Service manual

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1. General information

1.1 Getting start

This manual is for SPF 5000 ES series, it can help service personal perform the basic maintenance and repair service.
This manual focus on the service, so you should get the basic operation of the Inverter/Charger from the user manual, and make sure you had read and understood user manual before you use this service manual.
The manual include 7 sections, as follows

- General Information, this section show you the general information of the service manual
- Functional Block, this section show you the major functional block of the Inverter/Charger
- Working Principle of the major Functional Block, this section show you the major functional block
- Function explanations for each PCB, this section show you all the PCBs of the Inverter/Charger
- Trouble shooting, this section will give you the way to find the trouble
- Test step ,this section tell you how to test the Inverter/Charger after you repair the unit
- Key components location, this section tell you where the key components are that you can easy find them out and repair them

1.2 Important safety instructions

⚠ **WARNING: This chapter contains important safety and operating instructions. Read and keep this manual for future reference.**

1. Before using the unit, read all instructions and cautionary markings on the unit, the batteries and all appropriate sections of this manual.
2. Do not disassemble the unit. Take it to a qualified service center when service or repair is required. Incorrect re-assembly may result in a risk of electric shock or fire.
3. To reduce risk of electric shock, disconnect all wirings before attempting any maintenance or cleaning. Turning off the unit will not reduce this risk.
4. **CAUTION** – Only qualified personnel can install this device with battery.
5. **NEVER** charge a frozen battery.
6. For optimum operation of this inverter/charger, please follow required spec to select appropriate cable size. It's very important to correctly operate this inverter/charger.
7. Be very cautious when working with metal tools on or around batteries. A potential risk exists to drop a tool to spark or short circuit batteries or other electrical parts and could cause an explosion.
8. Please strictly follow installation procedure when you want to disconnect AC or DC terminals. Please refer to INSTALLATION section of this manual for the details.
9. Fuses with particular standard are provided as over-current protection for the battery supply.
10. GROUNDING INSTRUCTIONS -This inverter/charger should be connected to a permanent grounded wiring system. Be sure to comply with local requirements and regulation to install this inverter.
11. NEVER cause AC output and DC input short circuited. Do NOT connect to the mains when DC input short circuits.
12. **Warning!!** Only qualified service persons are able to service this device. If errors still persist after following troubleshooting table, please send this inverter/charger back to local dealer or service center for maintenance.

2. Functional block

The SPF 5000 ES series production employ a double conversion topology, comprise following functional blocks, as shown in figure 2.1.

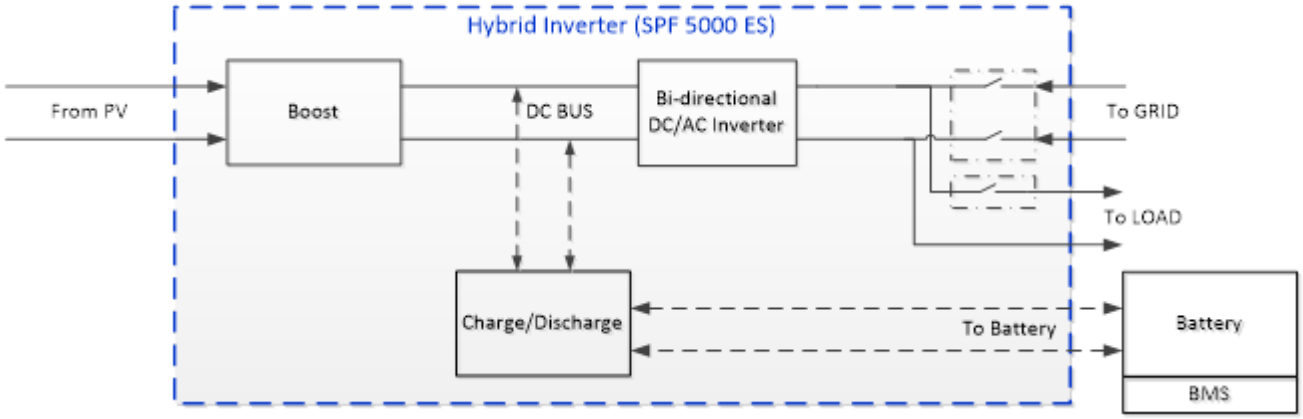


Figure 2.1 function block diagram

3. Working principle of the major functional block

3.1 Switch Power Supply

The switch power supply (SPS) supplies DC power for Inverter/Charger operation. The input voltage of the SPS is the battery or AC/PV Charger output voltage.

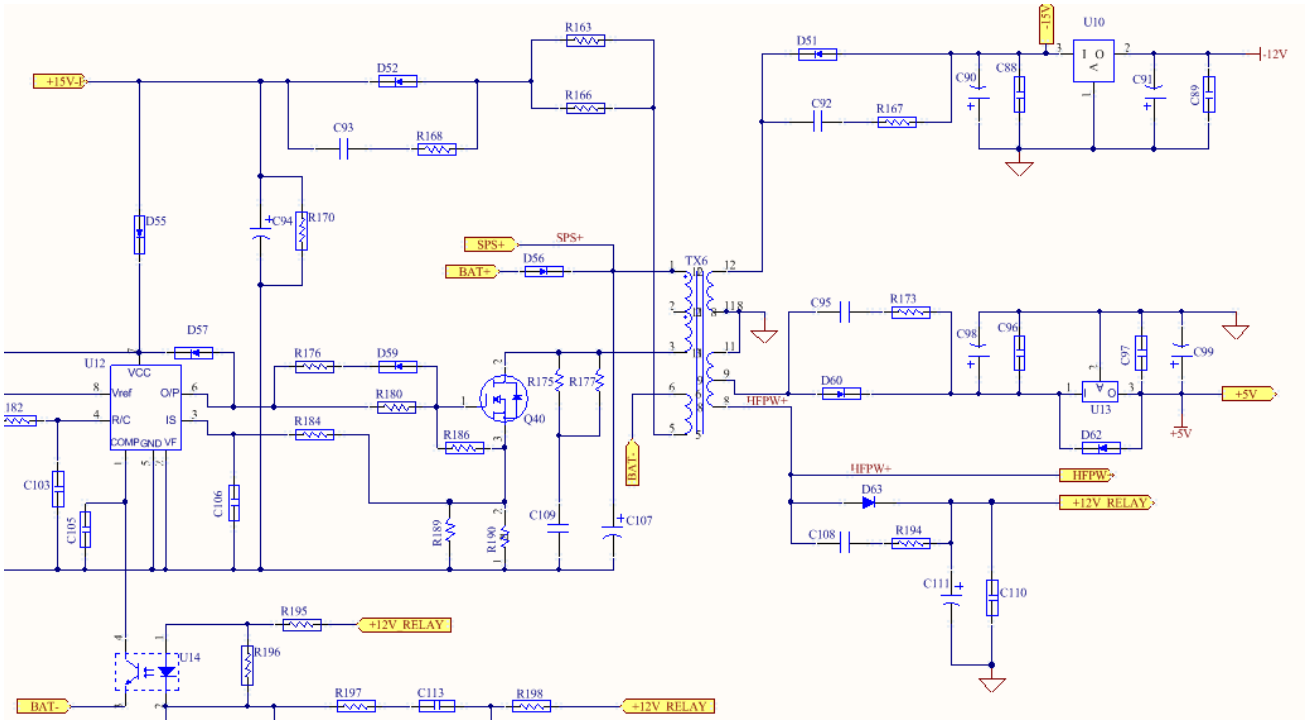


Figure 3.1 basic circuit of power supply

This is the fly-back DC-DC converter, fly-back operation can be easily recognized from the position of the dots on the transformer primary and secondary(these dots show starts of the winds). When Q40 is ON, the dot ends of all winds are negative with respect to their no-dot ends. Output rectifier diodes D51, D52, D60 and D63 are reverse-biased and all the output load currents are supplied from storage filter capacitors C78, C75, C79 and C116.The primary coil of the transformer acts as an inductor and stored energy.

When Q40 is OFF, the stored energy in the primary coil is delivered to secondary filter capacitors C90, C94, C98 and C111.

As shown in figure 3.1, this circuit may generate several output voltage, such as +12V,-12V, +15V, +5V, HFPW+.

3.2 DC TO DC dual converter (Full bridge converter)

The full bridge topology is a transformer isolated forward-mode regulator. Unlike the Fly-back transformer, the push-pull transformer does not store any energy and output current is drawn when either power switches (S1-S4 or S2-S3) is conducting. P1 is the battery, P2 is the BUS

This is dual converter, it means that battery can feed power to BUS and also BUS can charge the battery. And it is an open loop control: the transformer N1:N2 is 1:8, when the battery voltage is transformed through the converter to more than the BUS voltage, the battery discharge power to the BUS, or the BUS can charge the battery.

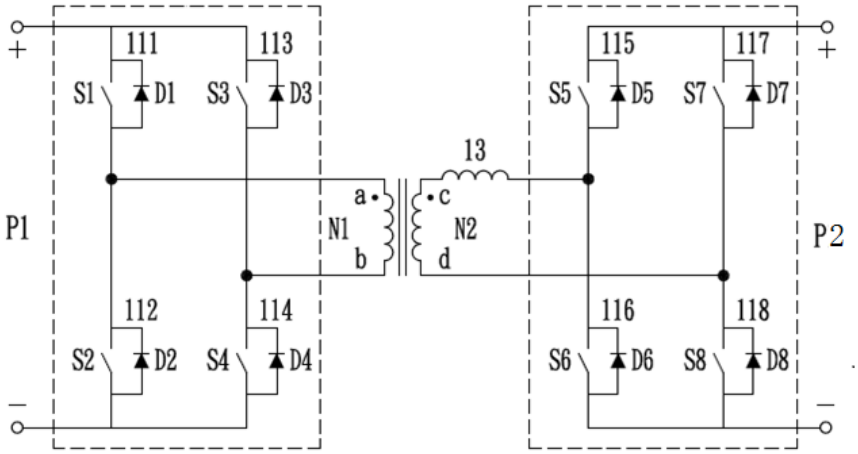


Figure 3.2 DC TO DC dual converter

3.3 Inverter (Full bridge)

The Inverter circuit (Figure 3.3) and PWM control are can both active under battery mode and line mode. In line mode, the inverter can convert power from gird to BUS for charging .The Inverter circuit of SPF 5000 ES series is based on a full-bridge circuitry and its output is driven by photo-couplers. The photo-couplers are capable to drive high energy and high speed power of MOSFET and IGBT with independent high and low referenced output channels.

To construct a high frequency PWM inverter, the drivers receive switching signals from PWM generation circuit through a pair of photo-couplers to trigger the upper IGBT and the lower IGBT alternately. The output of IGBT's is filtered by an LC circuit to reduce the o/p voltage harmonics distortion.

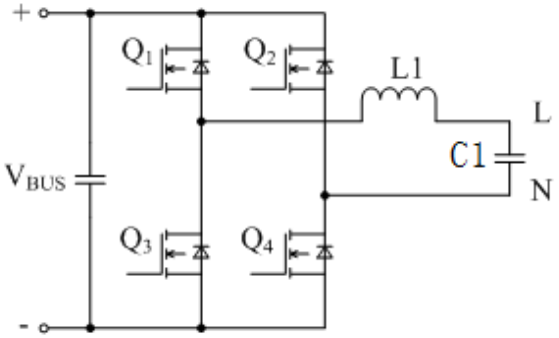


Figure 3.3 Full-bridge topology

3.4 Buck converter

The Buck circuit (Figure 3.4) is active only when the line charging the battery. When the battery is discharging, S1 is ON, D1 is reversed cut off, L1 is used as a filter inductor.

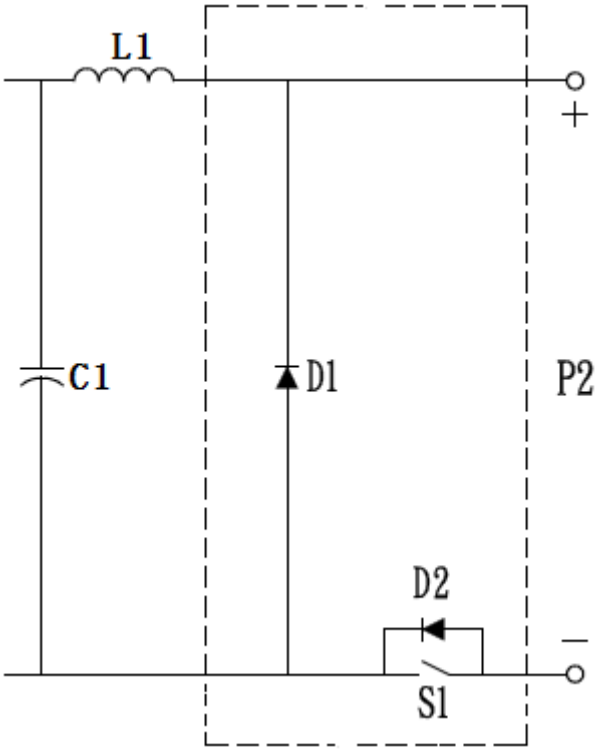


Figure 3.4 Buck topology

4. Functional explanations for each PCB

Item	Series name	PCB name	PCB serial number	Quantity	Remark
1	SPF 5000 ES	Main	530.SK00008XX	1	
2		CNTL	530.SK00009XX	1	
3		MPPT	530.SK00010XX	1	
4		COMM	530.SK00035XX	1	
5		BMS	530.SK00042XX	1	
6		MOV	530.00552XX	1	
7		SWITCH	530.00555XX	1	
8		PARALLEL_COM	530.SK00037XX	1	

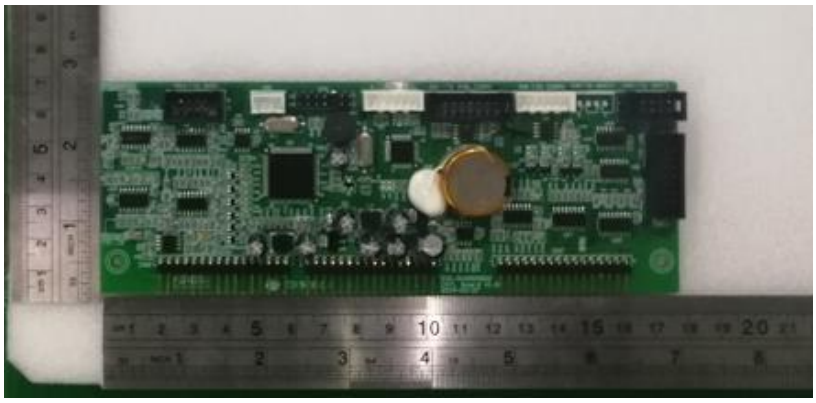
Note: “XX” in the serial number is the version of the PCB.

4.1 Main board

The main board consists of SPS, DC-DC converter, inverter. Many semiconductors and easy-failure components on the board, so it should be play more attention when the system is abnormal.

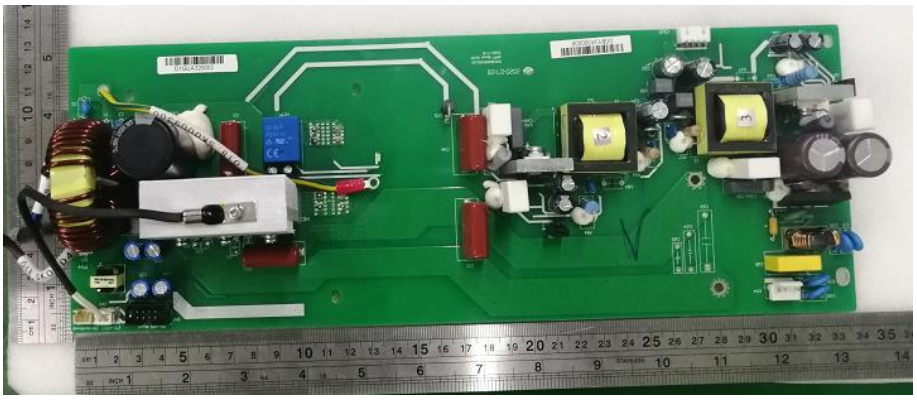
4.2 CNTL board

The CNTL board consists of AD sample, MCU control and communication module. It control the other module work orderly.



4.3 MPPT board

The Maximum Power Point Tracking (MPPT) board based on a PWM control mode .When the solar source is presented, battery charged from solar source; MAX charge current is 100A if solar panel with enough energy.



4.4 COMM board

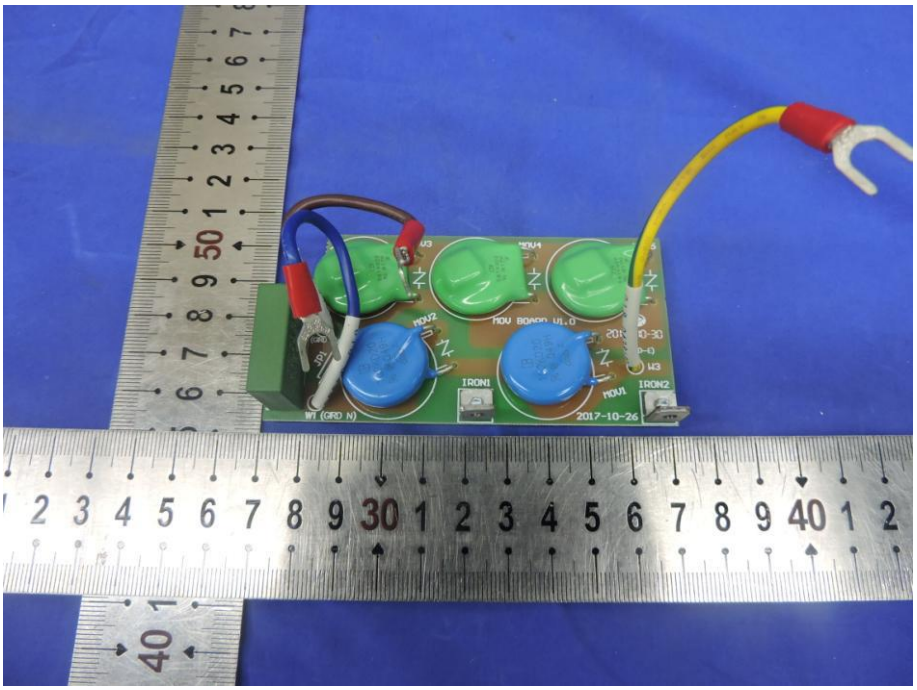
This inverter/charger is equipped with a communication port to communicate with a PC with corresponding software. Please use supplied communication cable to connect to communication port of this inverter and USB port of the PC.

4.5 BMS board

The BMS board is designed for relays protection.

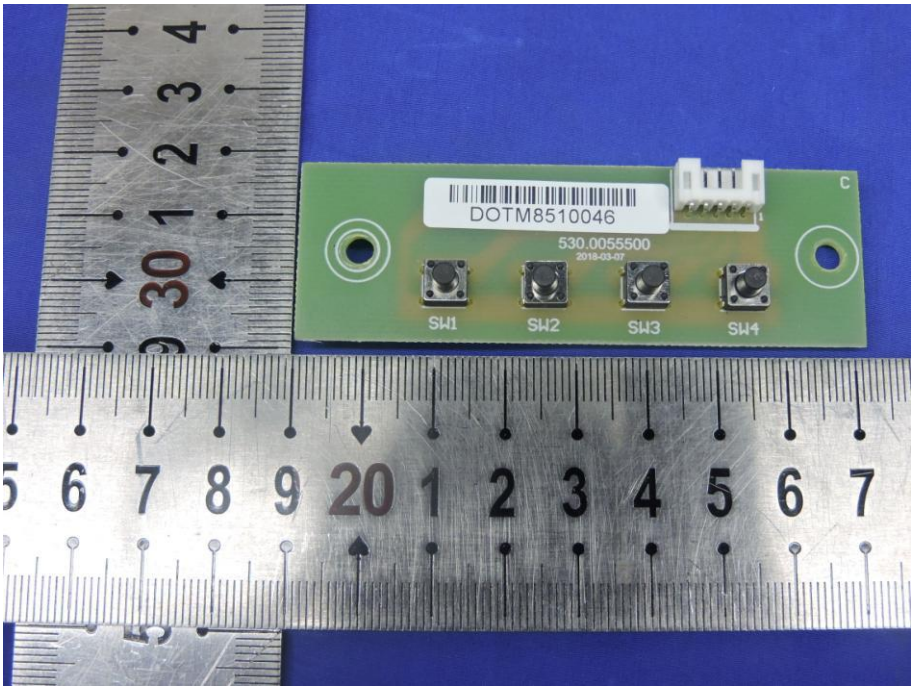
4.6 MOV board

The function of this board is to prevent lightning strikes.



4.7 SWITCH board

This board includes four functional keys.



4.8 PARALLEL_COM board

For parallel communication.


CN1
CN2
CN3
CN6
CN5
cm 1 2 3 4 5 6 7 8 9 10 11 12 13
INCH 1 2 3 4 5

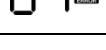
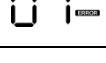
5. Troubleshooting

This section describes how to find the trouble when the system is abnormal. We suggest you can follow the service procedure:

a. Check the system status by LED and LCD display, the sounds of buzzer.
b. Observe the failure board, static checking.
c. Replace the failure components.
d. Static checking.
e. Power up checking.
f. Test after repair.

Following section will help service person to solve most of problem.

5.1 Fault Reference Code

Fault Code	Fault Event	Icon on
01	Fan is locked	
02	Over temperature	
03	Battery voltage is too high	
04	Battery voltage is too low	
05	Output short circuited	
06	Output voltage is too high.	
07	Overload time out	
08	Bus voltage is too high	
09	Bus soft start failed	
51	Over current or surge	
52	Bus voltage is too low	

53	Inverter soft start failed	
55	Over DC voltage in AC output	
56	Battery connection is open	
57	Current sensor failed	
58	Output voltage is too low	
60	Negative power fault	
61	PV voltage is too high	
62	Internal communication error	
80	CAN fault	
81	Host loss	

5.2 Warning Indicator

Warning Code	Warning Event	Audible Alarm	Icon flashing
01	Fan is locked when inverter is on.	Beep 3 times every second	
02	Over temperature	Beep once every second	
03	Battery is over-charged	Beep once every second	
04	Low battery	Beep once every second	
07	Overload	Beep once every 0.5 second	
10	Output power derating	Beep twice every 3 seconds	

12	Solar charger stops due to low battery	Beep once every second	
13	Solar charger stops due to high PV voltage	Beep once every second	
14	Solar charger stops due to overload	Beep once every second	
15	Parallel input utility grid different	Beep once every second	
16	Parallel input phase error	Beep once every second	
17	Parallel output phase loss	Beep once every second	
18	Buck over current	Beep once every second	
19	Battery disconnect	No beep	
20	BMS communication error	Beep once every second	
21	PV power insufficient	Beep once every second	
22	Parallel forbidden without battery	Beep once every second	
25	Parallel inverters' capacity different	Beep once every second	
33	BMS communication loss	Beep once every second	
34	Cell over voltage	Beep once every second	
35	Cell under voltage	Beep once every second	
36	Total over voltage	Beep once every second	
37	Total under voltage	Beep once every second	
38	Discharge over voltage	Beep once every second	
39	Charge over voltage	Beep once every second	
40	Discharge over temperature	Beep once every second	
41	Charge over temperature	Beep once every second	

42	Mosfet over temperature	Beep once every second	
43	Battery over temperature	Beep once every second	
44	Battery under temperature	Beep once every second	
45	System shut down	Beep once every second	

5.3 Trouble shooting according to fault indication

Problem	LCD/LED/Buzzer	Explanation / Possible cause	What to do
Unit shuts down automatically during startup process.	LCD/LEDs and buzzer will be active for 3 seconds and then complete off.	The battery voltage is too low (<1.91V/Cell)	1. Re-charge battery. 2. Replace battery.
No response after power on.	No indication.	1. The battery voltage is far too low. (<1.4V/Cell) 2. Battery polarity is connected reversed.	1. Check if batteries and the wiring are connected well. 2. Re-charge battery. 3. Replace battery.
Mains exist but the unit works in battery mode.	Input voltage is displayed as 0 on the LCD and green LED is flashing.	Input protector is tripped	Check if AC breaker is tripped and AC wiring is connected well.
	Green LED is flashing.	Insufficient quality of AC power (Shore or Generator)	1. Check if AC wires are too thin and/or too long. 2. Check if generator (if applied) is working well, or check if input voltage range setting is correct (UPS or Appliance)
	Green LED is flashing.	Set Solar power as the priority of output source	Change output source priority to Utility first.
When the unit is turned on, internal relay is switched on and off repeatedly.	LCD display and LEDs are flashing.	Battery is disconnected.	Check if battery wires are connected well.
Buzzer beeps continuously and red LED is on.	Fault code 07.	Overload error. The inverter is loaded with more than 110% load and time is up	Reduce the connected load by switching off some equipment.
	Fault code 05.	Output short circuited.	Check if wiring is connected well and remove abnormal load.

	Fault code 02.	Internal Inverter component over 100°C	Check whether the air flow of the unit is blocked or whether the ambient temperature is too high.
	Fault code 03.	Battery is over charged.	Return to repair center.
		The battery voltage is too high.	Check if spec and quantity of batteries are meet requirements.
	Fault code 01.	Fan fault	Replace the fan.
	Fault code 58/06.	Output abnormal (Inverter voltage below than 190Vac or is higher than 260Vac)	1. Reduce the connected load. 2. Return to repair center
	Fault code 08.	Internal components may be failed.	1. Restart the inverter again. 2. If the problem still exists, please return to repair center.
	Fault code 09.		
	Fault code 51		
	Fault code 52		
	Fault code 53		
	Fault code 55		
	Fault code 57		
	Fault code 56	Battery is disconnected.	1. Check if battery wires are connected well. 2. If the problem still exists, please return to repair center.
	Fault code 60	Negative power fault	1. Check whether the AC output connects to the Grid. 2. Check whether the output voltage setting in program 8 of all the Inverters in parallel are the same. 3. Check whether the current sharing cables are connected well in the same parallel phases. 4. Check whether all the neutral wires of each unit in a parallel system are connected together. 5. If the problem still exists, please return to repair center.
	Fault code 80	CAN fault	1. Check whether the parallel communication cables are connected well. 2. If the problem still exists, please return to repair center.
	Fault code 81	Host loss	

5.4 Quick start

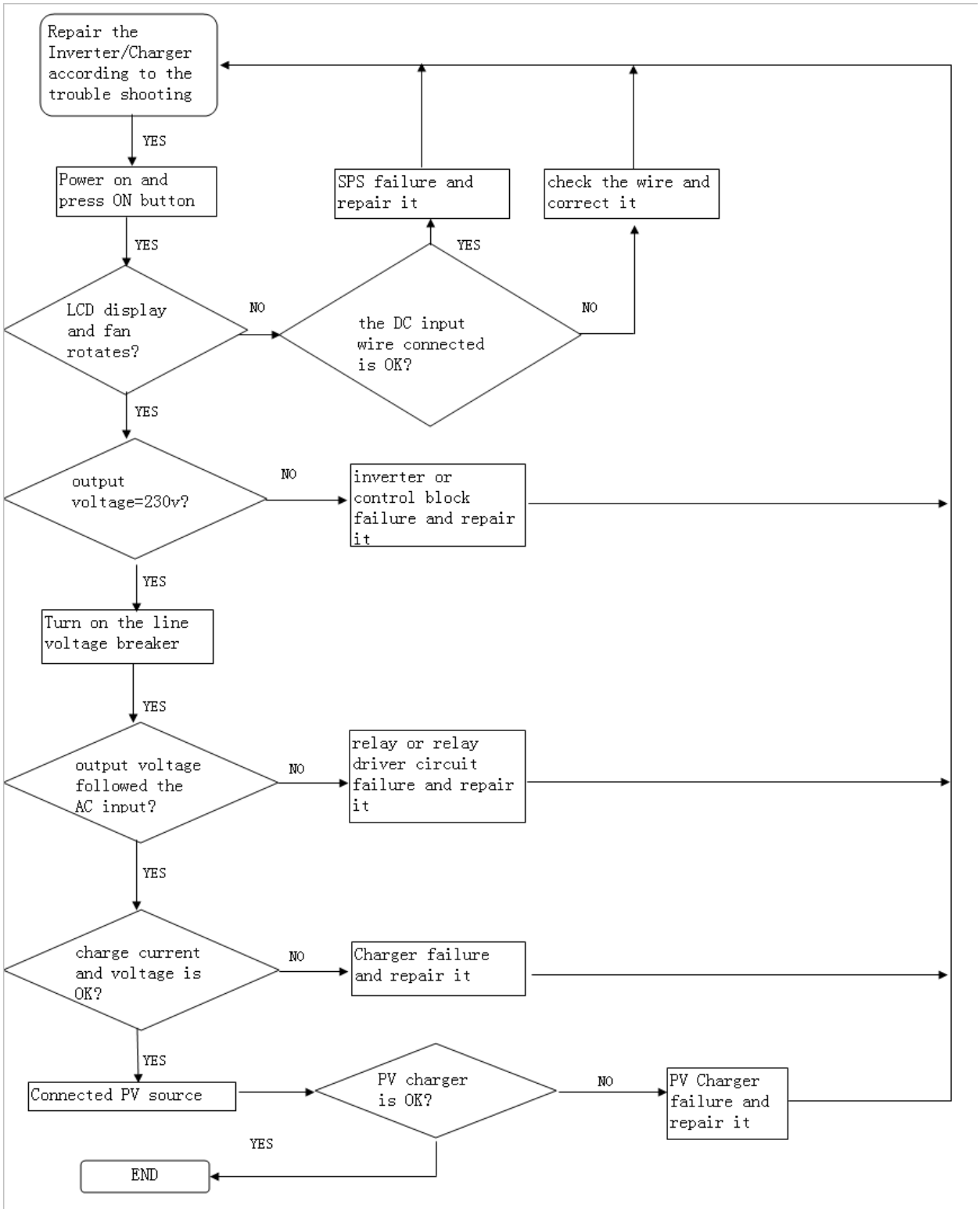
Before any detail check of the system, please check the components listed as follow table.
NOTE: It is important to check the capacitor's voltage on the board lower than the safety voltage before any check action.

Functional block	Checked components		Instruction function	Reference value	Failed status
DC-DC Converter	Fuse	F1	Resistance	<0.5ohm	open
	MOSFET (CSD19505KCS)	Q45/Q46/Q47/Q48/Q49/ Q50/Q51/Q52/Q54/Q55/ Q56/Q57/Q58/Q58/Q60/ Q61	Resistance Diode position	>20k DS	short or open
				V_{SD}=0.434V REF	0 or OL
				240k GD	short or open
				11.74k GS	short or open
	Diode(1N4148SM)	D15/D17/D19/D20/D21/D 22/D25/D26	Resistance	>240K	short or open
			Diode position	V_{PN}=0.562V REF	0 or OL
	Driver NPN /PNP	Q21/Q26/Q30/Q31	Resistance	11.9K PIN1-2	short or open
		Q23/Q27/Q32/Q33		11.9K PIN1-3	short or open
	Driver IC	KA3525	Resistance	>400K PIN14-PIN13/12 PIN12-PIN13/11	short or open
	IGBT (STGWT80H65DFB)	Q64/Q66/Q67/Q68	Resistance Diode position	>60K CE	short or open
				V_{EC}=0.346V REF	0 or OL
				100K GC	short or open
				47ohm GE	short or open
	Resistance	R221/R222/R223/R224/R 225/R226/R227/R228/R2 37/R238/R239/R240/R24 1/R242/R243/R244	Resistance	22 ohm	short or open
		R229/R230/R231/R232/R 233/R234/R235/R236/R2 45/R246/R247/R248/R24 9/R250/R251/R252	Resistance	47K	short or open
		R100/R104/R107/R117/R 118/R119/R122/R123	Resistance	10 ohm	short or open
		R255/R256/R268/R269	Resistance	47 ohm	short or open
		R257/R258/R268/R269	Resistance	49.9K	short or open

DC-AC Inverter	IGBT (STGWT80H65DFB)	Q5/Q6/Q8/Q10	Resistance Diode position	>60K CE	short or open
				V_{EC}=0.346V REF	0 or OL
				100K GC	short or open
				49.9K GE	short or open
	BUCK (STGWT80H65DFB)	Q69	Resistance Diode position	>60K CE	short or open
				V_{EC}=0.346V REF	0 or OL
				100K GC	short or open
				49.9K GE	short or open
	Resistance	R33/R34/R55/R56	Resistance	47 ohm	short or open
	Photo-coupler	U5/U6/U7/U8/U9	Resistance	64K PIN 8-7 >100K PIN 5-6	short or open
Main board S.P.S	Control IC	UC2845	Resistance	2K PIN5-PIN7	short or open
	Diode	D52/D56	Resistance	>1K	short or open
			diode position	V_{PN}=0.357V REF	0 or OL
	MOSFET (IRF640NPBF)	Q40	Resistance Diode position	>400K DS	short or open
				V_{SD}=0.512V REF	0 or OL
				0.7M GD	short or open
				>14K GS	short or open
	Resistance	R176/R180	Resistance	10 ohm	short or open
MPPT	IGBT (FGH60N60SMD)	Q1/Q2	Resistance Diode position	>20K CE	short or open
				V_{EC}=0.358V REF	0 or OL
				180K GC	short or open
				24.9K GE	short or open
	Diode (APT30DQ60BG)	D1	Resistance	>180K	short or open
			Diode position	V_{PN}=0.374 REF	0 or OL
	Photo-coupler	U1	Resistance	>200K PIN5-PIN6 , PIN7-PIN8,	short or open
			Diode position	PIN2-PIN3 , V=1.27 REF	0 or OL
	Driver NPN /PNP	Q3	Diode position	PIN1-2 V=0.56 REF PIN1-3 V=0.56 REF	0 or OL
		Q4		PIN1-3 V=0.56 REF PIN2-3 V=0.88 REF	0 or OL
MPPT board S.P.S	MOSFET (IXTP3N100P)	Q7/Q9	Resistance Diode position	>100K DS	short or open
				V_{SD}=0.526V REF	0 or OL

				0.7M GD	short or open
				>14K GS	short or open
	Diode (STTH310SSM)	D9/D18	Resistance	50K	short or open
			Diode position	V_{PN}=0.47 REF	0 or OL
	Resistance	R48/R65	Resistance	22 ohm	short or open
	Resistance	R51/R69	Resistance	0.33ohm	short or open

6. Test Step


Repair the Inverter/Charger according to the trouble shooting
YES
Power on and press ON button
YES
LCD display and fan rotates?
NO
SPS failure and repair it
YES
the DC input wire connected is OK?
NO
check the wire and correct it
YES
output voltage=230v?
NO
inverter or control block failure and repair it
YES
Turn on the line voltage breaker
YES
output voltage followed the AC input?
NO
relay or relay driver circuit failure and repair it
YES
charge current and voltage is OK?
NO
Charger failure and repair it
YES
Connected PV source
PV charger is OK?
NO
PV Charger failure and repair it
YES
END

7. Key components location

7.1 Main board

Figure 5.4.1 DC-DC Converter/MOSFET

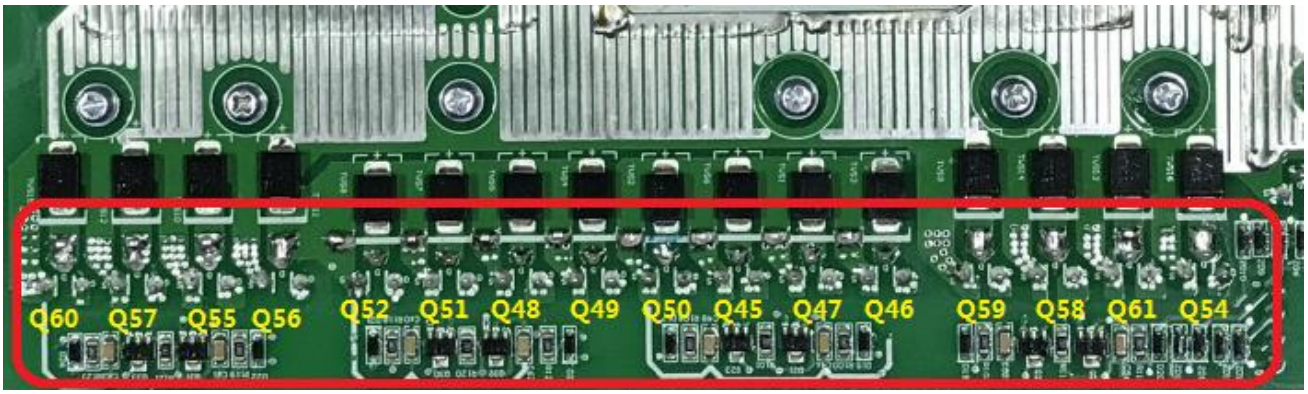


Figure 5.4.2 DC-DC Converter/ MOSFET

Figure 5.4.3 DC-DC Converter/ IGBT

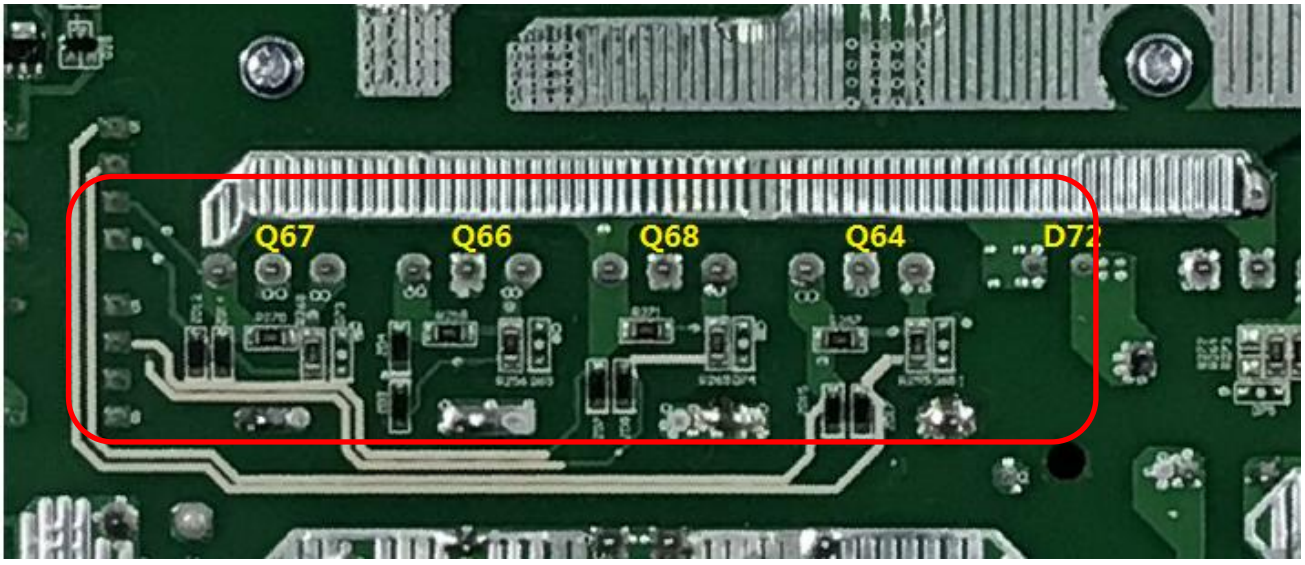


Figure 5.4.4 DC-DC Converter/ IGBT

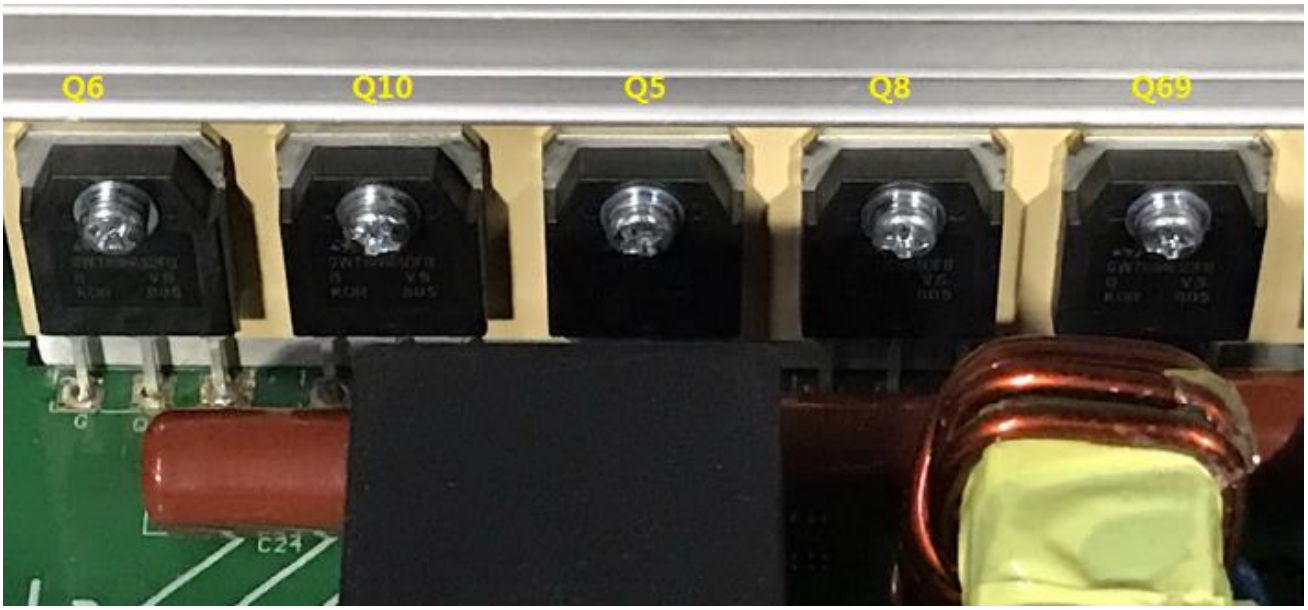


Figure 5.4.5 DC-AC Inverter/ IGBT

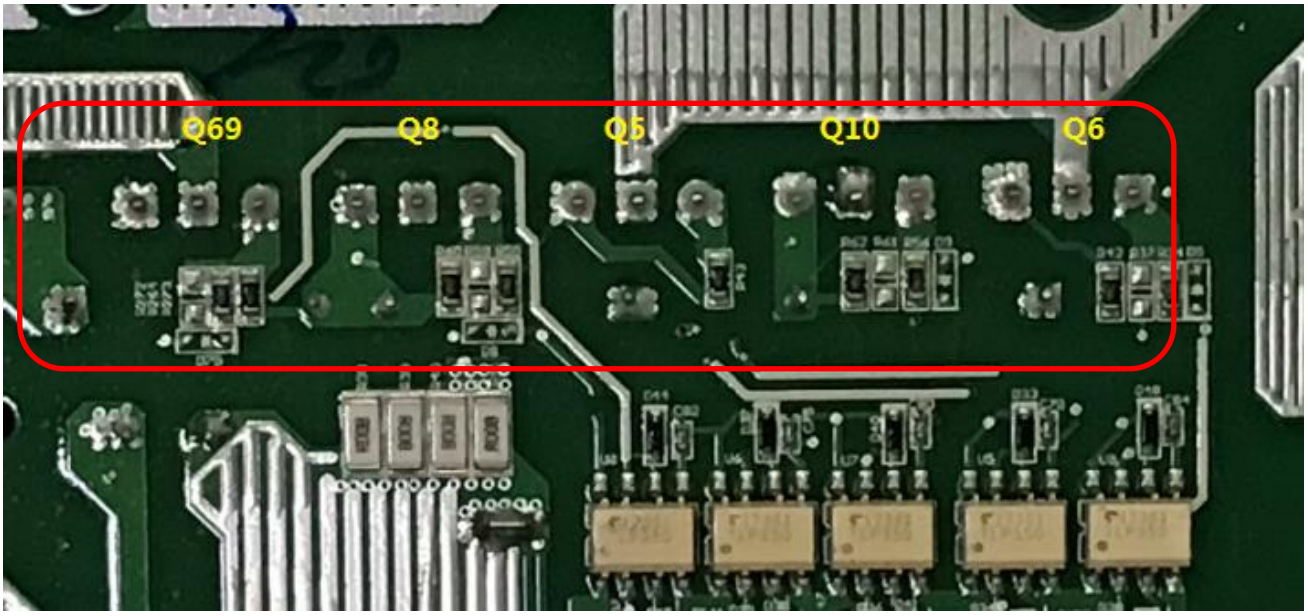


Figure 5.4.6 DC-AC Inverter/ IGBT

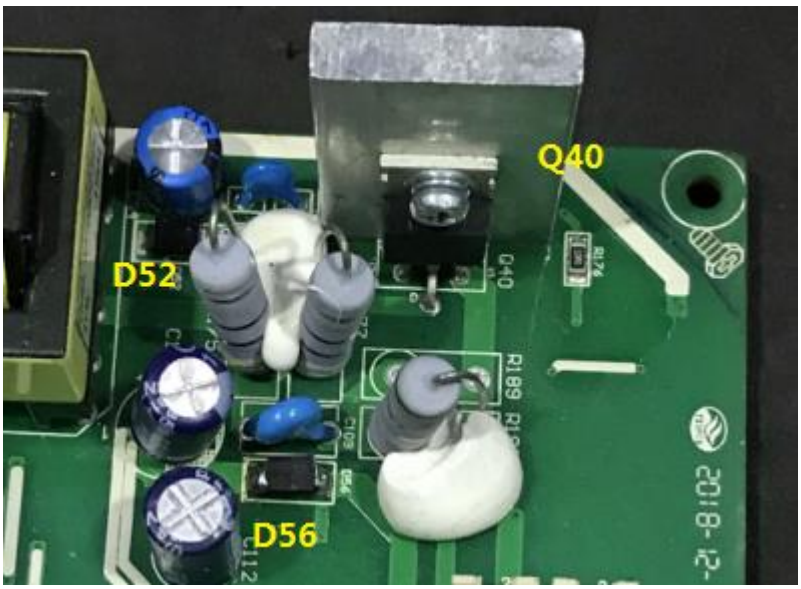


Figure 5.4.7 S.P.S /MOSFET

7.2 MPPT board

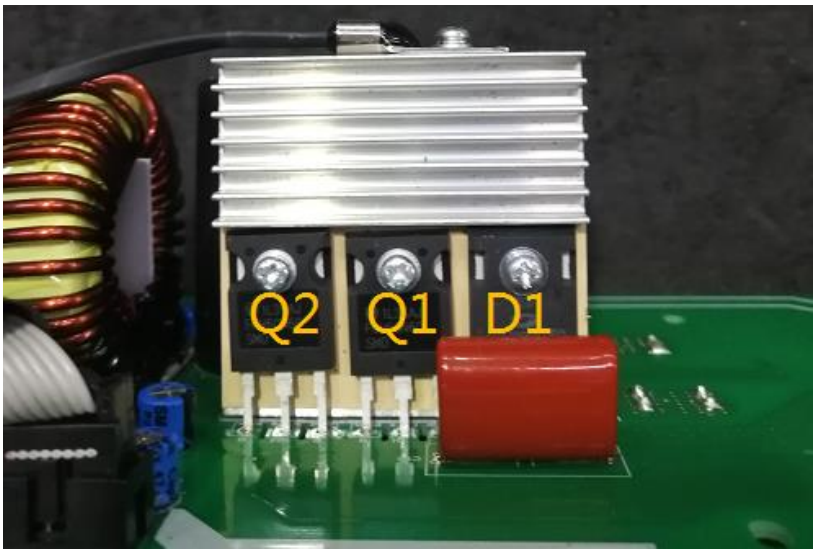


Figure 5.4.8 MPPT /MOSFET& Diode

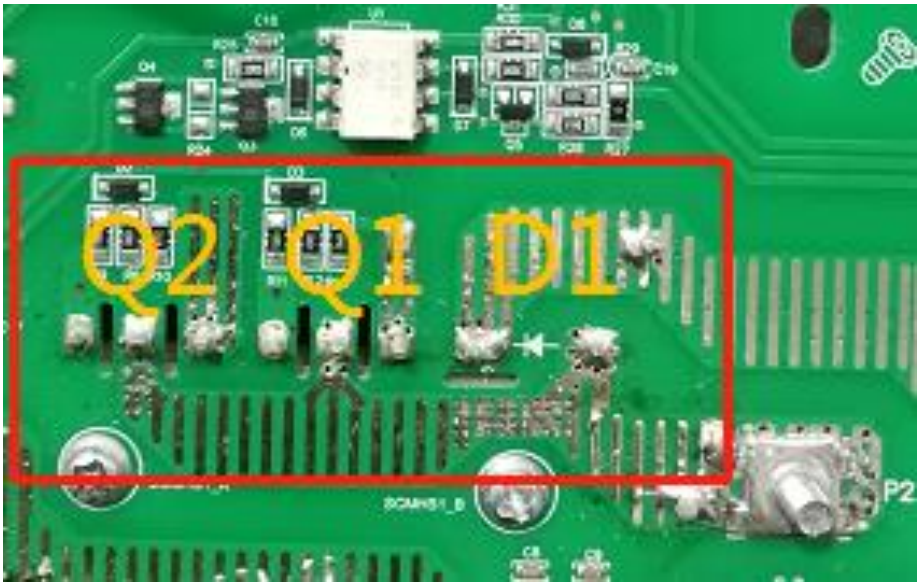


Figure 5.4.9 MPPT /MOSFET& Diode