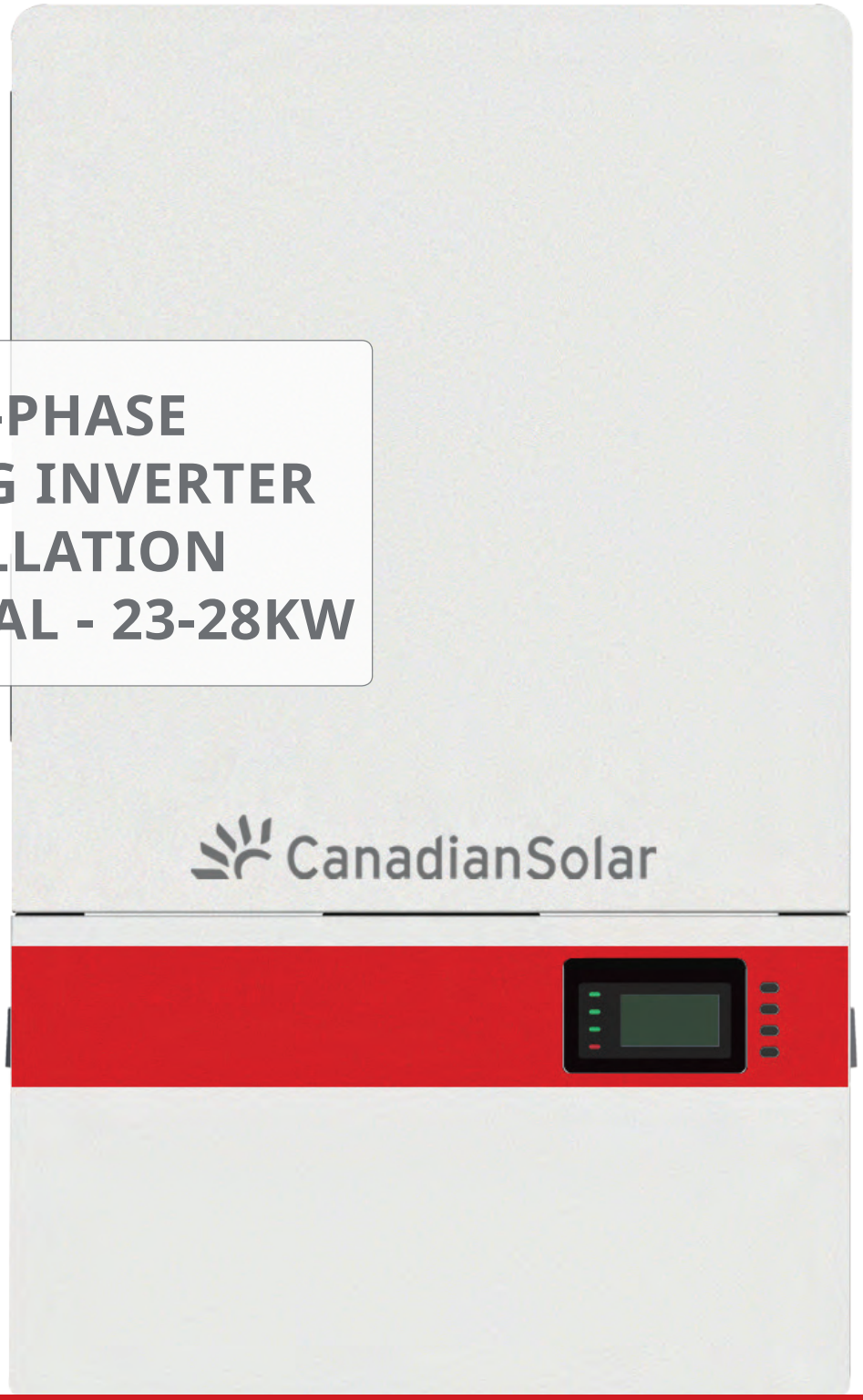
CanadianSolar

THREE-PHASE STRING INVERTER INSTALLATION MANUAL - 23-28KW



PRELIMINARY

CanadianSolar

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Before You Start.

This manual contains important information regarding installation and safe operation of this unit. Be sure to read this manual carefully before using.

Thank you for choosing this CSI Grid-tied PV Inverter. This PV Inverter is a high performance and highly reliable product specifically designed for the North American Solar market.

If you encounter any problems during installation or operation of this unit, first check the user manual before contacting your local dealer or supplier.
This user manual is applicable for the following 2 models:
CSI 23KTL-CT/US-480 and CSI 28KTL-CT/US-480.

Instructions inside this user manual will help you solve most installation and operation difficulties.
Contact your local supplier if the problem still exists.

Please keep this user manual on hand for quick reference.

Chapter 1

IMPORTANT SAFETY INSTRUCTIONS
(SAVE THESE INSTRUCTIONS)

Please read this user manual carefully before product installation. Canadian Solar reserves the right to refuse warranty claims for equipment damage if the user fails to install the equipment according to the instructions in this manual.

Warnings and symbols in this document:

DANGER:

WARNING:

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION:

NOTICE:

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE indicates a hazardous situation which, if not avoided, could result in equipment working abnormally or property loss.

MARKINGS ON THE PRODUCT

INSTRUCTION:

HIGH VOLTAGE:

INSTRUCTION indicates important supplementary information or provides skills or tips that can be used to help you solve a problem or save you time.
HIGH VOLTAGE indicates the product works with high voltages. All work on the product must only be performed as described in this document.

MARKINGS ON THE PRODUCT

HOT SURFACE:

The equipment is designed to meet international safety standards, but surfaces can become hot during operation. Do not touch the heat sink or peripheral surfaces during or shortly after operation.

EARTH GROUND:

This symbol marks the location of grounding terminal, which must be securely connected to the earth through the PE (protective earthing) cable to ensure operational safety.

WARNING:

All the installation and wiring connections should be performed only by qualified technical personnel. Disconnect the inverter from PV modules and the Power Grid before maintaining and operating the equipment.

DANGER:

Please disconnect the inverter from AC grid and PV modules before opening the equipment. Make sure hazardous high voltage and energy inside the equipment has been discharged. Do not operate or maintain the inverter until at least 5 minutes after disconnecting all sources from DC and AC sides.

NOTICE:

This inverter is designed to connect AC power only to the public grid. Do not connect the AC output of this equipment directly to any private AC power equipment.

CAUTION:

CSI 23/28KTL-CT series inverter is approx 55kg (=122 pounds).
Please ensure the mounting is properly installed before hanging the inverter on the bracket.
CSI 23/28KTL-CT series inverter has the Arc Fault Detection feauture in the disabled mode by default.
Please ensure that this setting meets local code requirements. If you need to enable this feature for your install, please contact your local sales or service manager for assistance.

INSTRUCTION:

Please check with your local electricity supply company before selecting the grid standard. If the inverter is operated with a wrong grid standard, the electricity supply company may cancel the operation license. Putting the inverter into operation before the overall system complies with the national rules and safety regulation of the application is not permitted.

2.1 Inverter for grid-tied PV systems

CSI 23/28KTL-CT/US-480 series inverter is suitable for use with commercial and large scale PV grid-tied systems. The system is generally made up of PV modules, DC power distribution equipment, PV inverter and AC power distribution equipment (Figure 2-1). The inverter converts the DC from PV modules to AC with the same frequency and phase as the AC grid. All or part of the AC power is supplied to local loads, and the surplus power is supplied to the electricity grid.

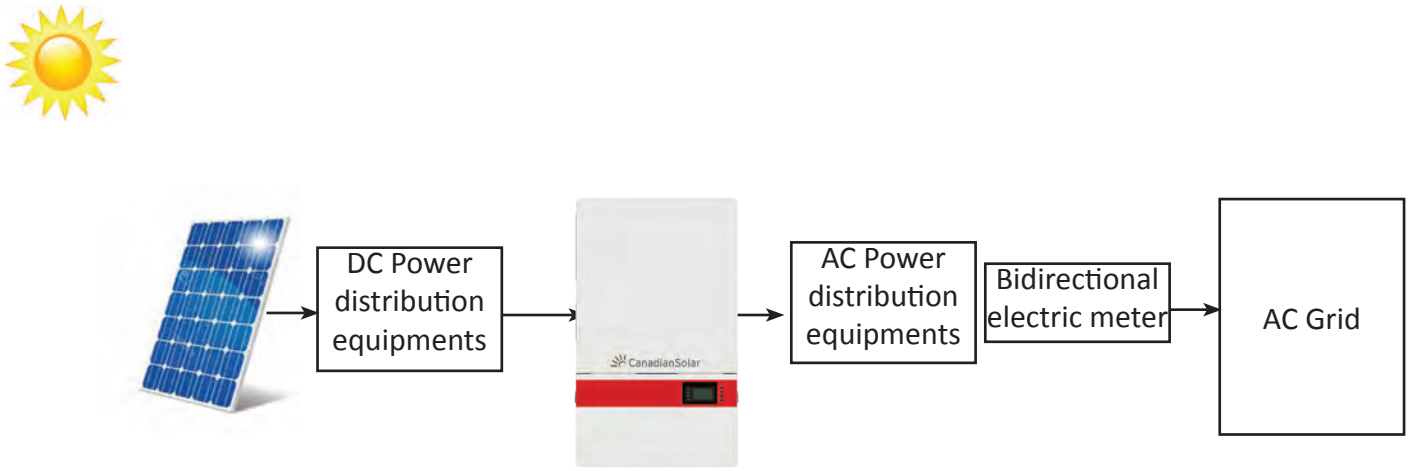

Figure 2-1 Grid-tied PV system

2.2 Product features

- **High conversion efficiency:** Advanced 3-level conversion technology; Max. efficiency: 98.6%; CEC efficiency: 98%
- **Strong grid adaptability:** 7 grid standards applicable; Reactive power adjustable; PF value:±0.8, Remote Curtailment
- **Flexible communication:** Supports standard modbus communications to ensure compatibility with 3rd party monitoring and control systems
- **Wide DC input voltage range:** Operating DC Input Voltage Range: 300-900Vdc; Max DC input voltage: 1000V
- **Long service life:** Uses thin-film capacitors to extend inverter's service life
- **2 MPPTs:** Dual and independent MPPT (Maximum Power Point Tracking) enable maximum design flexibility and optimize energy harvest over the life of the system
- **Integrated AFCI:** Integrated AFCI (Arc Fault Circuit Interruption) feature meets the need to meet advanced local electrical and grid codes. This feature is disabled by default but can be enabled if needed in the field. Please contact your local sales or service manager for assistance.
- **High protection degree:** NEMA 4 protection degree meets the needs of both indoor and outdoor use;
- **Intelligent Integration:** Embedded DC/AC switches and up to 8 fused string inputs eliminates the need for external combiner boxes and simplifies installation.

2.3 Product protection functions

- Polarity reverse protection of DC input
- Short circuit protection
- DC input insulation against ground monitoring
- AC output voltage and frequency monitoring
- Integrated Arc Fault Detection and Interruption*
- Leakage current against ground monitoring
- Monitoring of DC injection from AC output
- Anti-islanding protection
- Input and output over-voltage protection
- Input over-current protection
- Environmental temperature monitoring
- Module temperature monitoring

*The AFCI function ships from the factory in diaabled mode. To enable this feature, please contact your local sales or service manager to get instructions.

2.4 Circuit structure design

The basic schematic diagram of CSI 23/28KTL-CT/US-480 series inverter is shown in Figure 2-2.
The input of PV modules passes through surge protection circuitry, DC EMI wave filter, and the front-end boost circuitry to achieve maximum power tracking and boost up voltages. The output of the inverter converts the DC voltage to 3-phase AC voltage. The high frequency AC components are removed with a wave filter. Then the 3-phase AC voltage is passed through two-stage relays and EMI wave filter to produce high quality AC power.

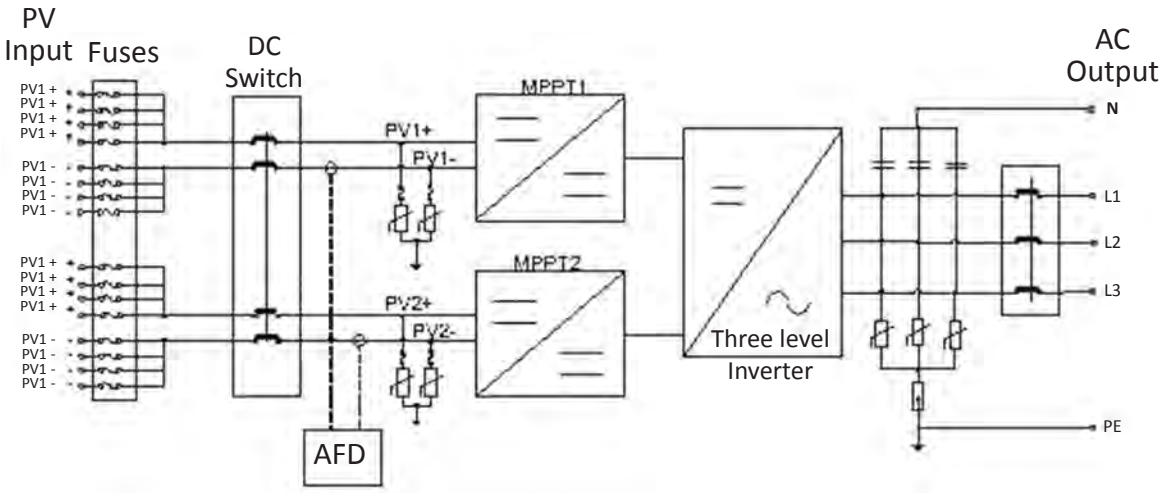

Figure 2-2 Schematic diagram of CSI 23/28KTL-CT series inverter

2.5 Appearance Description

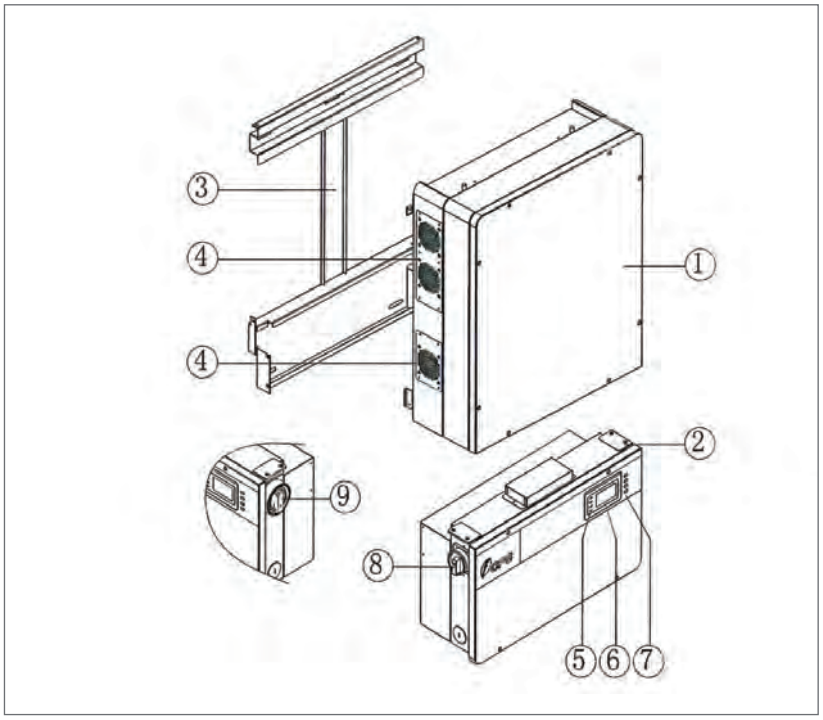

Figure 2-3 Appearance sketch of CSI 23/28KTL-CT series inverter

Main items of the inverter:

1) Main housing of the inverter

2) Wiring box of the inverter

3) Mounting bracket

4) External cooling fans

5) LED indication lights

6) LCD display

7) Key buttons

8) DC switch: DC power on/off

9) AC switch: AC power on/off

Below is the installation procedure for the inverter. Please read carefully and install the product step-by-step.

Before installation, please check that the following items are included in the package:

Table 3-1 Main items

No.	Item	Q'ty	Note
(1)	Main housing of the PV inverter	1	
(2)	Wiring box of the PV inverter	1	
(3)	Mounting bracket	1	Upon which inverter is hung and mounted onto a wall
(4)	User manual	1	Installation and operation manual
(5)	Accessory kit	1	Contains all necessary accessories

The (5) Accessory kit contains items listed below:

Table 3-2 Accessories

No.	Item	Q'ty	Note
(1)	M8 Expansion tubes	8	For mounting bracket
(2)	M8 x 25 assembling bolts	8	For mounting bracket
(3)	M6X 16 screw	6	For wiring box and main housing; 2 spare parts
(4)	M5X 10 screw	8	For mounting bracket and inverter, external ground connection
(5)	M3X8 screw	2	For partition plate; 1 spare part

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No.	Item	Q'ty	Note
(6)	M5 flange nut	2	For internal ground stud connection; 1 spare part
(7)	Lifting eye nut M10	2	For lifting the main housing
(8)	OT type terminal	2	For ground connection
(9)	Pre-insulated end ferrule for AC side	5	For AC output cables, 1 spare part
(10)	Pre-insulated end ferrule	8	For ground cables
(11)	Pre-insulated end ferrule for DC side	20	For DC input cables, 4 spare parts
(12)	RJ45 connector	4	For RS485 or Ethernet communication, 2 spare parts
(13)	5 pin connector	1	For RS485 communication
(14)	3 pin connector	1	For dry contact communication
(15)	Partition plate	1	For partition signal cable and the power cable

INSTRUCTION:
The items in the accessory kit table above are for the standard configuration.
The accessories may vary if optional parts are purchased.

3.1 Recommendations before installation

- Check that the product environmental specifications (protection degree, operating temperature range, humidity and altitude, etc) meet the requirements of the specific project location;
- Make sure that the power grid voltage is within normal range;
- Ensure that the local electricity supply authority has granted permission to connect to the grid;
- Ensure that local code requirement is met by enabling the AFCI function from the LCD screen. This feature is disabled by default but can be enabled in the field.
- Installation personnel must be qualified electricians or people who have received professional training;
- Sufficient space is provided to allow the inverter cooling system to operate normally;
- Install the inverter away from flammable and explosive substances;
- Avoid installing the inverter in locations that exceed the temperature limits specified in the inverter data sheet to limit undesirable power loss;
- Do not install the inverter near the electromagnetic source which can compromise the normal operation of electronic equipment

3.2 Mechanical installation

1) Dimensions

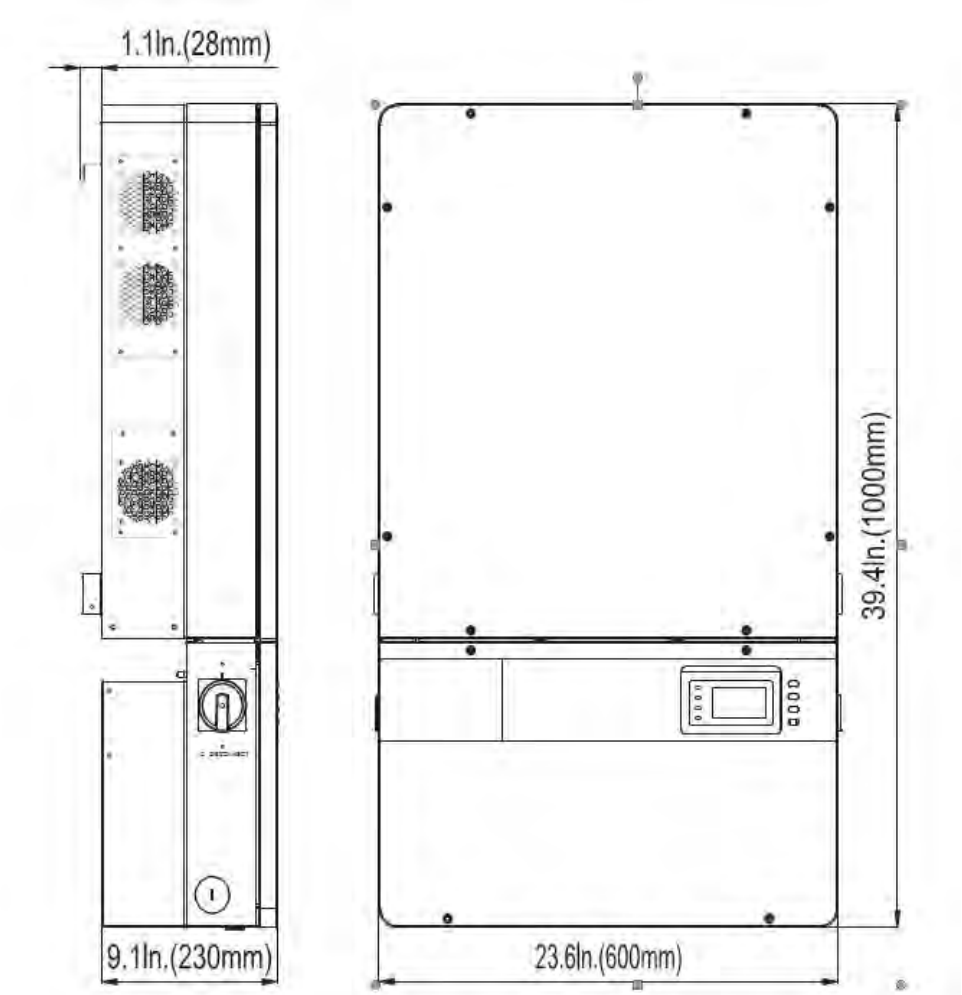

Figure 3-1 Dimensions of CSI 23/28KTL-CT series inverter

2) Installation method (see Figure 3-2):

Make sure that the mounting structure (wall, rack, etc.) is suitable to support the inverter weight.
Follow the mounting guidelines:

(a) If the location permits, install the inverter vertically
b) If the inverter cannot be mounted vertically, it may be tilted backward by no lower than 15 degrees from horizontal
(c) Do NOT mount the inverter leaning forward
(d) Do NOT mount the inverter in a horizontal position (<15 degrees)
(e) Do NOT mount the inverter upside down

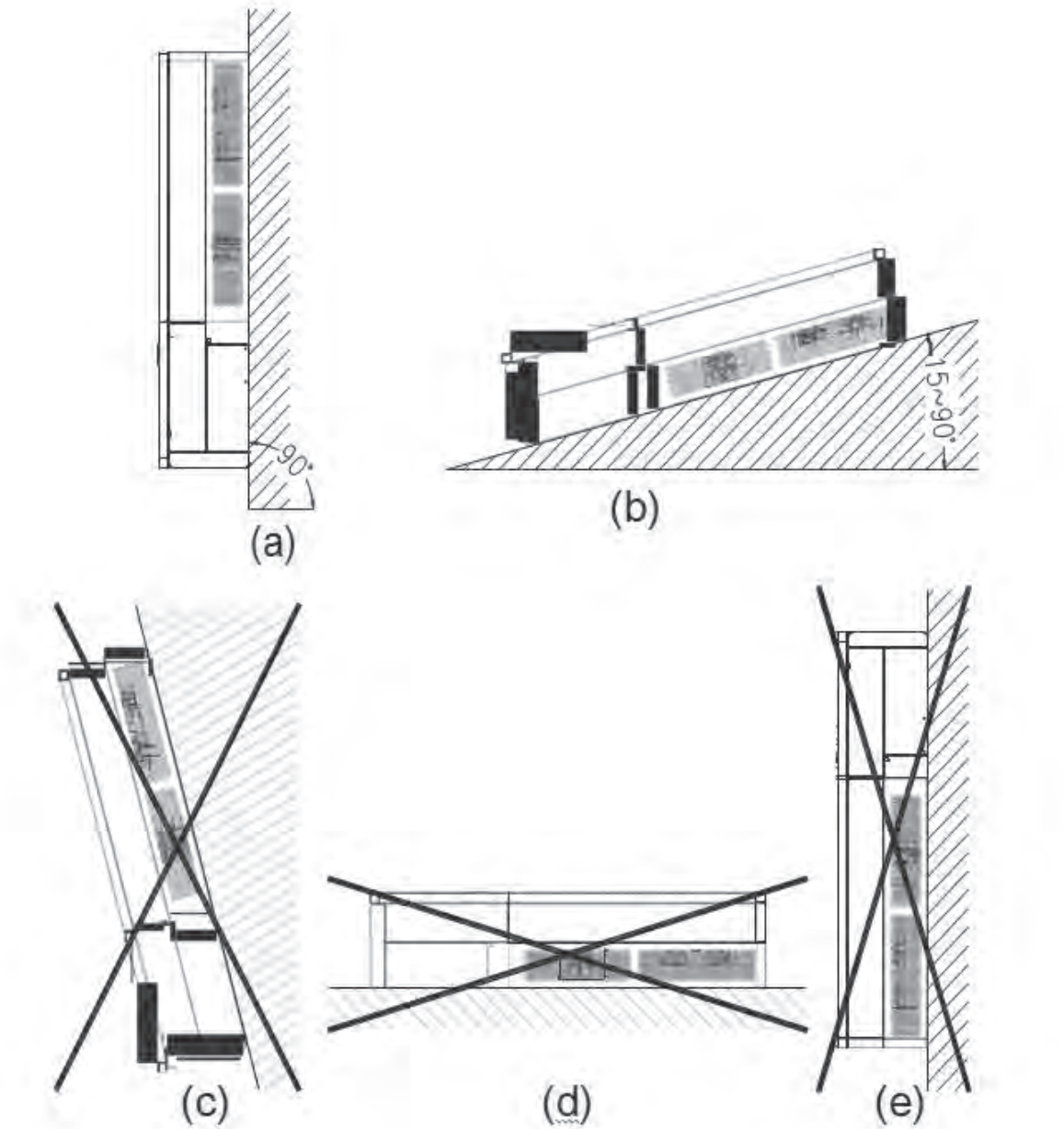

Figure 3-2 Mount the inverter correctly

NOTICE:

When the inverter is mounted backward by ≥ 15° outdoor, shield cover is recommended to be installed above the inverter to avoid direct sunlight.

3) Installation space requirement (see Figure 3-3):
The distances between the inverters or the surrounding objects should meet the following conditions:

NOTICE:

The spacing between two adjacently mounted inverters should be ≥500mm (19.7 inches). Ensure that the air space around the inverter is well ventilated.

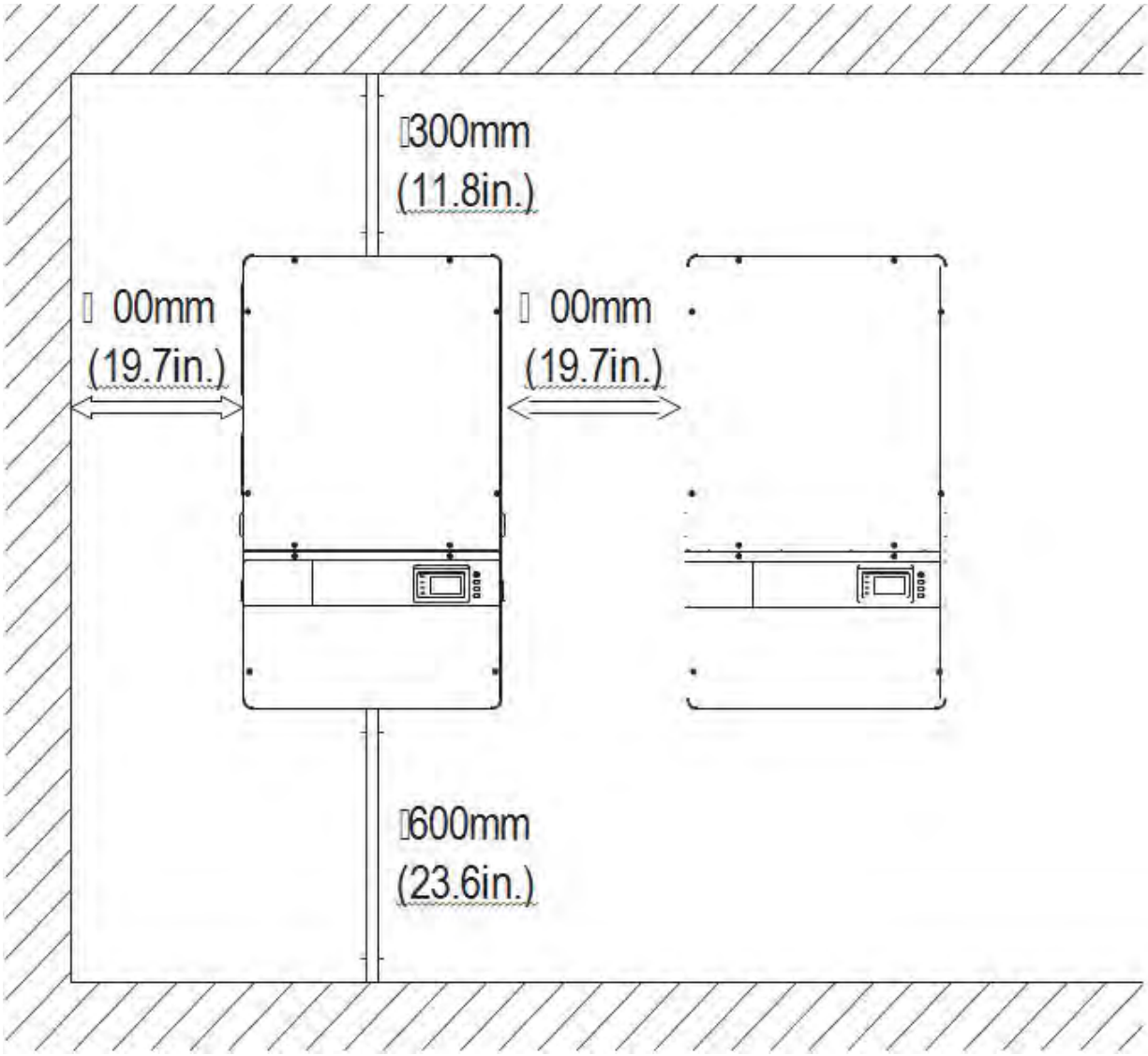

Figure 3-3 Inverter wall mounting dimensions

NOTICE:

The installation clearance between two inverters needs to be increased when the ambient temperature is higher than 45° C.

INSTRUCTION:

If the inverter is tilted backward by no lower than 15° from horizontal, the bottom clearance distance can be reduced according to specific conditions

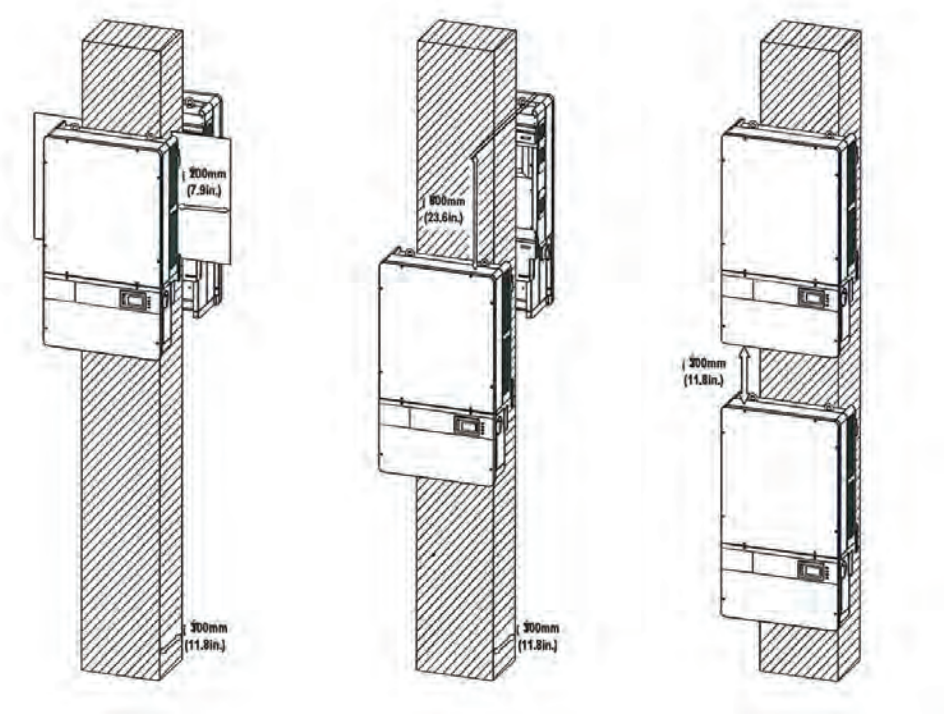

Figure 3-4 Inverter pillar mounting dimensions

INSTRUCTION:

If the inverter is installed in open air on metallic brackets (instead of solid wall), the top clearance distance can be reduced to as minimum as 100mm (3.94in.)

4) Mount the inverter onto the bracket

(1) Mark the 8 holes on the bearing surface for mounting the bracket as shown in Figure 3-5:

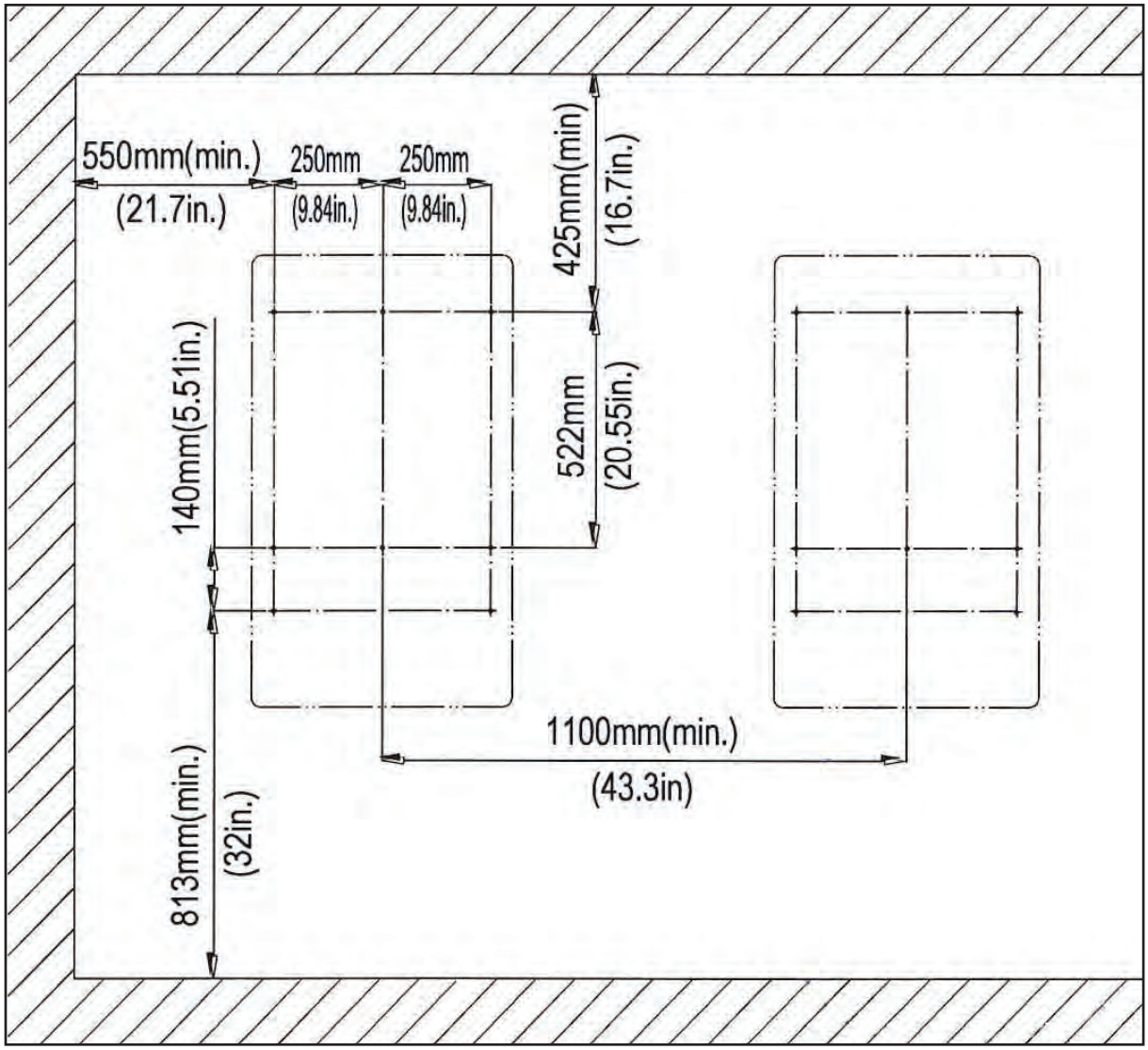

Figure 3-5 Dimensions of holes on the bearing surface

(2) Drill holes at hte marked positions with a 10mm (0.4in.) drill and put the M8 expansion tubes① into the holes; Fasten the mounting bracket② with the M8x25 assembling bolts③ in the accessory kit.
Tool: Electric drill (ϕ10mm/0.4in. head), No. 13 wrench

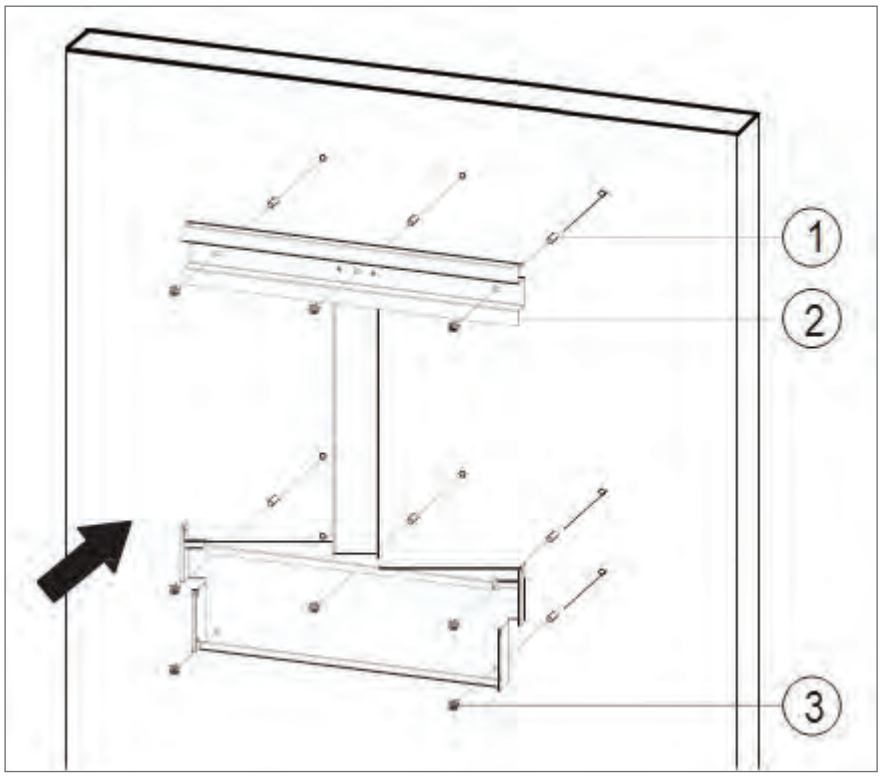

Figure 3-6 Secure the mounting bracket

(3) Hang the inverter onto the mounting bracket as shown in Figure 3-7 and Figure 3-8:
Lift mounting: Take out the lifting eye nut M10 (2pcs) from the accessory kit, and screw them on the bolts at the top of the inverter. Use sling rope or bar (inserted through both lifting eye nuts) to lift the inverter onto the bracket. The minimum angle between the two sling ropes should be less than 90 degrees.
Manual mounting: Two people grab the handle positions marked in Figure 3-8, and mount the inverter onto the bracket.

CAUTION:

The main housing of the CSI 23/28KTL-CT series inverter is about **46.5kg (=102.5 pounds)**
Please ensure the mounting is properly installed before hanging the inverter on the bracket. It is recommended to have at least 2 people to mount the inverter due to the weight of the equipment.

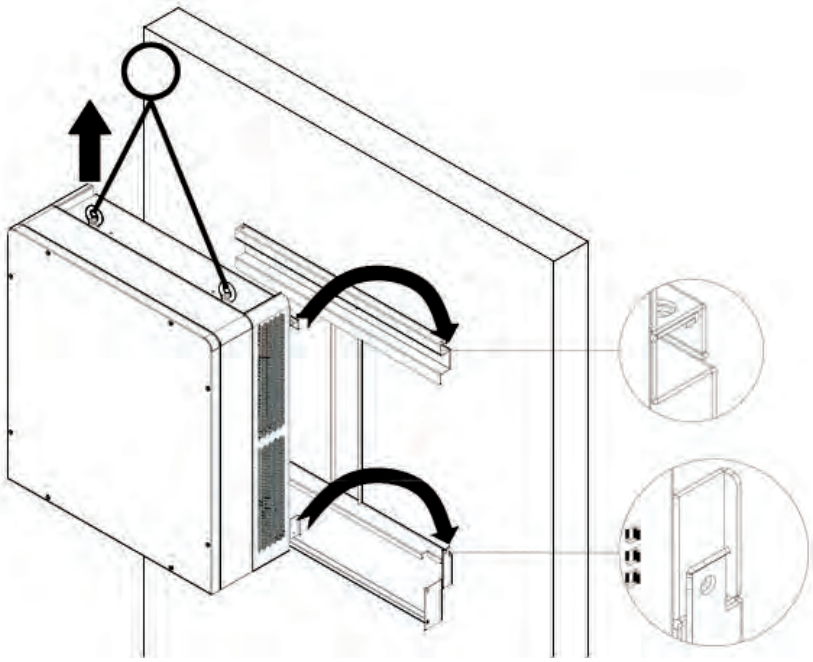

Figure 3-7 Mount the main housing on the bracket by lifting

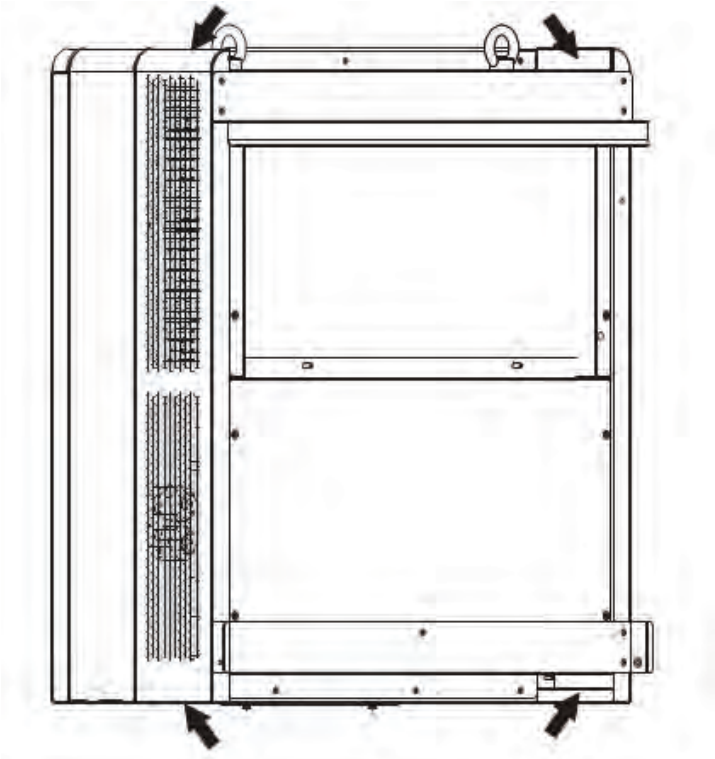

Figure 3-8 Position of grab handle

(4) Install the wiring box

① Remove the cover plate at the bottom of the main housing. (see Figure 3-9)

Tool: No. 2 Phillips head screwdriver

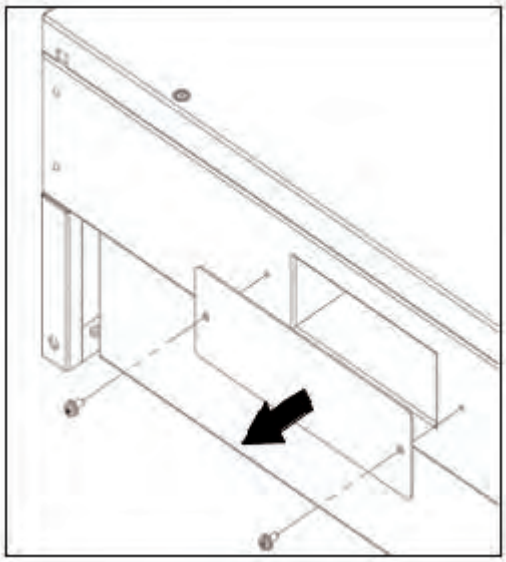

Figure 3-9 Cover plate of the main housing

② Remove the cover board at the top of the wiring box (see Figure 3-10)

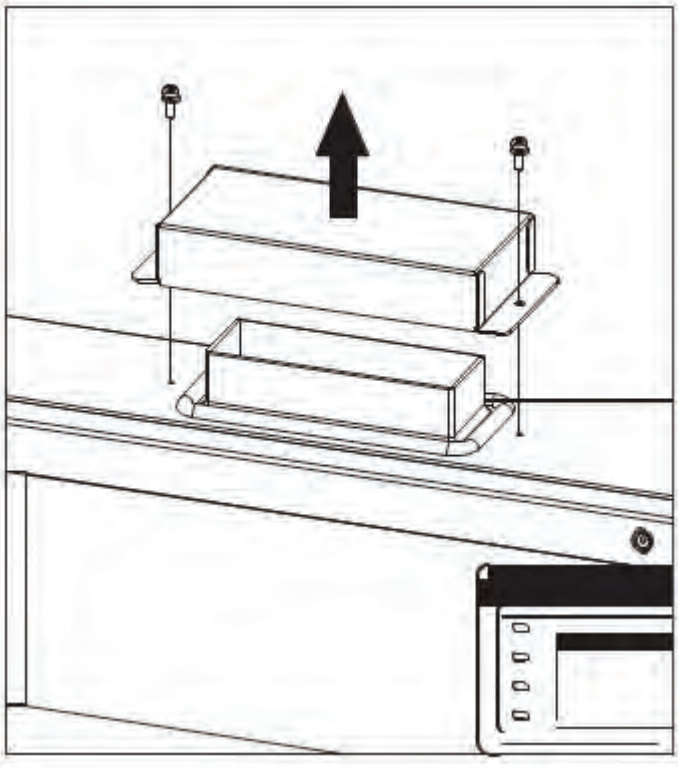

Figure 3-10 Cover board of the wiring box

Save the cover board ad screws, and fix the board on the left side of the wiring box after the wiring box is attached to the inverter housing (see step 6, Figure 3-13)
Tool: No. 2 Phillips head screwdriver

③ Insert the wiring box to the main housing, and use M6x12 screws (4 pcs) to attach the wiring box to the inverter housing. (see Figure 3-11)
Tool: No. 10 Wrench, torque value of 2.8N.m

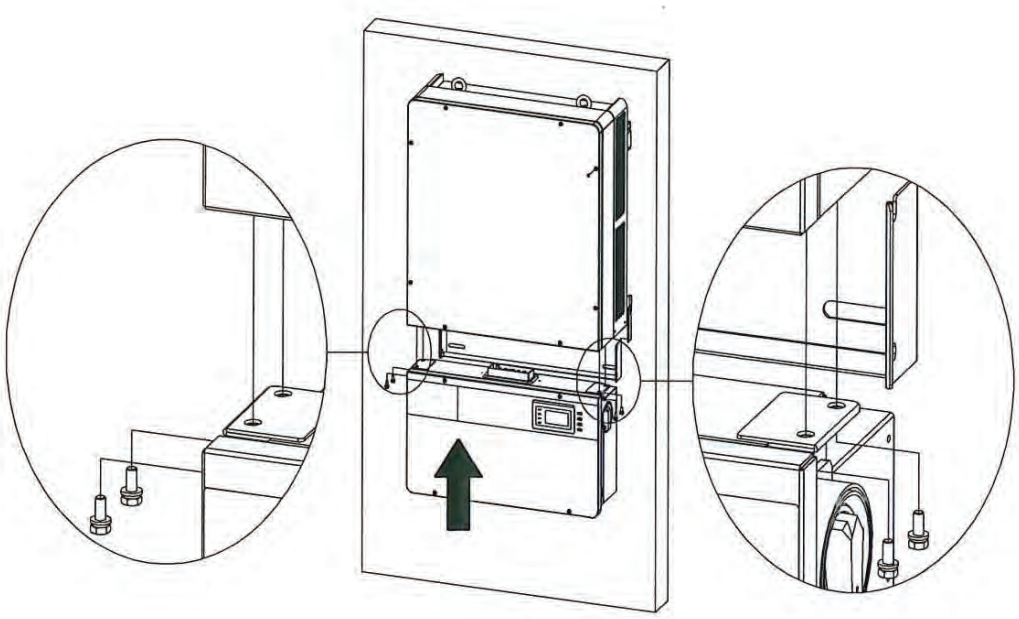

Figure 3-11 Installation of the wiring box

CAUTION:

The total weight of the CSI 23/28KTL-CT series inverter is about **55kg (=122 pounds).** Please ensure the mouting is properly installed before hanging the inverter on the bracket

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(5) Attach the main housing and the wiring box to the mounting bracket with the **M5x10 bolts (6pcs.)** (see Figure 3-12)
Tool: No. 2 Phillips head screwdriver, torque value of 1.6N.m

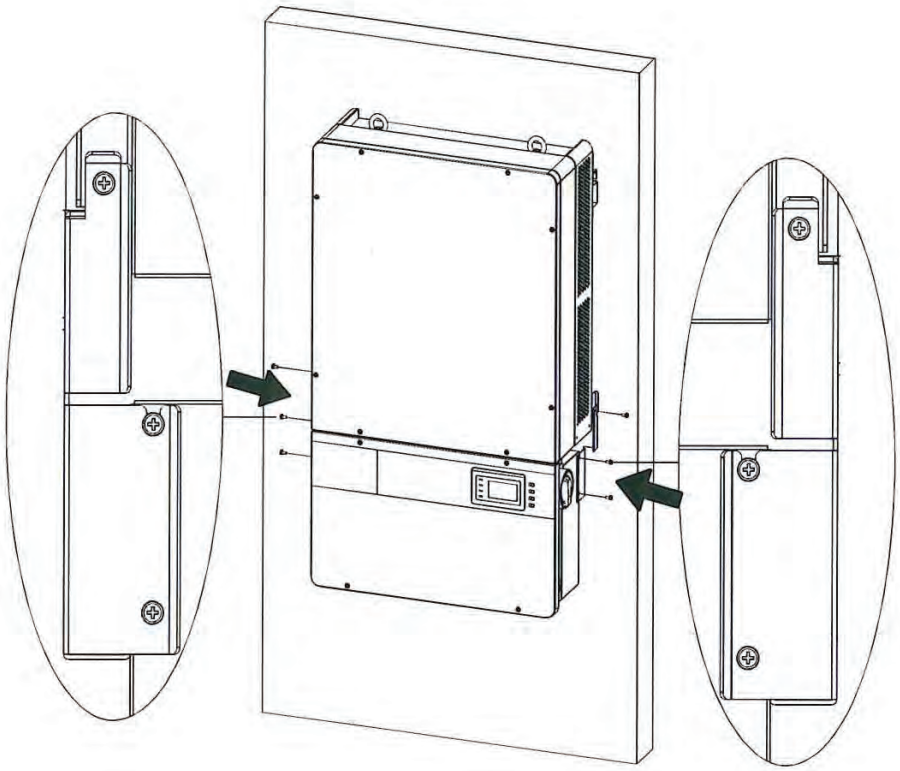


Figure 3-12
Fix the main housing and wiring box on the bracket

(6) Attach the cover board shown in Figure 3-10 to the left side of the wiring box. (see Figure 3-13)
Tool: No. 2 Phillips head screwdriver, torque value of 1.2N.m

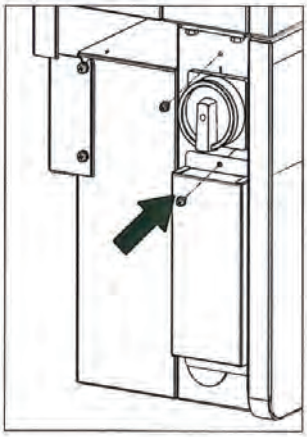


Figure 3-13
Attach the cover board to the left side of the wiring box

(7) Optional - Install an anti-theft padlock when the installation is complete. The anti-theft padlock is used to prevent the inverter from being stolen when the equipment is installed outdoors. You can lock the inverter on the bracket, as shown in Figure 3-14:

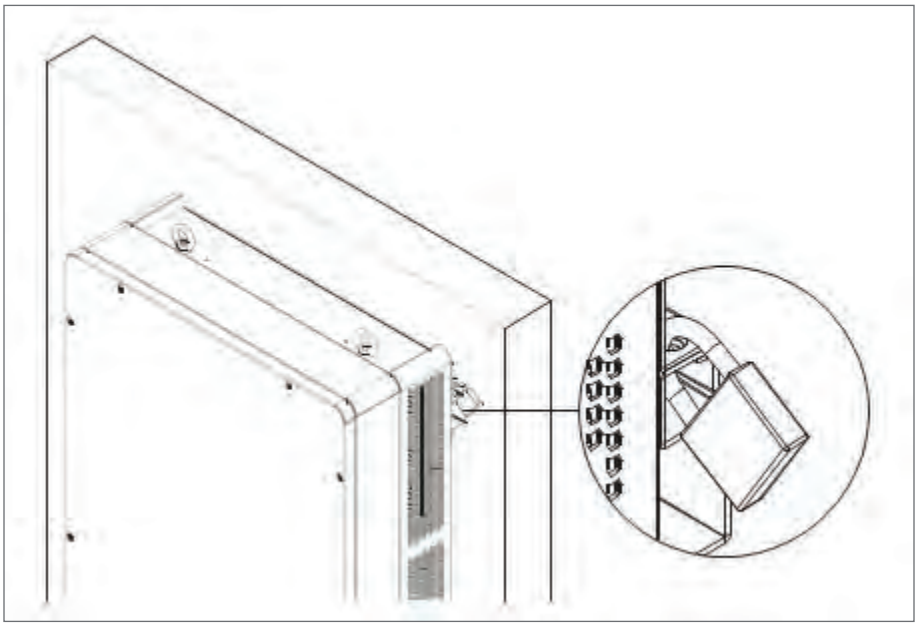
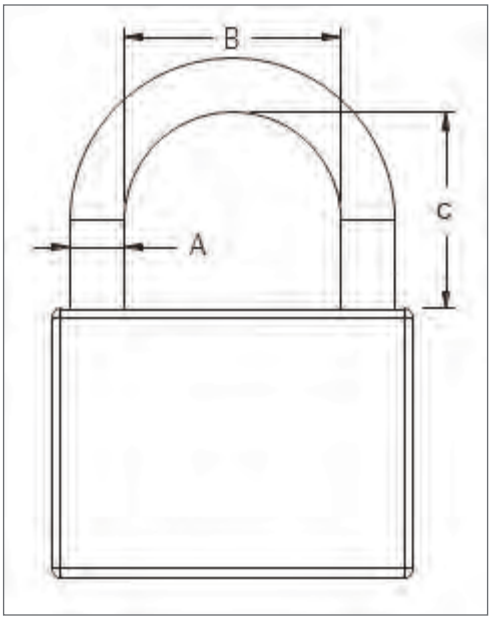


Figure 3-14 Location of the anti-theft padlock

The anti-theft padlock should meet the requiremen of the dimensions shown in Figure 3-15:



Recommended lock size:

A: ϕ3~6mm

B: 20~50mm

C: 20~50mm

Figure 3-15 The dimensions of anti-theft padlock

Removing/Replacing the wire box cover:

(1) Use a 3mm (0.12in.) Hex screwdriver to remove the 4 screws on the wiring box and take off the cover. (See Figure 3-16(a)).

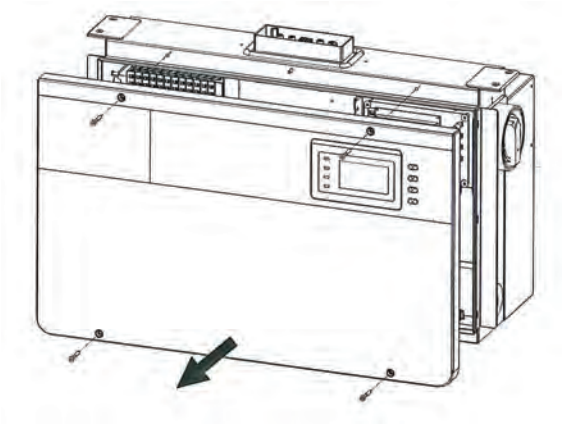


Figure 3-16(a) - Take off the cover of the wiring box

(2) To replace the cover, use a 3mm (0.12in.) Hex screwdriver to replace the 4 screws on the cover.

INSTRUCTION:
It is important to use a hand tool (e.g. Hex key, Allen key/socket or T-handle, 3mm) and not power drivers or other types of screw drivers. Also, it is important to hold the cover in alignment with balanced force across the cover, not weighted toward any edge, for screw to Pem®-nut alignment. Partially engage all four screws to Pem®-nuts a few rotations before tightening any one screw. This is important to maintain alignment and avoid thread damage.

The connection interface of CSI 23/28KTL-CT series inverter:

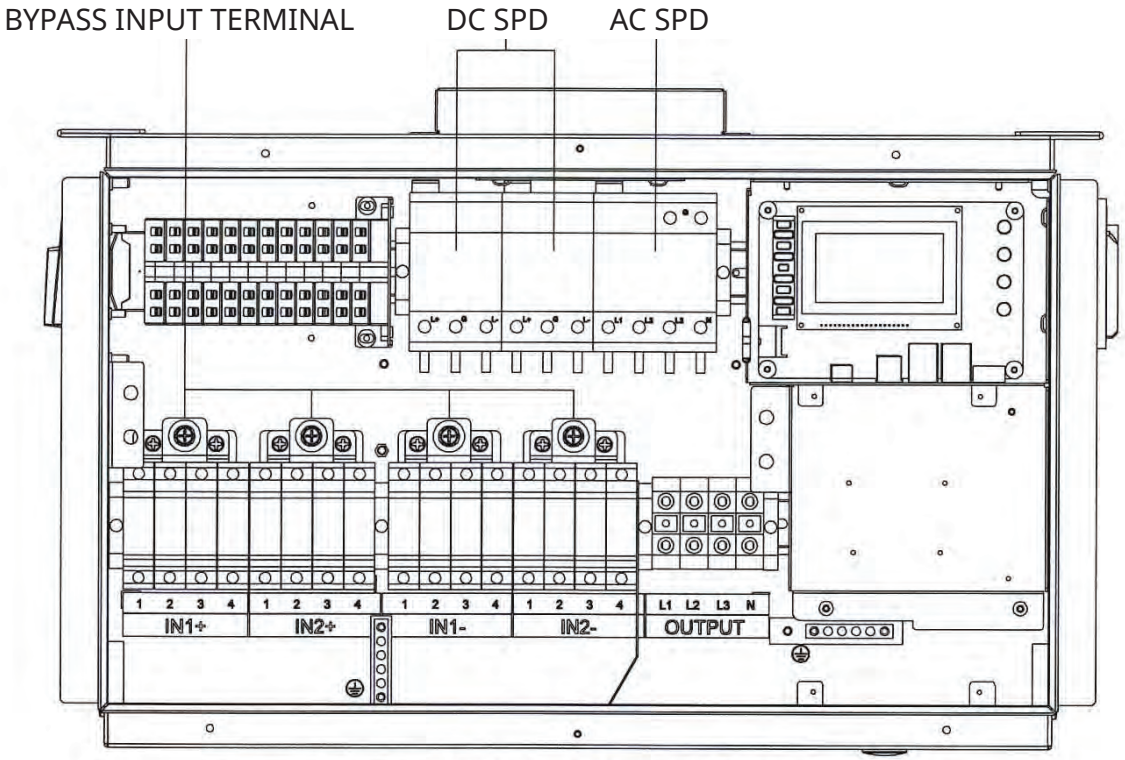


Figure 3-16(b) : Full view of wiring box with options.

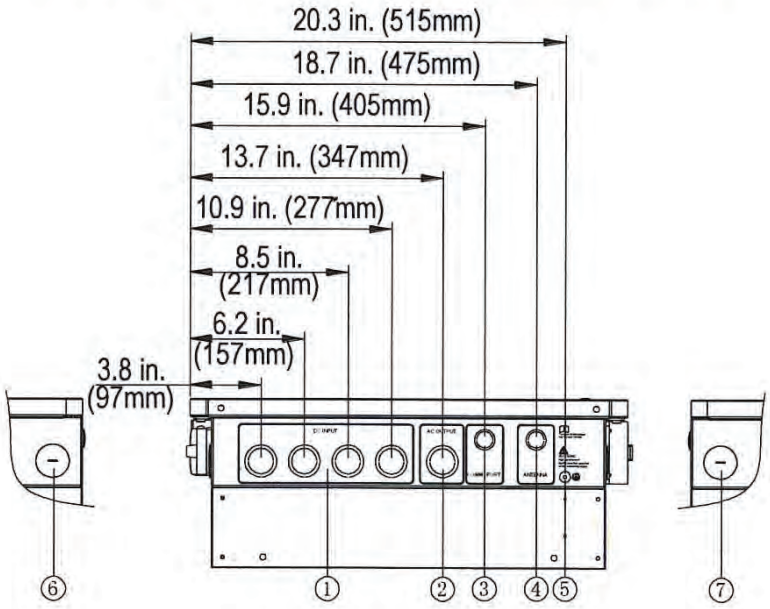


Figure 3-17 External connection ports

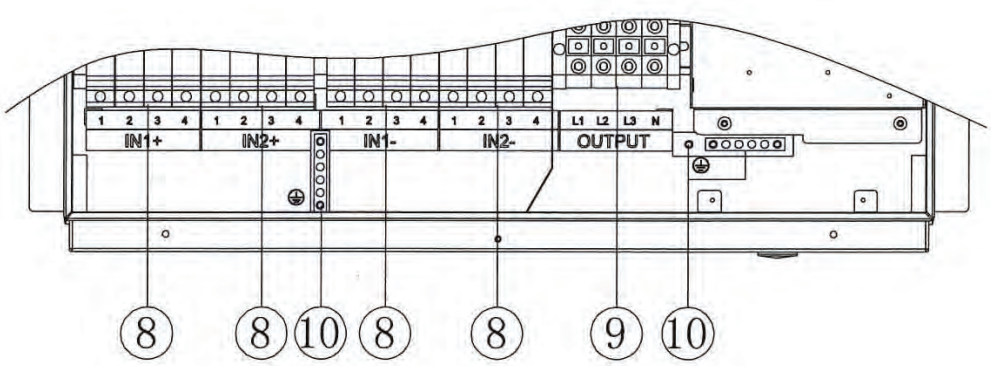


Figure 3-18 Internal connection points

- Knockout holes for DC input cable, 1-1/4" or 1"
- Knockout hole for AC output cable, 1-1/4" or 1"
- Knockout hole 1/2inch & 3/4inch, for comm. cable
- Knockout hole 1/2inch & 3/4inch, for comm. cable, reserved
- External ground connection point
- Side hole for DC input cable, 1-1/4"
- Side hole for AC output cable, 1-1/4"
- DC input fuse holders
- AC output terninal block
- Internal ground connection point & grounding studs

Choose the cables for inverters according to the following configuration table:

Table 3-3 Cables specifications

Position	Cable	
DC input (+ / -)	DC cables specifications refer to Table 3-6	
AC output (L1/L2/L3/N)	Cable # 10~6AWG	#8AWG cable recommended
PE	Cable # 10~6AWG	#8AWG cable recommended
RS485 communication	UTP CAT-5e or 3x#22~18AWG communication cable (eg. Belden 3106A)	

3.3.1 DC connection

1) Working mode
CSI 23/28KTL-CT series inverter has two PV input sections: DC Input-1 and DC Input-2. These two sections can work under “Parallel mode” or “Independent mode.” (see Figure 3-19)

Under Parallel mode, the two PV input sections share one MPP Tracker; Under Independent mode, each PV input section works with one MPP Tracker.

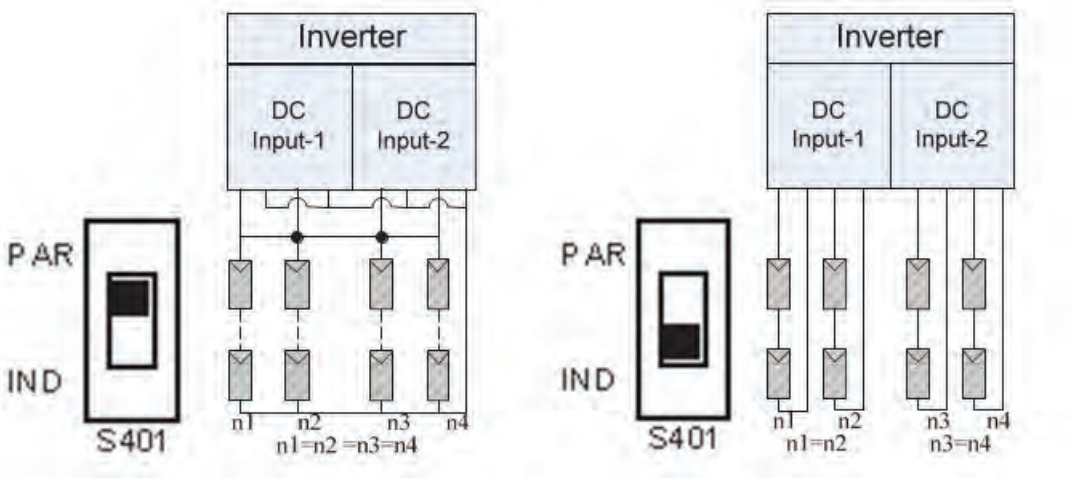


Table 3-4 DC input power specification

Inverter model	Max. DC input power	Rated DC input power of each input section
23KTL-CT	31kW	15.5kW
28KTL-CT	38kW	19kW

Remarks: The standard configuration is “Parallel mode.” If it needs to switch to the “Independent mode,” please take the following:

1. Remove the cover of the wiring box. (see Figure 3-25)
2. Remove the protection cover. (see Figure 3-20a)
3. Use No. 2 Phillips head screwdriver to remove the jumper busbar, torque value of 1.6N.m (see Figure 3-20b)
4. Set the selector switch on the LCD board (see Figure 3-21) to independent mode.

5. Reinstall the protection cover (see Figure 3-20c)

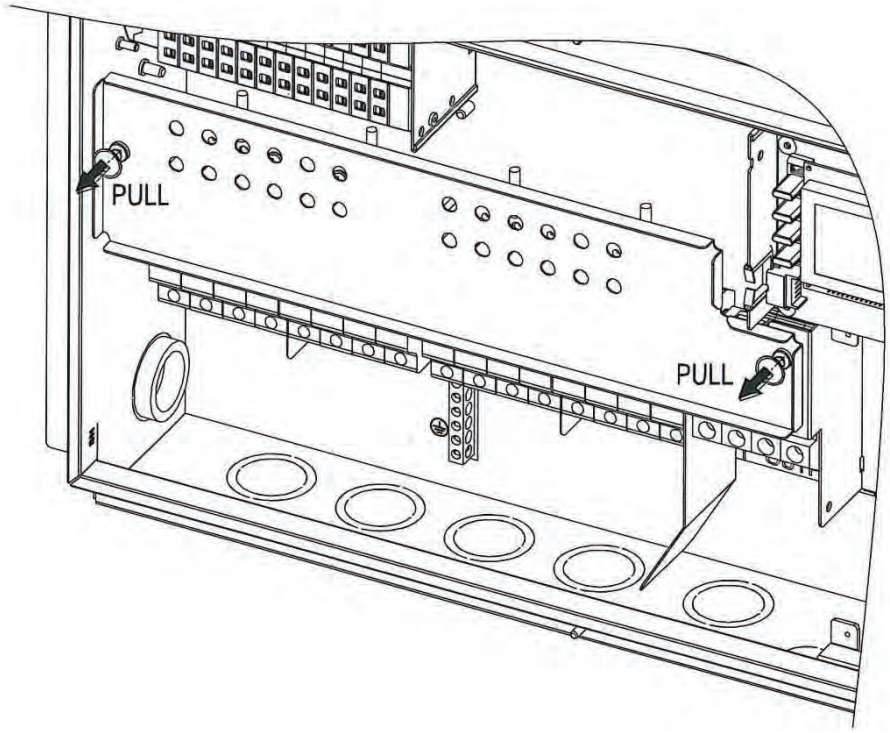


Figure 3-20(a)

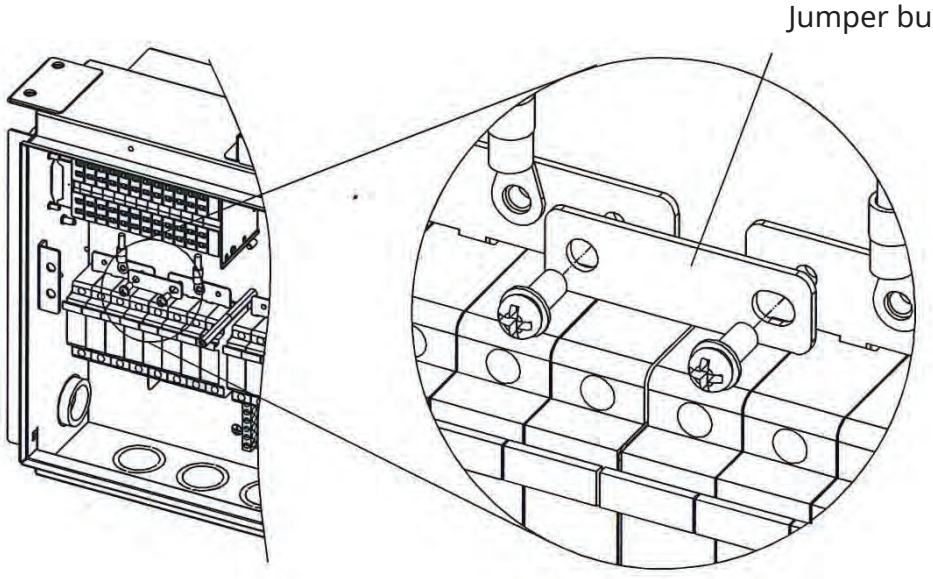


Figure 3-20(b)

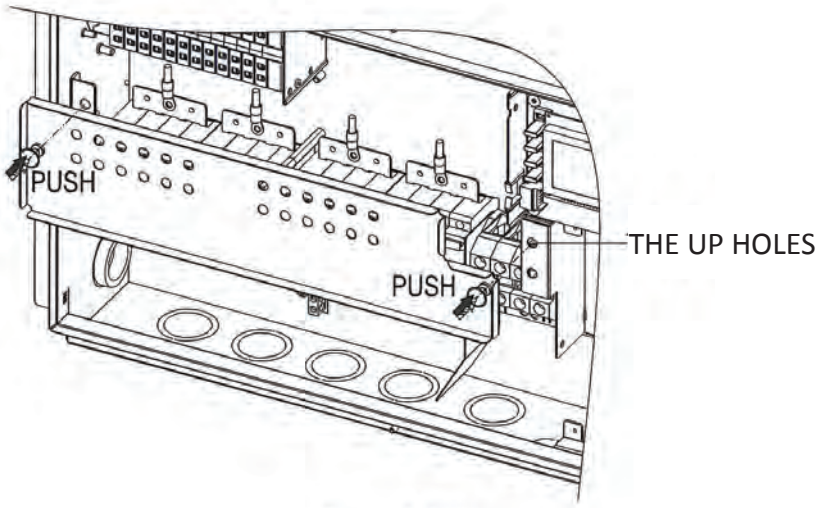


Figure 3-20(c)

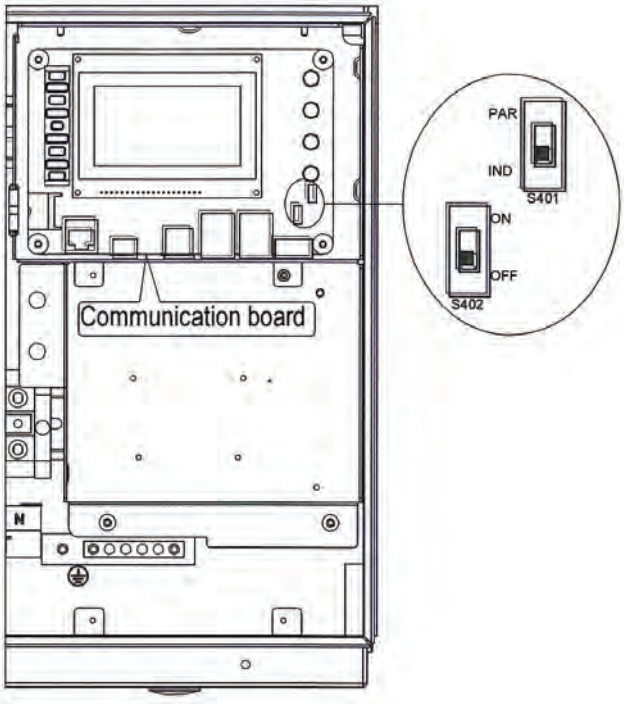
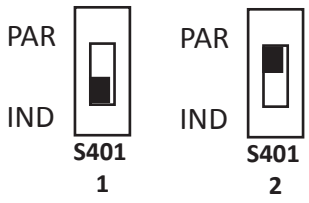


Figure 3-21 Location of the PV connection mode selector switch

Selector switch for PV connection mode		1—independent mode 2—parallel mode

2) DC fuse configuration

CSI 23/28KTL-CT inverters are equipped with standard 15A(23/287kW Inverter) DC fuses. Customers must verify that the appropriate fuses are used depending on the actual configuration on PV strings.

1) Each independent string of DC input from the PV strings needs fuse protection.
2) The rated voltage of fuse should be higher than the Max. Voc of each PV string.
3) In order to keep the output power normal, the rated current of fuse is generally larger than the 1.56 x Max. output current from the PV strings.
4) In order to protect the PV strings, the rated current of fuse should NOT be larger than the sum of the Isc of any two of the PV strings. Make sure the rated current of fuse is as small as possible on the condition of
normal output power.

The following table lists the fuse type, specifications and number under the rated voltage and power range of
8 strings of PV panels.

Table 3-5 DC Fuse selection

	Brand	4 Strings	5 Strings	6 Strings	7 Strings	8 Strings
23 kW	Littelfuse	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V
28 kW	Littelfuse	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V	OSPF015.T 15A/1000V

Note 1: The input string size must be the same.
Note 2: The DC fuse protectors of different fusing capacity should be chosen according to the short circuit current of PV modules. The 1000VDC Littelfuse KLKD fuse series are recommended. The detailed information is available for customers to find and download from http://www.littelfuse.com/.

3) DC cable connection

To ensure the optimum performance of the inverter, please read the following guidelines before DC connection:
(a) Confirm the DC configuration referring to Table 3-5 and ensure that the maximum open circuit voltage of the PV modules is lower than 1000Vdc under any conditions;
(b) Confirm that the PV strings for each MPPT of the inverter are of the same type and specification before connection. The number, orientation, and tilt of PV strings may differ for different applications.
(c) Configure the external wiring according to the following conditions:

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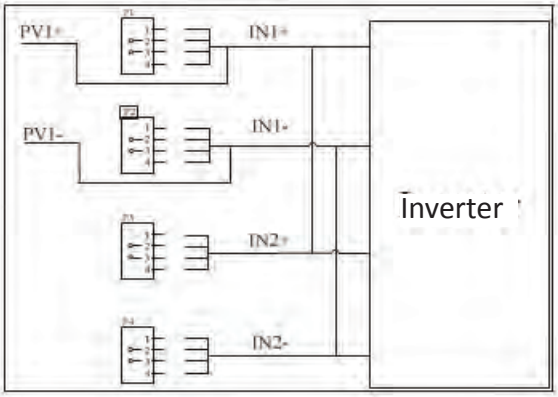
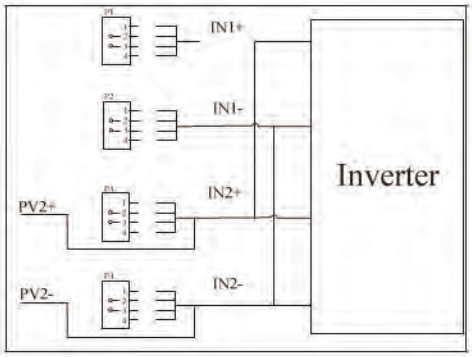
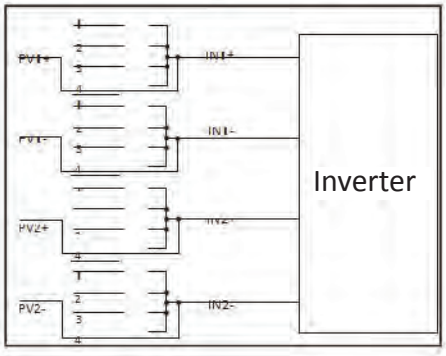
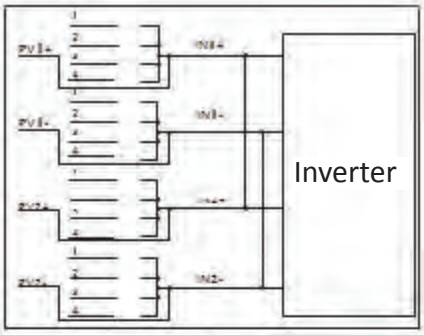
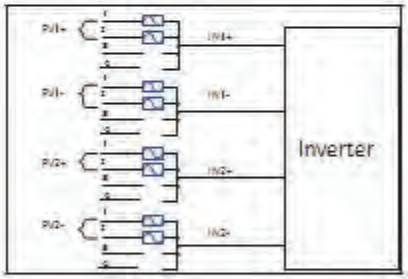
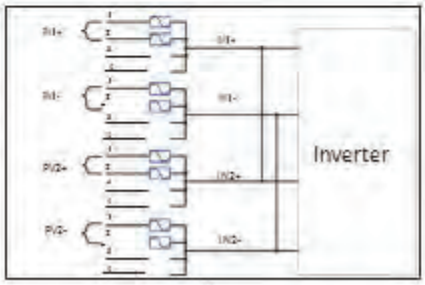
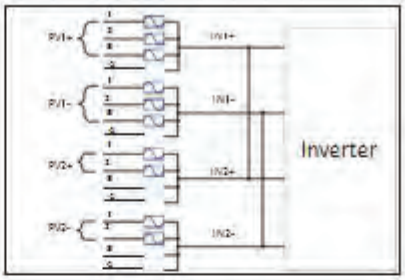
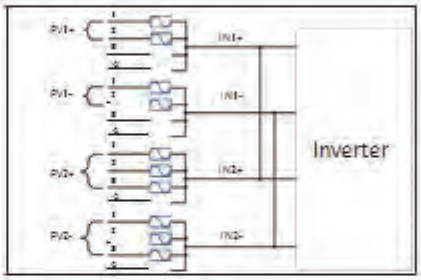
Rare Configuration	1 strings	
	23kW	28kW
1MPPT-Parallel Mode Bypass Fuse		

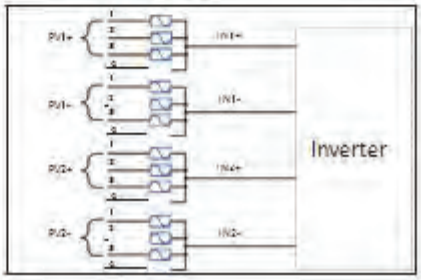
1MPPT-Parallel Mode Bypass Fuse		
Current		8
DC cable	2 WG(Maximum)	
Fuse	N	

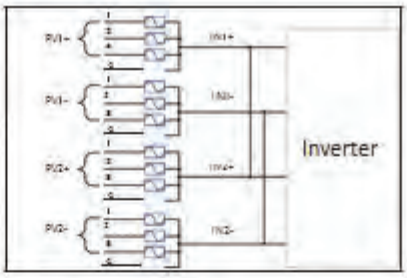
Rare Configuration	2 strings	
	23kW	28kW
2MPPT-Independent Mode Bypass Fuse		

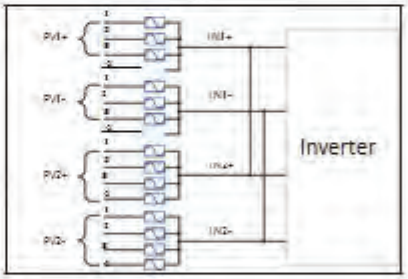
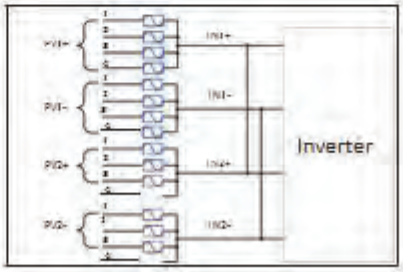
1MPPT-Parallel Mode Bypass Fuse		
Current	2	29
DC cable	2 WG (Maximum)	
Fuse	N	

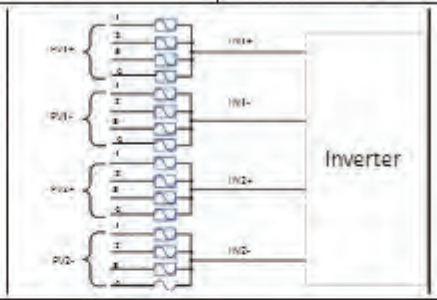
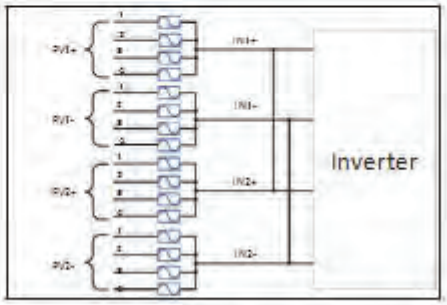
Common Configuration	4 strings	
	23kW	28kW
2MPPT-Independent Mode		
1MPPT-Parallel Mode		
Current	12.5A	14.5A
DC cable	16~6AWG	16~6AWG

Common Configuration	5 Strings	
	23kW	28kW
1MPPT-Parallel Mode		
1MPPT-Parallel Mode		
Current	10A	11.6A
DC cable	16~6AWG	16~6AWG

Common Configuration	6 Strings	
	23kW	28kW
2MPPT-Independent Mode		

1MPPT-Parallel Mode		
Current	8.4A	9.7A
DC cable	16~6AWG	16~6AWG

Common Configuration	7 strings	
	23kW	28kW
1MPPT-Parallel Mode		
1MPPT-Parallel Mode		
Current	7.2A	8.3A
DC cable	16~6AWG	16~6AWG

Common Configuration	8 strings	
	23kW	28kW
2MPPT-Independent Mode		
1MPPT-Parallel Mode		
Current	6.3A	7.3A
DC cable	16~6AWG	16~6AWG

Note 1: The temperature rating of the input wirings should be no less than 90°C (194°F).
Note 2: The recommended fuse types are configured according to the condition that the input strings are the same.

(d) Check the polarity (Figure 3-22) before plugging the DC connectors with the cables of PV strings according to the following steps:
i. Use a multi-meter to measure the PV strings' cable ends and check the polarity.
ii: The positive (+) terminal of cable should match the positive (+) terminal of inverter's DC output.
iii:The negative (-) terminal of cable should match the negative (-) terminal of inverter's DC output

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NOTICE:
It is important to use a multi-meter to check the polarity of DC input cables to avoid any risk of reverse polarity.

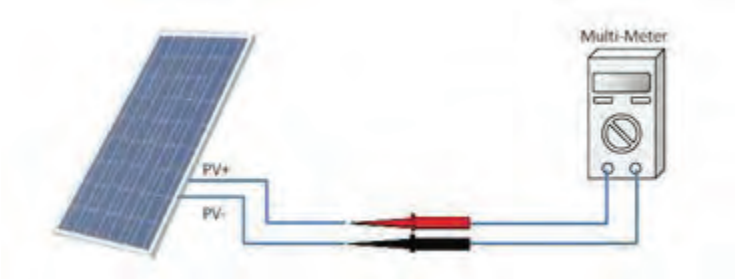


Figure 3-22 Polarity Check

(e) Knock out the holes of the DC side and plug the suitable conduits of 1-1/4 or 1 inch through the holes. Then put the cables through the conduits inside the wiring box.

(f) The DC cables are recommended to be pre-insulated to ensure the cables are well connected. Crimp the DC cables with the attached pre-insulated end ferrule (16Pcs) by using the crimping pliers. (See Figure 3-23)
Tools: Diagonal pliers, wire stripping pliers, crimping pliers

Figure 3-23 Set up the DC input cables

(g) Connect the crimped DC cables to the fuse holders and fasten the screws, as shown in Figure 3-24
Tools: 6mm (0.23in.) flat screwdriver, Torque value: 3.4 N-m

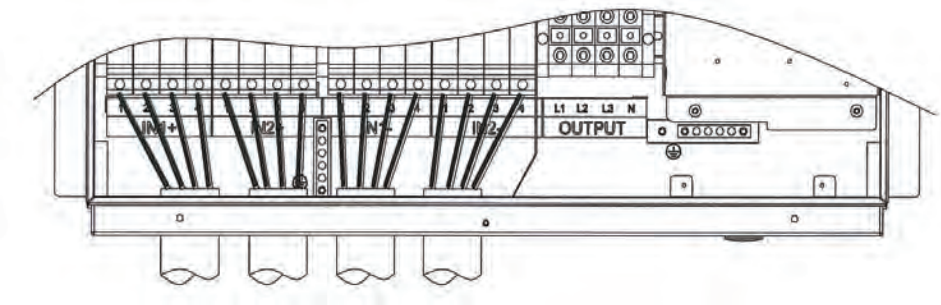


Figure 3-24(a) Connection of DC input cables

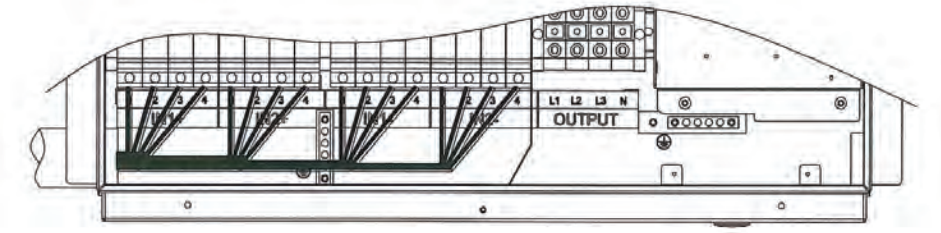


Figure 3-24(b) Connection of DC input cables

3.3.2 AC and ground connection

The following describes how to connect the AC output and ground cables between the inverter and the AC grid:
1) Use the 3mm (0.12in.) Hex screwdriver to screw off the 4 screws on the wiring box and take off the cover.
(See Figure 3-25)
2) Knock out the holes of the AC side and plug the suitable conduits of 1-1/4 or 1 inch through the holes. Then put the cables through the conduit inside the wiring box.
3) The inverter supports 3 kinds of cable connection on the AC side depending on the grounding connection method. The cable set-up procedures are illustrated below.

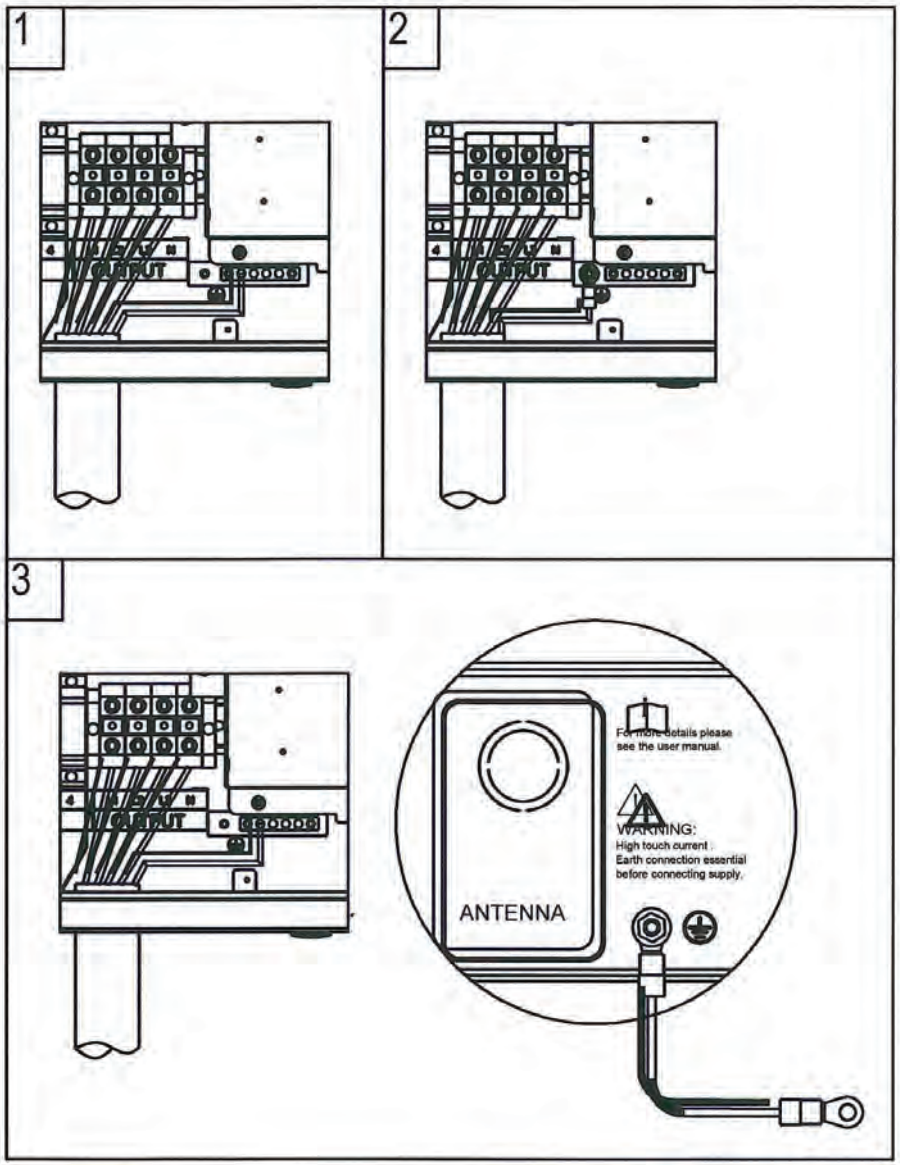


Figure 3-26(a) AC output and ground cable connection

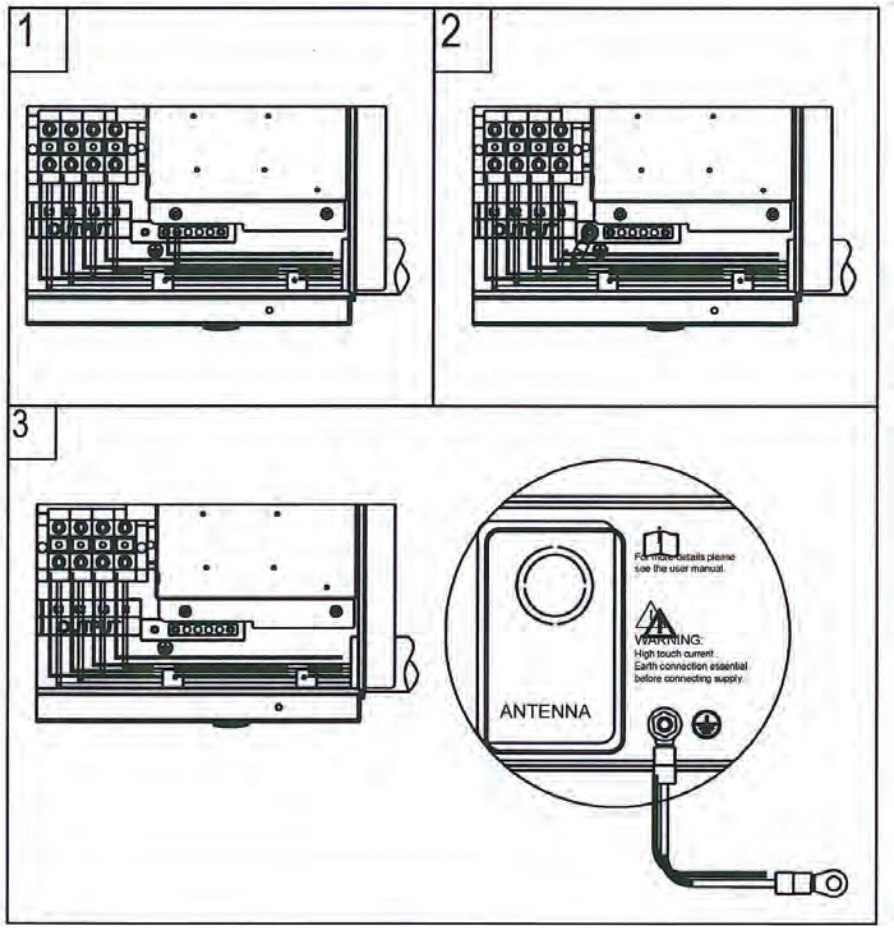


Figure 3-26(b) AC output and ground cable connection

(1)The AC cables are recommended to be pre-insulated to ensure the cables are well connected. Connect the AC (L1, L2, L3, N) cables to the terminal block and the ground cable to the grounding bar. (see the 1st graph in Figure 3-26) Set up the cables referring to Figure 3-27.

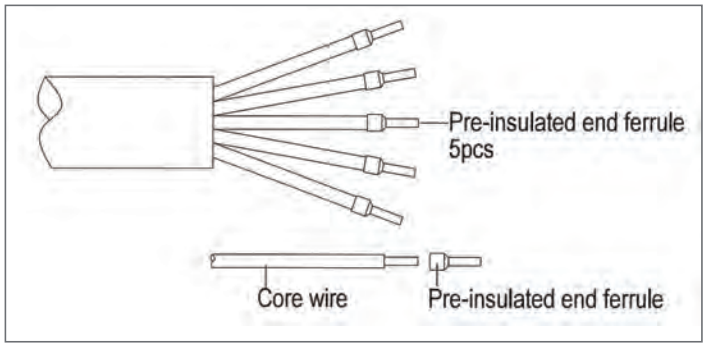


Figure 3-27 AC output and ground cable set up

(2) Connect the AC (L1, L2, L3, N) cables to the terminal block and use the OT type terminal to connect the ground cable to the internal grounding stud inside the wiring box. (See the 2nd graph in Figure 3-26). Set up the cables referring to Figure 3-28.

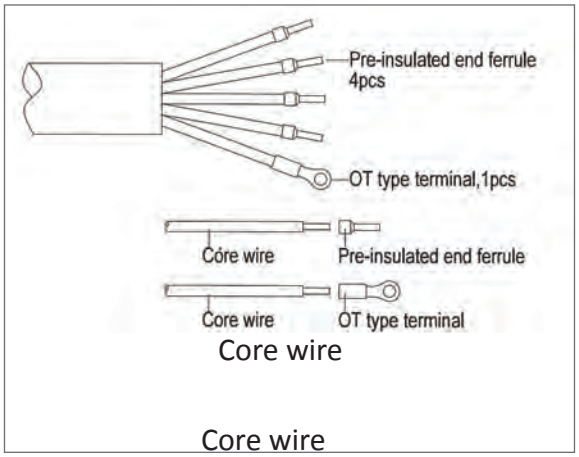


Figure 3-28 AC output and ground cable set up

(3) Connect the AC (L1, L2, L3, N) cables to the terminal block and use the OT type terminal to connect the ground cable to the external grounding point at the bottom of the wiring box. (See the 3rd graph in Figure 3-26). Set up the cables referring to Figure 3-29.

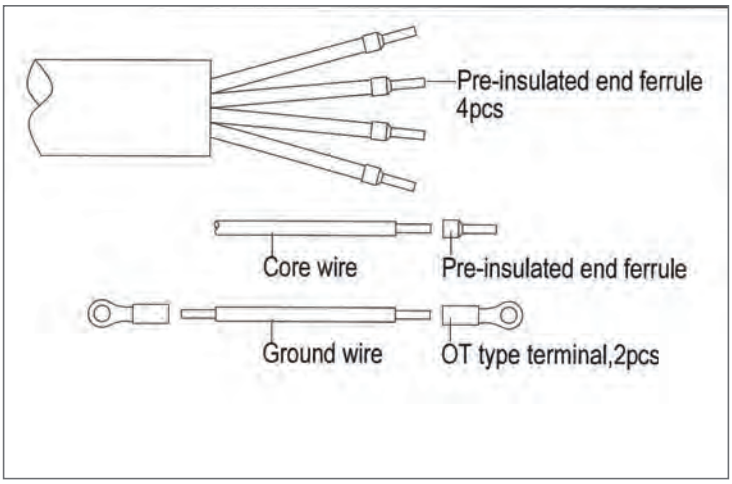


Figure 3-29 AC output and ground cable set up

INSTRUCTION:

The attached pre-insulated end ferrules match with the #8AWG cables. If the cable of other gauge is selected, a different pre-insulated end ferrule is needed and provided by the installers.

4) When the output of the inverter is connected to the grid, an AC circuit breaker is recommended to be installed to safely disconnect the inverter from the grid when overcurrent happens.
Either 3 pole or 4 pole AC circuit breaker should be selected as per the following specifications:

Table 3-9 Specification of AC breaker selection

Inverter	AC breaker rated current (A)
CSI 23KTL-CT	50
CSI 28KTL-CT	64

Notes:

3.3.3 Communication connection

CSI 23/28KTL-CT series inverter supports industry standard Modbus RS485 communication.

1. Communication board description

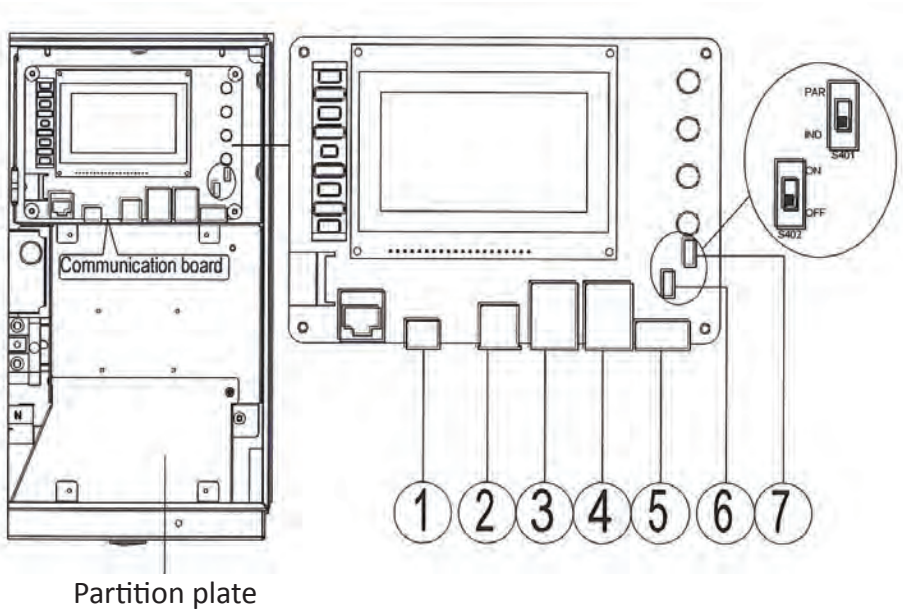
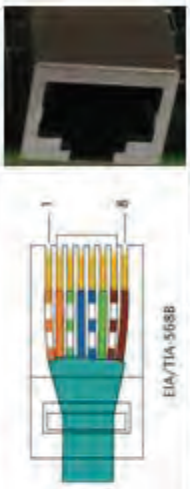
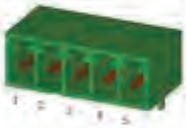


Figure 3-30 Communication board

2. Connectors and communication cards

Table 3-10 Communication connection interfaces

Item	Picture	Configuration description
① Dry contact communication port P205		Please see the section after the table for detailed information
② USB port P207		Firmware upgrade via USB disk

@ RS485 port IN CP204❯ @ RS485 port OUT CP203❯ (RJ45 connector)		No. Colour Function 1 White orange 485+ 2 Orange N.C 3 White green 485- 4 Blue N.C. 5 White blue N.C. 6 Green N.C. 7 White brown COM 8 Brown N.C
@ RS485 port (5pin connector) P208		1 —NC 2 —NC 3 —RS485+ 4 —RS485- 5 —COM
⑥Selector switch for setting the 120Ω terminal resistor of the RS485 communication S402		1—Disable the termination resistance 2—Enable the terminal resistor
⑦ Selector switch for setting the PV connection mode S401		1————Independent mode 2————Parallel mode

① Dry Contact communication:

The inverter features an alarm function that opens or closes a dry contact on the communication board. (Available both as contact normally open - N.O. - and as contact normally closed - N.C.), as shown below:

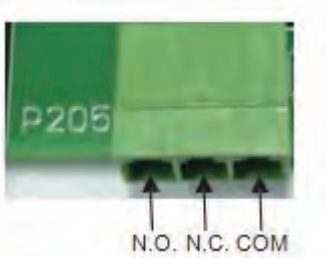


Figure 3-31 Dry contact communication port

The voltage and current rating of the dry contact shown in the following table must not be exceeded in any case.

Table 3-11 Rating of dry contact

	Voltage	Current
AC	Maximum 277V	Maximum 3 A
DC	Maximum 30V	Maximum 1 A

Different modes of dry contact output can be accessed by connecting different pins of the P205 connector, as shown in the following table.

Table 3-12 Working modes of dry contact

Dry contact communication port	Status in fault condition	Status without fault condition
P205: N.O. – COM	Closed	Open
P205: N.O. – COM	Open	Closed

Connection Plan:

You can connect an LED or other loads to indicate the operational status of the inverter, as shown in the following figure:

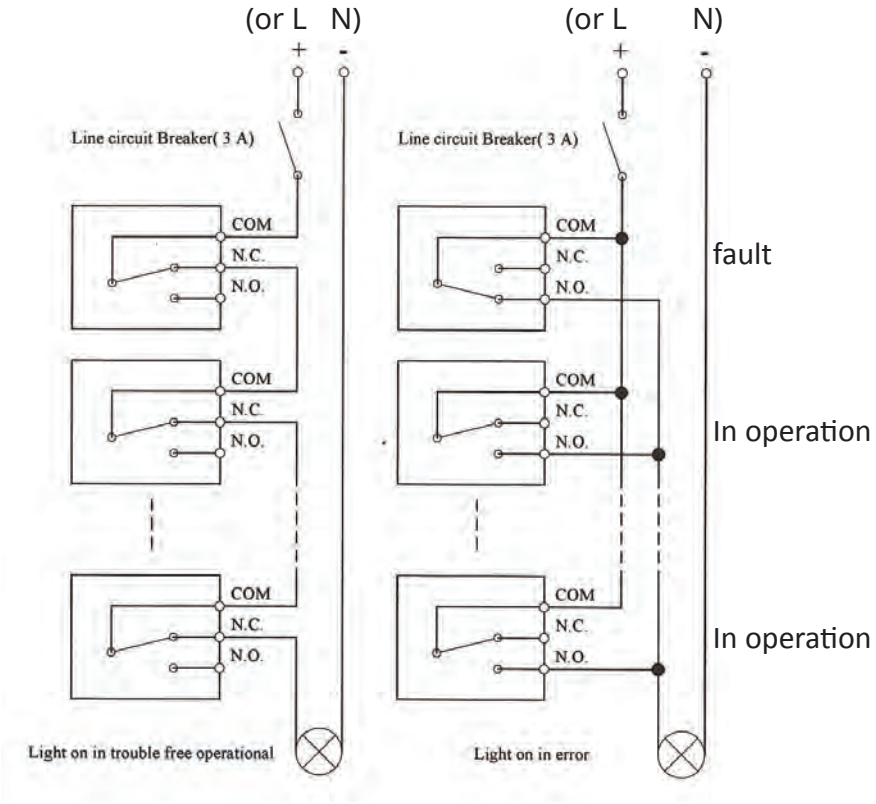


Figure 3-32 Schematic diagram of dry contact communication

If you connect the contact port to the power distribution grid, you must install an individual miniature circuit-breaker between the dry contact and the power distribution grid.

Dry contact communication cable connection:

a) Knock out the holes for suitable conduits of 3/4 inch.

b) Put the dry contact communication cable through the cable conduit and inside the wiring box.

c) Use double-layer insulated cables. Strip the cables according to the following requirements.

Tool: Wire stripping pliers

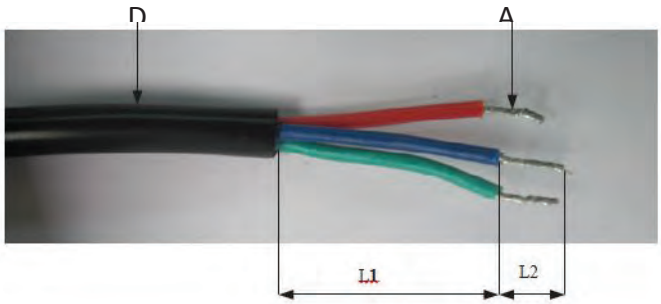


Figure 3

Table 3-13 Cable set-up

Position	Description	Value
	Cable type	Double-layer insulated cable
D	Outer diameter	4.5 mm~ 6 mm
A	Cross-section area of conductor	0.2 mm2 ~ 0.75 mm2
L1	Length of stripped outer wire skin	Maximum 15mm
L2	Length of stripped inner wire skin	Maximum 7mm

d) Connect wires to the terminal.

Tool: 2 or 2.5mm flat screwdriver

No.	Cable color	Function
1	Red	N.O.
2	Blue	N.C.
3	Green	COM

Figure 3-34 Wire connection

e) Plug the cable terminal into the P205 connector

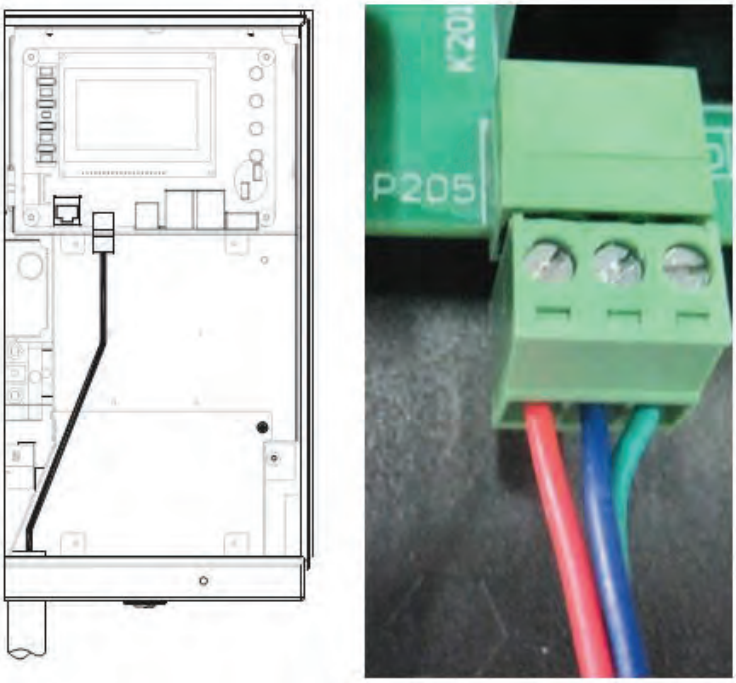


Figure 3-35 The dry contact communication cable connection

② RS485 communication cable connection:

Choose the RS485 communication cables according to the following table:

Table 3-14 Cable specifications

	Cable
RS485 communication	**UTP CAT-5e or 3x#22~18AWG communication cable (eg. Belden 3106A)**

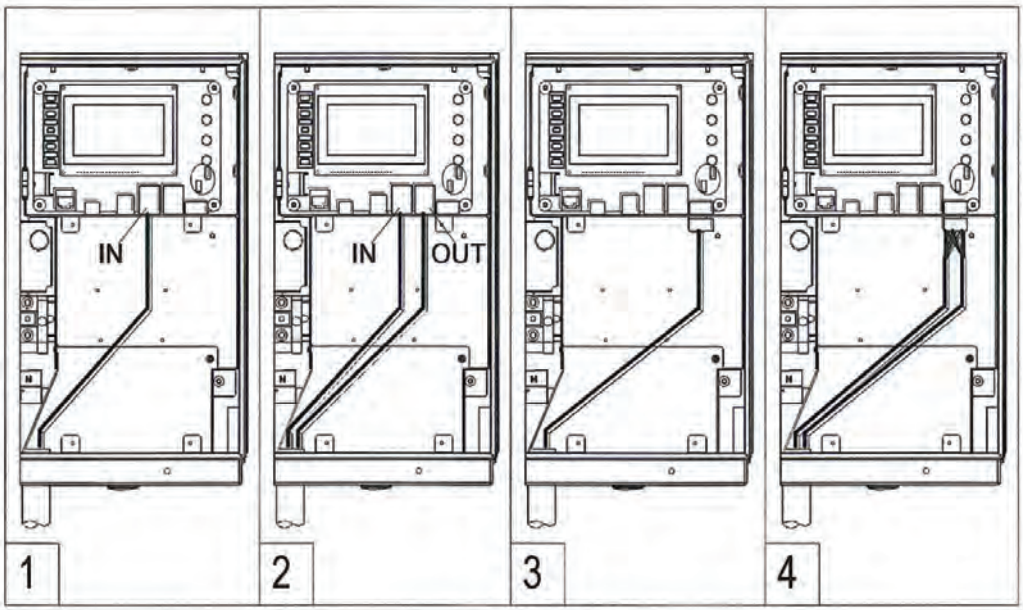


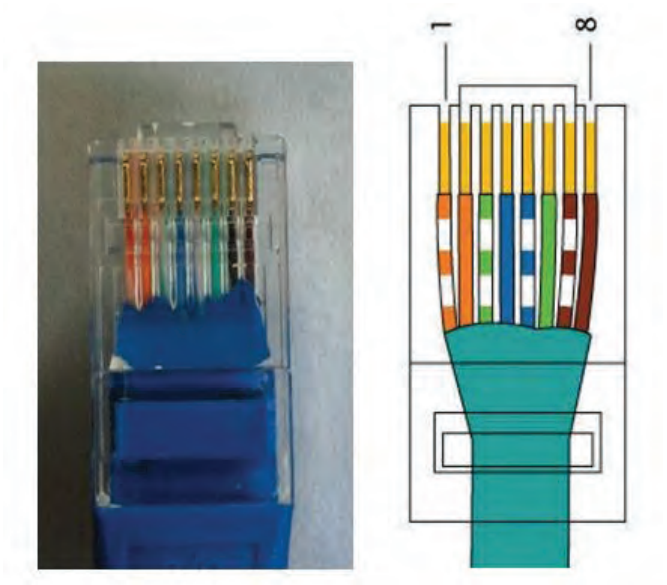
Figure 3-36 RS485 connection

1. Cable connection of RS485 communication: RJ45 connector

2. Cable connection of RS485 network communication: RJ45 connector

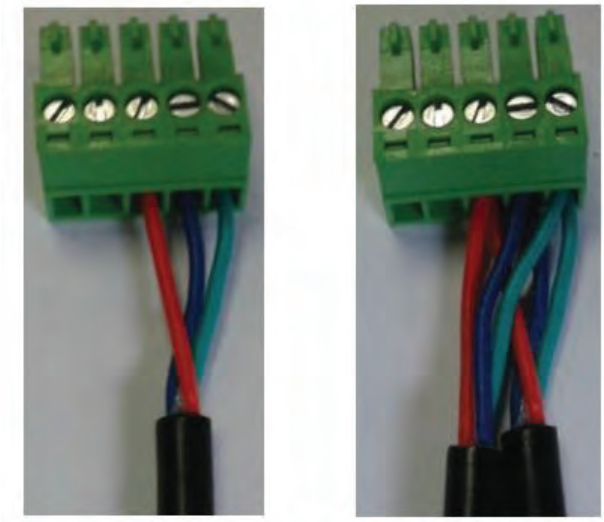
3. Cable connection of RS485 communication: 5 pin connector

4. Cable connection of RS485 network communication: 5 pin connector



No.	Color	Function
1	White orange	485+
2	Orange	N.C.
3	White green	485-
4	Blue	N.C.
5	White blue	N.C.
6	Green	N.C.
7	White brown	COM
8	Brown	N.C.

Figure 3-37 Crimp RJ45 connector on the RS485 and Ethernet cable



1-------NC

2-------NC

3 (Red)-----RS485+

4 (Blue)----RS485-

5 (Green)-----COM

(1) RS485 communication of single inverter

(2) RS485 network communication

Figure 3-38 Fasten the cable terminal on the RS485 5 pin connector

a.) Put the communication cable through the conduits inside the wiring box, and crimp the cable as shown in Figure 3-37 and Figure 3-38.
Tools: Wire stripping pliers, crimping pliers (for RJ45 connector), Wire stripping pliers, 2 or 2.5mm (0.08in. or 0.1in.), flat scewdriver (for 5 pin connector)
b.) Plug the crimped connector into the corresponding port.

RS485 network connection:

When the inverters are monitored via the RS485 communication, the unique RS485 address for each inverter can be set through the LCD interface. Up to 31 inverters can be connected together in the RS485 communication network. The Daisy-chain topology is recommended for the RS485 network connection, as shown in Figure 3-39. And the port RS485-IN should be connected to the port RS485-OUT of other inverter for RJ45 connections. Other communication topologies, such as the star networks, are not recommended.

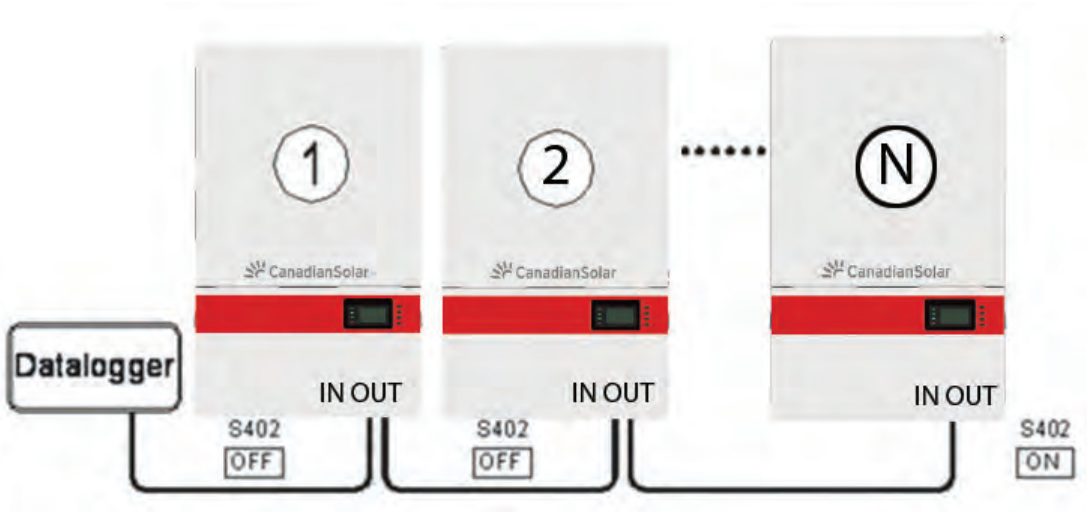


Figure 3-39 R485 network connection (Reference to Figure 3-36)

If there are multiple inverters in the RS485 network, the selector switch S402 of the last inverter in the daisy chain should be in ON position to have the 120ohm terminal resistor enabled while keeping the selector switch S402 of the other inverters in OFF position to disable the terminal resistor.

WARNING:

Please follow the guidelines below before on-grid operation to eliminate possible dangers and ensure safety.

4.1 Commissioning Checklist

4.1.1 Mechanical installation

Make sure that the mounting bracket is secure and all the screws have been tightened to the specified torque values. (Please refer to 3.2 Mechanical installation)

4.1.2 Cable connections

➢ Make sure that all cables are connected to the right terminals.

➢ The appropriate cable management is important to avoid physical damage.

➢ The polarity of DC input cables should be correct and the DC Switch should be in “OFF” position. (Please refer to 3.3 Electrical installation)

4.1.3 Electrical check

➢ Make sure that the AC circuit breaker is appropriately sized.

➢ Test whether the AC voltage is within the normal operating range.

➢ Make sure the DC open circuit voltage of input strings is less than 1000V.

4.2 Commissioning steps

Complete the checklist above before commissioning the inverter as follows:

1.) Turn on the AC circuit breaker.
2.) Turn on the DC circuit breaker.
(Skip these two steps if there are no circuit breakers.)
3.) Switch the DC Switch to the “ON” position. When the energy supplied by the PV array is sufficient, the LCD screen of the inverter will light up. The inverter will then start up with the message “sys checking.”
4.) Set up the grid standard:

INSTRUCTION:

Please check with your local electricity supply company before selecting the grid standard. If the inverter is operated with a wrong grid standard, the electricity supply company may cancel the operation license.
Putting the inverter into operation before the overall system complies with the national rules and safety regulation of the application is not permitted.

➢ When the inverter completes "sys checking," the LCD shows the screen as Figure 4-1 below. Press ENTER to the standard selection interface, as shown in Figure 4-2.

➢ Select the corresponding grid standard and press ENTER.

Figure 4-1 Set up grid standard

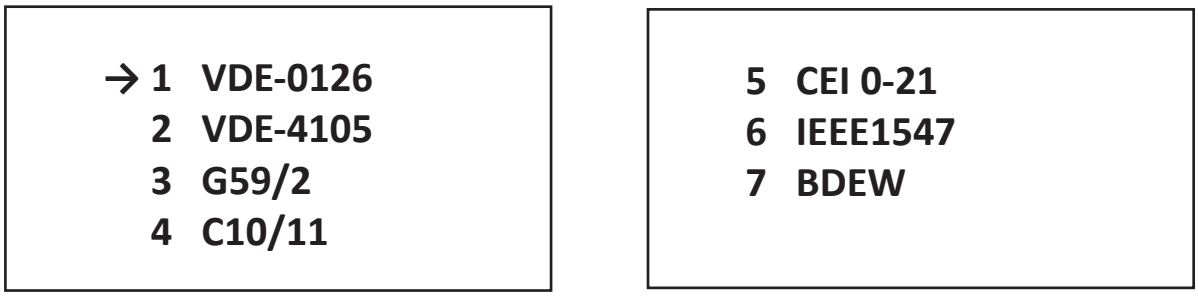
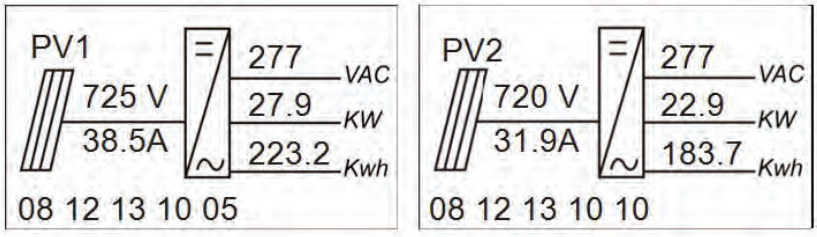


Figure 4-2 Select grid standard

5.) When the LCD screen shows the normal operation status (Figure 4-3) and the "RUN" light on the LED panel lights up, it indicates that the grid connection and power generation are successful.



(a) (b)

Figure 4-3 Normal operation status

6.) If the inverter fails to operate normally, "FAULT" light will light up and the fault information will show on the LCD screen. (Please refer to 7.1.2 Troubleshoot LCD faults).
7.) Set up system time and language, set up system time and language according to "5.4.4 System configuration."
8.) To check the real time operation information, you can refer to "5.4.1 Operation information."

5.1 Description of LCD panel

The inverter's LCD panel mainly consists of LCD screen, LED indicator lights, buzzer and 4 keys, as shown in Figure 5-1.

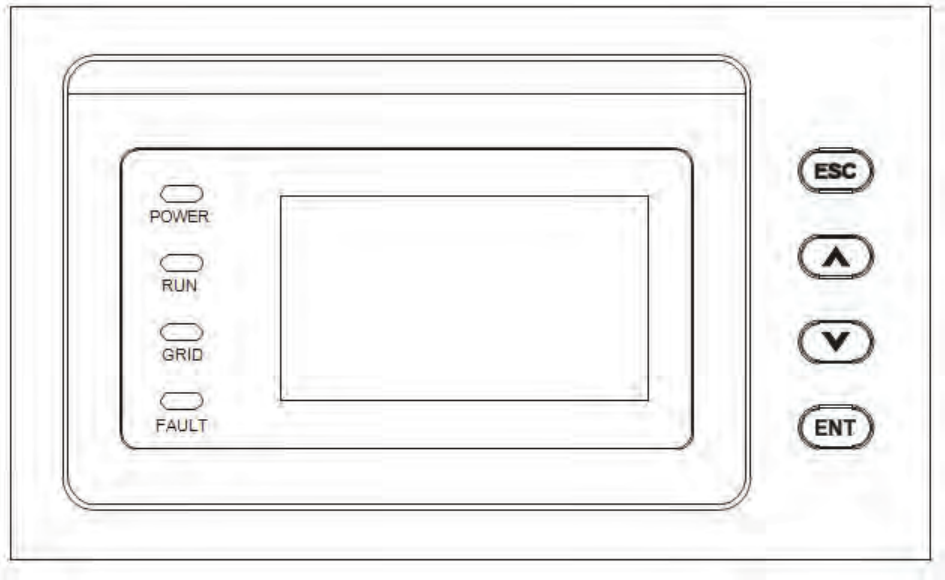


Figure 5-1 LCD panel

Interpretation for the indicator lights is shown in Table 5-1 and function of the keys is shown in Table 5-2.

Table 5-1 LED Indication

LED light	Name	Status	Indication
POWER	Working power light	Light on	Energized (control panel starts to work)
		Light off	Power supply is not working
RUN	Grid-tied Operation indication light	Light on	In grid-tied power generation state
		Flash	Derated running status (light up 0.5s, light off 1.6s)
		Light off	In other operation status or power supply not working
GRID	Grid Status Indication Light	Light on	Grid is normal
		Flash	Grid fault (light up 0.5s, light off1.6s)
		Light off	Power supply not working

FAULT	Fault status indication light	Light on	Indicates a fault
		Slow flash	Indicates alarm (light up 0.5s, light off 2s)
		Fast flash	Protective action (light up 0.5s, light off 0.5s)
		Light off	No fault or power supply not working

Table 5-2 Definition of the keys

Key	Description	Definition of function
ESC	Escape key	Back/end/mute
ENT	Enter key	Confirm entering the menu/confirm set value/ Switch to parameter setting mode
∧	Up	Page up in selection menu/+1 when setting parameters
∨	Down	Page down in selection menu/-1 when setting parameters

5.2 Operation state

Table 5-1 indicates the definitions of LED, i.e. indicates the information of the inverter's operation state. It indicates that the system is energized and under DSP control when "POWER" lights up.
"RUN" will light up when the inverter detects that the grid connection conditions meet the requirements and power is fed into the grid. "RUN" will blink if the grid is in de-rated running state during the period of feeding power into the grid.
"GRID" will light up when the grid is normal during the operation of the inverter. Otherwise, "GRID" will blink until the grid restores to normal.
"FAULT" will blink quickly as a fault (except grid fault) occurs. "FAULT" will not light out until the fault is eliminated. The light will blink slowly when an alarm occurs. "FAULT" remains illuminated when an internal fault occurs. The buzzer give an alarm if a fault (involving power grid fault) occurs.

5.3 Interface types

Users can perform the corresponding operations with the 4 function keys according to the indications of the LCD dispay.
(1) The LCD interface starts with the company logo once the system is energized, as shown in Figure 5-2.

Figure 5-2 LOGO interface

(2) Indication of inverter operation mode:

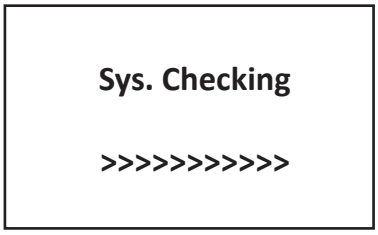


Figure 5-3 Inverter system check ongoing

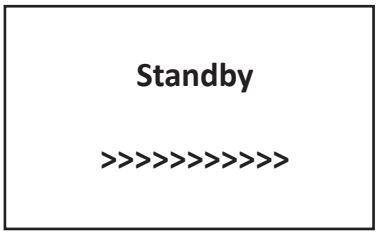
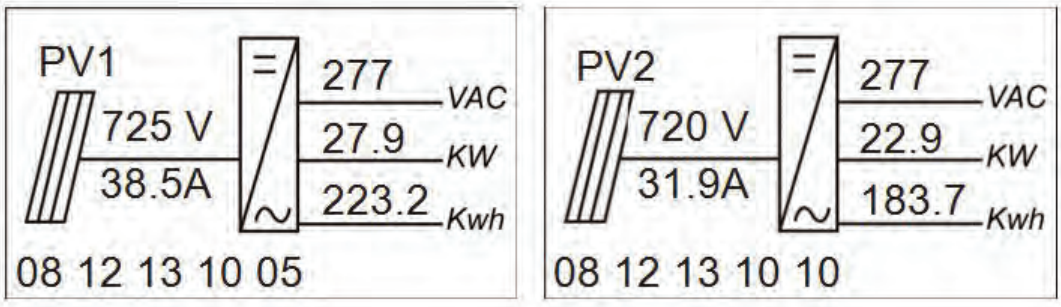


Figure 5-4 Inverter system in standby mode



(a) **(b)**

Figure 5-5 Default display interface for normal operation

Figure 5-6 Fault indication interface

LCD screen will display different mode interfaces based on the operation modes of the inverter. There are four operation modes: startup system check mode (as shown in Figure 5-3), standby mode (as shown in Figure 5-4),
normal operation mode (as shown in Figure 5-5, the switching time between (a) and (b) is 5 seconds), and fault mode (as shown in Figure 5-6). The default indication interface mainly indicates PV voltage, PV current, grid voltage, instant power, daily generated power and time information under normal operation. The fault information of the most recent/current fault will be indicated on the LCD screen when the inverter is in fault mode.

5.4 Menu functions

LCD screen displays “default indication interface” when the inverter is in operation mode. Press **ESC** in this interface to escape the default interface and enter the main operation interface. The main operation interface is shown in Figure 5-7.

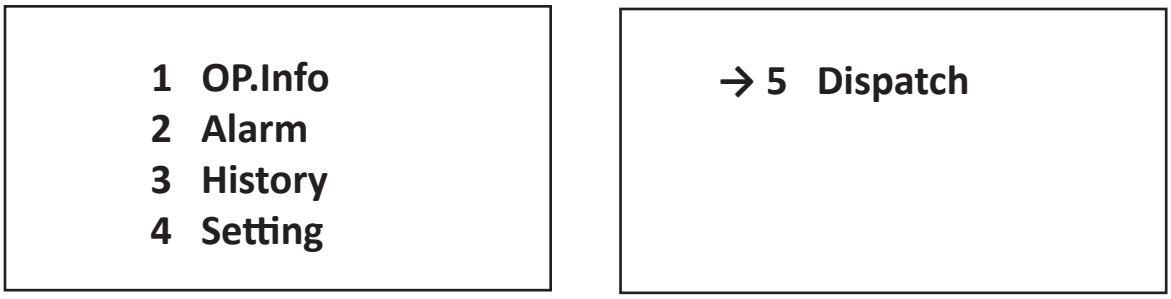


Figure 5-7 Main menus on the LCD screen

The main operation interface of LCD screen has 5 menus, i.e. “1 OP.Info,” “2 Alarm,” “3 History,” “4 Setting,” and “5 Dispatch.” The users may select options with **UP** and **DOWN**, and then press **ENT** to confirm selection. The users can return to the default indication interface by pressing **ESC**.

5.4.1 Operation information

When the cursor moves to “1 OP.Info” in the main screen, you should press **ENT** to select the operation information as shown in Figure 5-8. Check the information by pressing **UP** and **DOWN**. Return to the previous menu by pressing **ESC**.

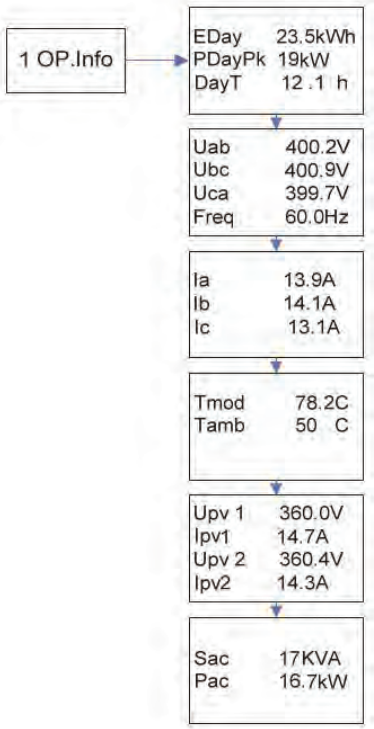


Figure 5-8 Operation information indication (PV independent mode)

Remarks: The LCD display is shown as follows when PV parallel mode is selected.

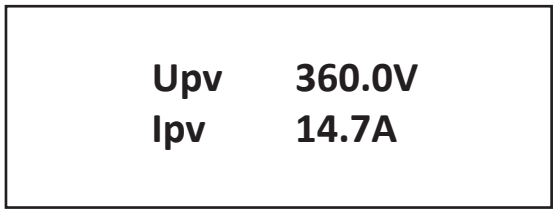
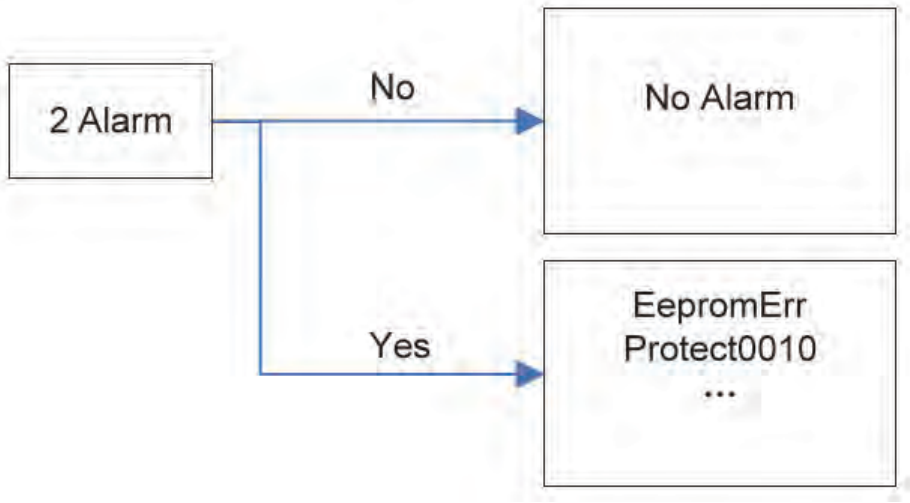


Figure 5-9 Operation information indication (PV parallel mode)

5.4.2 Alarm

As described before, if a fault occurs during normal operation of the inverter, corresponding fault messages will be indicated in “2 Alarm” menu in addition to the sound and light alarms. Move the cursor to “2 Alarm” and press ENT to check out the specific fault information, as shown in Figure 5-10.



5.4.3 History

Move the cursor to “3 History” in the main interface. Press ENT to check the history information, as shown in Figure 5-11. There are 4 submenus in “3 History”: “1 HistErr,” “2 OP. Recd,” “3 Version,” and “4 TotalTag.”
(1) The error log can store up to 100 fault messages in the “1 HistErr” menu.
(2) The last 21 days of operation history data is available to be checked in “2 OP.Recd” menu. All variable names in the data comply with the content in “1 OP.Info” menu of the main interface. The users can select the “2 OP. Recd” menu and input the retraceable days (For example, the input number is 21. If the current date is December 15th, the LCD will indicate the operation information of 21 days before that date which is November 24th).
(3) The DSP version, LCD version and serial number of the product are listed in “3 Version” menu.
(4) Cumulative generated power fromt the first day the inverter began working is available to be checked in “4 TotalTag” menu.

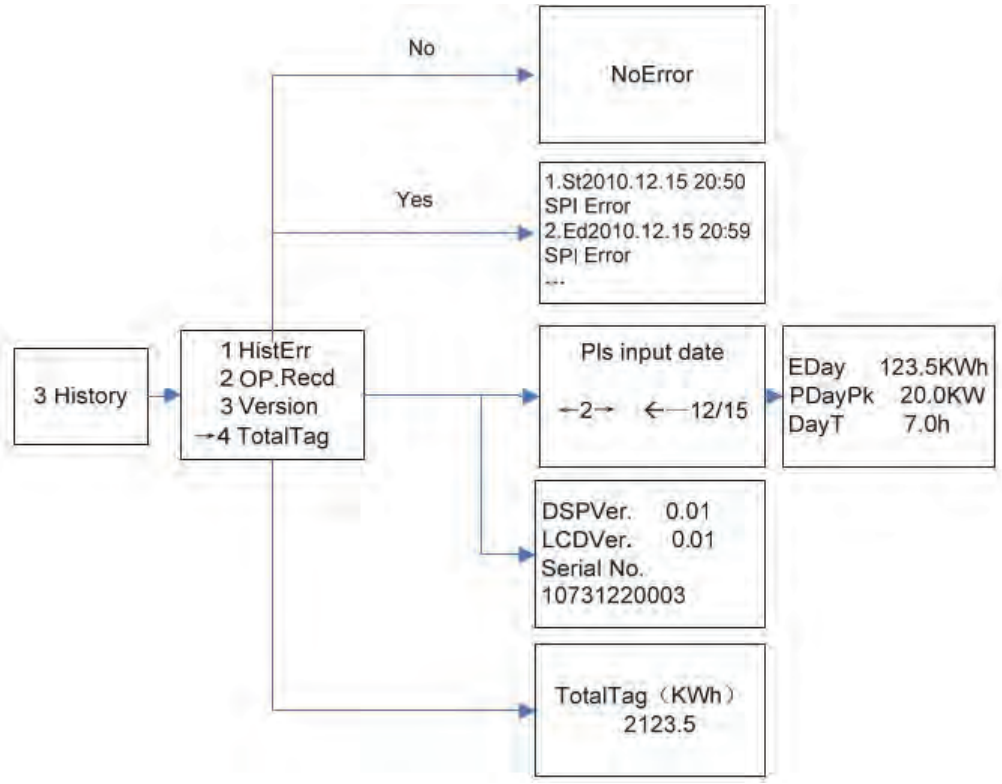


Figure 5-11 History menu and submenu

5.4.4 System configuration

Move the cursor to “4 Setting” in the main interface. Press **ENT** to enter the password: **UP -> DOWN -> UP ->DOWN**. Press **ENT** to confirm, and set the current system parameters, as shown in Figure 5-12. There are 7 submenus in “4 Setting”: “1 ON/OFF,” “2 Language,” “3 Buzzer,” “4 SysTime,” “5 Commun.,” “6 OtherCMD” and “7 NetConfig.”

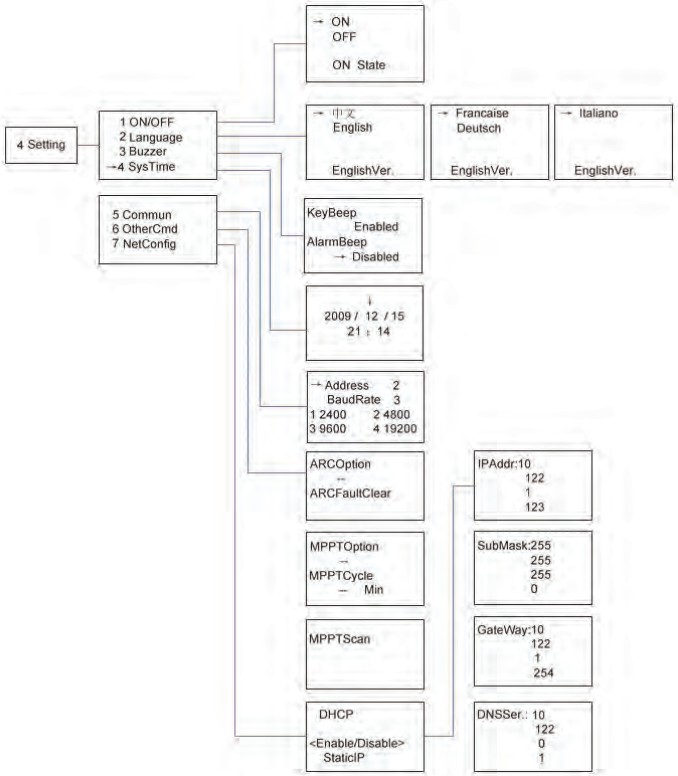


Figure 5-12 System setup menu and submenu

(1) The inverter can be started and shut down with “1 ON/OFF” menu. Move the cursor to “ON” and press **ENT**, “ON State” will then be indicated at the bottom of LCD screen; move the cursor to “OFF” and press **ENT**, then “OFF State” will be indicated as well. The inverter will stand by instead of working normally if the startup conditions do not meet the set value even if “ON” is selected. The inverter will be shut down immediately if “OFF” is selected in any case.
(2) Five languages, i.e. Chinese, French, English, German, and Italian are available in “2 Language” menu.
(3) Key beep and Alarm beep can be set mute/unmute in “3 Buzzer” menu. “Key beep” and “Alarm beep” can be chosen by pressing **UP** and **DOWN**. Shift between “Enable” and “Disable” by pressing **UP** and **DOWN** if the cursor is on the “Key beep.” Complete the setup by pressing **ENT**. Similarly, the Alarm beep can be set up in the same way.
(4) Set up the system date and time with “4 SysTime” menu (These parameters are of critical importance and will be used in history information).
(5) Set up the 485 communication parameters with “5 Commun.” menu.
(6) There are 5 submenus in the “6 MPPTScan” menu:

1. Arcing check and protection is mainly divided into two parts, the Arcing check board is responsible for whether there is Arcing in line, and transfer Arcing protection signal to the DSP in the dominating control board. The control board DSP is responsible for the control of the inverter off the grid after receiving Arcing signal to ensure safety. The Arcing board failure will cause ‘arc board err’ to show on the LCD and it will not connect to the grid until the arc board is OK. If there is Arcing fault, the LCD displays the fault which can only be cleared manually.
“ARCOption” is used to enable/disable the ARC function. Press **ENT** and use **UP** and **DOWN** to enable/disable the ARC function, and press ENT to confirm the setting.
2. “ARCFaultClear” is used to clear the ARC fault. Move the cursor to this menu and press **ENT**. The operation result will appear on the LCD, i.e. “Succeed” or “Failed.”
3. MPPT scan function is effective only when the total input power is lower than 90% of the active power spec on parallel, if not in parallel, each input power is lower than 75% of each input spec. The PV voltage should be larger than 300V. Once this MPPT scan function is set on LCD, it will search the maximum power point in steps of 5V on the full input voltage range, and get the maximum power point.
“MPPTOption” is used to enable the MPPT Scan. Move the cursor to this menu, press **ENT** to set up the function. Use **UP** and **DOWN** to enable/disable the “MPPTOption” function. Press **ENT** to confirm the setting.
4. “MPPTCycle” is used to set up the cycle time of MPPT scan. Move the cursor to this menu, press ENT to set up the cycle time. Use UP and DOWN to adjust the MPPT cycle time. Press **ENT** to confirm the setting.
5. “MPPTScan” is to execute the MPPT scanning manually. Move the cursor to this menu, and press **ENT** to initiate the scanning. The LCD screen will skip to normal operation interface if the MPPT scanning succeeds, but remain on the “MPPTScan” menu interface if the scanning fails.

(7) Configure the network address in the “7 NetConfig” menu. Move the cursor to the menu, press **ENT** and set up the parameters by **UP** and **DOWN**.

INSTRUCTION:

Move the cursor to the corresponding menu to set up the parameters, and the number will flash after pressing **ENT**. Use **UP** and **DOWN** to adjust the parameters.

5.4.5 Power dispatch

Move the cursor to “5 Dispatch” in the main interface and press **ENT** to go to the following interface (Figure 5-13):

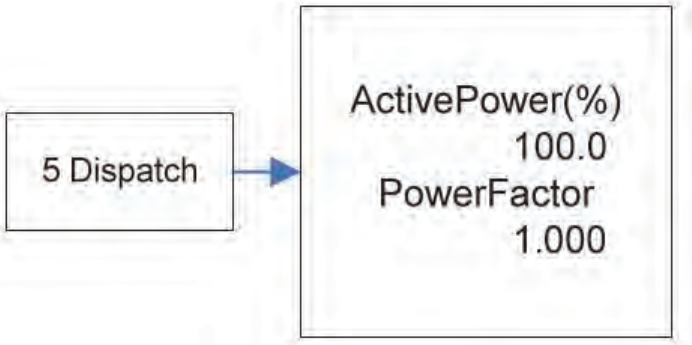


Figure 5-13 Active Power and PowerFactor

Remote power dispatch: The “ActivePower” and “PowerFactor” can be adjusted remotely by software.

5.4.6 System protection parameters setup

Press **DOWN** and **ENT** at the same time in the main interface and enter the password (UP -> DOWN -> UP -> DOWN) to access the system protection parameters setup menu. This menu includes 6 submenus: “1 SysPara,” “2 Restart,” “3 Recover,” “4 ClrErrRecd” and “54 Stdset,” as shown in Figure 5-14.

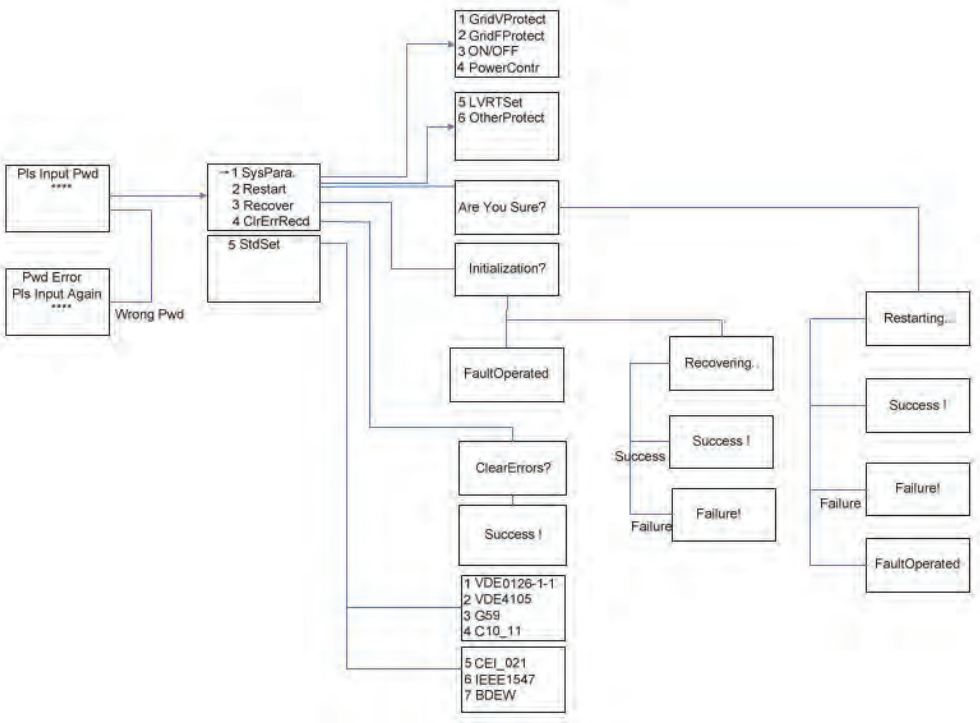


Figure 5-14 System protection parameter configuration

(1) The system protection parameters of each grid standard can be set up in “1 SysPara” menu. Please refer to Chapter 5.4.7.
(2) “2 Restart” menu: If a fault shutdown happens, a severe fault may have occurred inside the inverter. The user can perform a force reboot for one time in this menu if the user needs to restart the inverter.

INSTRUCTION:

This function is effective only when the fault “IntFault0010-0150” in the troubleshooting table occurs. The inverter may restore to normal operation automatically if alarm or protection faults occur. This function will not respond when the inverter is in operation mode and a “FaultOperated” alarm interface will be indicated.

(3) “3 Recover” menu: The manufacturer’s parameter default value can be restored when the inverter is not in operation mode. Otherwise “Fault Operated” will be reminded.
(4) “4 ClrErrRecd” menu: History information of the failures can be wiped clear after confirmation
(5) “5 Stdset” menu: The grid standard can only be changed when the inverter is turned off by LCD shut down. The change is ineffective under normal operation mode. Please refer to “6.2 Shut down” after the inverter stops working, and choose
the grid standard as per the local requirement of the electricity supply company.

NOTICE:

Please don’t change the grid standard when the inverter is in normal operation mode, or the change is invalid. Please refer to the “6.2 Manual shutdown” to turn off the inverter.

INSTRUCTION:

CSI 23/28KTL-CT series PV inverter supports 7 grid standards. Please check with your local electricity supply company before selecting the grid standard. If the inverter is operated with a wrong grid standard, the electricity supply company may cancel the operation license. Putting the inverter into operation before the overall system complies with the national rules and safety regulation of the application is not permitted.

5.4.7 System control parameters

The “1 SysPara” menu has 6 submenus, including “1 GridVProtect,” “2 GridFProtect,” “3 ON/OFF,” “4 PowerContr,” “5 LVRTSet” and “6 OtherProtect.”

(1) "1 GridVProtect" and "2 GridFProtect" menus: Set up the parameters of grid voltage, frequency protection and recovery, etc, as shown in Table 5-3:

Table 5-3 Parameters of grid voltage and frequency (IEEE-1547)

Parameter name	Description	Setup range (lower limit, default & upper limit)
GridV.Max1(V)	Threshold value of Level 1 Max. grid voltage	{200.0, 528.0, 552.0}
VMaxTripT1(S)	Threshold value of Level 1 Max. grid trip voltage	{0, 1.00, 600.00}
GridV.Min1(V)	Threshold value of Level 1 Min. grid voltage	{0, 422.4, 480.0}
VMinTripT1(S)	Threshold value of Level 1 Min. grid trip voltage	{0, 2.00, 600.00}
GridV.Max2(V)	Threshold value of Level 2 Max. grid voltage	{200.0, 576.0, 624.0}
VMaxTripT2(S)	Threshold value of Level 2 Max. grid trip voltage	{0, 0.16, 600.00}
GridV.Min2(V)	Threshold value of Level 2 Min. grid voltage	{0, 240.0, 480.0}
VMinTripT2(S)	Threshold value of Level 2 Min. grid trip voltage	{0, 0.16, 600.00}
GridVmaxRecT(V)	Recovery threshold value of Max. grid voltage	{200.0, 518.0, 533.0}
GridVminRecT(V)	Recovery threshold value of Min. grid voltage	{0, 432.4, 480.0}
GridVRecT(S)	Recovery time of grid voltage protection	{0, 300.00, 600.00}
GridF.Max1(Hz)	Protection threshold value of Level 1 Max. grid frequency	{50.00, 60.50, 66.00}
FmaxTripT1(S)	Trip time of Level 1 Max. grid frequency	{0, 0.16, 600.00}

GridF.Min1(Hz)	Protection threshold value of Level 1 Min. grid frequency	{45.00, 59.30, 60.00}
FminTripT1(S)	Trip time of Level 1 Min. grid frequency	{0, 0.16, 600.00}
GridF.Max2(Hz)	Protection threshold value of Level 2 Max. grid frequency	{50.00, 61.00, 66.00}
FmaxTripT2(S)	Trip time of Level 2 Max. grid frequency	{0, 0.05, 600.00}
GridF.Min2(Hz)	Protection threshold value of Level 2 Min. grid frequency	{45.00, 59.00, 60.00}
FminTripT2(S)	Trip time of Level 2 Min. grid frequency	{0, 0.05, 600.00}
GridFmaxRecT(Hz)	Recovery threshold value of Max. grid frequency	{49.00, 60.40, 66.00}
GridFminRecT(Hz)	Recovery threshold value of Min. grid frequency	{45.00, 59.40, 60.00}
GridFRecT(S)	Recovery time of grid frequency protection	{0, 300.00, 600.00}
GridV.Unbal(%)	Threshold value of grid voltage unbalance	{0.1, 2.6, 10.0}

(2) “3 ON/OFF” menu: Set up the start-up and shut-down control parameters.

NOTES:

Table 5-4 Start-up and turn-off control parameters

Parameter name	Description	Setup range (lower limit, default & upper limit)
PVStartVol(V)	PV start-up voltage	{300.0, 330.0, 400.0} {0.01, 0.92, 2.00} (CSI 23KTL)
SoftStep(KW/S) SoftOffOption	Soft step Soft turn off option	{0.01, 1.12, 2.00} (CSI 28KTL) {Disable, Disable, Enable}
OffPStep(KW/S)	Turn off power step	{{0.01, 1.38, 2.00} (CSI 23KTL)} {0.01, 1.68, 2.00} (CSI 28KTL)
IsoResis(KOhm)	Isolation resistance	{10.0, 250.0 1000.0}
GridReStep(KW/S)	Grid fault recovery step	{0.01, 0.04, 2.00}

(3) "4 PowerContr" menu: relative functions of active, reactive power control and over-frequency derating, including "ActiveContr(%)," "RePowerContr," and "FreqDeratCtrl" menus.
1. "ActiveContr(%)" menu: adjust the active power of AC output, the range is 0-100.0%.
2. "RePowerContr" menu: set up the reactive power control mode, including 6 submenus: "1. None," "2. Dispatch," "3. Q Set," "4. PF Set," "5.PF(P) Set" and "6. Q(U) Set."

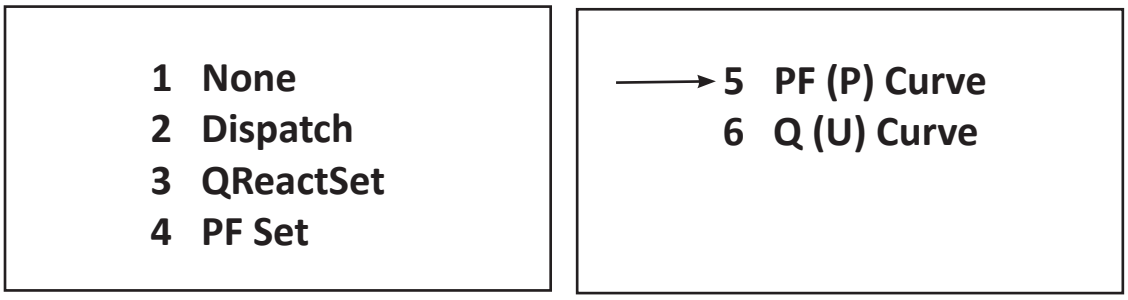


Figure 5-15 Reactive power mode

1). None: No mode/disable reactive power mode
2). Dispatch: Remote power dispatch mode
Note: The ActivePower, PF and Q value can be adjusted by remote software if the "Dispatch" is selected.
3). QReactSet: Set the Q value
Note: Change the reactive power by adjusting the Q value (reactive compensation)
4). PF Set: Set the PF value
Note: Change the reactive power by adjusting the PowerFactor
5). PF(P) Curve:PF curve mode

Note: The power factor changes according to the power change, as shown in Figure 5-16:

INSTRUCTION:

The PF (P) Curve function is only available for VDE-4105, CEI 0-21 and IEEE-1547 grid standards.

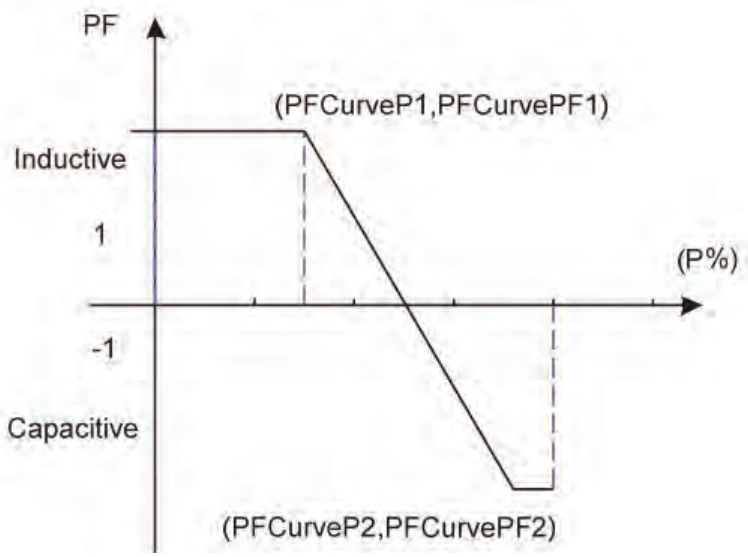


Figure 5-16 PF (P) curve mode

6). Q(U) Curve: Q(U) curve mode
Note: The reactive compensation changes according to the grid voltage change, as shown in Figure 5-17.

INSTRUCTION:

The Q(U) curve function is only available for CEI 0-21 and IEEE-1547 grid standards.

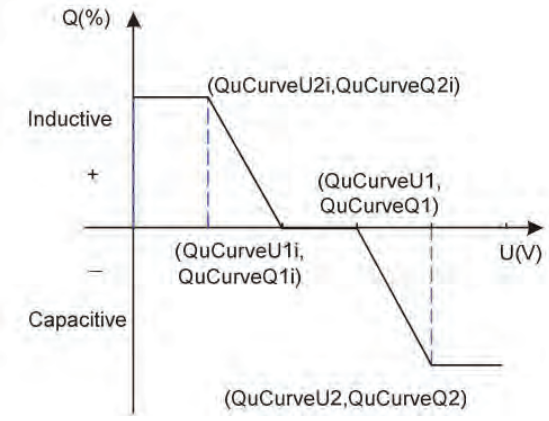


Figure 5-17 Q(U) curve mode

The Table 5-5 lists the parameters of QReactSet, PF Set, PF(P) Curve and Q(U) Curve modes. Press ENT to start up the modes after the parameters are set up.

Table 5-5 Parameters of reactive power control (IEEE-1547)

Mode	Parameter Name	Setup range (lower limit, default & upper limit)	Description
Q	ReactiveComp(%)	(-100.0%, 0.0%, 100.0%)	
PF	PowerFactor	(-0.80, 1.000, 0.80)	
PF(P)	PFCurveP1(%)	(0, 50.0%, 100.0%)	See Figure 5-17
	PFCurvePF1	(-0.800, 1.000, 0.800)	See Figure 5-17
	PFCurveP2(%)	(0, 100.0%, 100.0%)	See Figure 5-17
	PFCurvePF2	(-0.800, -0.900, 0.800)	See Figure 5-17
	PFCurvTripV(V)	(480.0, 480.0, 528.0)	PF curve trip voltage
	PFCurveReV(V)	(422.4, 432.0, 480.0)	PF curve revocation voltage
Q(U)	QuCurveU1(V)	(480.0, 518.4, 528.0)	See Figure 5-18
	QuCurveQ1(%)	(-100.0%, 0.0%, 100.0%)	See Figure 5-18
	QuCurveU2(V)	(480.0, 528.0, 528.0)	See Figure 5-18
	QuCurveQ2(%)	(-100.0%, -50.0%,100.0%)	See Figure 5-18
	QuCurveU1i(V)	(422.4, 441.6, 480.0)	See Figure 5-18
	QuCurveQ1i(%)	(-100.0%, 0.0%, 100.0%)	See Figure 5-18
	QuCurveU2i(V)	(422.4, 432.0, 480.0)	See Figure 5-18
	QuCurveQ2i(%)	(-100.0%, 50.0%,100.0%)	See Figure 5-18
	QuCurvTripP(%)	(5.0%, 20.0%, 100.0%)	Qu curve trip power
	QuCurveReP(%)	(5.0%, 5.0%, 100.0%)	Qu curve revocation power

3. “FreqDeratCtrl” menu: Set up the parameters of over-frequency active power deraring.

INSTRUCTION:

The “FreqDeratCtrl” function is not available for the IEEE-1547 grid standard.

---

(4) “6 OtherProtect” menu: set up the threshold value of leakage current and output DC component protection:

Table 5-6 Protection parameters of leakage current and output DC component

Parameter name	Description	Setup range (lower limit, default & upper limit)
LeakCurMax(mA)	Leakage current Max. limit	{0, 250, 300}
IdcMax(mA)	DC component current Max. limit	{0, 135, 1000} (CSI 23KTL)
		{0, 165, 1000} (CSI 28KTL)

5.4.8 Arcing fault current interruption

CSI 23/28KTL-CT/US-480 is embedded with Type 1 DC arcing fault current detection device which stops the inverter from working when arcing fault current is detected on the DC side and shows “ARC Protect” on the LCD. This fault can only be cleared by manual operation.

Figure 5-18 ARC Protect fault

In the “System Setting”→”OtherCmd” menu, execute the “AFCI Test,” the inverter will stop working and test AFCI. When the test is over, “TestFinish” will be displayed on the LCD if no fault is detected or “AFCI Fault” will be shown if a fault occurs, as shown in Figure 5-20.

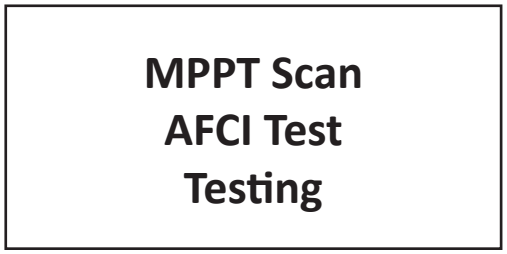


Figure 5-19 AFCI test

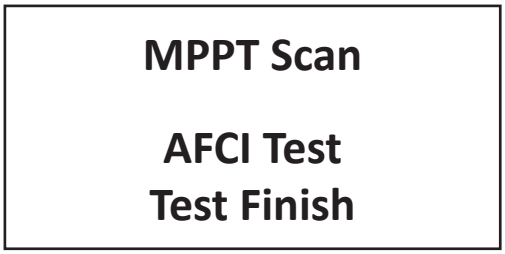


Figure 5-20 AFCI test result

In the “System Setting”→”OtherCmd” menu, execute “ARCFaultClear” command to clear “ARC Protect” fault alarm, and LCD will show “Succeed” if the fault is successfully cleared, as shown in Figure 5-21.

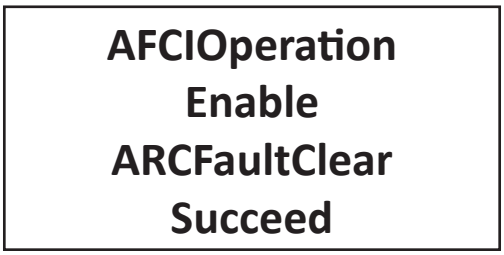


Figure 5-21 Manually clear “ARC Protect” fault

6.1 Start-up

Manual start-up: Manual start-up is required after regulation setting or manual (fault) shut-down. Move the cursor from the main operation interface to “4 Setting”. Press **ENT** and go to submenu “1 ON/OFF”. Then move the cursor to “ON” and press **ENT** to start the inverter. Then the inverter will start up and operate normally if the start-up condition is met. Otherwise, the inverter will go to stand-by mode.

Automatic start-up: The inverter will start up automatically when the output voltage and power of PV arrays meet the set value, AC power grid is normal, and the ambient temperature is within allowable operating range.

6.2 Shut-down

Manual shutdown: Normally, it is not necessary to shutdown the inverter, but it can be shut down manually if regulation setting or maintenance is required.
Move the cursor from the main operation interface to “4 Setting”. Press **ENT** and go to submenu “1 ON/OFF.” Move the cursor to “OFF” and press **ENT**, and then the inverter will be shut down.

Automatic shutdown: The inverter will be shut down automatically when the output voltage and power of PV modules are lower than the set value, or AC power grid fails; or the ambient temperature exceeds the normal range.

6.3 Operation mode

There are 4 operation modes. The following are corresponding indications for each mode.
(1) System check mode for start up, as shown in Figure 6-1:

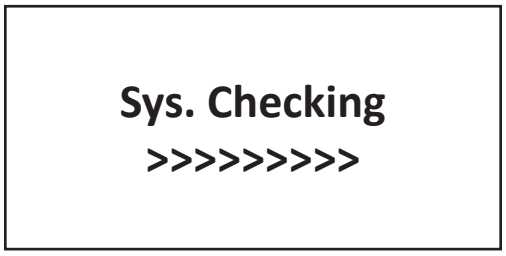
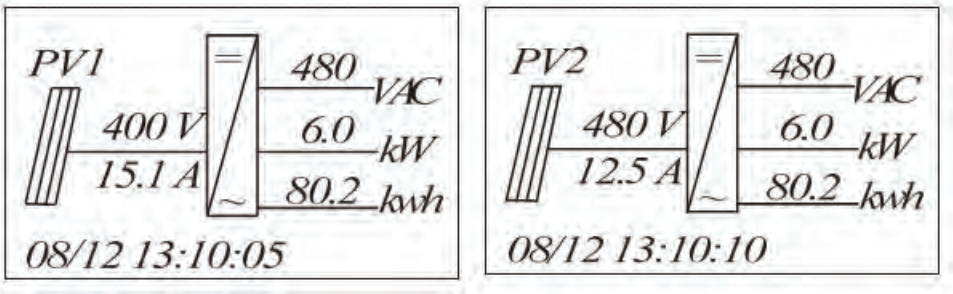


Figure 6-1 System self check ongoing

This mode indicates that the inverter is checking whether it is ready for normal operation after the manual start-up of inverter.
(2) Normal operation mode: Default indication interface for normal operation is shown in Figure 6-2 (a) and 6-2 (b). The switching time between (a) and (b) is 5 seconds.



(a) **(b)**

Figure 6-2 Default indication interface for manual operation

In this mode, the inverter converts the power generated by PV modules to AC continuously and feeds into the power grid.

(3) Standby mode, as shown in Figure 6-3:

The inverter will enter standby mode when the output voltage and power of PV modules do not meet the startup conditions or PV voltage and input power are lower than the set value. The inverter will check automatically whether it meets the startup conditions in this mode until it turns back to normal mode. The inverter will switch from standby mode to fault mode if a malfunction occurs.

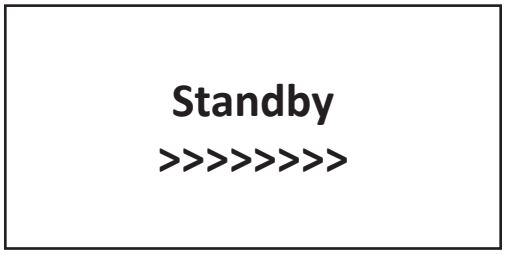


Figure 6-3 Inverter system in standby mode

(4) Fault mode, as shown in Figure 6-4:

The inverter will disconnect from the power grid and turn into fault mode when the inverter or power grid fails. Check the specific cause in “Troubleshooting table” (Table 7-2) according to the fault message displayed on the LCD and eliminate the fault referring to the instructions.

Figure 6-4 Fault indication interface

WARNING:

All the installation installation and wiring connections should be performed by qualified technical personnel. Disconnect the inverter from PV modules and the AC supply before undertaking maintenance. Do not operate or maintain the inverter until at least 5 minutes after disconnecting all sources of DC and AC.

6.4 Grid-tied power generation

CSI 23/28KTL-CT/US-480 series inverter has an automatic grid-tied power generation process. It will check constantly whether AC power grid meets the conditions for grid-tied power generation, and also test whether the PV array has adequate energy. After all conditions are met, the inverter will enter grid-tied power generation mode. While in grid-tied power generation, the inverter can detect the power grid at all times, and also keep the photovoltaic array output in maximum power point tracking (MPPT) mode. In case of any abnormity, the inverter will enter the protection program immediately. In low light conditions when power generation is not enough to keep the inverter in operation, the inverter will enter standby mode. When the voltage of PV array changes and becomes stable and higher than the required set value, the inverter will attempt to start grid-tied power generation again.

Notes:

7.1 Fault shut down and troubleshooting

7.1.1 LED fault and troubleshooting

Please refer to the definition of LED lights in Table 5-1 and troubleshoot according to Table 7-1:

Table 7-1 Trouble shooting of LED lights

LED fault status	Solutions
Neither the "Power" LED nor the LCD screen lights up.	1. Turn off the external AC breaker 2. Switch the DC switch to "OFF" position 3. Check the PV input voltage and polarity
The "GRID" LED is blinking.	1. Turn off the external AC breaker 2. Switch the DC switch to "OFF" position 3. Check whether the grid voltage is normal and whether the cable connection of AC side is correct and secure
The "RUN" LED lights off or "FAULT" LED lights up.	Refer to Table 7-2 for troubleshooting

7.1.2 LCD fault and troubleshooting

The inverter will be shut down automatically if the PV power generation system fails, such as output short circuit, grid overvoltage/undervoltage, grid malfunction of the machine. The fault information will be displayed on the LCD screen. Please refer to "5.4.2 Present fault" for detailed operation.
The causes of a fault can be identified based on the faults listed in Table 7-2. Proper analysis is recommended before contacting after-sales service. There are 3 types of fault: alarm, protection and hardware fault.

Table 7-2 LCD Troubleshooting table

Alarm	**1.TempSensorErr**	**Definition:** **Prompt detection of abnormal temperature** **Possible causes:** **1. Temperature Sensor socket connector has poor contact;** **2. Temperature Sensor is damaged** **Recommended solutions:** **1. Observe temperature display;** **2. Switch off 3-phase working power supply and then reboot the system.** **3. Contact after-sales service personnel**

Alarm	**2. CommErr**	**Definition:** **Communication inside inverter fails** **Possible causes:** **Terminal block connectors of internal communication wires have poor contact** **Recommended solutions:** **1. Observe for 5 minutes and see whether the alarm will be eliminated automatically;** **2. Switch off 3-phase working power supply and then reboot the system** **3. Contact after-sales service personnel**
Alarm	**3. ExtFanErr**	**Definition:** **Cooling fan failure by visual check** **Possible causes:** **1. Fan is blocked** **2. Fan service life has expired** **3. Fan socket connector has poor contact** **Recommended solutions:** **1. Observe for 5 minutes and see whether the alarm will be eliminated automatically;** **2. Check for foreign objects on fan blades;** **3. Switch off 3-phase work power supply and then reboot the system;** **4. Contact after-sales service personnel**
Alarm	**4. EepromErr**	**Definition:** **Internal alarm** **Possible causes:** **Internal memory has a problem** **Recommended solutions:** **1. Observe for 5 minutes and see whether the alarm will be eliminated automatically;** **2. Contact after-sales service personnel**
Protection	**1. TempOver**	**Definition:** **Ambient or internal temperature is too high** **Possible causes:** **1. Ambient temperature outside the inverter is too high;** **2. Fan is blocked;** **3. Convection airflow is insufficient due to improper installation**

Protection	1. TempOver	1. Confirm that external ambient temperature is within the specified range of operating temperature; 2. Check whether air inlet is blocked; 3. Check whether fan is blocked; 4. Check whether the location of installation is appropriate or not; 5. Observe for 30 minutes and see whether the alarm will be eliminated automatically; 6.Contact after-sales service personnel
Protection	2. GridV.OutLim	Definition: Grid voltage exceeds the specified range, Possible causes: 1. Grid voltage is abnormal; Power grid breaks down 2. Cable connection between the inverter and the grid is poor; Recommended solutions: 1.Observe for 10 minutes and see whether the alarm will be eliminated automatically; 2.Check whether the grid voltage is within the specified range; 3.Check whether the cable between the inverter and power grid is disconnected or has any fault; 4.Contact after-sales service personnel
Protection	3. GridF.OutLim	Definition: Grid voltage frequency is abnormal, or power grid is not detected Possible causes: 1.Grid frequency is abnormal; 2.Cable connection between the inverter and the grid is poor; Recommended solutions: 1.Observe for 10 minutes and see whether the alarm will be eliminated automatically; 2.Check whether the grid frequency is within the specified range; 3.Check whether the cable between the inverter and power grid is disconnected or has any fault; 4.Contact after-sales service personnel

Protection	**4. PVVoltOver***	**Definition:** **PV voltage exceeds the specified value** **Possible causes:** **PV over-voltage** **Recommended solutions:** **1. Observe for 30 minutes and see whether the alarm will be eliminated automatically;** **2. Check whether PV voltage exceeds the specified range;** **3. Turn off the PV input switch, wait for 5 minutes, and then turn on the switch again;** **4. Contact after-sales service personnel**
Protection	**5. PV1 (2) Reverse****	**Definition:** **PV module is connected inversely** **Possible causes:** **PV positive pole and negative pole are connected inversely;** **Recommended solutions:** **1.Check whether positive pole and negative pole are connected inversely;** **2.Contact after-sales service personnel**
Protection	**6. GFCIErr**	**Definition:** **System leakage current is too high** **Possible causes:** **1. Excessive parasitic capacitance on PV module due to environmental factor;** **2. Grounding is abnormal;** **3. Internal inverter fault** **Recommended solutions:** **1. Observe for 10 minutes and see whether the alarm will be eliminated automatically;** **2. Detect whether the electrical connection is abnormal** **3. Contact after-sales service personnel**
Protection	**7. IsolationErr**	**Definition:** **Insulation impedance of PV positive to ground or PV negative to ground exceeds the specified range** **Possible causes:** **Air humidity is high** **Recommended solutions:** **1. Observe for 10 minutes and see whether the alarm will be eliminated automatically;** **2. Check insulation of PV system;** **3. Contact after-sales service personnel**

Protection	**8. ARC Protect**	**Definition:** **ARC fault** **Possible causes:** **Protection actions of ARC board** **Recommended solutions:** **1. Use "ARCFaultClear" to clear the ARC fault. (Refer to section 5.4.4)** **2. Check if there is an arc in PV input or the connection of PV cable is not good.** **2. Contact after-sales service personnel**
Protection	**9. Arcboard Err**	**Definition:** **Arcboard error** **Possible causes:** **Poor contact or damage of Arcboard** **Recommended solutions:** **1. Check whether the Arcboard is in good condition** **2. Use "ARCFaultClear" to clear the ARC fault. (Refer to section 5.4.4)** **3. Contact after-sales service personnel**
Protection	**10. IntProtect 0010-0620**	**Definition:** **Internal protection of the inverter** **Possible causes:** **Protection procedure occurs inside the inverter** **Recommended solutions:** **1. Observe for 10 minutes and see whether the alarm will be eliminated automatically;** **2. Contact after-sales service personnel**
Fault	**IntFault 0010-0150**	**Definition:** **Internal fault of the inverter** **Possible causes:** **Fault occurs inside the inverter** **Recommended solutions:** **1. The inverter can be forced to restart once if it is required by operation and if it is confirmed that there is no other problem;** **2. Contact after-sales service personnel**

INSTRUCTION:

*The actual display of "PV.VoltOver" is "PV1VoltOver" or "PV2VoltOver."
*The actual display of "PV.Reverse" is "PV1Reverse" or "PV2Reverse."

DANGER:

Please disconnect the inverter from AC grid and PV modules before opening the equipment. Make sure hazardous high voltage and energy inside the equipment has been discharged. Do not operate or maintain the inverter until at least 5 minutes after disconnecting all sources of DC and AC.

Notes:

7.2 Product maintenance

7.2.1 Check the electrical connection

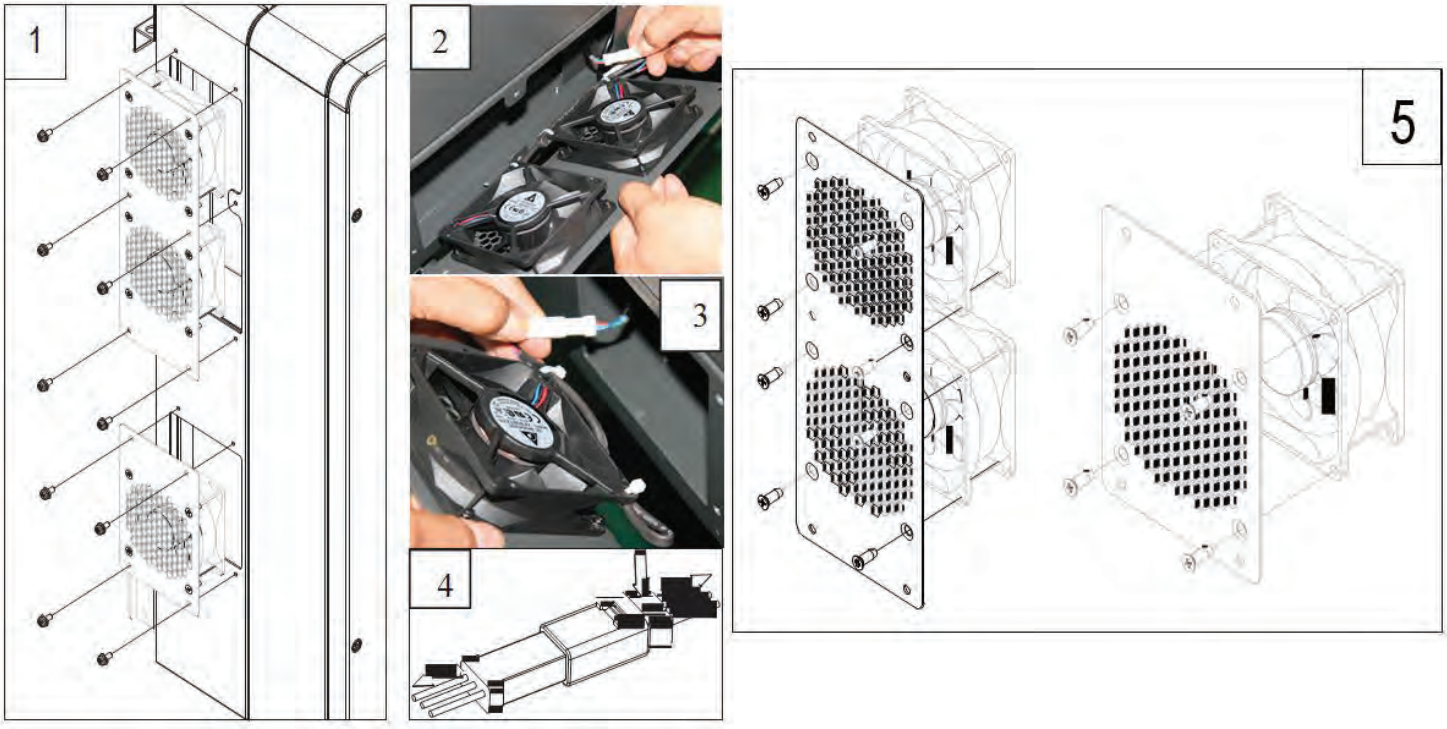
Check all the cable connections as a regular maintenance inspection every 6 months or once a year.
1.) Check the cable connections. If loose, please tighten all the cables referring to "3.3 Electrical installation."
2.) Check for cable damage, especially whether the cable surface is scratched or smooth. Repair or replace the cables if necessary.

7.2.2 Clean the air vent filter

The inverter can become hot during normal operation. It uses built in cooling fans to provide sufficient air flow to help in heat dissipation.
Check the air vent regularly to make sure it is not blocked and clean the vent with soft brush or vacuum cleaner if necessary.

7.2.3 Replace cooling fans

If the internal temperature of the inverter is too high or abnormal noise is heard assuming the air vent is not blocked and is clean, it may be necessary to replace the external fans.
Please refer to Figure 7-1 for replacing the cooling fans.
1. Use a No.2 Phillips head screwdriver to take off the 10 screws on the fan tray (6 screws on the upper fan tray, and 4 screws on the lower fan tray).
2. Disconnect the waterproof cable connector from the cooling fan.
3. Use a No.2 Phillips head screwdriver to take off the screws.
4. Fix the new cooling fan on the fan tray, and fasten the cable on the fan tray with cable ties
Torque value: 0.8-1N.m
5. Install the assembled fans back to the inverter. Torque value: 1.2N.m



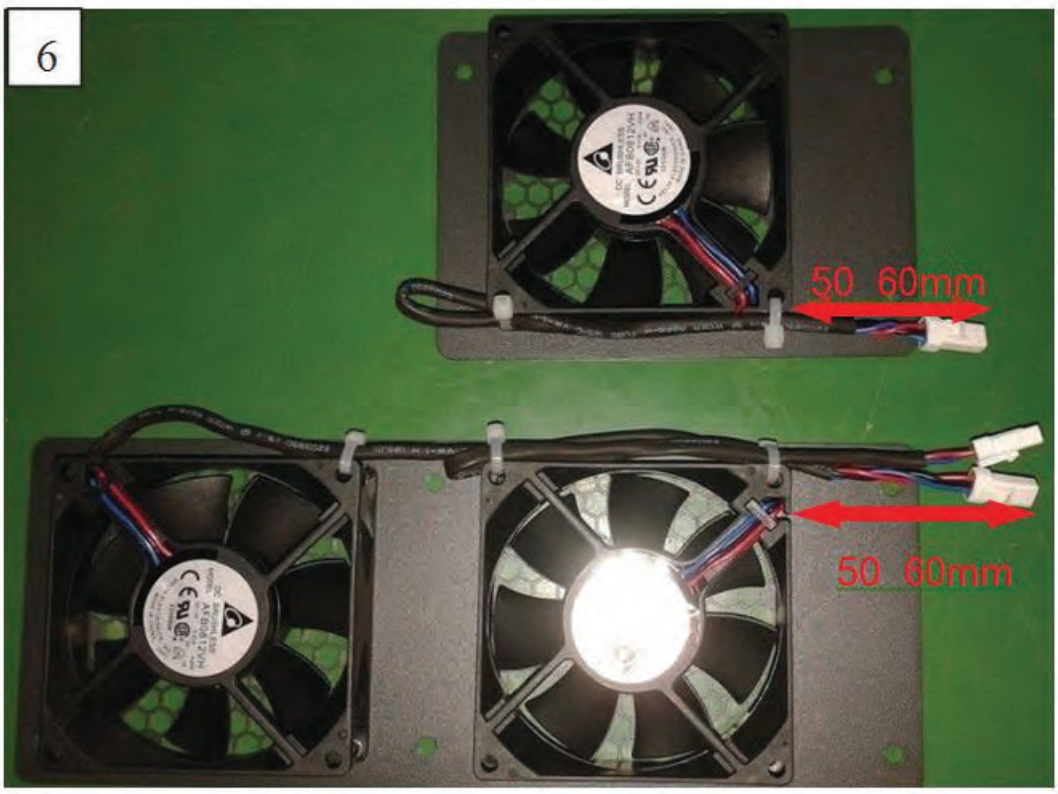


Figure 7-1 Replace cooling fans

7.2.4 Replace the inverter

Please confirm the following things before replacing the inverter: (1) The inverter is turned off.
(2) The DC switch of the inverter is turned to OFF position. Then Replace the inverter according to the following steps:
a.) Unlock the padlock if it is installed on the inverter.

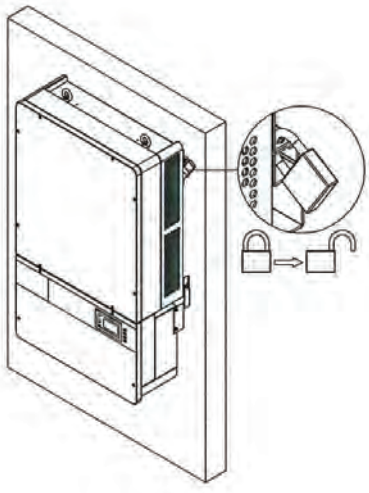


Figure 7-2 Unlock the padlock

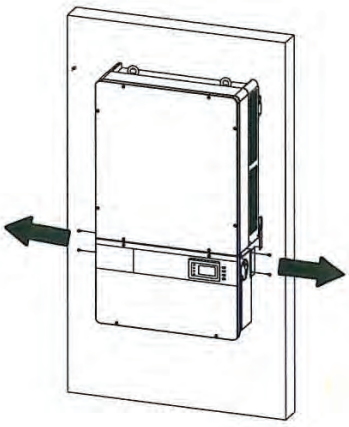


Figure 7-3 Remove the screws on both sides

b.) Use a No. 2 Phillips head screwdriver to unscrew the 2 screws on both sides of the inverter.

c.) Use a No. 10 Hex wrench to remove the 4 screws between the main housing and the wiring box. Lift up the main housing and disconnect from the wiring box.

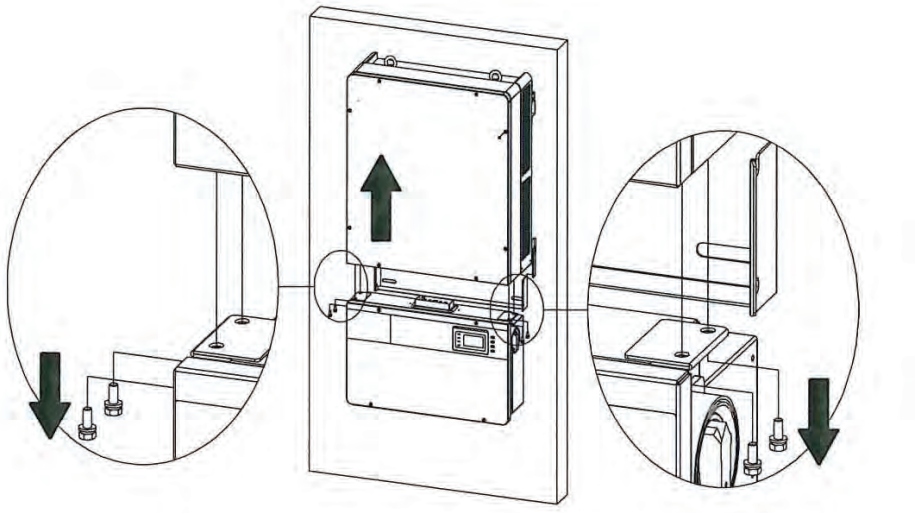


Figure 7-4 Disconnect the main housing from the wiring box

d.) Use a No.2 Phillips head screwdriver to remove the 2 screws on the left side of the wiring box, and take off the cover board. Put the board on the connector of wiring box.
Torque value: 1.2N.m

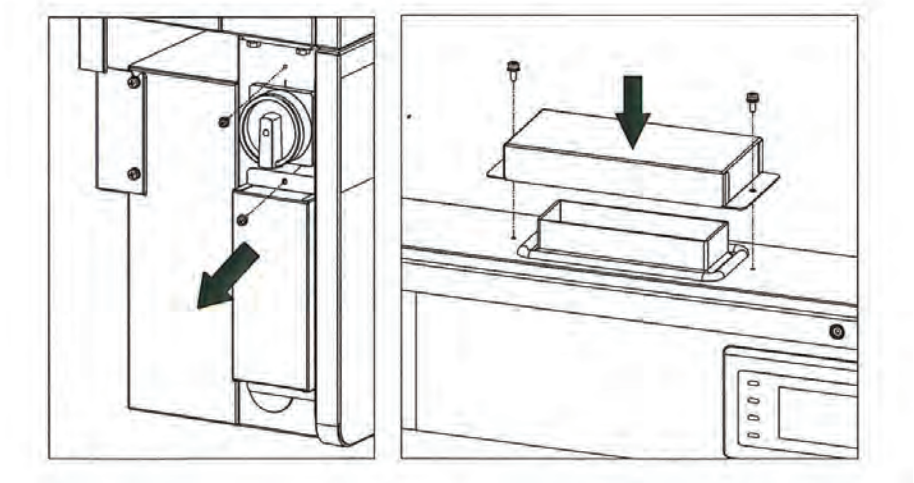


Figure 7-5 Install the cover board on the connector of the wiring box

7.3 De-installing the inverter

De-install the inverter according to the following steps when the service time is due or for other reasons:

DANGER:

Please disconnect the electrical connection in strict accordance with the following steps. Otherwise, the inverter will be damaged and the service personnel's life will be endangered.

1.) Turn off the AC breaker, and use Padlocks if provided.

2.) Turn off the DC breaker, and use Padlocks if provided. (Skip the two steps if there are no circuit breakers.)

3.) Switch the AC switch to "OFF" position.

4.) Switch the DC switch to "OFF" position.

5.) Wait for 10 minutes to ensure the internal capacitors have been completely discharged.

6.) Measure the AC output cable terminal voltage against the ground, and make sure the voltage is 0V.

7.) Disconnect the AC and PE cables referring to "3.3.2 AC and ground connection."

8.) Disconnect the DC cables referring to "3.3.1 DC connection."

9.) De-install the inverter using reverse of installation steps referring to "3.2 Mechanical installation."

Model Name	CSI 23KTL-CT/US-480	CSI 28KTL-CT/US-480
DC Input		
Max. PV Power	31kW	38kW
Nominal DC Input Power	24kW	29kW
Max. DC Input Voltage[1]	1000Vdc	
Operating DC Input Voltage Range	300-900Vdc	
Start-up DC Input Voltage / Power	330V/300W	
Number of MPP Trackers	2	
MPPT Voltage Range[2]	480-800Vdc	500-800Vdc
Max. Input Current (Imp)	50A (25A per MPPT)	58A (29A per MPPT)
Max. Short Circuit Current (Isc)	82A (41A per MPPT)	96A (48A per MPPT)
Number of DC Inputs	8 inputs, 4 per MPPT	
DC Disconnection Type	Load rated DC switch	
AC Output		
Rated AC Output Power	23kW	28kW
Max. AC Output Power	23kW	28kW
Rated Output Voltage	480Vac	
Output Voltage Range[3]	422-528Vac	
Grid Connection Type	3¢/ N / PE	
Max AC Output Current	27.7A	33.7A
Rated Output Frequency	60Hz	
Output Frequency Range[4]	59.3-60.5Hz	
Power Factor	>0.99 (±0.8 adjustable)	

[1] Exceeding the Max. DC Input Voltage may cause permanent damage to the equipment.
[2] The MPPT Voltage Range is adjustable through LCD operations.
[3] The Output Voltage Range may differ according to specific grid standard.
[4] The Output Frequency Range may differ according to specific grid standard.

Current THD	<3%
AC Disconnection Type	Load rated AC switch
System	
Topology	Transformerless
Max. Efficiency	98.6%
CEC Efficiency	98.0%
Stand-by / Night Consumption	<20W / <2W
Environment	
Protection Degree	NEMA 4
Cooling	Variable speed cooling fans
Operating Temperature Range	-13°F to +140°F / - 25°C to +60°C (derating from +113°F / +45°C)
Operating Humidity	0-95%, non-condensing
Operating Altitude	13123.4ft / 4000m (derating from 6561.7ft /2000m)
Display and Communication	
Display	LCD + LED
Communication	Standard: RS485 (Modbus)
Mechanical Data	
Dimensions (WxHxD)	23.6x39.4x9.1in / 600x1000x230mm
Weight	122lbs / 55kg
Orientation	15 - 90 degrees from horizontal
Safety	
PV Arc-Fault Circuit Protection	Type 1
Safety and EMC Standard	UL1741:2010, CSA-C22.2 NO.107.1-01,IEEE1547; FCC PART15
Grid Standard	IEEE1547: 2003, IEEE1547.1: 2005

Note 1: When the DC input voltage is lower than 400V or higher than 800V, the inverter begins derating, as shown in Figure 8-1:

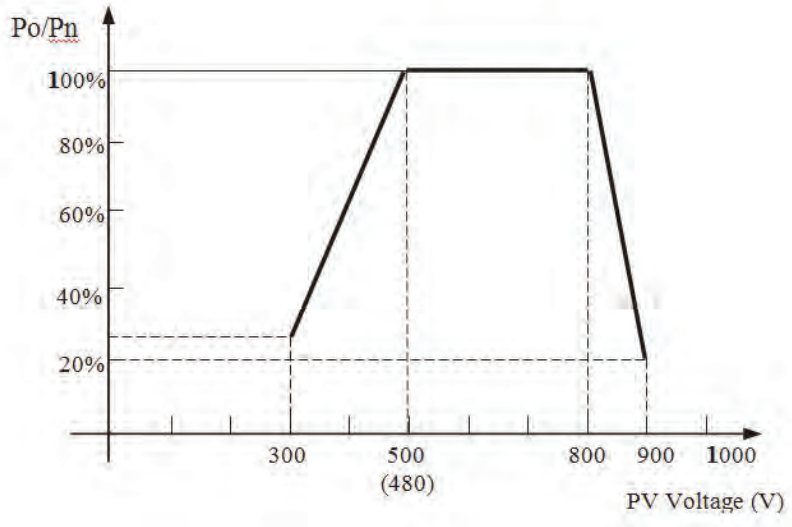


Figure 8-1 SCA23/28KTL derating curve of PV input voltage

Note 2: When the ambient temperature is higher than 113F (45C), the output power begins derating, as shown in Figure 8-2:

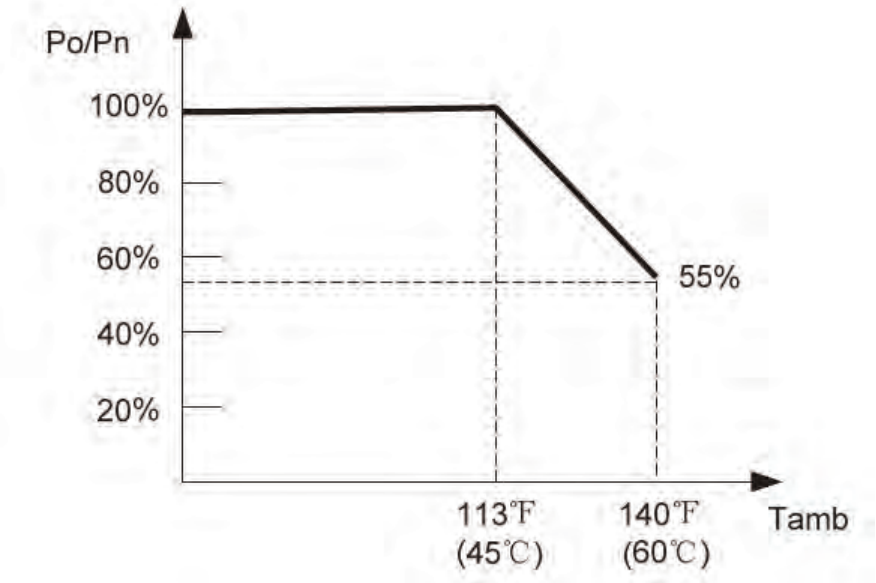


Figure 8-2 CSI 23/28KTL derating curve with high temperature

Note 3: When the altitude is higher than 6562ft (2000m), the power of the inverter needs derating, as shown in Figure 8-3:

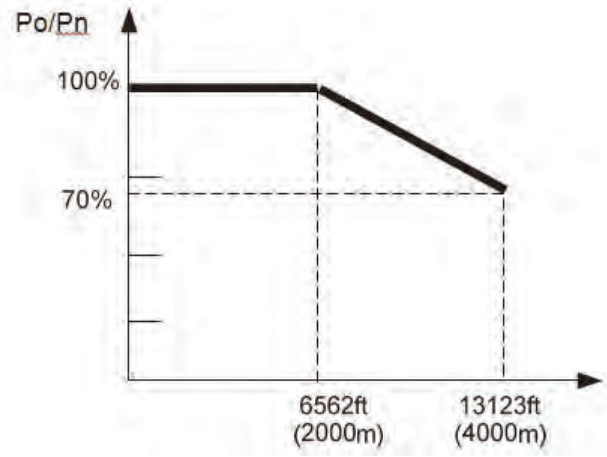


Figure 8-3 CSI 23/28KTL derating curve of grid voltage

Note 4: The inverter can output the AC power with full loads under 90%-110% of the rated grid voltage. When the grid voltage is lower than 90%, the output current will be limited within the allowable Max. current.

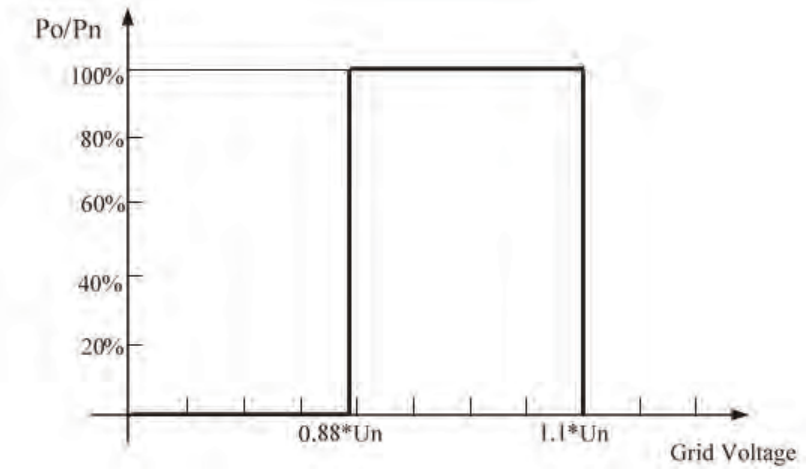


Figure 8-4 CSI 23/28KTL derating curve of grid voltage

Notes:

The warranty policy of this product is specified in the contract; otherwise, the warranty period is 5 years. For service, Canadian Solar will provide local support. For Warranty terms, please refer to the CSI standard warranty policy in place at time of purchase.

Appendix: Instruction of inverter selection

Table A-1 Optional accessory

	Item	Number	Note
Standard	•CSI 23/28KTL-CT/US-480 inverter 1		
Options	o 2DC SPD	1	
	o 1DC	1	
	o 2DC and 1AC SPD	1	
	o 1DC and 1AC SPD	1	
	o Zigbee card	1	
	o Ethernet card	1	
	o Bypass input terminalsx2		1 or 2

The following figure shows the wiring box equipped with the optional components:

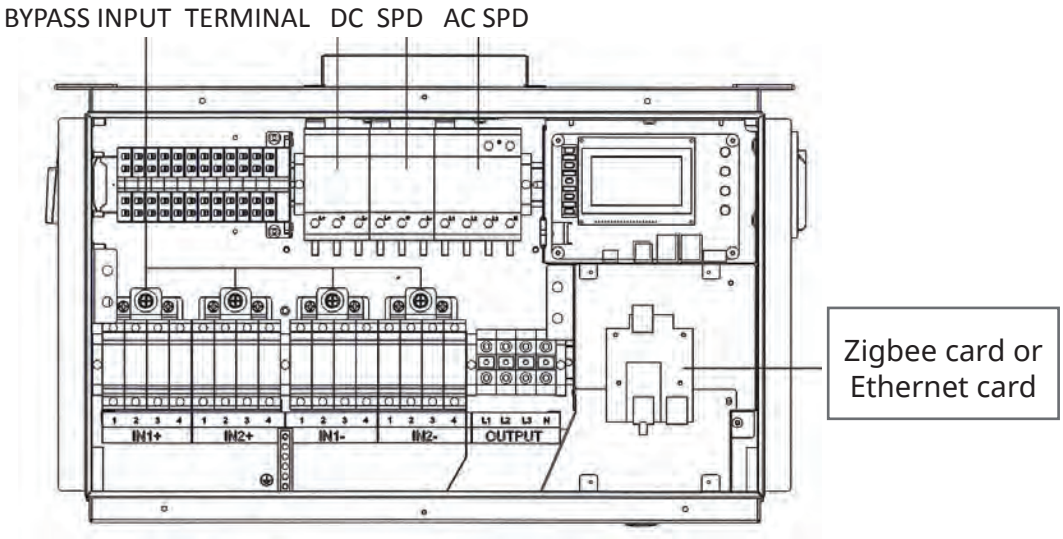


Figure A-1 Internal structure of CSI 23/28KTL-CT inverter with optional components

Bypass input terminal instructions:

1. Remove the protection cover . (see Figure A-2)
2. Use No.2 Phillips head screwdriver to remove the jumper busbar, torque value of 1.6N.m. (see Figure A-3)
3. Use No.2 Phillips head screwdriver to install the bypass input terminals, 2sets or 1set, torque value of 1.6N.m. (see Figure A-5)
4. Use No. 10 wrench to screw DC input cable on the bypass input terminals, torque value of 6.0N.m. (see Figure A-6)
5. Reinstall the protection cover (see Figure A-7).

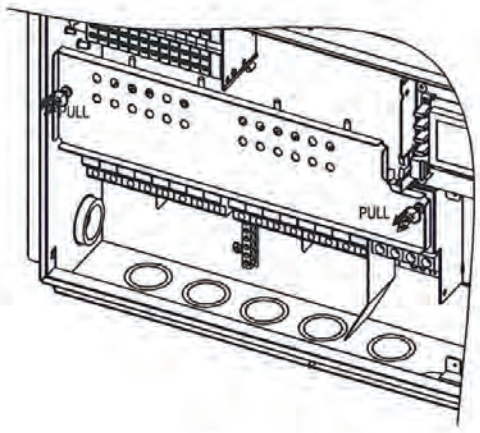


Figure A-2

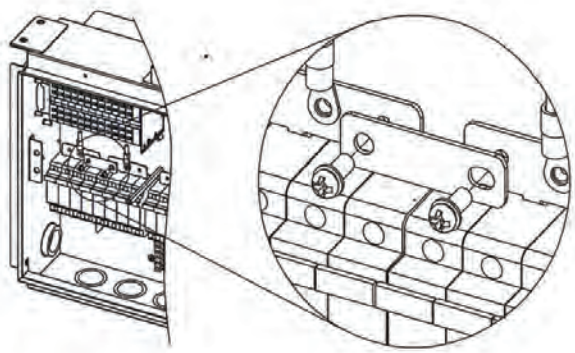


Figure A-3

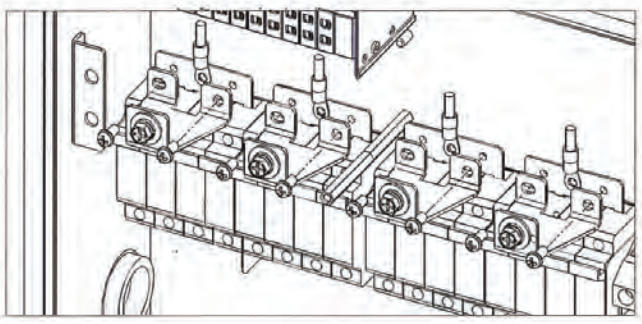


Figure A-4(a)

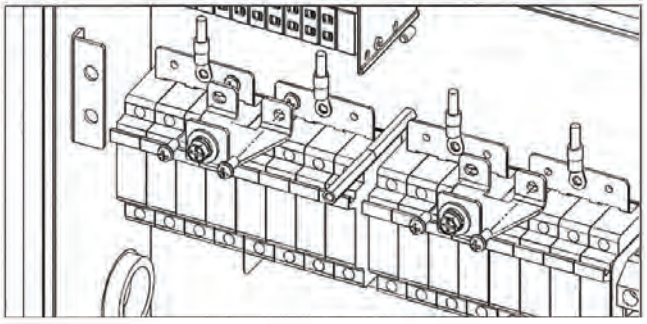


Figure A-4(b)

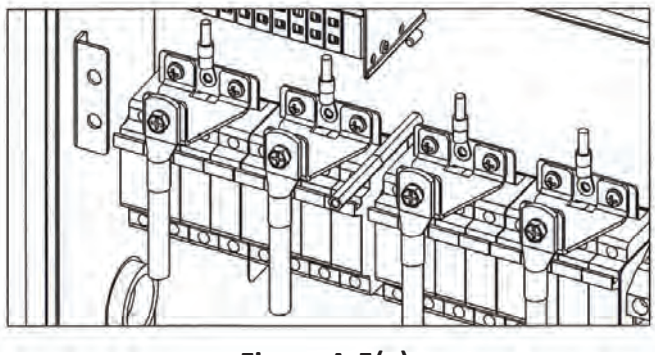


Figure A-5(a)

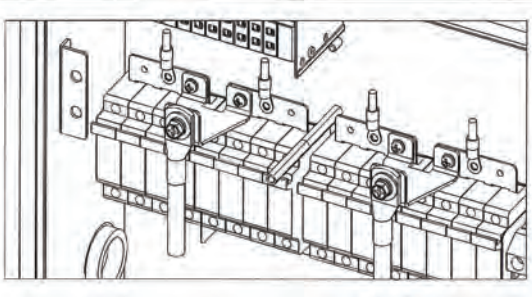


Figure A-5(b)

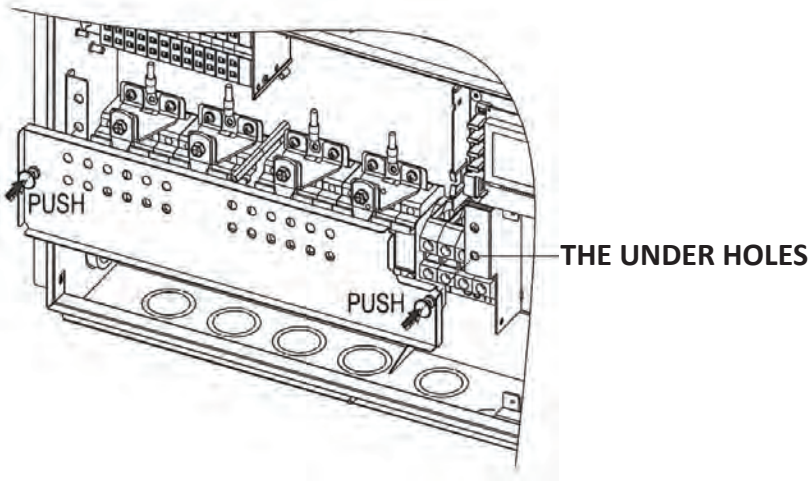


Figure A-6

Notes:

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