Service Manual For

RM150/25C and RM200/25C

INVT Power System

Power Solution Specialist

INVT POWER SYSTEM (SHENZHEN) CO.,LTD

Safety Instruction

Safety Message

Danger: Serious human injury or even death may be caused, if this requirement is ignored.
Warning: Human injury or equipment damage may be caused, if this requirement is ignored.
Attention: Equipment damage, loss of data or poor performance may be caused, if this requirement is ignored.
Commissioning Engineer: The engineer who installs or operates the equipment should be well trained in electricity and safety and familiar with the operation, debug, and maintenance of the equipment.

Warning Label

The warning label indicates the possibility of human injury or equipment damage, and advises the proper step to avoid the danger. In this manual, there are three types of warning labels as below.

Labels	Description
 **Danger**	Serious human injury or even death may be caused, if this requirement is ignored.
 **Warning**	Human injury or equipment damage may be caused, if this requirement is ignored.
 **Attention**	Equipment damage, loss of data or poor performance may be caused, if this requirement is ignored.

Safety Instruction

 **Danger**	✧ Performed only by commissioning engineers. ✧ This UPS is designed for commercial and industrial applications only, and is not intended for any use in life-support devices or system.
 **Warning**	✧ Read all the warning labels carefully before operation, and follow the instructions.
	✧ When the system is running, do not touch the surface with this label, to avoid any hurt of scald.
	✧ ESD sensitive components inside the UPS, anti-ESD measure should be taken before handling.

Move & Install

 **Danger**	✧ Keep the equipment away from heat source or air outlets. ✧ In case of fire, use dry powder extinguisher only, any liquid extinguisher can result in electric shock.
 **Warning**	✧ Do not start the system if any damage or abnormal parts founded. ✧ Contacting the UPS with wet material or hands may be subject to electric shock.
 **Attention**	✧ Use proper facilities to handle and install the UPS. Shielding shoes, protective clothes and other protective facilities are necessary to avoid injury. ✧ During positioning, keep the UPS way from shock or vibration. ✧ Install the UPS in proper environment, more detail in section 3.3.

Debug & Operate

 **Danger**	✧ Make sure the grounding cable is well connected before connecting the power cables, the grounding cable and neutral cable must be in accordance with the local and national codes practice. ✧ Before moving or re-connecting the cables, make sure to cut off all the input power sources, and wait for at least 10 minutes for internal discharge. Use a multi-meter to measure the voltage on terminals and ensure the voltage is lower than 36V before operation.
 **Attention**	✧ The earth leakage current of load will be carried by RCCB or RCD. ✧ Initial check and inspection should be performed after long time storing of UPS.

Maintenance & Replacement

 **Danger**	✧ All the equipment maintenance and servicing procedures involving internal access need special tools and should be carried out only by trained personnel. The components that can only be accessed by opening the protective cover with tools cannot be maintained by user. ✧ This UPS full complies with “IEC62040-1-1-General and safety requirements for use in operator access area UPS”. Dangerous voltages are present within the battery box. However, the risk of contact with these high voltages is minimized for non-service personnel. Since the component with dangerous voltage can only be touched by opening the protective cover with a tool, the possibility of touching high voltage component is minimized. No risk exists to any personnel when operating the equipment in the normal manner, following the recommended operating procedures in this manual.

Battery Safety

 **Danger**	✧ All the battery maintenance and servicing procedures involving internal access need special tools or keys and should be carried out only by trained personnel. ✧ WHEN CONNECTED TOGETHER, THE BATTERY TERMINAL VOLTAGE WILL EXCEED 400Vdc AND IS POTENTIALLY LEATHAL. ✧ Battery manufacturers supply details of the necessary precautions to be observed when working on, or in the vicinity of, a large bank of battery cells. These precautions should be followed implicitly at all times. Particular attention should be paid to the recommendations concerning local environmental conditions and the provision of protective clothing, first aid and fire-fighting facilities. ✧ Ambient temperature is a major factor in determining the battery capacity and life. The nominal operating temperature of battery is 20°C. Operating above this temperature will reduce the battery life. Periodically change the battery according to the battery user manuals to ensure the back-up time of UPS. ✧ Replace the batteries only with the same type and the same number, or it may cause explosion or poor performance. ✧ When connecting the battery, follow the precautions for high-voltage operation before accepting and using the battery, check the appearance the battery. If the package is damaged, or the battery terminal is dirty, corroded or rusted or the shell is broken, deformed or has leakage, replace it with new product. Otherwise, battery capacity reduction, electric leakage or fire may be caused. ● Before operating the battery, remove the finger ring, watch, necklace, bracelet and any other metal jewelry ● Wear rubber gloves. ● Eye protection should be worn to prevent injury from accidental electrical arcs. ● Only use tools (e.g. wrench) with insulated handles. ● The batteries are very heavy. Please handle and lift the battery with proper Possible reason to prevent any human injury or damage to the battery terminal. ● Do not decompose, modify or damage the battery. Otherwise, battery short circuit, leakage or even human injury may be caused. ● The battery contains sulfuric acid. In normal operation, all the sulfuric acid is attached to the separation board and plate in the battery. However, when the battery case is broken, the acid will leak from the battery. Therefore, be

	sure to wear a pair of protective glasses, rubber gloves and skirt when operating the battery. Otherwise, you may become blind if acid enters your eyes and your skin may be damaged by the acid. ● At the end of battery life, the battery may have internal short circuit, drain of electrolytic and erosion of positive/negative plates. If this condition continues, the battery may have temperature out of control, swell or leak. Be sure to replace the battery before these phenomena happen. ● If a battery leaks electrolyte, or is otherwise physically damaged, it must be replaced, stored in a container resistant to sulfuric acid and disposed of in accordance with local regulations. ● If electrolyte comes into contact with the skin, the affected area should be washed immediately with water.

Disposal

 **Warning**	✧ Dispose of used battery according to the local instructions

Contents

1 Introduction to UPS Structure and Key components

1.1 Structure

The modular UPS consists of power unit, STS, Bypass Maintenance Switch and external battery, as is shown in Figure 1-1.

Power unit：

It consists of parallel power modules. Each power module includes Rectifier and Inverter.

STS： It consists of two paralleled SCR. The load can be powered directly by the utility through the STS.

Bypass Maintenance Switch： The Bypass Maintenance Switch is used when Maintenance work needs to be done while keep the load on.

External Battery：When the utility is off or being abnormal, the UPS power the load by obtaining energy from the External Battery.

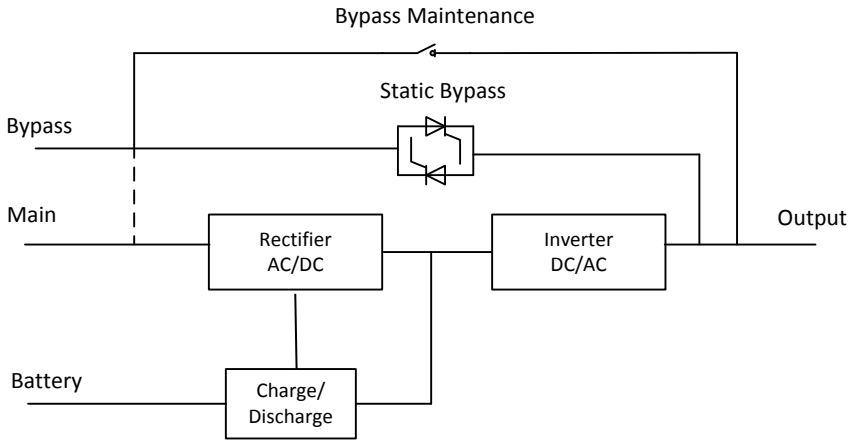


Figure 1-1 UPS Structure

1.2 Topological Diagram

The Topological diagram of the system is shown as Figure 1.2:

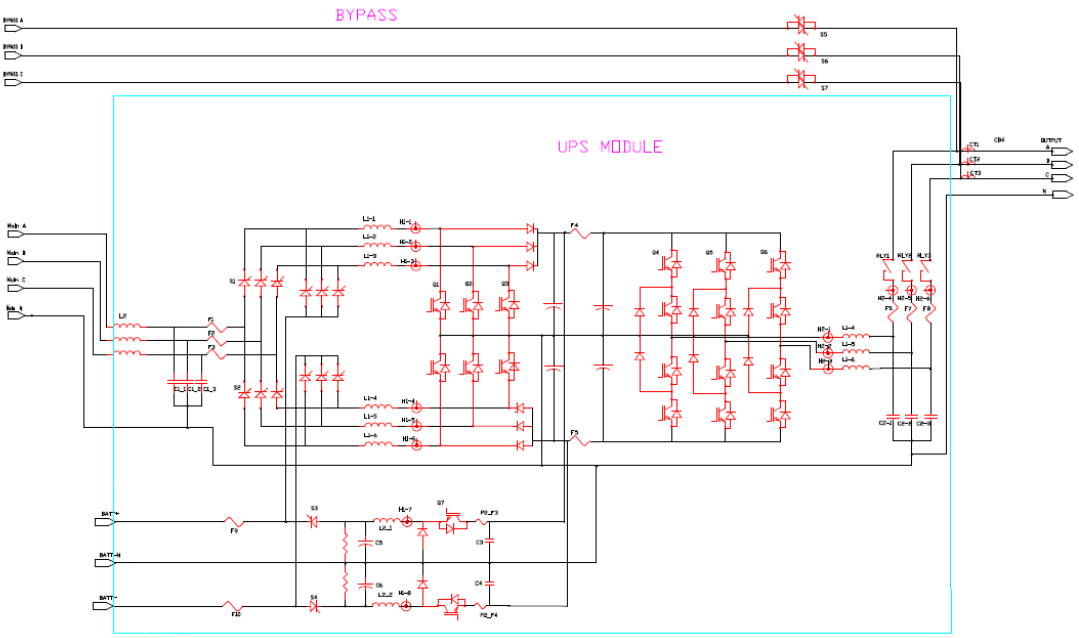


Figure 1.2 Topological diagram of the system

2 Structure of the Cabinet

2.1 Front of the Cabinet

The front view is shown in Figure 2.1.

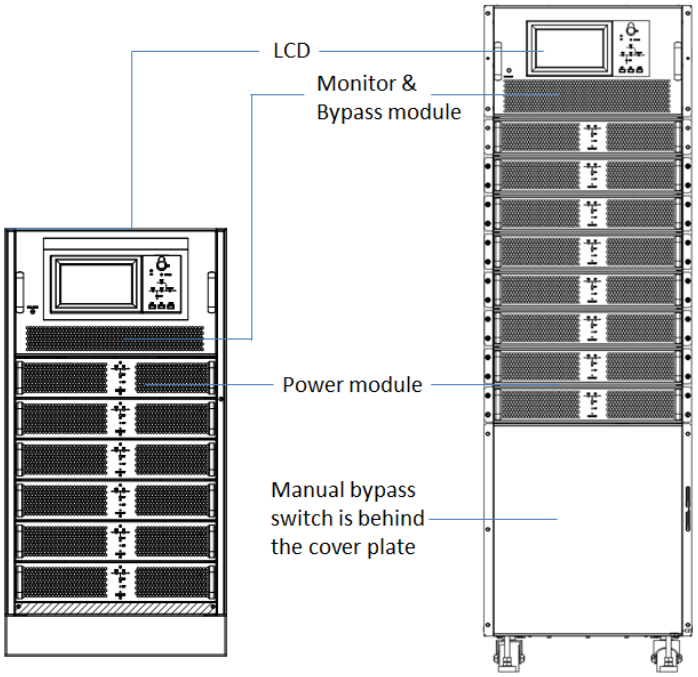


Figure 2.1 Front view

2.2 Back of the Cabinet

The back view is shown in Figure 2.2

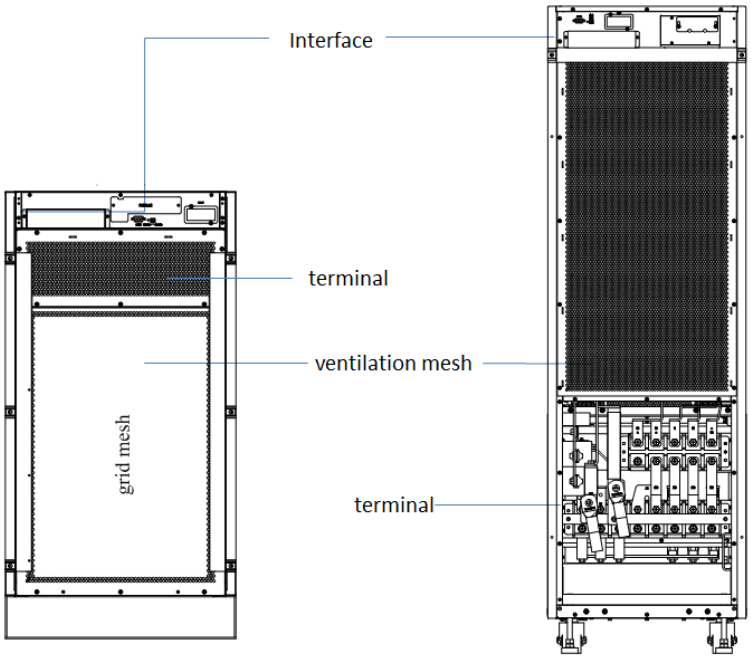
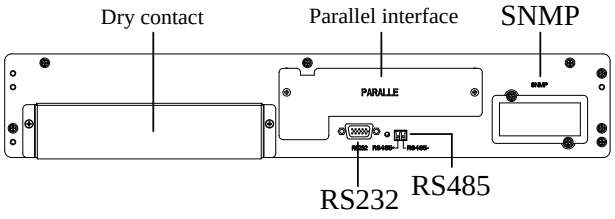


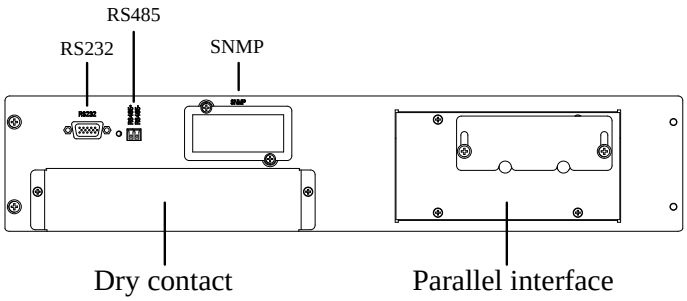
Figure 2.2 Back view

2.3 Communication Interface

The more details of interface is shown in Figure 2.3



(a) Communication interface of RM150/25C



(b) Communication interface of RM200/25C

Figure 2.3 Communication interface

3 Structure of Module

3.1 Bypass and monitor module

The details of bypass and monitor module is shown in Figure 3.1

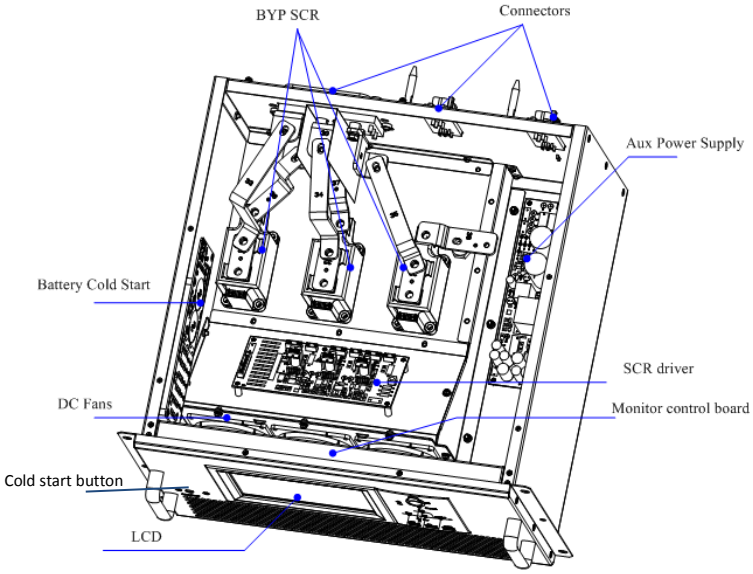


Figure 3.1 bypass and monitor module

3.2 Power module

The power module mainly contains input board, rectifier board, inverter board, output board, REC control board, INV control board, etc. More details is shown in Figure 3.2

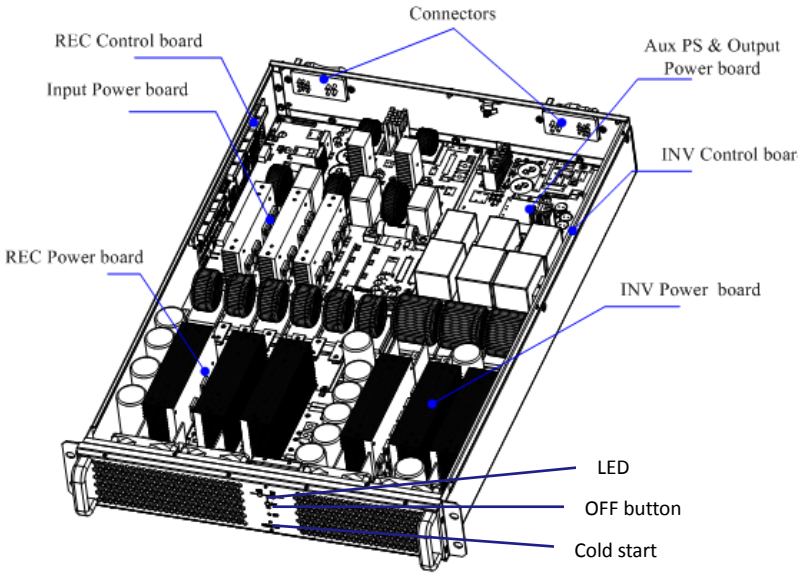
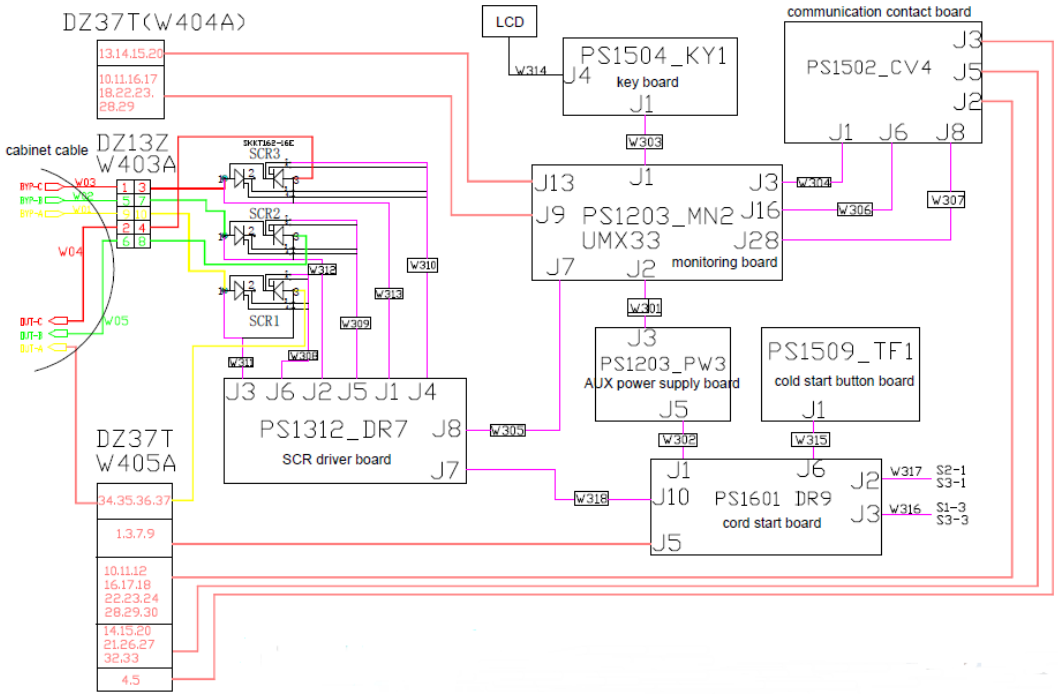


Figure 3.2 power module

3.3 Wiring diagram of module

The wiring diagram of bypass and monitoring module is shown in Figure 3.3.



Fig

3.3 Wiring diagram of bypass and monitoring module

The wiring diagram of power module is shown in Figure 3.4.

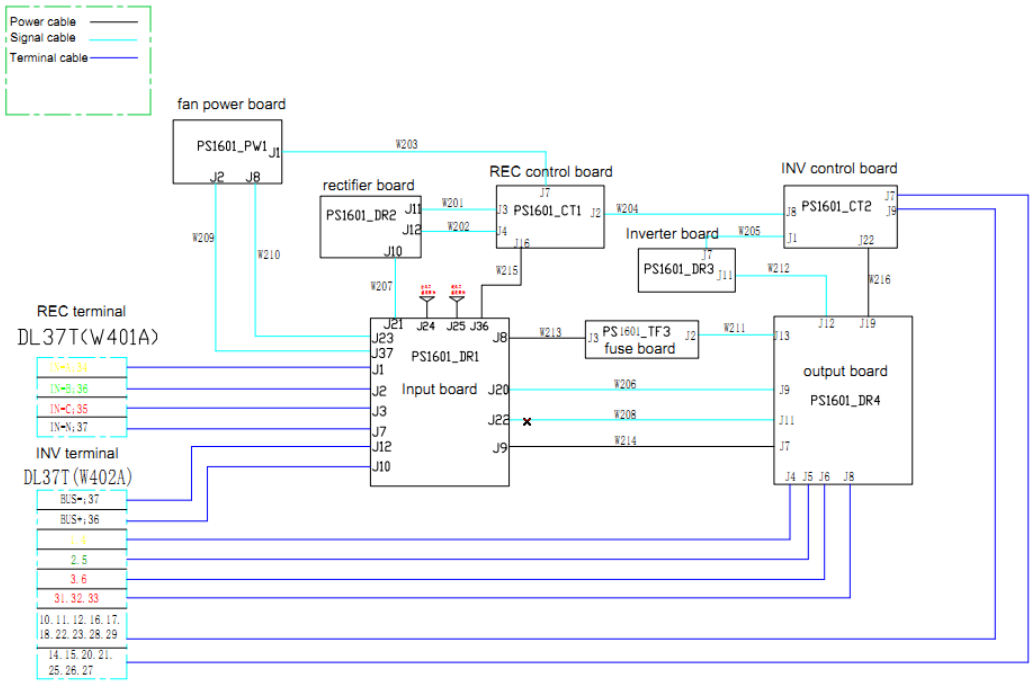


Fig 3.4 Wiring diagram of power module

4 Power module inspection

Firstly, please follow the below steps to check the components in the power module.

① Exam the connectors terminals at the back of power module if they are out of shape, burnt or drawn in.

② Open the cover to check visually whether the circuit paths are burnt, broken or have bumps on copper foils. To exams whether the components are burnt or have bumps (such as input or output capacitors)

③ Exam the fuses of input and output

④ Detect rectifier SCR, IGBT of rectifier and inverter, as is shown in chapter 7

⑤ Exam the relay of output

⑥ Record the fault information on the cabinet

4.1 Testing of Rectifier SCR and drive

Turn the multi-meter to the resistive channel, measure the resistance of pin A-K (pin1 to pin3), **the normal value should be around 10Ω-40Ω.**The pins of the SCR are defined in Figure 4.1.

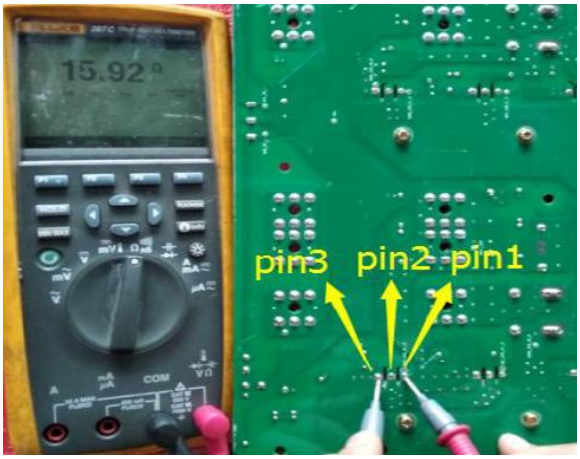


Figure 4.1 Pins definition the SCR module

The normal drive signal of the pin A-K SCR is shown in Figure 4.2

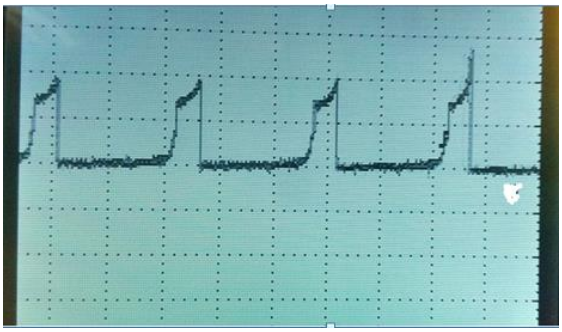


Figure 4.2 Drive signal of the SCR pin A-K

4.2 Rectifier IGBT

Turn the multi-meter to the diode channel, measure the status of diode (anode to cathode), **the normal value should be around 0.4V.** The procedures of testing rectifier IGBT are shown in Figure 4.3.

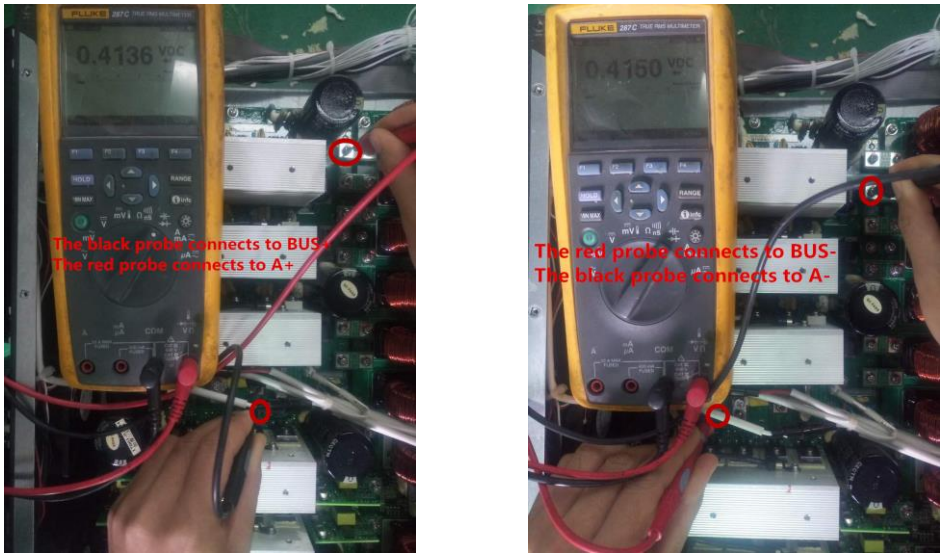


Figure 4.3 Rectifier IGBT pin test

Test the G-K pin of IGBT modules with multi-meter, the normal wave should be as follows, as is shown in Figure 4.4.

Figure 4.4 Normal drive signal wave for IGBT

4.3 Inverter IGBT

Turn the multi-meter to Diode Chanel and test the voltage drop of the inverter IGBT, the normal value should be around 0.4V. The procedures of testing inverter IGBT are shown in Figure 4.5.

Figure 4.5 Definition of the pin

The drive signal wave is as following, as shown in Figure 4.6.

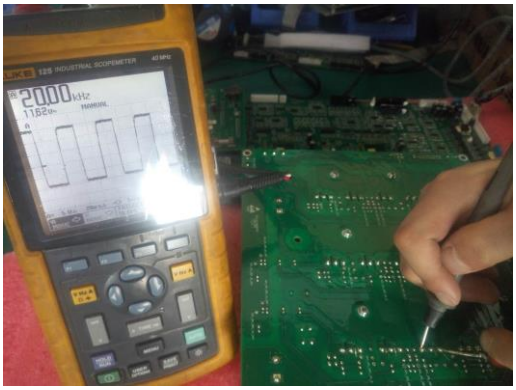


Figure 4.6 Drive signal wave

4.4 Fuse

Detect the resistance of the fuses. If the resistance is less than 1ohm, it means the fuses work well. If the resistance is infinite or no value, the fuses have be damaged. The fuses to be detected and their definitions are shown in Figure 4.7 to 4.9.

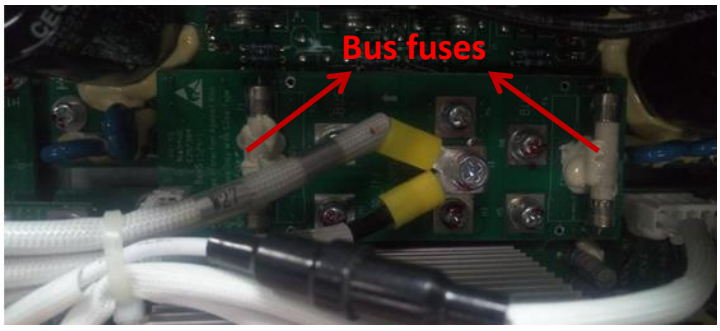


Figure 4.7 BUS fuses

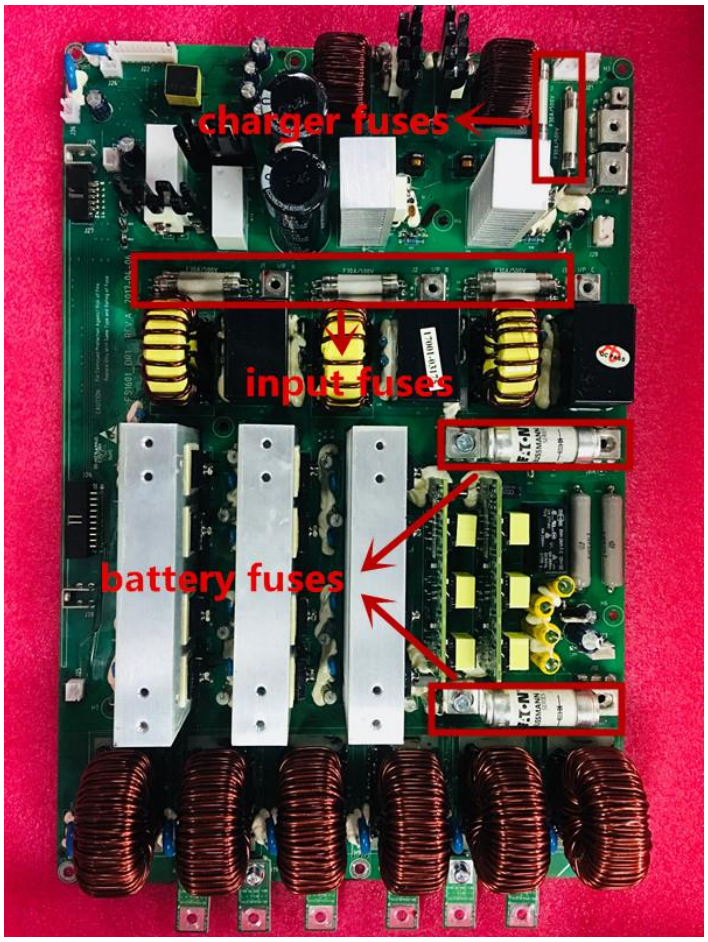


Figure 4.8 Input fuses and battery fuses

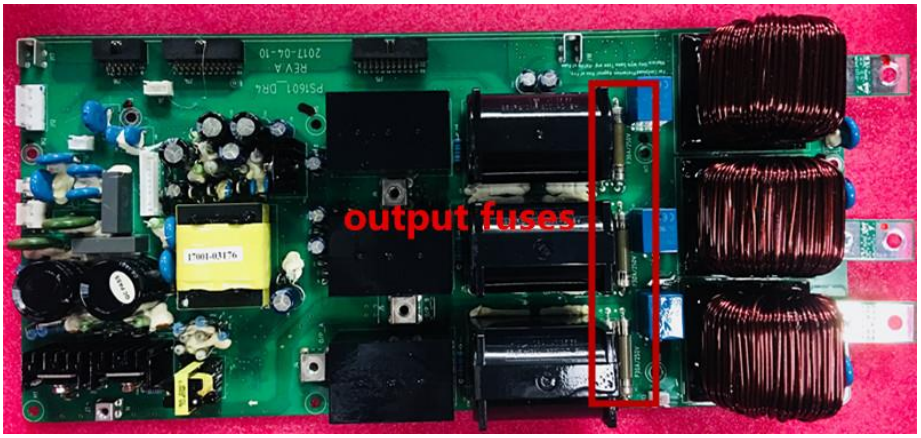


Figure 4.9 Output fuses

4.5 Relay

Check the resistance of the relay between the input terminal and the fuse, as shown in Figure 4.10. If the resistance is infinite or no value, the relays should be OK. If the values are under several ohms the relays maybe get shorted.

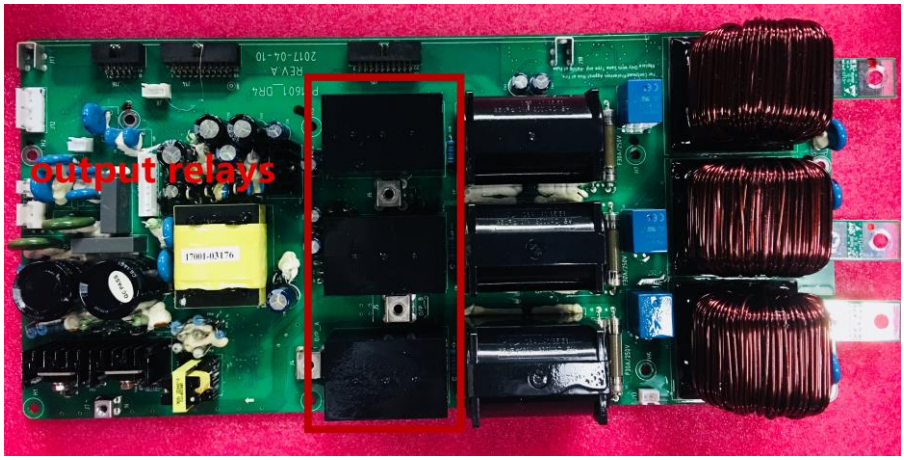


Figure 4.10 output relays

5 Trouble shooting

5.1 Status Bits Description

Seq.				Items	0	1	2	4	8
1	S0	1	1	Load on status	None	UPS	BYP	Other Module	
2			2	REC status	OFF	Soft-start	Normal work		
3			3	INV status	OFF	Soft-start	Normal work		
4			4	BYP status	Out range	Ok for supply			
5		2	5	Battery status	Not connected	Boost	float	Discharging	not work
6			6	Reserved					
7			7	Reserved					
8			8	Reserved					
9		3	9	Maintenance CB status	Open	Closed			
10			10	Reserved					
11			11	Reserved					
12			12	Positive Battery connect status	Not connect	Connected			
13		4	13	negative Battery connect status	Not connect	Connected			
14			14	INV allow on status	Inhibited On	Allow On			

15			15	INV supply status	Not allow to supply	Ready for supply	Supplying		
16			16	Generator in	Not Generator	Generator In			
17	S1	1	1	Reserved					
18			2	Reserved					
19			3	Reserved					
20			4	Exterior BCB trip	Trip signal inactive	Trip signal active			
21		2	5	Exterior BCB connect status	Not connected	Connected			
22			6	Exterior BCB status	Open	Closed			
23			7	EPO status	Not EPO	EPO			
24			8	Module pulled Out	Pushed (Connected OK)	Pulled (Connected Fail)			
25		3	9	Inv available	Inv not available	Available			
26			10	System power up end	During power up step	Power up step ended.			
27			11	Reserved					
28			12	Reserved					
29		4	13	Reserved					
30			14	Reserved					
31			15	Reserved					
32			16	Reserved					

5.2 Alarm Bits Description

Seq.				Items	0	1	2	4	8
1	A0	1	1	Synchronous Fault	Sync.	Not sync.			
2			2	Main Input Fault	OK	Fault			

3			3	REC Fault	OK	Fault			
4			4	INV Fault	OK	Fault			
5		2	5	Reserved					
6			6	Reserved					
7			7	Reserved					
8			8	Reserved					
9		3	9	Reserved					
10			10	Reserved					
11			11	Reserved					
12			12	Reserved					
13		4	13	Input phase A over current	OK	Fault			
14			14	Input phase B over current	OK	Fault			
15			15	Input phase C over current	OK	Fault			
16			16	Output phase A voltage Fault	OK	Fault			
17		1	1	Output phase B voltage Fault	OK	Fault			
18			2	Output phase C voltage Fault	OK	Fault			
19			3	Reserved					
20			4	Reserved					
21		2	5	Reserved					
22			6	Positive bus voltage Fault	OK	Low voltage	Over voltage		
23	A1		7	Negative bus voltage Fault	OK	Low voltage	Over voltage		
24			8	Input current unbalance Fault	OK	Fault			
25		3	9	Input voltage Fault	OK	Fault			
26			10	Input Frequency Fault	OK	Fault			
27			11	Input Sequence Fault	OK	Fault			
28			12	REC soft-start Fault	OK	Fault			
29		4	13	REC IGBT over current	OK	Fault			
30			14	Reserved					
31			15	REC over temperature	OK	Fault			
32			16	Positive bus over voltage Fault	OK	Fault			
33	A2	1	1	Negative bus over	OK	Fault			

				voltage Fault					
34			2	Fan Fault	OK	Fault			
35			3	Reserved					
36			4	Reserved					
37		2	5	Positive bus under voltage	OK	Fault			
38			6	Negative bus under voltage	OK	Fault			
39			7	Positive battery reversed	OK	Fault			
40			8	Negative battery reversed	OK	Fault			
41		3	9	Reserved					
42			10	Reserved					
43			11	Positive charger voltage Fault	OK	under voltage	over voltage		
44			12	Negative charger voltage Fault	OK	under voltage	over voltage		
45		4	13	Reserved					
46			14	Reserved					
47			15	Positive charger Fault	OK	Fault			
48			16	Negative charger Fault	OK	Fault			
49	A3	1	1	Positive battery voltage low	OK	Fault			
50			2	Negative battery voltage low	OK	Fault			
51			3	Positive battery EOD	OK	Fault			
52			4	Negative battery EOD	OK	Fault			
53		2	5	Input neutral lost	OK	Fault			
54			6	BYP sequence Fault	OK	Fault			
55			7	BYP voltage Fault	OK	Fault			
56			8	Reserved					
57		3	9	Reserved					
58			10	Reserved					
59			11	BYP frequency over track range	OK	Fault			
60			12	Reserved					
61		4	13	Reserved					
62			14	Over load time out	OK	Fault			
63			15	Reserved					
64			16	Reserved					

65	A4	1	1	Manual shutdown	normal	shutdown			
66			2	INV protect	OK	Fault			
67			3	Transfer times limit in one hour	OK	Fault			
68			4	INV power back feed	OK	Fault			
69		2	5	Reserved					
70			6	Reserved					
71			7	Reserved					
72			8	INV over temperature Fault	OK	Fault			
73		3	9	INV IGBT over current	OK	Fault			
74			10	Reserved					
75			11	Over load	normal	over load			
76			12	INV relay or fuse Fault	OK	Fault			
77		4	13	Reserved					
78			14	Reserved					
79			15	Reserved					
80			16	Reserved					
81	A5	1	1	Reserved					
82			2	Output shorted	OK	Fault			
83			3	Battery test	None	OK	Fault		
84			4	Battery maintenance	None	OK	Fault		
85		2	5	Reserved					
86			6	Reserved					
87			7	Reserved					
88			8	Reserved					
89		3	9	Reserved					
90			10	Reserved					
91			11	Reserved					
92			12	Reserved					
93		4	13	Reserved					
94			14	Reserved					
95			15	Reserved					
96			16	Reserved					

5.3 alarms Check and Solution tips

1) Synchronous Fault

A) BYP frequency out of synchronize range.

B) SYNC signal in the parallel Fault.

2) Main Input Fault

A) Main input voltage out of range.
B) Main input frequency out of range.
C) Main input sequence is reversed

3) REC Fault

A) REC over temperature.
B) Dc bus over voltage latched.
C) REC soft-start Fault.
D) Input current unbalance.

4) INV Fault

A) INV IGBT over current.
B) INV over temperature.
C) INV voltage abnormal

5) Input phase A/B/C over current

A) Input current over limited.
Tip 1: IGBT Fault.
Tip 2: DC bus shorted.
Tip 3: IGBT driver Fault.

6) Output Phase A/B/C Voltage Fault

A) INV voltage out of range.
Tip 1: IGBT open.
Tip 2: IGBT driver lost.
Tip 3: Voltage detects and sample fail.

7) Positive/Negative Bus Voltage Fault

A) DC bus voltage out of range.

8) Input current unbalance fault

A) The difference of max current and min current of the input three phases is out of the limited range.
Tip 1: One of the input current detecting CT/HALL fail..
Tip 2: Some REC IGBT open.
Tip 3: input current detecting and sample circuit fail.

9) Input Voltage Fault

A) Input voltage out of range.

10) Input Frequency fault

A) Input frequency out of range

11) Input Sequence Fault

A) Input sequence is reversed

12) REC soft-start fault

A) After the REC soft-start step, the bus voltage can not reach the default value.
Tip 1: REC SCR fail.
Tip 2: REC SCR driver fail.
Tip 3: Bus voltage detects and sample fail.

13) REC IGBT over current

A) Big current flow through REC IGBT.
Tip 1: REC IGBT fail.
Tip 2: DC Bus shorted.
Tip 3: REC IGBT driver fail.

14) REC over temperature

A) REC temperature out of the limited range.

15) Positive/Negative bus over voltage fault

A) Bus voltage over the up limited.

16) Fan fault

A) At least one of the fan fail.

17) Positive/Negative bus under voltage

A) Bus voltage out of the down limited.

18) Positive/Negative battery reversed

A) Battery connection reversed.

19) Positive/Negative charger voltage fault

A) Charger voltage out of the range limited.
Tip I: Charger IGBT fail.
Tip 2: Charger IGBT driver fail.
Tip 3: Charger voltage detecting and sampling circuit fail.

20) Positive/Negative charger fault

A) During charging step (boost or float), the charger voltage out of the range limited.
Tip I: Charger IGBT fail.
Tip 2: Charger IGBT driver fail.

Tip 3: Charger voltage detecting and sampling circuit fail.

21) Positive/Negative battery voltage low

A) Battery voltage is low (a little bigger than the EOD point).

22) Positive/Negative battery EOD

A) Battery voltage reaches the end of discharge point.

23) BYP sequence fault

A) BYP sequence reversed.

24) BYP voltage fault

A) BYP voltage out of the range limited.

25) BYP frequency over track range

A) BYP frequency out of the sync window.

26) Over load time out

A) INV over load time out.

27) Manual shutdown

A) Manual Off button is pressed to shutdown the PM.

28) INV protect.

A) INV detects power back feed to dc bus.

B) INV voltage out of range.

C) INV detects the bus voltage over the limited.

NOTES: INV protect fault is auto cleared.

29) Transfer times limit in one hour

A) Transfer to BYP times in one hour exceeds the limited.

30) INV power back feed

A) INV detects power back feed to dc bus.

31) INV over temperature fault

A) INV temperature out of the limited range.

INV IGBT over current

A) Big current flow through INV IGBT.

Tip 1: INV IGBT fail.
Tip 2: INV IGBT driver fail.

32) Over load
A) PM over load.

33) INV relay or fuse fault.
A) INV relay Fail
Tip 1: relay can not be closed.
Tip 2: relay can not be opened.
B) INV fuse fail.

34) Output shorted
A) Output shorted is detected.
Notes: This fault could be cleared only by “Fault Clear” button.

35) Battery test Fail.
A) Battery test condition is not allowed.
Tip 1: Battery voltage (cell) smaller than (float voltage (cell) – 0.1V).
Tip 2: BYP is not qualified.
Tip 3: At least one Alarm exists in the system.
B) Battery discharging time is less than 20 Sec.

36) Battery maintenance Fail.
A) Battery test condition is not allowed.
Tip 1: Battery voltage (cell) smaller than (float voltage (cell) – 0.1V).
Tip 2: BYP is not qualified.
Tip 3: At least one Alarm exists in the system.
B) The time lasted before battery voltage low is less than 20 Sec.

5.4 Cabinet trouble shooting

1) Maintenance CB Operation.

Step 1: Transfer system to BYP manually.
Step 2: Close Maintenance CB.
Step 3: Open Output and Input CB.
Step 4: Doing maintenance.
Step 5: After system is fixed, Close Output and Input CB.
Step 6: After BYP SCR is fired, Open Maintenance CB.
Step 7: System will works automatically.

2) Cabinet Failures Description.

i. On UPS Inhibited

A) System transfer to UPS is inhibited.

Tip 1: BYP SCR shorted.

Tip 2: System is in EPO.

Tip 3: Maintenance CB is Closed.

Tip 4: Manual transfer to BYP latched.

Tip 5: Transfer times per hours Limited.

Tip 6: Output load is more than the total capacitor of the ready INV.

ii. BYP Fault

A) BYP SCR shorted.

Tip 1: SCR fail.

Tip 2: SCR driver fail.

B) BYP SCR opened.

Tip 1: SCR fail.

Tip 2: SCR driver lost.

Appendix: LED INDICATION

		OFF	FLASHING GREEN	CONSTANT GREEN	FLASHING RED	CONSTANT RED
Power Module	REC	REC not work	REC soft-start.	REC works normally.	Input is abnormal.	REC failure.
	INV	INV not work	INV soft-start or started but not supply.	INV is supplying.	INV is not allowed to start.	INV failure.
	BATT	BATT not work	BATT is discharging.	BATT is charging.	BATT voltage is low.	EOD, not connected or connected reversely.
Cabinet Monitor	STATUS	---	---	System is normal.		Alarm or failure exists.
	REC	REC of all PMs do not work.	At least one PM's REC soft-starts.	REC of all PMs work normally.	At least one PM detected input failure.	At least one PM's REC failure.
	BYP	BYP is OK, but not supply output.	---	BYP is normal and is supplying output.	BYP is abnormal or frequency is out of the trace range.	BYP Failure (SCR shorted or Open)
	INV	INV of all PMs do not work.	At least one PM's INV soft-start or started but not supply.	At least one PM's INV is supplying output and all INV are not failure.	At least one PM's INV is supplying output and some INV is failure.	None INV supplies output and at least one INV is failure.
	OUTPUT	Output None.	---	Output is normal	Output is in over load	Over load time out or output shorted and output lost.
	BATTERY	Battery not work	Battery is discharging.	Battery is charging.	BATT voltage is low.	EOD, not connected or connected reversely.