the V/F curve of FU9000SI series motor 1 to meet the need of different loads. 0: Straight line V/F curve, applying to the constant torque load 1: Multi-dots V/F curve 2: 1.3th power low torque V/F curve 3: 1.7th power low torque V/F curve 4: 2.0th power low torque V/F curve Curves 2 ~ 4 apply to the torque loads such as fans and water pumps. Users can adjust according to the features of the loads to get the best performance. 5: Customized V/F (V/F separation) In this mode, V can be separated from f, and f can be adjusted through the frequency given channel set by P00.06 or the voltage given channel set by P04.27 to change the feature of the curve. **Note:** V_b in the below picture is the motor rated voltage and f_b is the motor rated frequency. 	4	★
P04.01	Torque boost	P04.01 setting range : ① 0.0%: Automatic ② 0.1 ~ 10.0% P04.02 setting range: 0.0 ~ 50.0% Torque boost to the output voltage for the features of low frequency torque. P04.01 is for the max. output voltage V_b. P04.02 defines the percentage of closing frequency of manual torque to f_b. Torque boost should be selected according to the load. The bigger the load is, the bigger the torque is. Too big torque boost is inappropriate because the motor will run with over magnetic, and the current of the inverter will increase to add the temperature of the inverter and decrease the efficiency. When the torque boost is set to 0.0%, the inverter is automatic torque boost. Torque boost threshold: below this frequency point, the torque boost is valid, but over this frequency point, the torque boost is invalid. 	0.0%	☆
P04.02	Torque boost close		20.0%	☆

Function Code	Name	Setting Range	Default	Change
P04.09	V/F slip compensation gain	Setting range: 0.0 ~ 200.0% This function code is used to compensate the change of the rotation speed caused by load during compensation SVPWM control to improve the rigidity of the motor. It can be set to the rated slip frequency of the motor which is counted as below: △f = f_b-n*p/60 • f_b: Rated frequency of the motor → function code is P02.01 • n: Rated rotating speed of the motor → function code is P02.02 • p: Pole pair of the motor • 100.0% corresponds to the rated slip frequency △f	0.0%	☆
P04.10	Low frequency oscillation suppression factor	P04.10 and P04.11 setting range: 0 ~ 100 In the space voltage vector control mode, the motor, especially the high-power motor, is prone to current oscillation at certain frequencies. In mild cases, the motor cannot run stably, and in severe cases, it will cause the inverter to overcurrent. This parameter can be adjusted appropriately to eliminate this phenomenon.	10	☆
P04.11	High frequency oscillation suppression factor		10	☆
P04.12	Oscillation suppression cutoff point	Reversed	30.00Hz	☆
P04.34	Two phase control selection of single-phase motor	Setting range: 0x00 ~ 0x11 Units: Reserved Tens: Reversal of the secondary winding (V-phase) voltage 0: Not reversed 1: Reversed	0x00	★
P04.35	Voltage ratio of V-phase and U-phase	0.00 ~ 2.00	1.40	☆
P04.36	Reactive closed-loop KP	0 ~ 5000	50	☆
P04.37	Reactive closed-loop KI	0 ~ 5000	50	☆

Function Code	Name	Setting Range	Default	Change
Group P5: Input Terminals				
P05.01	S1 terminals function selection	0: No function 1: Forward rotation operation 2: Reverse rotation operation 3: 3-wire control operation 4: Forward jogging 5: Reverse jogging 6: Coast to stop 7: Fault reset 8: Operation pause 9: External fault input 10: Increasing frequency setting (UP) 11: Decreasing frequency setting (DOWN) 12: Cancel the frequency change setting 13: Shift between A setting and B setting 14: Shift between combination setting and A setting 15: Shift between combination setting and B setting 16: Multi-step speed terminal 1 17: Multi-step speed terminal 2 18: Multi-step speed terminal 3 19: Multi-step speed terminal 4 20: Multi-step speed pause 21: ACC/DEC time 1 22: ACC/DEC time 2 23: Simple PLC stop reset 24: Simple PLC pause 25: PID control pause 26: Traverse pause (stop at the current frequency) 27: Traverse reset (return to the center frequency) 28: Counter reset 29: Torque control prohibition 30: ACC/DEC prohibition 31: Counter trigger 32: Reserved 33: Cancel the frequency change setting 34: DC brake 35: Reserved 36: Shift the command to the keypad 37: Shift the command to terminals 38: Shift the command to communication 39: Pre-magnetized command 40: Clear the power 41: Keep the power 42: Forced switch to mains input (Switching-on indicates switching to mains input; switching-off indicates the input mode is controlled by the keypad.) 43: Full water signal 44: Non-water signal 45: Two-phase control mode of the single-phase motor 46: Boost module-free PV digital input (for auto switching) 47 ~ 63: Reserved	42	★
P05.02	S2 terminals function selection		43	★
P05.03	S3 terminals function selection		44	★
P05.04	S4 terminals function selection		45	★
P05.05	S5 terminals function selection		1	★
P05.09	HDI terminals function selection		46	★

<table>
<tr><th>Function Code</th><th>Name</th><th colspan="4">Setting Range</th><th>Default</th><th>Change</th></tr>
<tr><td rowspan="3">P05.10</td><td rowspan="3">Polarity selection of the input terminals</td><td colspan="4">0x000 ~ 0x018</td><td rowspan="3">0x000</td><td rowspan="3">★</td></tr>
<tr><td>BIT3</td><td>BIT2</td><td>BIT1</td><td>BIT0</td></tr>
<tr><td>S4</td><td>S3</td><td>S2</td><td>S1</td></tr>
<tr><td colspan="8">Group P6: Output Terminals</td></tr>
<tr><td>P06.03</td><td>Relay RO1 output selection</td><td colspan="4">0: Invalid
1: In operation
2: Forward rotation operation
3: Reverse rotation operation
4: Jogging operation
5: Inverter fault
6: Frequency degree test FDT1
7: Frequency degree test FDT2
8: Frequency arrival
9: Zero speed running
10: Upper limit frequency arrival
11: Lower limit frequency arrival
12: Ready for operation
13: Pre-magnetizing
14: Overload alarm
15: Underload alarm
16: Completion of simple PLC stage
17: Completion of simple PLC cycle
18: Setting count value arrival
19: Defined count value arrival
20: External fault valid
21: Reserved
22: Running time arrival
23: Modbus communication virtual terminals output
24 ~ 26: Reserved
27: Weak light
28 ~ 29: Reserved
30: Shift to PV mode
(If the system works in PV mode, relay output is high.)</td><td>30</td><td>☆</td></tr>
<tr><td>P06.10</td><td>Switch on delay of RO1</td><td colspan="4">0.000 ~ 50.000s</td><td>10.000s</td><td>☆</td></tr>
<tr><td>P06.11</td><td>Switch off delay of RO1</td><td colspan="4">0.000 ~ 50.000s</td><td>10.000s</td><td>☆</td></tr>
</table>

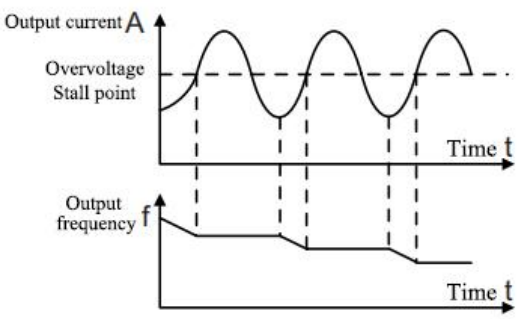
Function Code	Name	Setting Range	Default	Change
Group P7: Human-Machine Interface				
P07.00	User password	Setting range: 0 ~ 65535 When set the function code to a non-zero number, password protection is enabled. If set the function code to 00000, the previous user password is cleared and password protection 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 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 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 before using this function.	0	☆
P07.01	Parameter copy	Setting range: 0 ~ 4 0: No operation. 1: Upload parameters from the local address to the keypad. 2: Download parameters (including motor parameters) from the keypad to the local address. 3: Download parameters (excluding Group P2 and P12) from the keypad to the local address. 4: Download parameters (only including Group P2 and P12) from the keypad to the local address. **Note:** After any operation among 1 ~ 4 is complete, parameter restores to 0. The upload and download functions are not applicable to Group P29. The function is valid only for an external keypad that is an optional part and provides the parameter copy function.	0	★
P07.02	QUICK/JOG function election	0: No function 1: Jogging running. Press QUICK/JOG to begin the jogging running. 2: Shift the display state by the shifting key. Press QUICK/JOG to shift the displayed function code from right to left. 3: Shift between forward rotations and reverse rotations. Press QUICK/JOG to shift the direction of frequency commands. This function is only valid in the keypad commands channels. 4: Clear UP/DOWN settings. Press QUICK/JOG to clear the set value of UP/DOWN. 5: Coast to stop. Press QUICK/JOG to coast to stop. 6: Shift the running commands source. Press QUICK/JOG to shift the running commands source. 7: Quick commissioning mode. (based on non-factory parameters) **Note:** Press QUICK/JOG to shift between forward rotation and reverse rotation, the inverter does not record the state after shifting during powering off. The inverter will run according to parameter P00.13 during next powering on.	6	☆

Function Code	Name	Setting Range	Default	Change
P07.03	QUICK/JOG the shifting sequence of running command	When P07.02 = 6, set the shifting sequence of running command channels by QUICK/JOG key. 0: Keypad control→ Terminal control→ Communication control 1: Keypad control ←→ Terminal control 2: Keypad control ←→ Communication control 3: Terminal control ←→ Communication control	1	☆
P07.04	STOP/RST stop function	Select the stop function by STOP/RST. STOP/RST is effective in any state for the keypad reset. 0: Only valid for the keypad control 1: Both valid for keypad and terminals control 2: Both valid for keypad and communication control 3: Valid for all control modes	1	☆
P07.12	Converter module temperature	-20.0 ~ 120.0℃	-	●
P07.13	Control board software version	1.00 ~ 655.35	-	●
P07.14	The cumulative running time of this machine	0 ~ 65535h	-	●
P07.15	MSB of inverter power consumption	P07.15 setting range: 0 ~ 65535kWh (*1000) P07.16 setting range: 0.0 ~ 999.9kWh Display the power used by the inverter. Inverter power consumption = P07.15*1000 + P07.16	-	●
P07.16	LSB of inverter power consumption		-	●
P07.27	Current fault type	0: No fault 1: Inverter unit U-phase protection (OUt1) 2: Inverter unit V-phase protection (OUt2) 3: Inverter unit W-phase protection (OUt3) 4: Overcurrent during acceleration (OC1) 5: Overcurrent during deceleration (OC2) 6: Overcurrent during constant speed running (OC3)	-	●
P07.28	Previous fault type	7: Overvoltage during acceleration (OV1) 8: Overvoltage during deceleration (OV2) 9: Overvoltage during constant speed running (OV3) 10: Bus undervoltage (UV) 11: Motor overload (OL1) 12: Inverter overload (OL2) 13: Phase loss on input side (SPI) 14: Phase loss on output side (SPO)	-	●

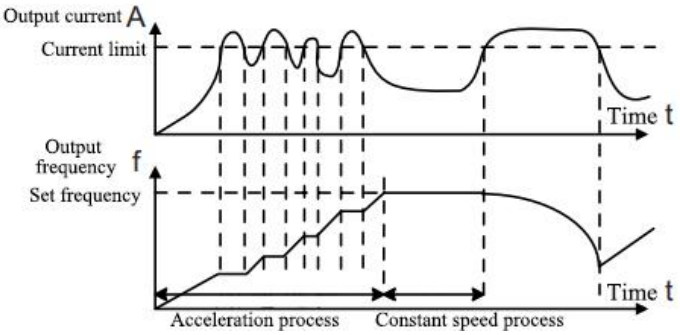
Function Code	Name	Setting Range	Default	Change
P07.29	Previous 2 fault type	15: Boost module overheat (OH1) 16: Inverter module overheat (OH2) 17: External fault (EF) 18: RS485 communication fault (CE) 19: Current detection fault (ItE) 20: Motor auto-tuning fault (tE) 21: EEPROM operation fault (EEP) 22: PID response offline fault (PIDE) 23: Braking unit fault (bCE) 24: Running time arrival (END) 25: Electrical overload (OL3) 26 ~ 31: Reserved 32: Grounding short circuit fault 1 (ETH1) 33: Grounding short circuit fault 2 (ETH2) 34: Speed deviation fault (dEu) 35: Maladjustment (STo) 36: Underload fault (LL) 37: Hydraulic probe damage (tSF) 38: PV reverse connection fault (PINV) 39: PV overcurrent (PVOC) 40: PV overvoltage (PVOV) 41: PV undervoltage (PVLV) 42: Fault on communication with the boost module (E-422) 43: Bus overvoltage detected on the boost module (OV) **Note:** Faults 38 ~ 40 are only detected in boost. The boost module stops working immediately after detecting a fault, while returning the fault information to the inverter module in the next data returning. **Alarms:** • Weak light alarm (A-LS) • Under load alarm (A-LL) • Full water alarm (A-tF) • Water-empty alarm (A-tL)	-	●
P07.30	Previous 3 fault type		-	●
P07.31	Previous 4 fault type		-	●
P07.32	Previous 5 fault type		-	●
P07.33	Running frequency at present fault	-	0.00Hz	●
P07.34	Ramp reference frequency at present fault	-	0.00Hz	●
P07.35	Output voltage at present fault	-	0V	●
P07.36	Output current at present fault	-	0.0A	●
P07.37	Bus voltage at present fault	-	0.0V	●
P07.38	Max. temperature at present fault	-	0.0℃	●
P07.39	Input terminal state at present fault	-	0	●

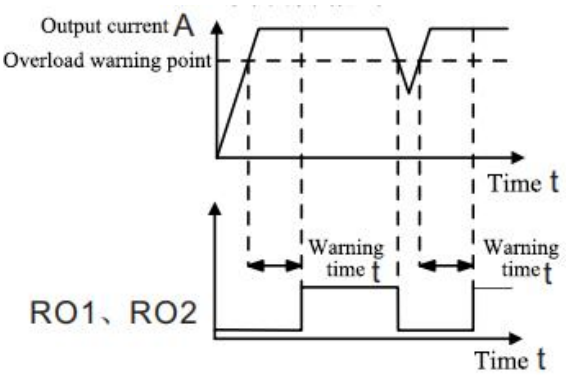
Function Code	Name	Setting Range	Default	Change
P07.40	Output terminal state at present fault	-	0	●
P07.41	Running frequency at last fault	-	0.00Hz	●
P07.42	Ramp reference frequency at last fault	-	0.00Hz	●
P07.43	Output voltage at last fault	-	0V	●
P07.44	Output current at last fault	-	0.0A	●
P07.45	Bus voltage at last fault	-	0.0V	●
P07.46	Max. temperature at last fault	-	0.0℃	●
P07.47	Input terminal state at last fault	-	0	●
P07.48	Output terminal state at last fault	-	0	●
P07.49	Running frequency at 2nd-last fault	-	0.00Hz	●
P07.50	Ramp reference frequency at 2nd-last fault	-	0.00Hz	●
P07.51	Output voltage at 2nd-last fault	-	0V	●
P07.52	Output current at 2nd-last fault	-	0.0A	●
P07.53	Bus voltage at 2nd-last fault	-	0.0V	●
P07.54	Max. temperature at 2nd-last fault	-	0.0℃	●
P07.55	Input terminal state at 2nd-last fault	-	0	●
P07.56	Output terminal state at 2nd-last fault	-	0	●

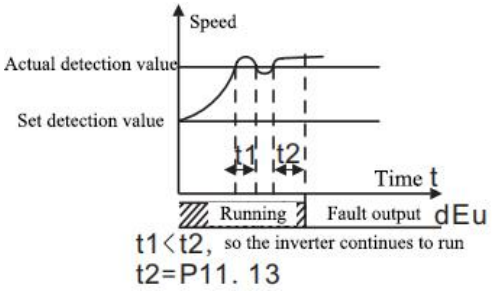
Function Code	Name	Setting Range	Default	Change
P07.57	Previous 6 fault type	0: No fault 1: Inverter unit U-phase protection (OUt1) 2: Inverter unit V-phase protection (OUt2) 3: Inverter unit W-phase protection (OUt3) 4: Overcurrent during acceleration (OC1) 5: Overcurrent during deceleration (OC2) 6: Overcurrent during constant speed running (OC3) 7: Overvoltage during acceleration (OV1) 8: Overvoltage during deceleration (OV2) 9: Overvoltage during constant speed running (OV3) 10: Bus undervoltage (UV) 11: Motor overload (OL1) 12: Inverter overload (OL2) 13: Phase loss on input side (SPI) 14: Phase loss on output side (SPO) 15: Boost module overheat (OH1) 16: Inverter module overheat (OH2) 17: External fault (EF) 18: RS485 communication fault (CE) 19: Current detection fault (ItE) 20: Motor auto-tuning fault (tE) 21: EEPROM operation error (EEP) 22: PID feedback disconnection (PIDE) 23: Braking unit fault (bCE) 24: Running time reached (END) 25: Electronic overload (OL3) 26 ~ 31: Reserved 32: To-ground short-circuit fault 1 (ETH1) 33: To-ground short-circuit fault 2 (ETH2) 34: Speed deviation fault (dEu) 35: Maladjustment (STo) 36: Underload fault (LL) 37: Hydraulic probe damage (tSF) 38: PV reverse connection fault (PINV) 39: PV overcurrent (PVOC) 40: PV overvoltage (PVOV) 41: PV undervoltage (PVLV) 42: Fault on 422 communication with the boost module (E-422) 43: Bus overvoltage detected on the boost module (OV) **Note:** Faults 38 ~ 40 are only detected in boost. The boost module stops working immediately after detecting a fault, while returning the fault information to the inverter module in the next data returning. **Alarms:** • Light-weak pre-alarm (A-LS) • Underload pre-alarm (A-LL) • Full-water pre-alarm (A-tF) • Empty-water pre-alarm (A-tL)	-	●
P07.58	Previous 7 fault type		-	●
P07.59	Previous 8 fault type		-	●
P07.60	Previous 9 fault type		-	●
P07.61	Previous 10 fault type		-	●
P07.62	Previous 11 fault type		-	●
P07.63	Previous 12 fault type		-	●
P07.64	Previous 13 fault type		-	●
P07.65	Previous 14 fault type		-	●
P07.66	Previous 15 fault type		-	●
P07.67	Previous 16 fault type		-	●
P07.68	Previous 17 fault type		-	●
P07.69	Previous 18 fault type		-	●
P07.70	Previous 19 fault type		-	●
P07.71	Previous 20 fault type		-	●

<table>
<tr><th>Function Code</th><th>Name</th><th>Setting Range</th><th>Default</th><th>Change</th></tr>
<tr><td colspan="5">Group P8: Enhanced Functions</td></tr>
<tr><td>P08.28</td><td>Interval time of auto fault reset count</td><td>0 ~ 10</td><td>5</td><td>☆</td></tr>
<tr><td>P08.29</td><td>Interval time of auto fault reset count</td><td>0.1 ~ 3600.0s</td><td>10.0s</td><td>☆</td></tr>
<tr><td>P08.53</td><td>Enable hidden function codes</td><td>-</td><td>0</td><td>☆</td></tr>
<tr><td colspan="5">Group P11: Protective Parameters</td></tr>
<tr><td>P11.00</td><td>Phase loss protection</td><td>Setting range: 0x000 ~ 0x011
LED units:
0: Input phase loss software protection disabled
1: Input phase loss software protection enabled
LED tens:
0: Input phase loss software protection disabled
1: Input phase loss software protection enabled
LED hundreds: Reserved</td><td>Model depended</td><td>☆</td></tr>
<tr><td>P11.01</td><td>Voltage point for frequency drop at transient power-off</td><td>20.0%-120.0%</td><td>80.0%</td><td>☆</td></tr>
<tr><td>P11.02</td><td>Frequency decrease ratio at sudden power loss</td><td>Setting range: 0.00Hz/s ~ P00.03
After the power lass of the grid, the bus voltage drops to the sudden frequency decrease point, the inverter begin to decrease the running frequency at P11.02, to make the inverter generate power again. The returning power can maintain the bus voltage to ensure a rated running of the inverter until the recovery of power.<table><tr><td>Voltage Degree</td><td>220V</td><td>400V</td></tr><tr><td>Frequency Decrease Point</td><td>260V</td><td>460V</td></tr></table></td><td>0.00Hz/s</td><td>☆</td></tr>
<tr><td>P11.03</td><td>Overvoltage stall protection</td><td>0: Disable
1: Enable 
</td><td>1</td><td>☆</td></tr>
</table>

Function Code	Name	Setting Range	Default	Change
P11.04	Overvoltage stall protection voltage	120 ~ 150% (standard bus voltage) (380V)	140%	☆
		120 ~ 150% (standard bus voltage) (220V)	120%	
P11.05	Current limiting action selection	Setting range: 0x00 ~ 0x12 Units: Current limiting action selection 0: Current limiting action invalid 1: Current limiting action is always valid Tens: Hardware current limiting overload alarm selection 0: Hardware current limiting overload alarm valid 1: Hardware current limiting overload alarm invalid	0x01	★
P11.06	Automatic current limiting level	P11.06 setting range: 50.0 ~ 200.0% P11.07 setting range: 0.00 ~ 50.00Hz/s During the acceleration operation of the inverter, due to excessive load, the actual increase rate of the motor speed is lower than the increase rate of the output frequency. If no measures are taken, it will cause an acceleration overcurrent fault and cause the inverter to trip. The current limiting protection function detects the output current during the operation of the inverter and compares it with the current limiting level defined by P11.06. • If it exceeds the current limiting level and is in acceleration operation, the inverter will operate at a stable frequency. • If it is in constant speed operation, the inverter will operate at a reduced frequency. • If it continues to exceed the current limiting level, the inverter output frequency will continue to decrease until the lower limit frequency. • When the output current is detected to be lower than the current limiting level again, it will continue to accelerate.	P type: 110.0% G type: 160.0%	★
P11.07	Frequency reduction rate during current limiting		10.00Hz/s	★



Function Code	Name	Setting Range	Default	Change
P11.08	Inverter/Motor overload and underload pre-alarm selection	P11.08 setting range: 0x000 ~ 0x131 P11.09 setting range: P11.11 ~ 200% P11.10 setting range: 0.1 ~ 60.0s If the inverter or motor output current exceeds the overload warning detection level (P11.09) and the duration exceeds the overload warning detection time (P11.10), an overload warning signal will be output.  Enable and define the pre-overload alarm function of the inverter and motor. LED units: 0: Motor overload and underload pre-alarm, relative to the rated current of the motor 1: Inverter overload and underload pre-alarm, relative to the rated current of the inverter LED tens: 0: Inverter continues to run after overload and underload alarm 1: Inverter continues to run after underload alarm, and stops running after overload fault 2: Inverter continues to run after overload alarm, and stops running after underload fault 3: Inverter stops running after overload and underload fault LED hundreds: 0: Always detect 1: Detect during constant speed operation	0x000	☆
P11.09	Overload warning detection level		G type: 150%	☆
P11.10	Overload pre-alarm detection time		1.0s	☆
P11.11	Underload pre-alarm detection level	P11.11 setting range: 0% ~ P11.09 P11.12 setting range: 0.1 ~ 60.0s If the inverter or motor output current is less than the underload pre-alarm detection level (P11.11) and the duration exceeds the underload warning detection time (P11.12), an underload warning signal is output.	50%	☆
P11.12	Underload pre-alarm detection time		1.0s	☆

Function Code	Name	Setting Range	Default	Change
P11.13	Fault output terminal action selection when fault occurs	Setting range: 0x00 ~ 0x11 Select the action of the fault output terminal during under voltage and fault automatic reset. LED units: 0: Action during undervoltage fault 1: No action during undervoltage fault LED tens: 0: Action during automatic reset 1: No action during automatic reset	0x00	☆
P11.14	Speed deviation detection value	0.0 ~ 50.0% (Used to set the speed deviation detection value.)	10.0%	☆
P11.15	Speed deviation detection time	0.0 ~ 10.0s (Used to set the speed deviation detection time.) 	0.5s	☆
Group P14: Serial Communication				
P14.00	Local communication address	Setting range: 1 ~ 247 When the master writes the slave communication address to 0 indicating a broadcast address in a frame, all the salves on the Modbus bus receive the frame but do not respond to it. Local communication address is unique in the communication network, which is the basis for point-to-point communication between the upper computer and the inverter. **Note:** The communication address of a slave cannot be set to 0.	1	☆
P14.01	Communication baud rate	The function code is used to set the data transmission speed between upper computer and the inverter. 0: 1200BPS 1: 2400BPS 2: 4800BPS 3: 9600BPS 4: 19200BPS 5: 38400BPS 6: 57600BPS **Note:** The baud rate set on the inverter must be consistent with that on the upper computer. Otherwise, the communication fails. A greater baud rate indicates faster communication.	4	☆

Function Code	Name	Setting Range	Default	Change
P14.02	Data bit check	The data format set on the inverter must be consistent with that on the upper computer. Otherwise, the communication fails. 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	1	☆
P14.03	Communication response delay	Setting range: 0 ~ 200ms The function code indicates the communication response delay, that is, the interval from when the inverter completes receiving data to when it sends response data to the upper computer. If the response delay is shorter than the inverter processing time, the inverter sends response data to the upper computer after processing data. If the delay is longer than the inverter processing time, the inverter does not send response data to the upper computer until the delay is reached although data has been processed.	5ms	☆
P14.04	RS485 communication timeout period	Setting range: 0.0 (invalid) ~ 60.0s When the function code is set to 0.0, the communication timeout time is invalid. When the function code is set a non-zero value, the rectifier reports the "485 communication fault" (CE) if the communication interval exceeds the value. In general, the function code is set to 0.0. When continuous communication is required, you can set the function code to monitor communication status.	0.0s	☆
Group P15: Special Functions for PV Inverters				
P15.00	PV inverter selection	0: Invalid 1: Enable 0 means the function is invalid and the group of parameters cannot be used. 1 means the function is enabled, and P15 parameters can be adjusted.	1	★
P15.01	Vmpp voltage reference	0: Voltage reference 1: Max. power tracking 0 means to apply voltage reference mode. The reference is a fixed value and given by P15.02. 1 means to apply the reference voltage of the max. power tracking. The voltage is changing until the system is stable. **Note:** If terminal 43 is valid, the function is invalid.	1	★

Function Code	Name	Setting Range	Default	Change
P15.02	Vmpp voltage keypad reference	Setting range: 0.0 ~ 6553.5V DC If P15.01=0, the reference voltage is given by P15.02. (During test, reference voltage should be lower than PV input voltage; otherwise, the system will run at lower limit of frequency).	250.0V	☆
P15.03	PI control deviation	Setting range: 0.0 ~ 100.0% (100.0% corresponds to P15.02) If the ratio percentage of real voltage to reference voltage, which is abs (bus voltage-reference voltage)*100.0% /reference voltage, exceeds the deviation limit of P15.03, PI adjustment is available; otherwise, there is no PI adjustment and the value is defaulted to be 0.0%. abs: Absolute value	0.0%	☆
P15.04	Upper frequency of PI output	Setting range: P15.05 ~ 100.0% (100.0% corresponds to P00.03) P15.04 is used to limit the max. value of target frequency, and 100.0% corresponds to P00.03. After PI adjustment, the target frequency cannot exceed the upper limit.	100.0%	☆
P15.05	Lower frequency of PI output	Setting range: 0.0% ~ P15.04 (100.0% corresponds to P00.03) P15.05 is used to limit the min. value of target frequency, and 100.0% corresponds to P00.03. After PI adjustment, the target frequency cannot be less than the lower limit.	20.0%	☆
P15.06	KP1	Setting range: 0.00 ~ 100.00 Proportion coefficient 1 of the target frequency. The bigger the value is, the stronger the effect and faster the adjustment is.	5.00	☆
P15.07	KI1	Setting range: 0.00 ~ 100.00 Integral coefficient 1 of the target frequency. The bigger the value is, the stronger the effect and faster the adjustment is.	5.00	☆
P15.08	KP2	Setting range: 0.00 ~ 100.00 Proportion coefficient 2 of the target frequency. The bigger the value is, the stronger the effect and faster the adjustment is.	35.00	☆
P15.09	KI2	Setting range: 0.00 ~ 100.00 Integral coefficient 2 of the target frequency. The bigger the value is, the stronger the effect and faster the adjustment is.	35.00	☆
P15.10	PI switching point	Setting range: 0.0 ~ 6553.5V DC If the absolute value of bus voltage minus the reference value is bigger than P15.10, it will switch to P15.08 and P15.09; otherwise, it is P15.06 and P15.07.	20.0V	☆

Function Code	Name	Setting Range	Default	Change
P15.11	Water level control	0: Digital input of the water-level control 1: AI1 (the water-level signal is input through AI1, not supported currently) 2: AI2 (the water-level signal is input through AI2) 3: AI3 (the water-level signal is input through AI3) If the function code is 0, the water-level signal is controlled by the digital input. See 43 and 44 functions of S terminals in Group P5 for detailed information. If the full-water signal is valid, the system will report the alarm (A-tF) and sleep after the time of P15.14. During the alarm, the full-water signal is invalid and the system will clear the alarm after the time of P15.15. If the empty-water signal is valid, the system will report the alarm (A-tL) and sleep after the time of P15.16. During the alarm, the empty -water signal is invalid and the system will clear the alarm after the time of P15.17. If the function code is 1 ~ 3, it is the reference of water-level control analog signal. For details, see P15.12 and P12.13.	0	★
P15.14	Full water delay	Setting range: 0 ~ 10000s Time setting of full water delay. (This function code is still valid when the digital indicates the full-water signal.)	5s	☆
P15.15	Wake-up delay in full water state	Setting range: 0 ~ 10000s Time setting of wake-up delay in full-water state. (This function code is still valid when the digital indicates the full-water signal.)	20s	☆
P15.16	Empty-water delay	Setting range: 0 ~ 10000s Time setting of empty-water delay. (This function code is still valid when the digital indicates the empty-water signal.)	5s	☆
P15.17	Wake-up delay in empty-water state	Setting range: 0 ~ 10000s Time setting of wake-up delay in empty-water state. (This function code is still valid when the digital indicates the empty-water signal.)	20s	☆
P15.18	Hydraulic probe damage	Setting range: 0.0 (invalid) ~ 100.0% If it is not 0.0%, when the signal is longer than P15.18, it will report tSF fault directly and stop.	0.0%	☆
P15.19	Operation time of water pump underload	Setting range: 0.0 ~ 1000.0s This parameter is used to set the operation time of water pump underload. Under the continuous underload operation, underload pre-alarm (A-LL) will be reported if operation time is reached.	60.0s	☆

Function Code	Name	Setting Range	Default	Change
P15.20	Current detection value of underload operation	Setting range: 0.0%: Automatic underload detection 0.1 ~ 100.0% If it is 0.0%, it is determined by the underload detection of the water pump inverter. If it is not 0.0%, it is determined by P15.20. 100.0% corresponds to the rated current of the motor. If the target frequency and the absolute value of the ramp frequency is less than or equal to P15.22, and the current is less than P15.20, after the time set by P15.19, underload fault is reported. Otherwise, it will be operated normally. If the state is not continuous, the delay counting will be cleared automatically.	0.0%	☆
P15.21	Underload reset delay	Setting range: 0.0 ~ 1000.0s This parameter is used to set the underload reset delay. The operation time and reset time are counted at the same time during underload, and it is generally bigger than P15.19 so as to ensure underload pre-alarm is reported after underload delay operation time is reached. After the time set by P15.21 ~ P15.19, it is reset. If the value is the same as P15.19, it is automatically reset when underload pre-alarm is reported.	120.0s	☆
P15.22	Lag frequency threshold	Setting range: 0.00 ~ 200.00Hz P15.22 is the lag frequency threshold for the analysis of the underload operation. If the target frequency and the absolute value of the ramp frequency is less than or equal to P15.22, the current will be compared.	0.30Hz	☆
P15.23	Delay time of weak light	Setting range: 0.0 ~ 3600.0s Delay time of weak light If the output frequency is less than or equal to the lower limit of PI output frequency and the state lasts for the set value, it will report A-LS and sleep. If the state is not continuous, the delay counting will be cleared automatically. **Note:** If the bus voltage is lower than the under voltage point or the PV voltage is lower than 70V, it will report the weak light alarm without any delay time. If P15.32 = 0, the system will switch to the mains input when the light is weak.	100.0s	☆
P15.24	Delay time of wake-up at weak light	Setting range: 0.0 ~ 3600.0s Delay time of wake-up at weak light. If the weak light alarm is reported, after the delay time of wake-up, the alarm will be cleared and it will run again. When P15.32 = 0, if the PV voltage is higher than P15.34, after the delay time, it will switch to PV input mode.	300.0s	☆

<table>
<tr><th>Function Code</th><th>Name</th><th>Setting Range</th><th>Default</th><th>Change</th></tr>
<tr><td>P15.25</td><td>Initial reference voltage display</td><td>0.0 ~ 2000.0V</td><td>0.0V</td><td>●</td></tr>
<tr><td>P15.26</td><td>Min. voltage reference during max. power tracking</td><td>Setting range: 0.00 ~ 1.00
This function code is used to set the min. voltage reference during max. power tracking.
Min. voltage reference during max. power tracking = Solar panel open-circuit voltage*P15.26.
Solar panel open-circuit voltage = P15.25 + P15.28.
Track the max. power in the range of min. voltage reference ~ P15.27. The P15.27 must be greater than min. voltage reference. The less the difference, the faster the tracking is. The max. voltage needs to be in the range. P15.26 and P15.27 can be adjusted according to site operation.</td><td>0.70</td><td>☆</td></tr>
<tr><td>P15.27</td><td>DI status upon 2nd fault</td><td>Min. voltage reference during max. power tracking ~ P15.31. Valid in MPPT max. tracking voltage, the tracked max. voltage. The default value depends on model.
<table>
<tr><th>Model</th><th>Max. Voltage Reference</th><th>Max. Vmppt</th></tr>
<tr><td>-SS2</td><td>400.0V</td><td>400.0V</td></tr>
<tr><td>-S2</td><td>400.0V</td><td>400.0V</td></tr>
<tr><td>-2</td><td>400.0V</td><td>400.0V</td></tr>
<tr><td>-4</td><td>800.0V</td><td>800.0V</td></tr>
<tr><td>-9</td><td>800.0V</td><td>800.0V</td></tr>
</table></td><td>400.0V</td><td>☆</td></tr>
<tr><td>P15.28</td><td>Adjustment of initial reference voltage</td><td>Setting range: 0.0 ~ 200.0V
MPPT begins to change from the reference voltage.
Initial reference voltage = PV voltage - P15.28.</td><td>5.0V</td><td>☆</td></tr>
<tr><td>P15.29</td><td>Adjustment of upper and lower limit time of Vmppt</td><td>Setting range: 0.0 ~ 10.0s
When P15.29 is set to 0.0, the automatic adjustment is invalid.
If it is not 0.0, the upper and lower limits of Vmppt will be adjusted automatically at the internal set by P15.29.
The medium value is the current PV voltage and the limit is P15.30: Max./ Min. reference voltage = Current PV voltage ± P15.30, and it will update to P15.26 and P15.27 at the same time.</td><td>1.0s</td><td>☆</td></tr>
<tr><td>P15.30</td><td>Adjustment of upper and lower limits of Vmppt</td><td>Setting range: 5.0 ~ 100.0V
Adjustment of the upper and lower limits.</td><td>30.0V</td><td>☆</td></tr>
<tr><td>P15.31</td><td>Max. value of Vmppt</td><td>Setting range: P15.27 ~ 6553.5V
During the max. power tracking, the upper limit of solar panel reference voltage will not exceed P15.31. The factory value depends on the model. By default, the value for the -4 and -9 models is 750.0V, and the value for other models is 400.0V.</td><td>400.0V</td><td>☆</td></tr>
</table>

<table>
<tr><th>Function Code</th><th>Name</th><th>Setting Range</th><th>Default</th><th>Change</th></tr>
<tr><td>P15.32</td><td>PV input and mains input selection</td><td>0: Automatic shift
1: Mains input
2: PV input
If the value is 0, the system will switch between PV input and mains input according to the detected PV voltage and threshold.
If the value is 1, the system will force to switch to mains input.
If the value is 2, the system will force to switch to PV input.
Note:
When the terminal input 42 is valid, the function code will be invalid.</td><td>2</td><td>★</td></tr>
<tr><td>P15.33</td><td>Threshold to switch to mains input</td><td>Setting range: 0.0V ~ P15.34
If PV voltage is lower than the threshold or the light is weak, it can switch to mains input through the relay output.
Note:
If the value is 0, it is invalid.
For inverters without the boost module, the switching point voltage is determined by the external voltage detection circuit. For inverters with the boost module, the switching point voltage is 70.0V.</td><td>70.0V</td><td>☆</td></tr>
<tr><td>P15.34</td><td>Threshold to switch to PV input</td><td>Setting range: P15.33 ~ 400.0V
If PV voltage is greater than the threshold, it can switch to PV input through the relay output after the time set by P15.24. To prevent frequent switching, this threshold must be greater than P15.33. If the value is 0.0, it is invalid.
The default value depends on model.</td><td>100.0V</td><td>☆</td></tr>
<tr><td>P15.35</td><td>Rated pump flow</td><td>The pump flow is Q_N when the pump runs at the rated pump frequency and rated lift.</td><td>0.0m³/h</td><td>☆</td></tr>
<tr><td>P15.36</td><td>Rated pump lift</td><td>The pump lift is H_N when the pump runs at the rated frequency and rated current.</td><td>0.0m</td><td>☆</td></tr>
<tr><td>P15.37</td><td>Voltage setting at PV under voltage point</td><td>Setting range: 0.0 ~ 400.0V
When the PV voltage is less than the preset voltage, the system reports the PV under voltage (UV) fault.
The default value depends on the model.
<table>
<tr><th>Model</th><th>PV UV Point</th></tr>
<tr><td>-SS2</td><td>140.0V</td></tr>
<tr><td>-S2</td><td>140.0V</td></tr>
<tr><td>-2</td><td>140.0V</td></tr>
<tr><td>-4</td><td>240.0V</td></tr>
<tr><td>-9</td><td>240.0V</td></tr>
<tr><td>Any model with the boost module</td><td>70.0V</td></tr>
</table></td><td>70.0V</td><td>☆</td></tr>
</table>

Function Code	Name	Setting Range	Default	Change
P15.39	Model	Setting range: 0 ~ 3 0: -SS2 (1PH 220V input and 1PH 220V output) 1: -S2 (1PH 220V input and 3PH 220V output) 2: -2 (3PH 220V input and 3PH 220V output) 3: -4 (3PH 380V input and 3PH 380V output) This function code is provided for users to change models. For example, if the user wants to use model -4 (default after factory delivery) as model -2, P15.39 must be set to 2.	Model depended	★
P15.40	PQ curve fitting enabling	Setting range: 0 ~ 1 0: Disable 1: Enable Enable P15.40, and use the point between P15.41 and P15.50 for PQ curve fitting calculation. In this way, the flow calculation will be more accurate.	0	★
P15.41	Power point 1 of PQ curve	Setting range: 0.0 ~ 1000.0kW It indicates the power point corresponding to the pump input power at the 1st point of the PQ curve.	0.0kW	★
P15.42	Power point 2 of PQ curve	Setting range: 0.0 ~ 1000.0kW It indicates the power point corresponding to the pump input power at the 2nd point of the PQ curve.	0.0kW	★
P15.43	Power point 3 of PQ curve	Setting range: 0.0 ~ 1000.0kW It indicates the power point corresponding to the pump input power at the 3rd point of the PQ curve.	0.0kW	★
P15.44	Power point 4 of PQ curve	Setting range: 0.0 ~ 1000.0kW It indicates the power point corresponding to the pump input power at the 4th point of the PQ curve.	0.0kW	★
P15.45	Power point 5 of PQ curve	Setting range: 0.0 ~ 1000.0kW It indicates the power point corresponding to the pump input power at the 5th point of the PQ curve.	0.0kW	★
P15.46	Flow point 1 of PQ curve	Setting range: 0.0 ~ 1000.0m³/h It indicates the flow point corresponding to the pump flow at the 1st point of the PQ curve.	0.0m³/h	★
P15.47	Flow point 2 of PQ curve	Setting range: 0.0 ~ 1000.0m³/h It indicates the flow point corresponding to the pump flow at the 2nd point of the PQ curve.	0.0m³/h	★
P15.48	Flow point 3 of PQ curve	Setting range: 0.0 ~ 1000.0m³/h It indicates the flow point corresponding to the pump flow at the 3rd point of the PQ curve.	0.0m³/h	★
P15.49	Flow point 4 of PQ curve	Setting range: 0.0 ~ 1000.0m³/h It indicates the flow point corresponding to the pump flow at the 4th point of the PQ curve.	0.0m³/h	★

Function Code	Name	Setting Range	Default	Change
P15.50	Flow point 5 of PQ curve	Setting range: 0.0 ~ 1000.0m³/h It indicates the flow point corresponding to the pump flow at the 5th point of the PQ curve.	0.0m³/h	★
P15.51	Efficiency of pump	Setting range: 0 ~ 100% This function code indicates the overall efficiency of the pump.	80%	☆
Group P17: PV State Viewing				
P17.01	Output frequency	Setting range: 0.00Hz ~ P00.03 Display the current output frequency of the inverter.	0.00Hz	●
P17.03	Output voltage	Setting range: 0 ~ 1200V Display the current output voltage of the inverter.	0V	●
P17.04	Output current	Setting range: 0.0 ~ 5000.0A Display the current output current effective value of inverter.	0.0A	●
P17.08	Motor power	Setting range: -300.0 ~ 300.0% (relative to the rated power of the motor) Display the current motor power, 100.0% relative to the rated power value of the motor, positive value is the motoring state, negative value is the generating state.	0.0%	●
P17.11	DC bus voltage	Setting range: 0.0 ~ 2000.0V Display the current DC bus voltage of the inverter.	0.0V	●
P17.12	Switch input terminal status	Setting range: 0000 ~ 00FF Display the current state of the switch input terminal of the inverter.	0x0000	●
P17.13	Switch output terminal status	Setting range: 0000 ~ 00FF Display the current state of the switch output terminal of the inverter.	0x0000	●
P17.38	Current of the main winding	Setting range: 0.00 ~ 100.00A It is the current of the main winding when applying capacitance-removing to control the single phase motor.	0.00A	●
P17.39	Current of the secondary winding	Setting range: 0.00 ~ 100.00A It is the current of the secondary winding when applying capacitance-removing to control the single phase motor.	0.00A	●
Group P18: PV State Viewing Special for Inverter				
P18.00	PV reference voltage	MPPT is implemented at the converter side. This value is determined at the converter side.	0.0V	●
P18.01	Current PV voltage	It is transferred from the boost module or equal to the bus voltage.	0.0V	●
P18.02	Display of MPPT min. reference voltage	The value displays the min. voltage reference during max. power tracking. It equals the solar panel open-circuit voltage multiplied P15.26.	0.0V	●

Function Code	Name	Setting Range	Default	Change
P18.04	Present inductive current	It is transferred from the boost module, and valid only in AC mode and invalid in PV mode.	0.0A	●
P18.08	Output power	0.00 ~ 655.35kW	0.0kW	●
P18.09	Previous PV voltage	0.0 ~ 6553.5V	0.0V	●
P18.10	Device configuration display	Setting range: 0x00 ~ 0x11 LED units: 0: PV power supply 1: AC grid power supply LED tens: 0: Detection indicates the system contains the boost module. 1: Detection indicates the system does not contain boost module.	0x00	●
P18.11	Current pump flow	$Q = Q_N * f / f_N$	0.0m³/h	●
P18.12	Current pump lift	$H = 0.9H_N * (f / f_N)^2$	0.0m	●
P18.13	MSBs in total pump flow	This function code displays the 16 most significant bits (MSBs) in the total pump flow.	0m³	●
P18.14	LSBs in total pump flow	This function code displays the 16 least significant bits (LSBs) in the total pump flow. Total pump flow = P18.13 * 65535 + P18.14	0.0m³	●
P18.15	Total pump flow resetting	Setting this value to 1 can reset the total pump flow. P18.13 and P18.14 will accumulate the flow after resetting. After the resetting succeeds, P18.15 is automatically set to 0.	0	★
Group P19: Voltage Boost (Inverter Module Communicates with Boost Module)				
P19.00	Boost voltage loop KP	0.000 ~ 65.535	0.500	☆
P19.01	Boost voltage loop KI	0.000 ~ 65.535	0.080	☆
P19.02	Boost current loop KP	0.000 ~ 65.535	0.010	☆
P19.03	Boost current loop KI	0.000 ~ 65.535	0.010	☆
P19.04	Upper limit of output current of boost voltage loop PI	Setting range: P19.05 ~ 15.0A Upper limit output of MPPT voltage loop PI, upper limit of the boost current loop reference current.	12.0A	☆

Function Code	Name	Setting Range	Default	Change
P19.06	Bus reference voltage	Setting range: 300.0 ~ 600.0V This function code is set to the bus reference voltage at PV input when the system contains the boost module. By default, this function code is set to 350.0V for models of 220V and 570.0V for models of 380V.	350.0V	★
P19.07	Boost voltage loop KP1	Setting range: 0.000 ~ 65.535 If the difference between the bus reference voltage and actual bus voltage is greater than 20V, the boost voltage loop uses this group PI parameter. Otherwise, the boost voltage loop uses the first group PI parameter.	0.500	☆
P19.08	Boost voltage loop KI1	Setting range: 0.000 ~ 65.535 If the difference between the bus reference voltage and actual bus voltage is greater than 20V, the boost voltage loop uses this group PI parameter. Otherwise, the boost voltage loop uses the first group PI parameter.	0.080	☆
P19.10	Boost software version	Once being powered, the boost module sends its version information to the converter module.	0.00	★

Note:

The time when the inverter operated to the lower limit of PI output frequency after inverter start-up is determined by the ACC time.

Delay time counting follows the rules if multiple fault conditions are met simultaneously: For example, if all fault conditions of weak light, full water, and underload are met at the same time, the inverter will count the delay time for each fault independently. If the delay time of a fault is reached, the fault is reported. The delay time counting of the other two faults keeps. If the reported fault is resolved but the conditions of the other two faults persist, the delay time counting of the other two faults continues. If a fault condition is not met during counting, the delay time of this fault is cleared.

Chapter 7 Fault Diagnosis and Solution

Do as follows after the inverter encounters a fault:

1. Check to ensure there is nothing wrong with the keypad. If not, please contact with the local USFULL office.
2. If there is nothing wrong, please check Group P7 and ensure the corresponding recorded fault parameters to confirm the real state when the current fault occurs by all parameters.
3. See the following table for detailed solution and check the corresponding abnormal state.
4. Eliminate the fault and ask for relative help.
5. Check to eliminate the fault and carry out fault reset to run the inverter.

Note: The numbers enclosed in square brackets such as [1], [2] and [3] in the fault type column in the following table indicate the inverter fault type codes read through communication.

Fault Code	Fault Type	Possible Cause	Solution
OUt1	Inverter unit U-phase protection	1. The acceleration is too fast. 2. The IGBT is damaged internally. 3. Interference causes misoperation. 4. Drive wires are poorly connected. 5. The load transients or is abnormal. 6. The grounding is short circuited.	1. Increase the acceleration time. 2. Change the power unit. 3. Check the drive wire. 4. Check whether the peripheral equipment has strong interference sources.
OUt2	Inverter unit V-phase protection		
OUt3	Inverter unit W-phase protection		
OV1	Overvoltage during acceleration	1. The input voltage is abnormal. 2. There is large energy feedback. 3. No braking components. 4. Braking energy is not open.	1. Check the input power. 2. Check if the deceleration time of the load is too short or the inverter starts during the rotation of the motor or it needs to increase the energy consumption components. 3. Install the braking components. 4. Check the setting of relative function codes.
OV2	Overvoltage during deceleration		
OV3	Overvoltage during constant speed running		
OC1	Overcurrent during acceleration	1.The acceleration or deceleration is too fast. 2.The voltage of the grid is too low. 3. Power of the inverter is too low. 4.The load transients is abnormal. 5.The grounding is short circuited or the output is phase loss. 6. There is strong external interference. 7. The over voltage stall protection is not open.	1. Increase the acceleration time. 2. Check the input power. 3. Select the inverter with a large power. 4. Check if the load is short circuited (the grounding short circuited or the wire short circuited) or the rotation is not smooth. 5. Check the output configuration. 6. Check if there is strong interference. 7. Check the setting of relative function codes.
OC2	Overcurrent during deceleration		
OC3	Overcurrent during constant speed running		

Fault Code	Fault Type	Possible Cause	Solution
UV	Bus undervoltage	1. The voltage of the power supply is too low. 2. The over voltage stall protection is not open.	1. Check input power of the supply line. 2. Check the setting of relative function codes.
OL1	Motor overload	1. The voltage of the power supply is too low. 2. The motor setting rated current is incorrect. 3. The motor stall or load transients is too strong.	1. Check the power of the supply line. 2. Reset the rated current of the motor. 3. Check the load and adjust torque lift.
OL2	Inverter overload	1. The acceleration is too fast. 2. The rotating motor is reset. 3. The voltage of the power supply is too low. 4. The load is too heavy. 5. The motor power is too small.	1. Increase the acceleration time. 2. Avoid the restarting after stopping. 3. Check the power of the supply line. 4. Select an inverter with bigger power. 5. Select a proper motor.
SPI	Phase loss on the input side	1. Phase loss or fluctuation of input R,S,T.	1. Check input power. 2. Check installation distribution.
SPO	Phase loss on output side	1. U,V,W phase loss output or serious asymmetrical three phase of the load.	1. Check the output distribution. 2. Check the motor and cable.
OH1	Rectifier overheat	1. Air duct jam or fan damage. 2. Ambient temperature is too high. 3. The time of overload running is too long.	1. Dredge the wind channel or change the fan. 2. Decrease the environment temperature.
OH2	IGBT overheat		
EF	External fault	1. SI external fault input terminals action.	1. Check the external device input.
CE	Communication error	1. The baud rate setting is incorrect. 2. Fault occurs to the communication wiring. 3. The communication address is wrong. 4. There is strong interference to the communication.	1. Set proper baud rate. 2. Check the communication connection distribution. 3. Set proper communication address. 4. Change or replace the connection distribution or improve the anti-interference capability.
ItE	Current detection fault	1. The connection of the control board is not good. 2. Assistant power is bad. 3. Hall components is broken 4. The magnifying circuit is abnormal.	1. Check the connector and repatch. 2. Change the Hall device. 3. Change the main control panel.

Fault Code	Fault Type	Possible Cause	Solution
tE	Motor auto-tuning fault	1. The motor capacity does not comply with inverter capability. 2. The rated parameter of the motor is not set correctly. 3. The offset between the parameters from auto-tuning and the standard parameter is huge. 4. Auto-tuning overtime.	1. Change the inverter mode. 2. Set the rated parameter according to the motor nameplate. 2.Empty the motor load. 4. Check the motor connection and set the parameter. 5. Check if the upper limit frequency is above 2/3 of the rated frequency.
EEP	EEPROM fault	1. Error of controlling the write and read of the parameters. 2. Damage to EEPROM.	1. Press STOP/RST to reset. 2. Change the main control panel.
PIDE	PID feedback fault	1. PID feedback is offline. 2. PID feedback source disappears.	1. Check the PID feedback signal. 2. Check the PID feedback source.
END	Time arrival of factory setting	1. The actual running time of the inverter is above the internal setting running time.	1. Ask for the supplier and adjust the setting running time.
OL3	Electrical overload	1. The inverter will report overload pre-alarm according to set value.	1. Check the load and the overload pre-alarm point.
ETH1	Grounding short circuit fault 1	1. The grounding of the inverter output terminal is short circuited. 2. The current detection circuit is faulty. 3. The actual motor power sharply differs from the inverter power.	1. Check if the motor wiring is proper. 2. Change the Hall device. 3. Change the main control panel. 4. Set motor parameters correctly.
ETH2	Grounding short circuit fault 2		
dEu	Velocity deviation fault	1. The load is too heavy or stalled.	1. Check the load and ensure it is normal. Increase the detection time. 2. Check whether the control parameters are normal.
STo	Maladjustment fault	1. Control parameters of synchronous motors not set properly. 2. The auto-tuning parameter is not correct. 3. The inverter is not connected to the motor.	1. Check load and ensure it is normal. 2. Check whether the control parameter is set properly or not. 3. Increase maladjustment detection time.
LL	Electronic underload fault	1. The inverter will report underload pre-alarm according to set value.	1. Check the load and the underload pre-alarm point.
tSF	Hydraulic probe damage	1. Hydraulic probe damage.	1. Change damaged hydraulic probe.
PINV	PV reverse connection fault	1. Incorrect PV wiring.	1. Change the wiring direction of the positive and negative terminals and connect the cables again.

Fault Code	Fault Type	Possible Cause	Solution
PVOC	PV overcurrent	1. The acceleration or deceleration is too fast. 2. The inverter power is too low. 3. The load transients or is abnormal. 4. The grounding is short circuited.	1. Increase the ACC or DEC time. 2. Select inverter with a larger power. 3. Check if the load is short circuited (the grounding short circuited or the wire short circuited) or the rotation is not smooth.
PVOV	PV overvoltage	1. The solar cell panel input voltage is too high. 2. Model -4 is set as another model.	1. Reduce the number of solar cell panels that are wired in series. 2. Check and reset the model.
PVLV	PV undervoltage	1. The power of the solar cell panel series is too low or it is cloudy and rainy weather. 2. Motor start-up current is too high.	1. Increase the number of solar cell panels or perform the test in the normal sun light. 2. Change the motor.
E-422	Fault on 422 communication with the boost module	1. Improper contact with the communication cables.	1. Check the four communication cables of 422 and ensure that they are connected properly.
OV	Bus over voltage detected at the boost module side	1. The sun light changes suddenly.	1. Adjust the boost PI parameters. Enlarge the values of P19.07 and P19.08.
A-LS	Weak light alarm	1. Sun light is weak or the solar cell panel configuration is insufficient.	1. The equipment automatically runs when the light becomes strong. 2. Check whether the solar panel configuration is proper.
A-LL	Underload alarm	1. The reservoir is empty.	1. Check the reservoir.
A-tF	Full-water alarm	1. The reservoir is full.	1. If the user has set the full-water alarm function, the equipment automatically stops when the full-water alarm time reaches the specified time. In this situation, the user does not need to perform any operation. Otherwise, check whether terminals are wired incorrectly.
A-tL	Empty-water alarm	1. The reservoir is empty.	1. If the user has set the empty-water alarm function, the equipment automatically stops when the empty-water alarm time reaches the specified time. In this situation, the user does not need to perform any operation. Otherwise, check whether terminals are wired incorrectly.

Chapter 8 Communication Protocol

8.1 Brief Instruction to Modbus Protocol

Modbus protocol is a software protocol and common language which is applied in the electrical controller. With this protocol, the controller can communicate with other devices via network (the channel of signal transmission or the physical layer, such as RS485). And with this industrial standard, the controlling devices of different manufacturers can be connected to an industrial network for the convenient of being monitored.

There are two transmission modes for Modbus protocol: ASCII mode and RTU (Remote Terminal Units) mode. On one Modbus network, all devices should select same transmission mode and their basic parameters, such as baud rate, digital bit, check bit, and stopping bit should have no difference.

Modbus network is a controlling network with single-master and multiple slaves, which means that there is only one device performs as the master and the others are the slaves on one Modbus network. The master means the device which has active talking right to send message to Modbus network for the controlling and inquiring to other devices. The slave means the passive device which sends data message to the Modbus network only after receiving the controlling or inquiring message (command) form the master (response). After the master sends message, there is a period of time left for the controlled or inquired slaves to response, which ensure there is only one slave sends message to the master at a time for the avoidance of singles impact.

Generally, the user can set PC, PLC, IPC and HMI as the masters to realize central control. Setting certain device as the master is a promise other than setting by a bottom or a switch or the device has a special message format. For example, when the upper monitor is running, if the operator clicks sending command bottom, the upper monitor can send command message actively even it cannot receive the message from other devices. In this case, the upper monitor is the master. And if the designer makes the inverter send the data only after receiving the command, then the inverter is the slave.

The master can communicate with any single slave or with all slaves. For the single-visiting command, the slave should feedback a response message; for the broadcasting message from the master, the slave does not need to feedback the response message.

8.2 Application of the Inverter

The inverter uses the Modbus RTU mode and the physical layer is 2-wire RS485.

8.2.1 2-wire RS485

2-wire RS485 interfaces works in half-duplex mode and send data signals in the differential transmission way, which is also referred to as balanced transmission. An RS485 interface uses a twisted pair, in which 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 inverter terminal block, the 485+ terminal corresponds to A, and 485- corresponds to B.

The communication baud rate (P14.01) 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 max. transmission distance varies according to the baud rate, as described in the following table:

Baud Rate	Max. Transmission Distance
2400bps	1800m
4800bps	1200m
9600bps	800m
19200bps	600m

When RS485 interfaces are used for long-distance communication, it is recommended that you use shielded cables, and use the shielding layer as the ground wires.

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 120Ω terminal resistor when the transmission distance is long.

8.2.1.1 When one inverter is used

Figure 8-1 is the Modbus wiring diagram for the network with one inverter and PC.

Generally, PCs do not provide RS485 interfaces, and therefore you need to convert an RS232 or USB interface of a PC to an RS485 interface through a converter. Then, connect end A of the RS485 interface to the 485+ port on the terminal block of the inverter, and connect end B to the 485- port. It is recommended that you use shielded twisted pairs. When an RS232-RS485 converter is used, the cable used to connect the RS232 interface of the PC and the converter cannot be longer than 15m. Use a short cable when possible. It is recommended that you insert the converter directly into the PC. Similarly, when a USB-RS485 converter is used, use a short cable when possible.

When the wiring is completed, select the correct port (for example, COM1 to connect to the RS232-RS485 converter) for the upper computer of the PC, and keep the settings of basic parameters such as communication baud rate and data check bit consistent with those of the inverter.

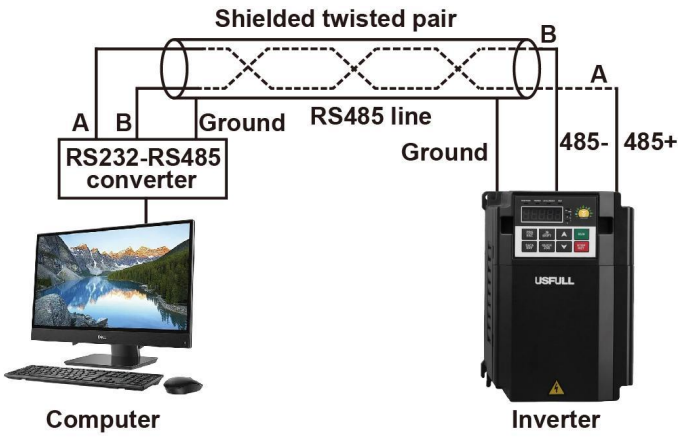


Figure 8-1 RS485 wiring diagram for the network with one inverter

8.2.1.2 When multiple inverters are used

In the network with multiple inverters, chrysanthemum connection and star connection are commonly used. According to the requirements of the RS485 industrial bus standards, all the devices need to be connected in chrysanthemum mode with one 120Ω terminal resistor on each end, as shown in Figure 8-2.

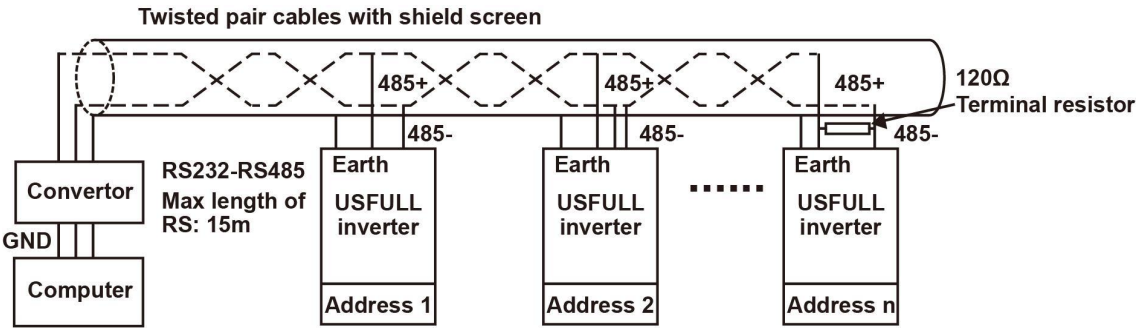


Figure 8-2 Practical application diagram of chrysanthemum connection

Figure 8-3 shows the start connection diagram. When this connection mode is adopted, the two devices that are farthest away from each other on the line must be connected with a terminal resistor (in this figure, the two devices are devices 1# and 15#).

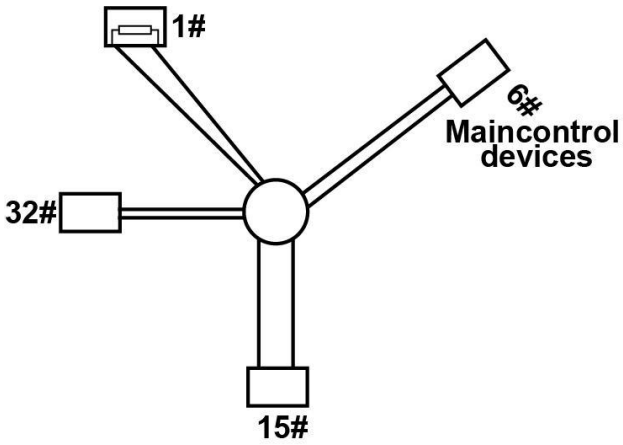


Figure 8-3 Star connection

Use shielded cables, if possible, in multi-inverter connection. The baud rates, data bit check settings, and other basic parameters of all the devices on the RS485 line must be set consistently, and addresses cannot be repeated.

8.2.2 RTU Mode

8.2.2.1 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 min. 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 stop bit (with check performed), or 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

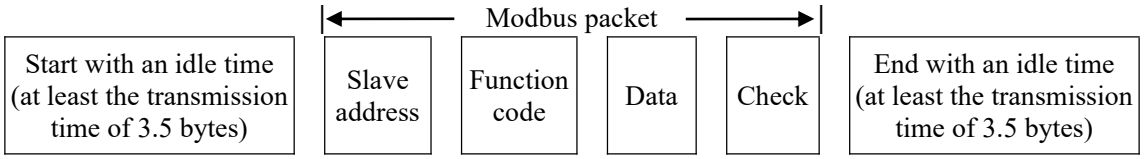
10-bit character frame (Bits 1 to 7 are data bits)

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 stop 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 transmitted 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 transmitted, a similar transmission interval (the transmission time of 3.5 bytes) is used to indicate that the transmission of the frame ends. Then, the transmission of a new frame starts.

RTU data frame format



The information of a frame must be transmitted 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 (in decimal system) (0 indicates the broadcast address)
CMD (function domain)	03H: Read slave parameters 06H: Write slave parameters
Data domain DATA (N-1) … DATA (0)	Data of 2*N bytes, main content of the communication as well as the core of data exchanging
LSB of CRC CHK	Detection value: CRC (16 bits)
MSB of CRC CHK	
END (frame tail)	T1-T2-T3-T4 (time gap with a min. length of 3.5 bytes)

8.2.2.2 RTU communication frame error check modes

During the transmission of data, errors may occur due to various factors (such as electromagnetic interference). For example, if the sending message is a logic "1", A-B potential difference on RS485 should be 6V, but in reality, it may be -6V because of electromagnetic interference, and then the other devices take the sent message as logic "0". Without error check, the data receiving device cannot identify data errors and may make a wrong response. The wrong 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 wrong.

The error check of a frame includes two parts, namely, bit check on individual bytes (that is, odd/even check 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 transmitted 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.

Cyclical Redundancy Check (CRC) method

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 min. 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, stop, 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 low-order bit to the high-order bit, and 0 is placed in the high-order bit. Then, the low-order bit is detected. If the low-order bit is 1, the XOR operation is performed on the current value in the register and the preset value. If low-order bit is 0, no operation is performed. This process is repeated 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);
}
```

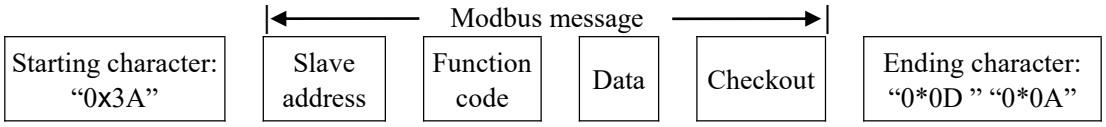
In the ladder logic, CKSM uses the table look-up method to calculate the CRC value according to the content in the frame. The program of this method is simple, and the calculation is fast, but the ROM space occupied is large. Use this program with caution in scenarios where there are space occupation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

8.2.3 ASCII Mode

<table>
<tr><th>Name</th><th>Definition</th></tr>
<tr><td>Coding system</td><td>Communication protocol belongs to hexadecimal system. The meaning of message character in ASCII: "0"…"9", "A" …" F", each hex is represented by the ASCII message corresponds to the character.
<table>
<tr><td>Character</td><td>"0"</td><td>"1"</td><td>"2"</td><td>"3"</td><td>"4"</td><td>"5"</td><td>"6"</td><td>"7"</td></tr>
<tr><td>ASCII code</td><td>0x30</td><td>0x31</td><td>0x32</td><td>0x33</td><td>0x34</td><td>0x35</td><td>0x36</td><td>0x37</td></tr>
<tr><td>Character</td><td>"8"</td><td>"9"</td><td>"A"</td><td>"B"</td><td>"C"</td><td>"D"</td><td>"E"</td><td>"F"</td></tr>
<tr><td>ASCII code</td><td>0x38</td><td>0x39</td><td>0x41</td><td>0x42</td><td>0x43</td><td>0x44</td><td>0x45</td><td>0x46</td></tr>
</table></td></tr>
<tr><td>Data format</td><td>Starting bit, 7/8 data bit, check bit and stop bit. The data formats are listed as follows:
<table>
<tr><td colspan="11">11-bit Character Frame</td></tr>
<tr><td>Starting bit</td><td>BIT1</td><td>BIT2</td><td>BIT3</td><td>BIT4</td><td>BIT5</td><td>BIT6</td><td>BIT7</td><td>BIT8</td><td>Check bit</td><td>Stop bit</td></tr>
</table>
<table>
<tr><td colspan="10">10-bit Character Frame</td></tr>
<tr><td>Starting bit</td><td>BIT1</td><td>BIT2</td><td>BIT3</td><td>BIT4</td><td>BIT5</td><td>BIT6</td><td>BIT7</td><td>Check bit</td><td>Stop bit</td></tr>
</table></td></tr>
</table>

In ASCII mode, the frame header is ":" ("0*3A"), frame end is "CRLF" ("0*0D", "0*0A") by default. In ASCII mode, all the data bytes, except for the frame header and frame end, are transmitted in ASCII code mode, in which four MSB groups will be sent out first and then, four LSB groups will be sent out. In ASCII mode, the data length is 8 bit. As for "A" ~ "F", its capital letters is adopted for ASCII code. The data now adopts LRC checkout which covers slave address to data information. The checksum equals to the complement of the character sum of all the participated checkout data.

ASCII data frame format



Standard structure of ASCII frame:

<table>
<tr><td>START</td><td>":" (0x3A)</td></tr>
<tr><td>Address Hi</td><td rowspan="2">Communication address:
8-bit address is formed by the combination of two ASCII codes</td></tr>
<tr><td>Address Lo</td></tr>
<tr><td>Function Hi</td><td rowspan="2">Function code:
8-bit address is formed by the combination of two ASCII codes</td></tr>
<tr><td>Function Lo</td></tr>
<tr><td>DATA (N-1)
…
DATA (0)</td><td>Data content:
nx8-bit data content is formed by combination of 2n (n≤16) ASCII codes</td></tr>
<tr><td>LRC CHK Hi</td><td rowspan="2">LRC check code:
8-bit check code is formed by the combination of two ASCII codes</td></tr>
<tr><td>LRC CHK Lo</td></tr>
<tr><td>END Hi</td><td rowspan="2">End character:
END Hi=CR (0x0D), END Lo=LF (0x0A)</td></tr>
<tr><td>END Lo</td></tr>
</table>

8.2.3.1 ASCII mode check (LRC Check)

Check code (LRC Check) is the value combined of address and data content result. For instance, the check code of above 2.2.2 communication message is: 0x02+0x06+0x00+0x08+0x13+0x88 = 0xAB, then take the compliment of 2 = 0x55.

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

```
Static unsigned char
LRC(auchMsg,usDataLen)
unsigned char *auchMsg;
unsigned short usDataLen;
{
unsigned char uchLRC=0;
while(usDataLen--)
uchLRC+=*auchMsg++;
return((unsigned char) (– ((char)uchLRC)));
}
```

8.3 Command Code and Communication Data

8.3.1 RTU Mode

8.3.1.1 Command code 03H (corresponding to binary 0000 0011), read N words (Word) (N≤16)

Command code 03H means that if the master read data from the inverter, the reading number depends on the "data number" in the command code. The max. continuous reading number is 16 and the parameter address should be continuous. The byte length of every data is 2 (one word). The following command format is illustrated by hex (a number with "H" means hex) and one hex occupies one byte.

The command code is used to read the working state of the inverter.

For example, read continuous 2 data content from 0004H from the inverter with the address of 01H (read the content of data address of 0004H and 0005H), the frame structure is as follows:

RTU Master Command (sent from the master to the inverter)		RTU Slave Response (sent from the inverter to the master)	
START	T1-T2-T3-T4	START	T1-T2-T3-T4
ADDR	01H	ADDR	01H
CMD	03H	CMD	03H
MSB of the start address	00H	Byte number	04H
LSB of the start address	04H	MSB of data in 0004H	13H
MSB of data number	00H	LSB of data in 0004H	88H
LSB of data number	02H	MSB of data in 0005H	00H
LSB of CRC	85H	LSB of data in 0005H	00H
MSB of CRC	CAH	LSB of CRC CHK	7EH
END	T1-T2-T3-T4	LSB of CRC CHK	9DH
-	-	END	T1-T2-T3-T4

T1-T2-T3-T4 between START and END is to provide at least the time of 3.5 bytes as the leisure time and distinguish two messages for the avoidance of taking two messages as one message.

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

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

"Start address" means reading data from the address and it occupies 2 bytes with the fact that the MSB is in the front and the LSB is in the behind.

"Data number" means the reading data number with the unit of word. If the "start address" is 0004H and the "data number" is 0002H, the data of 0004H and 0005H will be read.

CRC occupies 2 bytes with the fact that the LSB is in the front and the MSB is in the behind. The meaning of the response is that:

ADDR = 01H means the command message is transmitted by the inverter whose address is 01H. The ADDR information occupies one byte.

CMD = 03H means the message is received from the inverter to the master for the response of reading command The CMD information occupies one byte.

"Byte number" means all byte number from the byte (excluding the byte) to CRC byte (excluding the byte). 04 means there are 4 byte of data from the "byte number" to "LSB of CRC CHK", which are "MSB of data in 0004H", "LSB of data in 0004H", "MSB of data in 0005H" and "LSB of data in 0005H".

There are 2 bytes stored in one data with the fact that the MSB is in the front and the LSB is in the behind of the message, the data of data address 0004H is 1388H, and the data of data address 0005H is 0000H.

CRC occupies 2 bytes with the fact that the LSB is in the front and the MSB is in the behind.

8.3.1.2 Command code 06H (corresponding to binary 0000 0110), write a word

The command means that the master write data to the inverter and one command can write one data other than multiple dates. The effect is to change the working mode of the inverter.

For example, write 5000 (1388H) to 0004H from the inverter with the address of 02H, the frame structure is as follows:

RTU Master Command (sent from the master to the inverter)		RTU Slave Response (sent from the inverter to the master)	
START	T1-T2-T3-T4	START	T1-T2-T3-T4
ADDR	02H	ADDR	02H
CMD	06H	CMD	06H
MSB of data writing address	00H	MSB of data writing address	00H
LSB of data writing address	04H	LSB of data writing address	04H
MSB of to-be-written data	13H	MSB of to-be-written data	13H
LSB of to-be-written data	88H	LSB of to-be-written data	88H
LSB of CRC CHK	C5H	LSB of CRC CHK	C5H
MSB of CRC CHK	6EH	MSB of CRC CHK	6EH
END	T1-T2-T3-T4	END	T1-T2-T3-T4

Note: Sections 8.3.1.1 and 8.3.1.2 mainly describe the command format.

8.3.1.3 Command code 10H, continuous writing

Command code 10H means that if the master writes data to the inverter, the data number depends on the "data number" in the command code. The max. continuous reading number is 16.

For example, write 5000 (1388H) to 0004H of the inverter whose slave address is 02H and 50 (0032H) to 0005H, the frame structure is as follows:

RTU Master Command (sent from the master to the inverter)		RTU Slave Response (sent from the inverter to the master)	
START	T1-T2-T3-T4 (time gap with a min. length of 3.5 bytes)	START	T1-T2-T3-T4 (time gap with a min. length of 3.5 bytes)
ADDR	02H	ADDR	02H
CMD	10H	CMD	10H
MSB of data writing address	00H	MSB of data writing address	00H
LSB of data writing address	04H	LSB of data writing address	04H
MSB of data quantity	00H	MSB of data quantity	00H
LSB of data quantity	02H	LSB of data quantity	02H
Byte number	04H	LSB of CRC	C5H
MSB of data in 0004H	13H	MSB of CRC	6EH
LSB of data in 0004H	88H	END	T1-T2-T3-T4 (time gap with a min. length of 3.5 bytes)
MSB of data in 0005H	00H		
LSB of data in 0005H	32H		
LSB of CRC	C5H	-	-
MSB of CRC	6EH	-	-
END	T1-T2-T3-T4 (time gap with a min. length of 3.5 bytes)	-	-

8.3.2 ASCII Mode

8.3.2.1 Command code: 03H (0000 0011), read N words (Word) (max. number for continuous reading is 16 words)

For instance: As for the inverter whose slave address is 01H, the starting address of internal storage is 0004, read two words continuously, the structure of this frame is listed as follows:

ASCII Master Command (sent from the master to the inverter)		ASCII Slave Response (sent from the inverter to the master)	
START	":"	START	":"
ADDR	"0"	ADDR	"0"
	"1"		"1"
CMD	"0"	CMD	"0"
	"3"		"3"
MSB of starting address	"0"	Byte number	"0"
	"0"		"4"
LSB of starting address	"0"	MSB of data address 0004H	"1"
	"4"		"3"

ASCII Master Command (sent from the master to the inverter)		ASCII Slave Response (sent from the inverter to the master)	
MSB of data number	"0"	LSB of data address 0004H	"8"
	"0"		"8"
LSB of data number	"0"	MSB of data address 0005H	"0"
	"2"		"0"
LRC CHK Hi	"F"	LSB of data address 0005H	"0"
LRC CHK Lo	"6"		"0"
END Hi	CR	LRC CHK Hi	"5"
END Lo	LF	LRC CHK Lo	"D"
-	-	END Hi	CR
-	-	END Lo	LF

8.3.2.2 Command code: 06H (0000 0110), write a word (Word)

For instance: Write 5000 (1388H) to the 0004H address of the inverter whose slave address is 02H, then the structure of this frame is listed as follows:

ASCII Master Command (sent from the master to the inverter)		ASCII Slave Response (sent from the inverter to the master)	
START	":"	START	":"
ADDR	"0"	ADDR	"0"
	"2"		"2"
CMD	"0"	CMD	"0"
	"6"		"6"
MSB of data writing address	"0"	MSB of data writing address	"0"
	"0"		"0"
LSB of data writing address	"0"	LSB of data writing address	"0"
	"4"		"4"
MSB of to-be-written data	"1"	MSB of to-be-written data	"1"
	"3"		"3"
LSB of to-be-written data	"8"	LSB of to-be-written data	"8"
	"8"		"8"
LRC CHK Hi	"5"	LRC CHK Hi	"5"
LRC CHK Lo	"9"	LRC CHK Lo	"9"
END Hi	CR	END Hi	CR
END Lo	LF	END Lo	LF

8.3.2.3 Command code: 10H, continuous writing

Command code 10H means the master write data to the inverter, number of data being written is determined by the command "data number", max. number of continuous writing is 16 words.

For instance: Write 5000 (1388H) to 0004H of the inverter whose slave address is 02H, write 50 (0032H) to 0005H of the inverter whose slave address is 02H, then the structure of this frame is listed as follows:

ASCII Master Command (sent from the master to the inverter)		ASCII Slave Response (sent from the inverter to the master)	
START	":"	START	":"
ADDR	"0"	ADDR	"0"
	"2"		"2"
CMD	"1"	CMD	"1"
	"0"		"0"
MSB of starting address	"0"	MSB of starting address	"0"
	"0"		"0"
LSB of starting address	"0"	LSB of starting address	"0"
	"4"		"4"
MSB of data number	"0"	MSB of data number	"0"
	"0"		"0"
LSB of data number	"0"	LSB of data number	"0"
	"2"		"2"
Byte number	"0"	LRC CHK Hi	"E"
	"4"	LRC CHK Lo	"8"
MSB of data to be written to 0004H	"1"	END Hi	CR
LSB of data to be written to 0004H	"3"	END Lo	LF
MSB of data to be written to 0005H	"8"	-	-
	"8"	-	-
MSB of data to be written to 0004H	"0"	-	-
LSB of data to be written to 0004H	"0"	-	-
MSB of data to be written to 0005H	"3"	-	-
	"2"	-	-
LRC CHK Hi	"1"	-	-
LRC CHK Lo	"7"	-	-
END Hi	CR	-	-
END Lo	LF	-	-

8.4 Data Address Definition

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

8.4.1 Function Code Address Format Rules

The parameter address occupies 2 bytes with the fact that the MSB is in the front and the LSB is in the behind. The range of MSB and LSB are: MSB—00-ffH; LSB—00-ffH. The MSB is the group number before the radix point of the function code and the LSB is the number after the radix point. But both the MSB and the LSB should be changed into hex. For example P05.05, the group number before the radix point of the function code is 05, then the MSB of the parameter is 05, the number

after the radix point 05, then the LSB of the parameter is 05, then the function code address is 0505H and the parameter address of P11.01 is 0B01H.

Function Code	Name	Setting Range	Default	Change
P11.01	Frequency decrease at sudden power loss	0: Disable 1: Enable	0	O

Note:

• Group P29 is the factory parameter which cannot be read or changed. Some parameters cannot be changed when the inverter is in the running state and some parameters cannot be changed in any state. The setting range, unit and related instructions should be paid attention to when modifying the function code parameters.

• 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, the function code P00.13 is not stocked into EEPROM. Only by changing the value in RAM can set the address to 8007H. This address can only be used in writing RAM other than reading. If it is used to read, it is an invalid address.

8.4.2 Description of Other Function Addresses in Modbus

The master can operate on the parameters of the inverter as well as control the inverter, such as running or stopping and monitoring the working state of the inverter.

Below is the parameter list of other functions.

Function Instruction	Address Definition	Data Meaning Instruction	R/W Characteristics
Communication control command	2000H	0001H: Forward running	R/W
		0002H: Reverse running	
		0003H: Forward jogging	
		0004H: Reverse jogging	
		0005H: Stop	
		0006H: Coast to stop	
		0007H: Fault reset	
		0008H: Jogging to stop	
Address of the communication setting value	2001H	Communication setting frequency (Range: 0.00Hz ~ Fmax. (unit: 0.01Hz))	R/W
	2002H	PID reference (Range: 0 ~ 1000, 1000 corresponds to 100.0%)	
	2003H	PID feedback (Range: 0 ~ 1000, 1000 corresponds to 100.0%)	R/W
	2004H	Torque setting value (Range: -3000 ~ 3000, 1000 corresponds to the 100.0% of the rated current of the motor)	R/W

Function Instruction	Address Definition	Data Meaning Instruction	R/W Characteristics
	2005H	The upper limit frequency setting during forward rotation (Range: 0 .00Hz ~ Fmax. (unit: 0.01Hz))	R/W
	2006H	The upper limit frequency setting during reverse rotation (Range: 0.00Hz ~ Fmax. (unit: 0.01Hz))	R/W
	2007H	The upper limit torque of electromotion torque (Range: 0 ~ 3000, 1000 corresponds to the 100.0% of the rated current of the motor)	R/W
	2008H	The upper limit torque of braking torque (Range: 0 ~ 3000, 1000 corresponds to the 100.0% of the rated current of the motor)	R/W
	2009H	Special control command word Bit0~1: =00: Motor 1 =01: Motor 2 =10: Motor 3 =11: Motor 4 Bit2: =1: Torque control prohibit =0: Torque control prohibit invalid Bit3: =1: Power consumption clear =0: No power consumption clear Bit4: =1: Pre-exciting =0: Pre-exciting prohibition Bit5: =1: DC braking =0: DC braking prohibition	R/W
	200AH	Virtual input terminal command (Range: 0x000 ~ 0x1FF)	R/W
	200BH	Virtual output terminal command (Range: 0x00 ~ 0x0F)	R/W
	200CH	Voltage setting value (special for V/F separation) (Range: 0 ~ 1000, 1000 corresponds to the 100.0% of the rated voltage of the motor)	R/W
	200DH	AO output setting 1 (Range: -1000 ~ 1000, 1000 corresponds to 100.0%)	R/W
	200EH	AO output setting 2 (Range: -1000 ~ 1000, 1000 corresponds to 100.0%)	R/W
SW1 of the inverter	2100H	0001H: Forward running	R
		0002H: Forward running	
		0003H: Stop	
		0004H: Fault	
		0005H: POFF state	
		0006H: Pre-exciting state	
SW1 of the inverter	2101H	Bit0: =0: Bus voltage is not established =1: Bus voltage is established	R

Function Instruction	Address Definition	Data Meaning Instruction	R/W Characteristics
		Bi1~2: =00: Motor 1 =01: Motor 2 =10: Motor 3 =11: Motor 4 Bit3: =0: Asynchronous motor =1: Synchronous motor Bit4: =0: Pre-alarm without overload =1: Overload pre-alarm Bit5~6: =00: Keypad control =01: Terminal control =10: Communication control	
Fault code of the inverter	2102H	See the fault type instruction	R
Identifying code of the inverter	2103H	FU9000SI → 0x0190	R
Running frequency	3000H	0 .00Hz ~ Fmax. (unit: 0.01Hz)	R
Set frequency	3001H	0 .00Hz ~ Fmax. (unit: 0.01Hz)	R
Bus voltage	3002H	0.0 ~ 2000.0V (unit: 0.1V)	R
Output voltage	3003H	0 ~ 1200V (unit: 1V)	R
Output current	3004H	0.0 ~ 3000.0A (unit: 0.1A)	R
Rotating speed	3005H	0 ~ 65535RPM (unit: 1RPM)	R
Output power	3006H	-300.0 ~ 300.0% (unit: 0.1%)	R
Output torque	3007H	-250.0 ~ 250.0% (unit: 0.1%)	R
PID setting	3008H	-100.0 ~ 100.0% (unit: 0.1%)	R
PID feedback	3009H	-100.0 ~ 100.0% (unit: 0.1%)	R
Input state	300AH	000 ~ 1FF	
Output state	300BH	000 ~ 1FF	
AI1	300CH	0.00 ~ 10.00V (unit: 0.01V)	R
AI2	300DH	0.00 ~ 10.00V (unit: 0.01V)	R
AI3	300EH	-10.00 ~ 10.00V (unit: 0.01V)	R
AI4	300FH	Reserved	R
Read input of high-speed pulse 1	3010H	0.000 ~ 50.000kHz (unit: 0.001Hz)	R
Read input of high-speed pulse 2	3011H	Reserved	R
PLC and current step of multi-step Speed	3012H	0 ~ 15	R
External length	3013H	0 ~ 65535	R
External count value	3014H	0 ~ 65535	R
Torque setting	3015H	-300.0 ~ 300.0% (unit: 0.1%)	R
Inverter	3016H	Reserved	R

Function Instruction	Address Definition	Data Meaning Instruction	R/W Characteristics
identification code			
Fault code	5000H	Reserved	R

“R/W characteristics” means the function is with read and write characteristics. For example, "communication control command" is writing chrematistics and control the inverter with writing command (06H). R characteristic can only read other than write and W characteristic can only write other than read.

Note: when operating on the inverter with the table above, it is necessary to enable some parameters. For example, the operation of running and stopping, it is necessary to set P00.01 to communication running command channel.

The encoding rules for device codes (corresponding to identifying code 2103H of the inverter:

MSB of Code	Meaning	LSB of Code	Meaning
0x01	FU9000	90	FU9000SI series solar pump inverter

Note: The code is consisted of 16 bit which is high 8 bits and low 8 bits. High 8 bits mean the motor type series and low 8 bits mean the derived motor types of the series.

8.4.3 Fieldbus Ratio Values

The communication data is expressed by hex in actual application and there is no radix point in hex. For example, 50.12Hz cannot be expressed by hex so 50.12 can be magnified by 100 times into 5012, so hex 1394H can be used to express 50.12.

A non-integer can be timed by a multiple to get an integer and the integer can be called fieldbus ratio values.

The fieldbus ratio values are referred to the radix point of the setting range or default value in the function parameter list. If there are figures behind the radix point (n=1), then the fieldbus ratio value m is 10n. Take the table as the example:

Function Code	Name	Setting Range	Default	Change
P01.21	Power-off restart selection	0: Disable 1: Enable	0	O

The value specified in "Setting range" or "Default" contains one decimal, so the fieldbus scale is 10. If the value received by the upper computer is 50, the value of "Wake-up-from-sleep delay" of the inverter is 5.0 (5.0 = 50/10).

To set the "Wake-up-from-sleep delay" 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 transmit the following write command:

After receiving the command, the inverter converts 50 into 5.0 based on the fieldbus scale, and then sets "Wake-up-from-sleep delay" to 5.0s.

For another example, after the upper computer transmits the "Wake-up-from-sleep delay" parameter command, the master receives the following response from the inverter:

01	03	02	00 32	39 91
Inverter address	Read command	2-byte data	Parameters data	CRC check

The parameter data is 0032H, that is, 50, so 5.0 is obtained based on the fieldbus scale (50/10=5.0). In this case, the master identifies that the "Wake-up-from-sleep delay" is 5.0s.

8.4.4 Error Message Response

Operation errors may occur in communication-based control. For example, some parameters can only be read, but a write command is transmitted. In this case, the inverter returns an error message response. Error message responses are sent from the inverter to the master. The following table describes the codes and definitions of the error message responses.

Code	Name	Meaning
01H	Invalid command	The command code received by the upper computer 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 the faulty state when processing this request.
02H	Invalid data address	For the inverter, the data address in the request of the upper computer is not allowed. In particular, the combination of the register address and the number of the to-be-transmitted 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 is set to an invalid value in the write operation. For example, a function input terminal cannot be set repeatedly.
05H	Password error	The password entered in the password verification address is different from that set in P07.00.
06H	Data frame error	The length of the data frame transmitted by the upper computer is incorrect, 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 upper computer is a read-only parameter.
08H	Parameter cannot be modified in running	The parameter to be modified in the write operation of the upper computer cannot be modified during the running of the inverter.
09H	Password protection	A user password is set, and the upper computer does not provide the password to unlock the system when performing a read or write operation. The error of "system locked" is reported.

The slave uses functional code fields and fault addresses to indicate it is a normal response or some error occurs (named as objection response). For normal responses, the slave shows corresponding function codes, digital address or sub-function codes as the response. For objection responses, the slave returns a code which equals the normal code, but the first byte is logic 1.

For example: When the master sends a message to the slave, requiring it to read a group of address data of the inverter function codes, there will be following function codes:

1 0 0 0 0 0 1 1 (Hex 03H)

For normal responses, slave responds same codes, while for objection responses, it will return:

1 0 0 0 0 0 1 1 (Hex 83H)

Besides the function codes modification for the objection fault, the slave will respond a byte of abnormal code which defines the error reason.

When the master receives the response for the objection, in a typical processing, it will send the message again or modify the corresponding order.

For example: Set the "running command channel" of the inverter (P00.01, parameter address is 0001H) with the address of 01H to 03, the command is as following:

01	06	00 01	00 03	98 0B
Inverter address	Write command	Parameters address	Parameters data	CRC check

But the setting range of "running command channel" is 0 ~ 2, if it is set to 3, because the number is beyond the range, the inverter will return fault response message as follows:

01	86	04	43 A3
Inverter address	Abnormal response code	Fault code	CRC check

Abnormal response code 86H means the abnormal response to writing command 06H; the fault code is 04H. In the table above, its name is operation failed and its meaning is that the parameter setting in parameter writing is invalid. For example, function input terminal cannot be set repeatedly.

8.5 Read/Write Operation Example

For details about the formats of the read and write commands, see section 8.3.

8.5.1 Examples of Reading Command 03H

Example 1: Read the state word 1 of the inverter whose address is 01H. See 8.4.2 Description of other function addresses in Modbus, the parameter address of the state word 1 of inverter is 2100H.

• **RTU mode:**

The command sent to the inverter:

01	03	21 00	00 01	8E 36
Inverter address	Read command	Parameters address	Data number	CRC check

If the operation is successful, the following response is returned:

01	03	02	00 03	F8 45
Inverter address	Read command	Data address	Data content	CRC check

• **ASCII mode:**

The command sent to the inverter:

:	01	03	21 00	00 01	DA	CR LF
START	Inverter address	Read command	Parameters address	Data number	LRC check	END

If the operation is successful, the following response is returned:

:	01	03	02	00 03	F7	CR LF
START	Inverter address	Read command	Byte number	Data number	LRC check	END

The data content is 0003H. From the table 1, the inverter stops.

8.5.2 Examples of Writing Command 06H

Example 1: Set the inverter whose address is 03H to be forward running. See 8.4.2 Description of other function addresses in Modbus, the address of "Communication control command" is 2000H, and 0001H indicates forward running.

Function Instruction	Address Definition	Data Meaning Instruction	R/W Characteristics
Communication control command	2000H	0001H: Forward running	R/W
		0002H: Reverse running	
		0003H: Forward jogging	
		0004H: Reverse jogging	
		0005H: Stop	
		0006H: Coast to stop (emergency stop)	
		0007H: Fault reset	
		0008H: Jogging to stop	

• RTU mode:

The command sent by the master:

03	06	20 00	00 01	42 28
Inverter address	Write command	Parameters address	Forward running	CRC check

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

03	06	20 00	00 01	42 28
Inverter address	Write command	Parameters address	Forward running	CRC check

• ASCII mode:

The command sent to the inverter:

:	01	06	20 00	00 01	D6	CR LF
START	Inverter address	Write command	Parameters address	Data number	LRC check	END

If the operation is successful, the following response (same as the command transmitted from the

master) is returned:

:	01	06	20 00	00 01	D6	CR LF
START	Inverter address	Write command	Parameters address	Data number	LRC check	END

Example 2: Set the max. output frequency of the inverter with the address of 03H as 100Hz.

Function Code	Name	Setting Range	Default	Change
P00.03	Max. output frequency	Setting range: P00.04 ~ 400.00Hz Used to set the max. output frequency of the inverter. It is the basis of frequency setup and the acceleration/deceleration.	50.00Hz	O

See the figures behind the radix point, the fieldbus ratio value of max. output frequency (P00.03) is 100. 100Hz timed by 100 is 10000 and the corresponding hex is 2710H.

• **RTU mode:**

The command sent by the master:

03	06	00 03	27 10	62 14
Inverter address	Write command	Parameters address	Parameter data	CRC check

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

03	06	00 03	27 10	62 14
Inverter address	Write command	Parameters address	Parameter data	CRC check

• **ASCII mode:**

The command sent to the inverter:

:	03	06	00 03	27 10	BD	CR LF
START	Inverter address	Write command	Parameters address	Parameter data	LRC check	END

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

:	03	06	00 03	27 10	BD	CR LF
START	Inverter address	Write command	Parameters address	Parameter data	LRC check	END

8.5.3 Examples of Continuous Writing Command 10H

Example 1: Set the inverter whose address is 01H to be forward running at the frequency of 10Hz. See 8.4.2 Description of other function addresses in Modbus, the address of "Communication control command" is 2000H, and 0001H indicates forward running. The address of "Communication frequency setting" is 2001H, and 10Hz is 03E8H in the hexadecimal form.

Function Instruction	Address Definition	Data Meaning Instruction	R/W Characteristics
Communication control command	2000H	0001H: Forward running	R/W
		0002H: Reverse running	
		0003H: Forward jogging	
		0004H: Reverse jogging	
		0005H: Stop	
		0006H: Coast to stop (emergency stop)	
		0007H: Fault reset	
		0008H: Jogging to stop	
Address of communication setting	2001H	Communication setting frequency (Range: 0.00Hz ~ Fmax. (unit: 0.01Hz))	R/W
	2002H	PID given (Range: 0 ~ 1000, 1000 corresponds to 100.0%)	

• **RTU mode:**

The command sent to the inverter:

01	10	20 00	00 02	04	00 01	03 E8	3B 10
Inverter address	Continuous writing command	Parameters address	Data number	Byte number	Forward running	10Hz	CRC check

If the operation is successful, the following response is returned:

01	10	20 00	00 02	4A 08
Inverter address	Continuous writing command	Parameters address	Data number	CRC check

• **ASCII mode:**

The command sent to the inverter:

:	01	10	20 00	00 02	04	00 01	03 E8	BD	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	Byte number	Forward running	10Hz	LRC check	END

If the operation is successful, the following response is returned:

:	01	10	20 00	00 02	CD	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	LRC check	END

Example 2: Set ACC time of 01H inverter as 10s and DEC time as 20s.

Function Code	Name	Setting Range	Default	Change
P00.11	ACC time 1	0.0 ~ 3600.0s	Model dependent	O
P00.12	DEC time 1	0.0 ~ 3600.0s	Model dependent	O

The corresponding address of P00.11 is 000B, the ACC time of 10s corresponds to 0064H, and

the DEC time of 20s corresponds to 00C8H.

• **RTU mode:**

The command sent to the inverter:

01	10	00 0B	00 02	04	00 64	00 C8	F2 55
Inverter address	Continuous writing command	Parameters address	Data number	Byte number	10s	20s	CRC check

If the operation is successful, the following response is returned:

01	10	00 0B	00 02	30 0A
Inverter address	Continuous writing command	Parameters address	Data number	CRC check

• **ASCII mode:**

The command sent to the inverter:

:	01	10	00 0B	00 02	04	00 64	00 C8	B2	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	Number of bytes	10s	20s	LRC check	END

If the operation is successful, the following response is returned:

:	01	10	00 0B	00 02	E2	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	LRC check	END

Note: The blank in the above command is for illustration. The blank cannot be added in the actual application unless the upper monitor can remove the blank by themselves.

8.6 Common Communication Faults

Common communication faults include the following:

1. No response is returned.
2. The inverter returns an exception response.

Possible causes of no response include the following:

1. The serial port is set incorrectly. For example, the converter uses the serial port COM1, but COM2 is selected for the communication.
2. The settings of the baud rates, data bits, stop bits, and check bits are inconsistent with those set on the inverter.
3. The positive pole (+) and negative pole (-) of the RS485 bus are connected reversely.
4. The RS485 wire cap on the terminal board of the inverter is not connected. This wire cap is at the back of the terminal block.

Appendix A GPRS and Cable Guidance

A.1 GPRS Module and Monitoring Software

The pumping inverters support the installation of the GPRS module to implement remote monitoring. The GPRS module connects to the inverters through 485 communication. The inverter operation state can be monitored on the APP in the mobile phone or web page in real time.

Method for connecting the GPRS to the inverter:

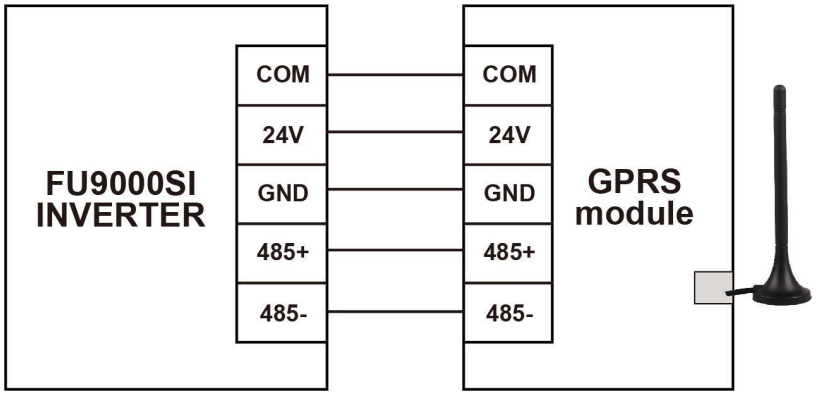


Figure A-1 Connecting the GPRS module to the inverter

For more information, see the GPRS/GPS adaptor operation guide matching the GPRS module or contact local USFULL office. When consulting, provide the product models and serial numbers.

A.2 Cables

A.2.1 Power Cables

Dimension the input power and motor cables according to local regulations.

Note: A separate PE conductor is required if the conductivity of the cable shield is not sufficient for the purpose.

A.2.2 Control Cables

The relay cable needs the cable type with braided metallic screen.

Keypads need to be connected with network cables. The network cables must be shielded in complicated electromagnetic environments.

Communication cables must be shielded twisted pairs.

Note:

- Run analog and digital signals in separate cables.
- Check the insulation of the input power cable according to local regulations before connecting to the drive.

Recommended power cables for standard inverter models:

Model	Recommended Cable Size (mm^2)		Terminal Screw	Tightening Torque (Nm)
	(+)/(-), R/S/T, U/V/W	⏚		
FU9000SI-0R7G-S2	1.5	1.5	M4	0.8
FU9000SI-0R7G-9	1.5	1.5	M4	0.8
FU9000SI-1R5G-9	1.5	1.5	M4	0.8
FU9000SI-2R2G-9	1.5	1.5	M4	0.8
FU9000SI-1R5G-S2	2.5	2.5	M4	0.8
FU9000SI-2R2G-S2	2.5	2.5	M4	0.8
FU9000SI-0R7G-SS2	2.5	2.5	M4	0.8
FU9000SI-1R5G-SS2	2.5	2.5	M4	0.8
FU9000SI-2R2G-SS2	2.5	2.5	M4	0.8
FU9000SI-004G-9	2.5	2.5	M4	1.2 ~ 1.5
FU9000SI-5R5G-9	2.5	2.5	M4	1.2 ~ 1.5
FU9000SI-7R5G-9	4	4	M4	2 ~ 2.5
FU9000SI-011G-9	6	6	M5	2 ~ 2.5
FU9000SI-015G-9	10	10	M5	2 ~ 2.5
FU9000SI-018G-9	16	16	M5	2 ~ 2.5
FU9000SI-022G-9	25	16	M5	2 ~ 2.5
FU9000SI-030G-9	25	16	M6	4-6
FU9000SI-037G-9	35	16	M6	4-6
FU9000SI-045G-9	35	16	M8	10
FU9000SI-055G-9	50	25	M8	10
FU9000SI-075G-9	70	35	M8	10
FU9000SI-090G-9	95	50	M12	31-40
FU9000SI-110G-9	120	70	M12	31-40
FU9000SI-132G-9	185	95	M12	31-40
FU9000SI-160G-9	240	120	M12	31-40
FU9000SI-185G-9	120*2P	150	M12	31-40
FU9000SI-200G-9	120*2P	150	M12	31-40
FU9000SI-220G-9	120*2P	150	M12	31-40
FU9000SI-250G-9	95*2P	95	M12	31-40
FU9000SI-280G-9	150*2P	150	M12	31-40
FU9000SI-315G-9	150*2P	150	M12	31-40
FU9000SI-355G-9	185*2P	185	M12	31-40
FU9000SI-400G-9	150*3P	120*2P	M12	31-40
FU9000SI-450G-9	185*3P	120*2P	M12	31-40
FU9000SI-500G-9	185*3P	120*2P	M12	31-40
FU9000SI-630G-9	185*3P	120*2P	M12	31-40

Note:

For the cable selection for model IP65, see the cables applicable to the models with the same power as model IP20 in this table.

It is appropriate to use the recommended cable size under 40℃ and rated current. The wiring distance should be no more than 100m.

If the control cable and power cable must cross, the angle between them must be 90°.

Appendix B Recommended Solar Modules

Recommended Configuration for Inverter

Model	Open-circuit Voltage Degree of Solar Module			
	50±1V		45±1V	
	Module Power ±5Wp	Modules per String*Strings	Module Power ±5Wp	Modules per String*Strings
FU9000SI-0R7G-SS2	550	8*1	300	9*1
FU9000SI-1R5G-SS2	550	8*1	300	9*1
FU9000SI-2R2G-SS2	550	8*1	300	9*2
FU9000SI-0R7G-9	550	14*1	300	15*1
FU9000SI-1R5G-9	550	14*1	300	15*1
FU9000SI-2R2G-9	550	14*1	300	15*1
FU9000SI-004G-9	550	14*1	300	16*1
FU9000SI-5R5G-9	550	14*1/14*2	300	15*2
FU9000SI-7R5G-9	550	14*2	300	15*2
FU9000SI-011G-9	550	14*2	300	15*3
FU9000SI-015G-9	550	14*3	300	15*4
FU9000SI-018G-9	550	14*3	300	15*5
FU9000SI-022G-9	550	14*4	300	15*6
FU9000SI-030G-9	550	14*5	300	15*8
FU9000SI-037G-9	550	14*7	300	15*9
FU9000SI-045G-9	550	14*8	300	15*13
FU9000SI-055G-9	550	14*9	300	15*16
FU9000SI-075G-9	550	14*13	300	15*22
FU9000SI-090G-9	550	14*16	300	15*26
FU9000SI-110G-9	550	14*21	300	15*34
FU9000SI-132G-9	550	14*26	300	15*41
FU9000SI-160G-9	550	14*31	300	15*49
FU9000SI-185G-9	550	14*34	300	15*54
FU9000SI-200G-9	550	14*38	300	15*60
FU9000SI-220G-9	550	14*43	300	15*70
FU9000SI-250G-9	550	14*47	300	15*74
FU9000SI-280G-9	550	14*52	300	15*83
FU9000SI-315G-9	550	14*59	300	15*93

Appendix B Recommended Solar Modules

Model	Open-circuit Voltage Degree of Solar Module	Model	Open-circuit Voltage Degree of Solar Module	Model
FU9000SI-355G-9	550	14*65	300	15*104
FU9000SI-400G-9	550	14*72	300	15*115
FU9000SI-450G-9	550	14*78	300	15*124
FU9000SI-500G-9	550	14*82	300	15*130
FU9000SI-630G-9	550	14*100	300	15*159

Appendix C EMC Regulations

The EMC product standard describes the EMC requirements on inverters.

Application environment categories

Category Ⅰ: Civilian environments, including application scenarios where inverters are directly connected to the civil power supply low-voltage grids without intermediate transformers.

Category Ⅱ: All environments except those in Category Ⅰ.

Inverter categories

C1: Rated voltgae lower than 1000V, applied to environments of Category Ⅰ.

C2: Rated voltage lower than 1000v, non-plug, socket, or mobile devices; power drive systems that must be installed and operated by specialized personnel when applied to environments of Category I.

Note: The EMC standard no longer restricts the power distribution of inverters, but it specifies their use, installation, and commissioning. Specialized personnel or organizations must have the necessary skills (including the EMC-rated knowledge) for installing and/or performing commissioning on the electrical drive systems.

C3: Rated voltage lower than 1000V, applied to environments of Category Ⅱ. They cannot be applied to environments of Category I.

C4: Rated voltage higher than 1000V, or rated current higher or equal to 400A, applied to complex systems in environments of Category II.

C.1 Category C2

The induction disturbance limit meets the following stipulations:

1. Select an optional EMC filter and install it following the description in the EMC filter manual.
2. Select the motor and control cables according to the description in the manual.
3. Select the inverter according to the description in the manual.
4. For the maximum length of the motor cable when the switching frequency is 4 kHz, see follows:

EMC compatibility and motor cable length

The following table describes the maximum motor cable lengths that meet the requirements of the EUEMC directive when the carrier frequency is 4 kHz.

All models (with external EMC filters)	Maximum motor cable length (m)
Environment category II (C3)	30
Environment category I (C2)	30

You can learn the maximum length of the motor cable through the running parameters of the inverter. To understand the accurate maximum cable length for using an external EMC filter, contact the USFULL team.

	· Currently in environments in China, the inverter may generate radio interference, you need to take measures to reduce the interference.

C.2 Category C3

The anti-interference performance of the inverter meets the requirements of environments Category II in the standard.

The induction disturbance limit meets the following stipulations:

1. Select an optional EMC filter and install it following the description in the EMC filter manual.
2. Select the motor and control cables according to the description in the manual.
3. Select the inverter according to the description in the manual.
4. For the maximum length of the motor cable when the switching frequency is 4 kHz, see follows:

EMC compatibility and motor cable length

The following table describes the maximum motor cable lengths that meet the requirements of the EUEMC directive when the carrier frequency is 4 kHz.

All models (with external EMC filters)	Maximum motor cable length (m)
Environment category II (C3)	30
Environment category I (C2)	30

You can learn the maximum length of the motor cable through the running parameters of the inverter. To understand the accurate maximum cable length for using an external EMC filter, contact the USFULL team.

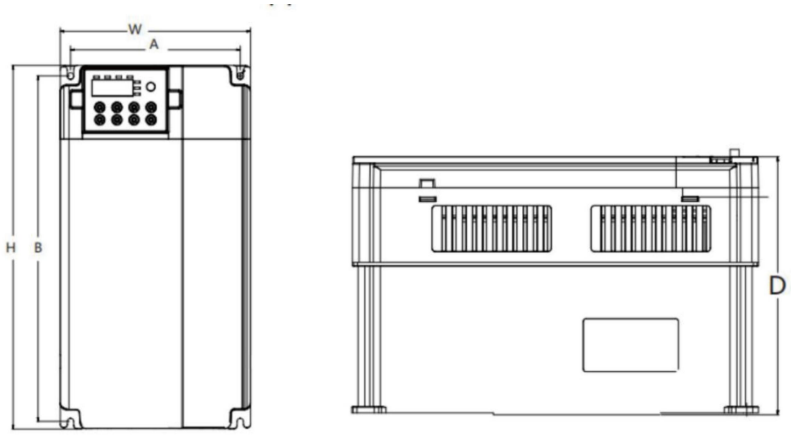
	· Inverters of C3 category cannot be applied to civilian low-voltage common grids. When applied to such grids, the inverter may generate radio frequency electromagnetic interference.

Appendix D Dimension Drawing

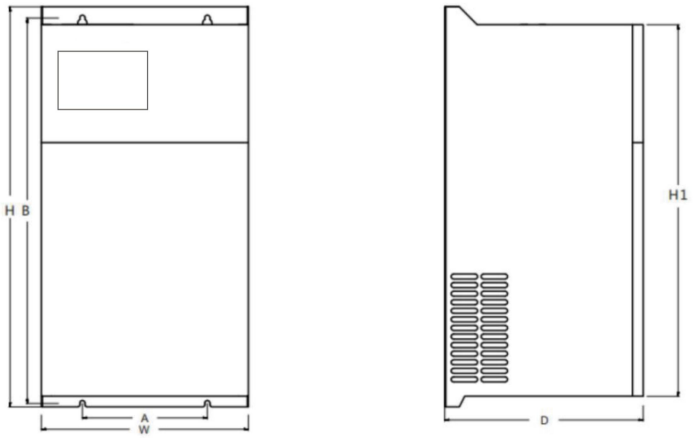
D.1 External Keypad Structure

If the keypad is externally installed on an optional bracket, it can be 20meters away from the inverter at most.

D.2 Dimensions



C.2.1 plastic structure



C.2.2 iron structure

Model	Installation Hole (mm)		Outside Dimension (mm)			Installation Hole Size (mm)	Weigh t
	A Width	B	H	W	D		kg
1PH 220V Input & 1PH/3PH 220V Output							
FU9000SI- 0R7G-SS2	152	305	320	170	200	5.5	6.75
FU9000SI-1R5G-SS2	152	305	320	170	200	5.5	6.75
FU9000SI-2R2G-SS2	152	305	320	170	200	5.5	6.75
FU9000SI-004G-SS2	152	305	320	170	200	5.5	6.75
FU9000SI-5R5G-SS2	152	305	320	170	200	5.5	6.75
3PH 380V Input & Output							
FU9000SI-0R7G-9	152	305	320	170	200	5.5	6.75
FU9000SI-1R5G-9	152	305	320	170	200	5.5	6.75
FU9000SI-2R2G-9	152	305	320	170	200	5.5	6.75
FU9000SI-004G-9	152	305	320	170	200	5.5	6.75
FU9000SI-5R5G-9	152	305	320	170	200	5.5	6.75
FU9000SI-7R5G-9	152	305	320	170	200	5.5	6.75
FU9000SI-011G-9	152	305	320	170	200	5.5	6.75
FU9000SI-015G-9	152	305	320	170	200	5.5	6.75
FU9000SI-018G-9	152	305	320	170	200	5.5	6.75
FU9000SI-022G-9	175	540	560	290	285	8	32
FU9000SI-030G-9	175	540	560	290	285	8	32
FU9000SI-037G-9	175	540	560	290	285	8	32
FU9000SI-045G-9	175	540	560	290	285	8	32
FU9000SI-055G-9	175	540	560	290	285	8	32
FU9000SI-075G-9	175	540	560	290	285	8	32
FU9000SI-090G-9	250	730	750	400	340	10	62
FU9000SI-110G-9	250	730	750	400	340	10	62
FU9000SI-132G-9	250	730	750	400	340	10	62
FU9000SI-160G-9	250	730	750	400	340	10	62
FU9000SI-185G-9	650	869	1470	960	470	12	175
FU9000SI-200G-9	650	869	1470	960	470	12	175
FU9000SI-220G-9	650	869	1470	960	470	12	175
FU9000SI-250G-9	650	869	1470	960	470	12	175
FU9000SI-285G-9	650	869	1470	960	470	12	175
FU9000SI-315G-9	650	869	1470	960	470	12	175
FU9000SI-355G-9	650	869	1470	960	470	12	175
FU9000SI-400G-9	650	869	1470	960	470	12	175
FU9000SI-450G-9	1658	440	1860	720	650	16	333
FU9000SI-500G-9	1658	440	1860	720	650	16	333
FU9000SI-630G-9	1658	440	1860	720	650	16	333

Appendix E Model Selection Reference for Low-voltage Apparatus

Breaker,electromagnetic contactor and leakage protection switch

Due to the inner configurations, the inverter will inevitably generate high-frequency leakage current to ground. The high-frequency leakage current will back flow to grid through the earth to interference the leakage protection switch, thus causing the leakage protection switch malfunction. This is due to the inverter output voltage characteristics inherent in the decision.

To ensure the stability of the system, it is recommend to use the inverter dedicated leakage protection switch which rated residual operation current 30mA or more. If you are not using the inverter dedicated leakage protection switch caused by malfunction, try to reduce the carrier frequency, or replace the electromagnetic leakage protection switch which rated residual operation current of 200mA or more.

It it necessary to add fuse for the avoidance of overload.

It is appropriate to use a breaker (MCCB) which complies with the VFD power in the 3-phase power and input power and terminals (R, S and T). The capacity of the VFD should be 1.5-2 times of the rated current.

· Due to the inherent operating principle and construction of circuit breakers, independent of the manufacturer, hot ionized gases may escape from the breaker enclosure in case of a short-circuit. To ensure safe use, special attention must be paid to the installation and placement of the breakers. Follow the manufacturer's instructions.

Model	AC breaker (A)	DC breaker (A)	AC contactor (A)	SPD	Fuse	Diode
FU9000SI-0R7G-SS2	16	16A/1000V	16	Type II, 1000V DC	30A	25A/1600V
FU9000SI-1R5G-SS2	25		25			
FU9000SI-2R2G-SS2	40		40			
FU9000SI-0R7G-9	10		12			
FU9000SI-1R5G-9	10		12			
FU9000SI-2R2G-9	10		12			
FU9000SI-004G-9	25		25			55A/1600V
FU9000SI-5R5G-9	25	25A/1000V	25			
FU9000SI-7R5G-9	40		40			
FU9000SI-011G-9	50	63A/1000V	50			
FU9000SI-015G-9	63		63			
FU9000SI-018G-9	63	100A/1000V	63			110A/1600V
FU9000SI-022G-9	100		95			
FU9000SI-030G-9	100		95			
FU9000SI-037G-9	125	125A/1000V	115			
FU9000SI-045G-9	200	160A/1000V	170			160A/1600V

Model	AC breaker (A)	DC breaker (A)	AC contactor (A)	SPD	Fuse	Diode
FU9000SI-055G-9	200	250A/1000V	170	Type II, 1000V DC	30A	250A/1600V
FU9000SI-075G-9	250		205			
FU9000SI-090G-9	315	350A/1000V	245			350A/1600V
FU9000SI-110G-9	350		265			
FU9000SI-132G-9	35	400A/1000V	330			400A/1600V
FU9000SI-160G-9	400	550A/1000V	400			550A/1600V
FU9000SI-185G-9	500		500			
FU9000SI-200G-9	500	600A/1000V	500			600A/1600V
FU9000SI-220G-9	630	630A/1000V	630			630A/1000V
FU9000SI-250G-9	630		630			800A/1000V
FU9000SI-280G-9	800	800A/1000V	800			1000A/1000V
FU9000SI-315G-9	800		800			1250A/1000V
FU9000SI-355G-9	1000	1000A/1000V	1000			1600A/1000V
FU9000SI-400G-9	1000		1000			630A/1000V
FU9000SI-450G-9	1250	1250A/1000V	1250			800A/1000V
FU9000SI-500G-9	1250		1250			1000A/1000V
FU9000SI-630G-9	1600	1600A/1000V	1600			1250A/1000V

Appendix F Further Information

F.1 Product and Service Inquiries

Address any inquiries about the product to your local USFULL offices, quoting the type designation and serial number of the unit in question. A listing of USFULL sales, support and service contacts can be found by navigating to www.usfull.com.

F.2 Feedback of USFULL Inverters Manuals

Your comments on our manuals are welcomed.

Go to www.usfull.com and select online feedback of contact us.

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ZHEJIANG FULLWILL ELECTRIC CO.,LTD.

ADD: 2-3 Floor, Building 10, No. 699 Lingzhan Road, Kunpeng Street,
Marine Economic Development Demonstration Zone, Wenzhou City, Zhejiang Province, China.

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