Power Conversion®

P91, TX91, TX91L, TXVR

Service Manual

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1 General Information

1.1 Getting start
This manual is for P91, TX91, TX91L, TXVR tower and R/T UPS. It can help service person perform the basic maintenance and repair service.

This manual only focuses on the service section, so you should get the basic operation of the UPS from the user manual, and make sure you had read and understood the user manual before reading the manual.

The manual include 9 sections:

- General Information, this section shows you the general information of the service manual.
- Electric Specifications, this section shows you the basic electric specification of the UPS.
- Functional block, this section shows you the major functional block of the UPS.
- Working Principle of the Major Functional Block, this section shows you the working principle of the major functional block.
- Function explanations for each PCB, this section explains you all the PCBs of the UPS system.
- Interface, this section shows you the LCD interface, including display and setting.
- Trouble Shooting, this section gives you the way to find the problems.
- Test Step, this section tells you how to test the UPS after you repair the unit.
- Appendix, this section shows you the basic waveforms for reference and the basic communication commands.

1.2 Important Safety Instructions

For qualified service person only.

 DO NOT perform any internal service or adjustment of this product unless the technical person is well trained and experienced. .

 Dangerous voltage exists at several points in this product. To avoid personal injury, don't touch any exposed connections or components while UPS is on.

 Turn off the UPS and switch off the input breaker before removing protective case. AC voltage is always present if the input AC power is still available.

 High voltage may exist at DC capacitors. Before removing the protective case, wait for at least five minutes after turning off the UPS.

 Verify input source (voltage and frequency) is within the maximum range before service.

2. Specifications

MODEL NUMBER		P91-5K	P91-6K	P91-10K
CAPACITY	Power rating	5kVA (5kW)	6kVA (6kW)	10kVA (10kW)
INPUT	Voltage	110–300VAC*		
	Frequency	50/60Hz		
OUTPUT	Voltage	200/208/220/230/240VAC (208/120V or 240/120V with optional transformer)		
	Frequency	50/60Hz ± 4Hz		
	THD (full load)	< 4%		
	Overload capacity	110% 10 min; 130% 1 min; > 130% 1 sec		
	Efficiency	Up to 95% online mode or 99% ECO mode		
BATTERY	Charger amps	1–4A		
	Nominal/float voltage	240/273VDC		
DIMENSIONS & WEIGHT	Dimensions (W x D x H)	17.2 x 23.6 x 3.5 in		
	Weight	33.1 lbs		39.7 lbs
BYPASS DISTRIBUTION MODULE	Model	XBDM-P91A	XBDM-P91B	
	Input connection	L6–30P (5, 6kVA)	Terminal Block (5,6,10kVA)	
	Output connection	(2) L6-30R+(2) C19 Optional: L6–30R, L6–20R, 6–20R	Terminal block + (1) L6-30R+(2) C19 Optional: L6–30R, L6–20R, 6–20R	
ENVIRONMENT	Operating temperature	32–104°F (0–40°C)		
	Audible noise	< 55dBA		< 58dBA
	Altitude	11,500 ft above sea level		
APPROVALS		UL, FCC, RoHS (pending)		
WARRANTY		3 years electronics, 3 years battery warranty (USA and Canada)		
COMMUNICATIONS INTERFACE		RS-232, USB, EPO, intelligent slot for optional cards (Web/SNMP, Relay/dry contact, Modbus)		
INCLUDED IN BOX		Software CD, horizontal brackets, tower pedestals, USB cable		
AVAILABLE OPTIONS		5 year extended warranty, 4-post rail kit, 2-post shelf kit, transformer		

**Depending on load level.*

MODEL NUMBER		TXVR-3.8K	TXVR-5K	TXVR-6K	TXVR-10K
CAPACITY	Power rating	3.8kVA/3.8kW	5kVA/5kW	6kVA/6kW	10kVA/10kW
INPUT	Voltage (nominal)	208/220/230/240VAC			
	Voltage range	110-300VAC			
	Frequency	46–54Hz or 56–64Hz			
OUTPUT	Voltage	240/120VAC or 230/115VAC			
	Voltage Regulation	± 1%			
	Frequency	50Hz ± 0.1Hz or 60 Hz ± 0.1Hz			
	Overload capacity	200% for 1 min	150% for 1 min	130% for 1 min	
	Efficiency	up to 97% ECO mode, 91% online mode			
	Harmonic Distortion	<2% @ 100% linear load (regardless of input distortion)			
PHYSICAL	Input/output	Terminal blocks or optional PDU			
	Dimensions (W x D x H)	9.8 x 23.2 x 32.4 in			
	Weight	142 lbs	145 lbs	148 lbs	187 lbs
OPTIONAL PDU	Input connection	Terminal Block with 6ft L6-30P*			Terminal Block
	120V receptacle options	5-15/20R			
	240V receptacle options	L6-30R, L6-20R, 6-15/20R, C19			
ENVIRONMENT	Temperature	32–104°F (0–40°C)			
	Audible noise	< 50dBA			
	Altitude	11,500 ft above sea level			
APPROVALS		UL, cUL, RoHS			
WARRANTY		3 years electronics (USA and Canada)			
COMMUNICATIONS INTERFACE		RS-232, EPO, intelligent slot for optional cards (Web/SNMP, Relay/dry contact, Modbus)			
INCLUDED IN BOX		User manual, RS-232 communication cable, ViewPower Software CD			
AVAILABLE OPTIONS		5 year extended warranty, output PDU, input L6-30P cord (for 3.8kVA, 5kVA, 6kVA)			

MODEL NUMBER		TX91-3.8K	TX91-5K	TX91-6K	TX91-10K
CAPACITY	Power rating	3.8kVA (3.8kW)	5kVA (5kW)	6kVA (6kW)	10kVA (10kW)
INPUT	Voltage (nominal)	208VAC (200VAC, 220VAC, 230VAC, 240VAC optional)			
	Voltage range	110-300VAC			
	Frequency	46–64Hz auto-sensing			
OUTPUT	Voltage	240/120VAC or 230/115VAC			
	Voltage regulation	± 1%			
	Frequency	50/60Hz ± 0.1Hz			
	Overload capacity	200% for 1 min	150% for 1 min	130% for 1 min	
	Efficiency	Up to 97% ECO mode, 91% online mode			
BATTERY/CHARGER	Battery type	Sealed, maintenance-free lead acid			
	Battery quantity and size (standard / XR models)	(20) 12V 9AH / (20) 12V 580W			
	Charger voltage/current	273VDC / 1A-4A (selectable)			
PHYSICAL	Input/output	Terminal blocks or optional PDU			
	Dimensions (W x D x H)	9.9 x 23.3 x 32.4 in			
	Weight	272 lbs	275 lbs	278 lbs	307 lbs
OPTIONAL BATTERY PACKS	Battery quantity and size	BP20-(20) 12V 9AH; BP40-(40) 12V 9AH; BP60-(60) 12V 9AH			
	Dimensions (W x D x H)	9.9 x 23.3 x 32.4 in			
	Weight	BP20 - 190lbs; BP40 - 320 lbs; BP60 - 450 lbs			
OPTIONAL PDU	Input connection	Terminal blocks or 6 ft, L6–30P*			Terminal blocks
	120V receptacle options	5–15/20R			
	240V receptacle options	L6–30R, L6–20R, 6–15/20R, C19			
ENVIRONMENT	Temperature	32–104°F (0–40°C)			
	Audible noise	< 50dBA			
	Altitude	11,500 ft above sea level			
APPROVALS		UL1778, cUL, FCC Class A, RoHS			
WARRANTY		3 years electronics, 3 years battery warranty (USA and Canada)			
COMMUNICATIONS INTERFACE		RS-232, EPO, intelligent slot for optional cards (Web/SNMP, Relay/dry contact, Modbus)			
INCLUDED IN BOX		User manual, RS-232 communication cable, ViewPower Software CD			
AVAILABLE OPTIONS		5 year extended warranty, output PDU, input L6–30P cord (for 3.8kVA, 5kVA & 6kVA)			

MODEL NUMBER		TX91L-3.8K	TX91L-5K	TX91L-6K	TX91L-10K
CAPACITY	Power rating	3.8kVA (3.8kW)	5kVA (5kW)	6kVA (6kW)	10kVA (10kW)
INPUT	Voltage (nominal)	208VAC (200VAC, 220VAC, 230VAC, 240VAC optional)			
	Voltage range	110-300VAC			
	Frequency	46–64Hz auto-sensing			
OUTPUT	Voltage	240/120VAC or 230/115VAC			
	Voltage regulation	± 1%			
	Frequency	50/60Hz ± 0.1Hz			
	Overload capacity	200% for 1 min	150% for 1 min	130% for 1 min	
	Efficiency	Up to 97% ECO mode, 91% online mode			
BATTERY/CHARGER	Charger amps	1A-4A (max) programmable from LCD			
	Charger voltage	273VDC			
PHYSICAL	Input/output	Terminal blocks or optional PDU			
	Dimensions (W x D x H)	9.9 x 23.3 x 32.4 in			
	Weight	152 lbs	155 lbs	158 lbs	187 lbs
OPTIONAL PDU	Input connection	Terminal blocks or 6 ft, L6–30P*			Terminal blocks
	120V receptacle options	5–15/20R			
	240V receptacle options	L6–30R, L6–20R, 6–15/20R, C19			
ENVIRONMENT	Temperature	32–104°F (0–40°C)			
	Audible noise	< 50dBA			
	Altitude	11,500 ft above sea level			
APPROVALS		UL1778, cUL, FCC Class A, RoHS			
WARRANTY		3 year electronics (USA and Canada)			
COMMUNICATIONS INTERFACE		RS-232, EPO, intelligent slot for optional cards (Web/SNMP, Relay/dry contact, Modbus)			
INCLUDED IN BOX		User manual, RS-232 communication cable, ViewPower Software CD			
AVAILABLE OPTIONS		5 year extended warranty, output PDU, input L6–30P cord (for 3.8kVA, 5kVA & 6kVA)			

**6kVA system capacity will be reduced by 30A input circut*

3. Functional Block

As a true online UPS, the product applies a double conversion topology, comprising functional blocks as shown in Figure 3.1

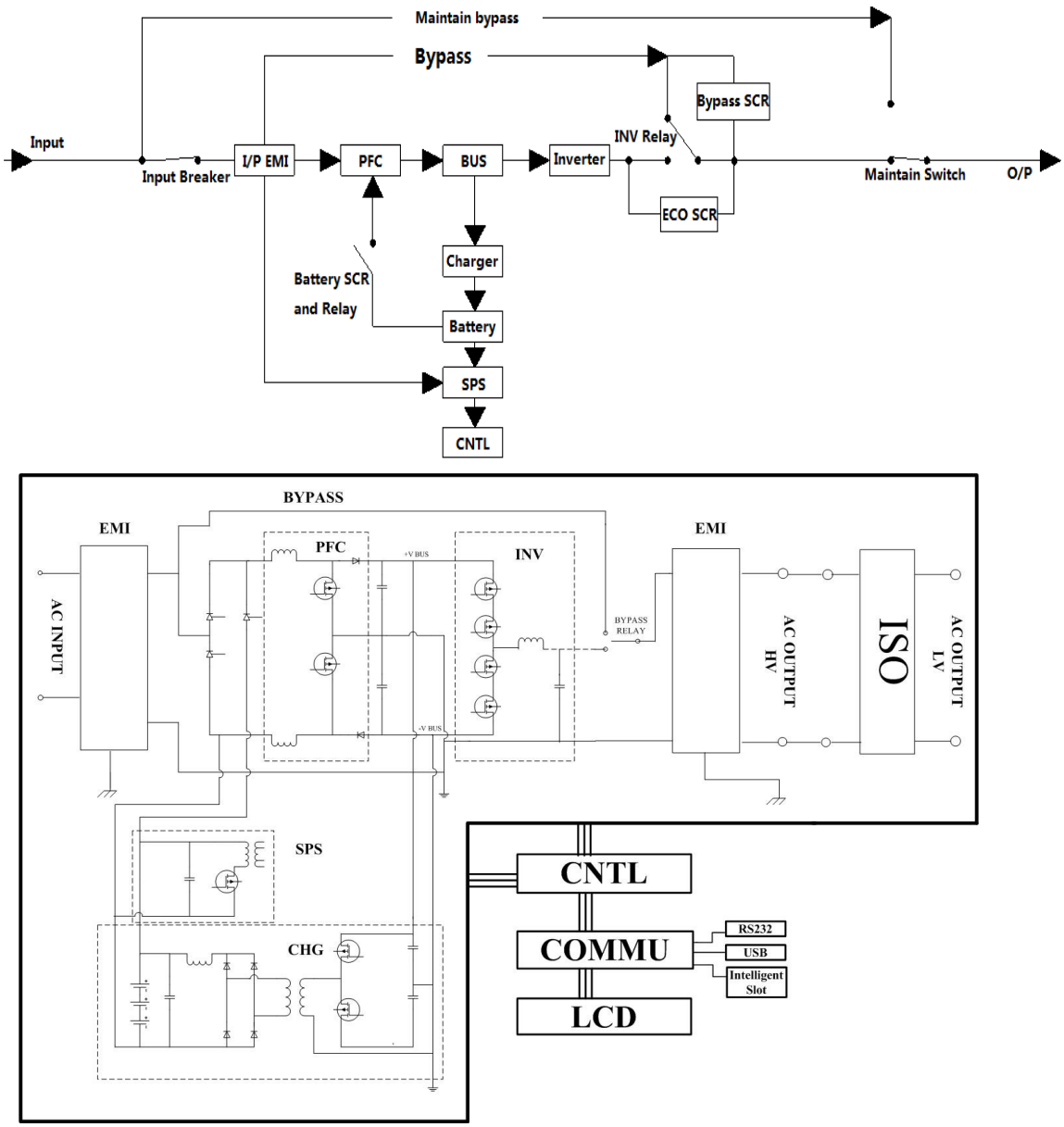


Figure 3.1 Function block Diagram

The CNTL block controls the action of the UPS system. It also provides the communication interface for receiving and executing command from users via the panel or other communication protocol. When the UPS becomes abnormal, in most case, the CNTL can provide basic information indicating the status of the UPS.

The Rectifier and PFC blocks are the input stage of the UPS. The blocks convert AC input power into two stable DC power stored in the BUS capacitor. In the meantime, PFC (Power Factor Correction) will be executed and allows input current tracking the input voltage waveform. Therefore, the input power factor will be corrected to 1 to achieve maximum efficiency and produce lowest power pollution to the utility.

The PFC block in battery mode, also called Booster, is used to convert the low voltage DC power to higher voltage with stable DC power, stored in the BUS capacitor.

The Inverter block is the output stage of the UPS and used to convert DC power from the BUS capacitor to sine waveform output power.

When the utility is within the acceptable range, the UPS will provide power directly from the utility input and the Rectifier and PFC will be executed at the same time. When the utility is outside of the acceptable range, no matter it's because of input voltage or input frequency, the UPS will shut down the Rectifier and PFC functions and turn on the Battery Booster. In case of sudden interruption from input utility, the controller can detect the interruption in very short time. During the short interval of detecting the interruption, the output power will be provided by the power stored in the BUS capacitor. In this way,
there is no any interruption on output power.

The charger charges the battery when the UPS system is working. Yo u can set the current to be 1A/2A/3A/4A by LCD or command. And you can choose a different voltage corresponding to different battery pieces by changing the jumper on the CNTL board, either LCD or command.

The Input EMI section provides EMI filter function. The input EMI filters can prevent the UPS from being interference by external electronic/magnetic noise which is generated by other electronic system and prevent other systems from the noise generated inside the UPS system.

The SPS generates DC power supply needed by operation of the circuit of the UPS itself. The Bypass provides a path that utility can power the output directly when the Inverter is not executed. The Maintenance Bypass provides another path that utility can power the output directly when UPS is in maintenance status.

4. Working Principle of the Major Functional Block

4.1 Switch Power Supply

The Switch Power Supply (SPS) supplies DC power for UPS operation. The input source of the SPS is the grid when the grid voltage is higher than 110V . Or the input source of the SPS is the battery.

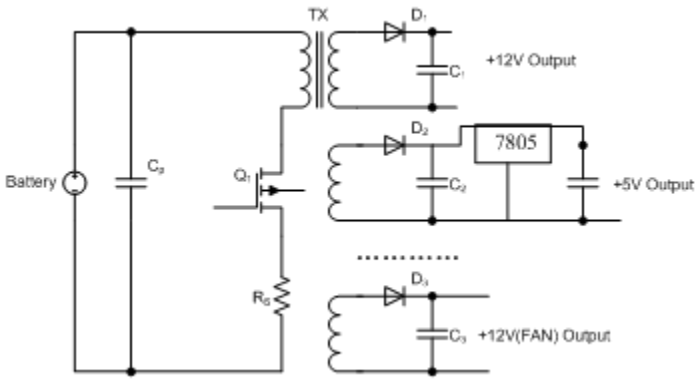


Figure 4.1 Basic circuit of power supply

Figure 4.1 is a flyback converter. When Q1 is on, all rectifier diodes (D1/D2/D3) are on open status and all output capacitors (C1/C2/C3) supply currents to the load. The primary coil of the transformer will become a pure inductor and the primary current will linearly increase to store energy in the coil. When Q1 is off, primary current will stop and all rectifier diodes (D1/D2/D3) will turn to “close” status. It will release the stored energy from the primary coil of the transformer to the secondary coil to supply loads. At the same time, it will charge output capacitors including 15V, +12V, +5V, +12V(Fan), and HFPW.

The power of 12V, +5V supplies stable voltage to all kinds of ICs and other devices such as HCT. The +12V (Fan) is supplied to fans and relays. The HFPW supplies a high frequency power for the switch (SCR/IGBT) driver and some other drive boards.

4.2 PFC/Booster

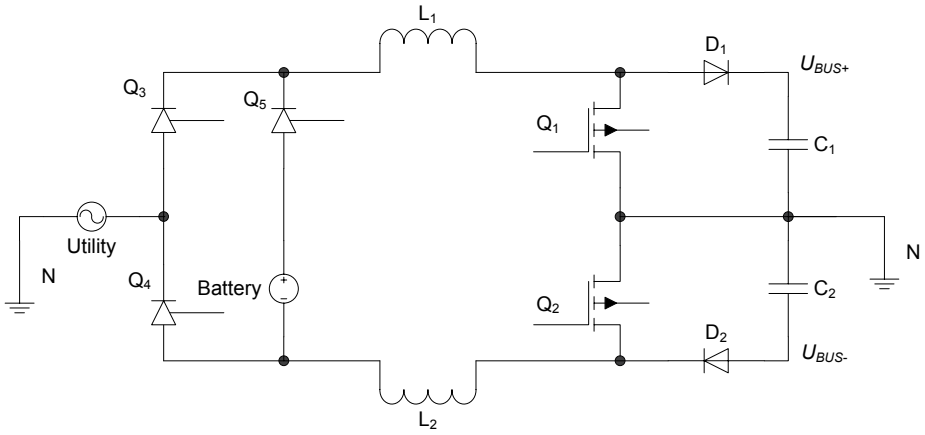


Figure 4.2 PFC/Booster

As shown in the Figure 4.2, when Q1/Q2 is on and D1/D2 is off, the current will increase to store energy in choke(L1/L2). When the Q1/Q2 is off and D1/D2 is on, the choke will release energy. Therefore, we can control the current in chokes (input current) by regulating the time of Q1/Q2 on and off.

4.3 Inverter

The input of the three level inverter topology is two DC voltages, and the output is an AC voltage, as shown in the Figure 4.3. When Q1/Q2 is on and Q/Q3 is off, the voltage of the bridge midpoint is +BUS. When Q1/Q2 is off and Q3/Q4 is on, the voltage of the midpoint bridge is –BUS. We can get any voltage waveform between ±BUS voltage from LC filter output by regulating the duty cycle of Q1/Q2/Q3/Q4, including sine wave form.

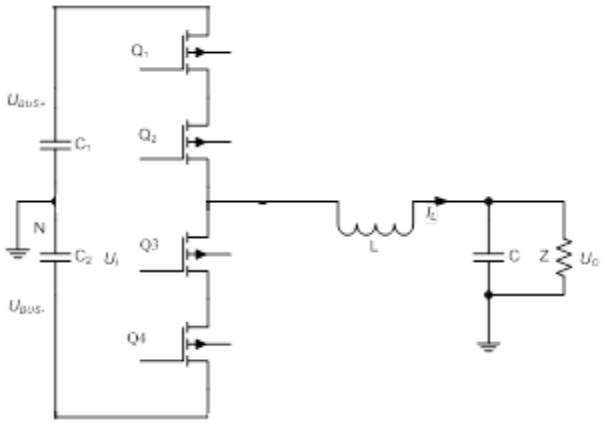


Figure 4.3 Three level inverter bridge

4.4 Charger

The function of charger is to charge and maintain the batteries at fully charged condition. The charger charges the batteries with a constant current at initial stage. At the same time, the battery voltage keeps increasing until reaching the constant charge voltage point. Then, the charge current will decrease accordingly, now it's in second stage. After one hour of constant voltage charging, the charge voltage will change to floating charge voltage, in general, the charger will control the output voltage at a constant level (13.65V±1% per battery) to optimize battery recharge time and prolong the lifetime of batteries
without overcharging.

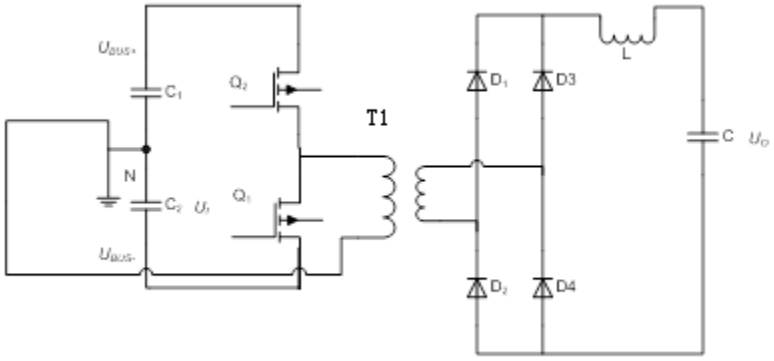


Figure 4.4 Topology of the charger

4.5 EMI Board

Input EMI board is connected between utility and the input of rectifier.

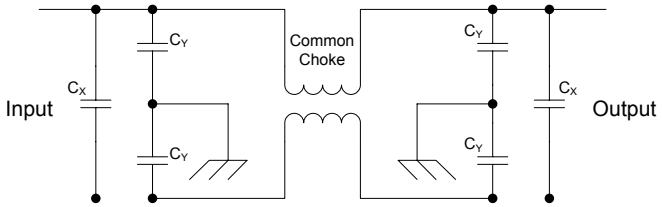


Figure 4.5 Topology of the EMI

5 Function explanations for each PCB

Table 5.1 PCB information

Item	PCB Name		PCB serial number	Quantity	Remark
1	SPS-Charger	6k	71-302390-XXG	1	
		10k		1	
2	CNTL		72-300211-XXG / 71-301569-XXG	1	
3	Communication		72-300294-XXG/71-302389-XXG 72-300571-XXG/71-303176-XXG	1	
4	EMI	6k	71-302448-XXG	1	For 6kVA model
		10k	71-302408-XXG	1	For 10kVA model
5	Main Power	6k	71-302114-XXG	1	For 6kVA model
		10k	71-301756-XXG	1	For 10kVA model
6	Para(A)		71-302096-XXG	1	They are optional for parallel function.
	Para(B)		71-302097-XXG	1	
	Para		71-303273-XXG Just for tower		
7	O/P Relay		71-300026-XXG	1	

Note: “XX” in the serial number is the version of the PCB. It may be modified according to releasing version in the future.

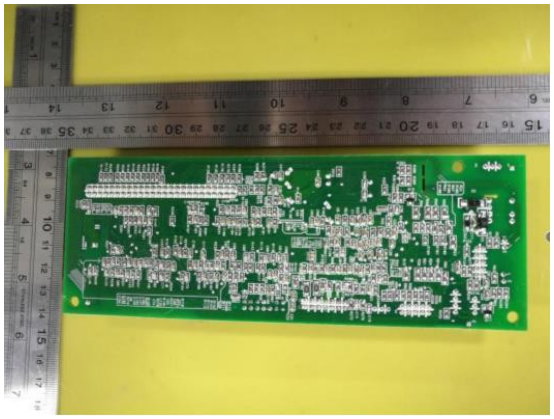
5.1 SPS-Charger board

The SPS-Charger board consists of switch power supply (SPS) and charger. The SPS generates all the powers needed by different circuits.

You can set the charge current to be 1A/2A/3A/4A on LCD by configuring jumpers JP01, JP02, JP03, JP04 and JP05 you can also set charge voltage based on the number of batteries per string

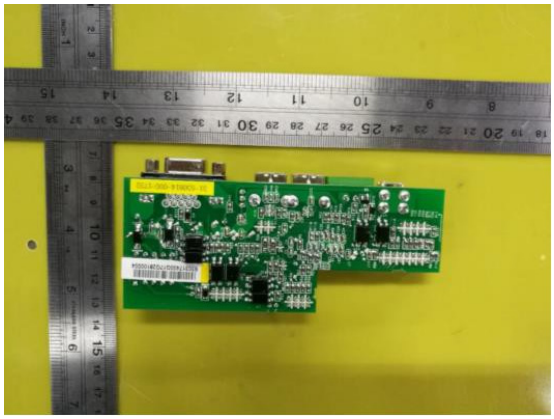
5.2 CNTL board (Control Board)

The CNTL board is the core of the UPS system. It controls the actions of the semiconductors and other mechanical switches, the display of the LED/LCD, the sound of the buzzer, the communication with the computer, and other important tasks.



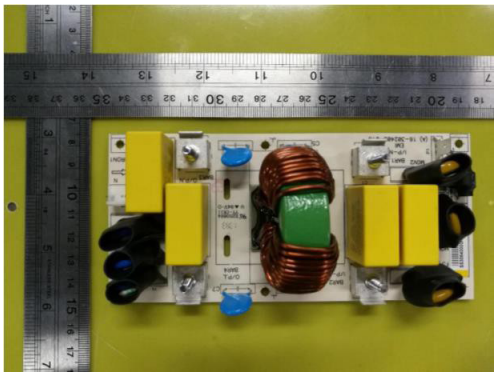
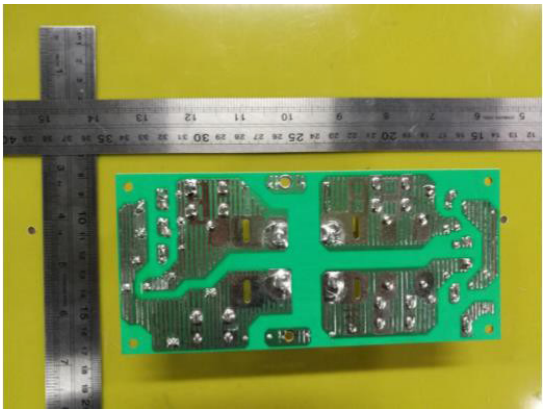
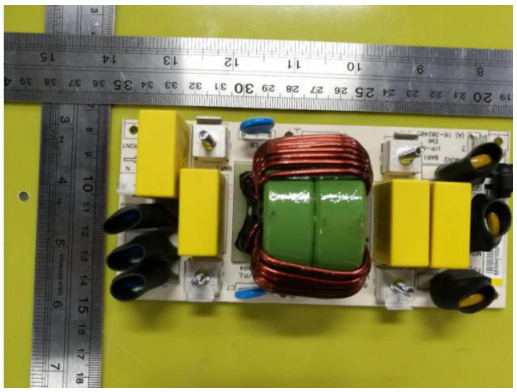
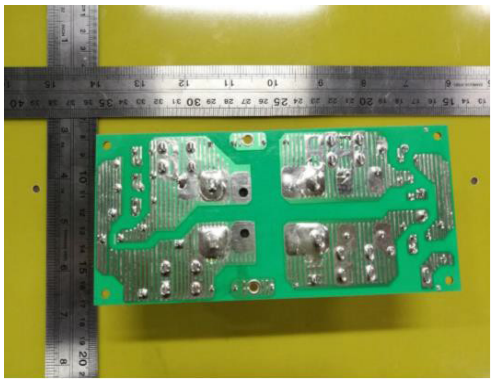
5.3 Communication board

The Communication board provides RS232/USB interface to the users, and it also provide one EPO port to cut off the output immediately.



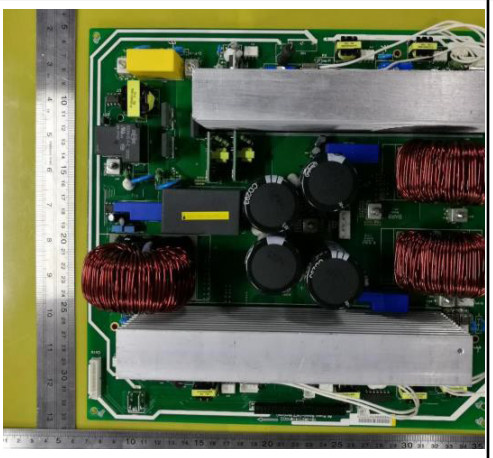
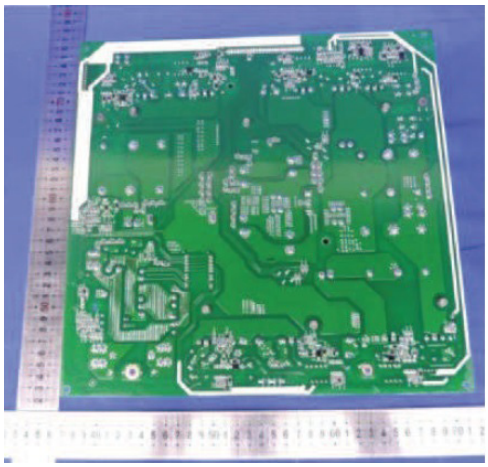
5.4 EMI board

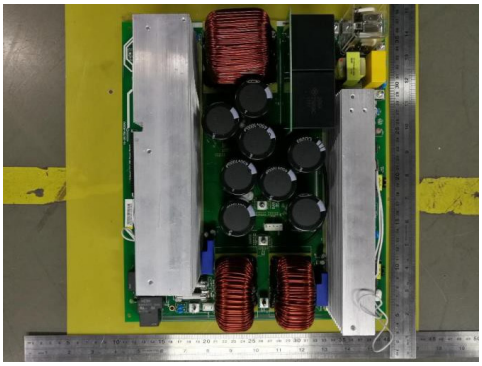
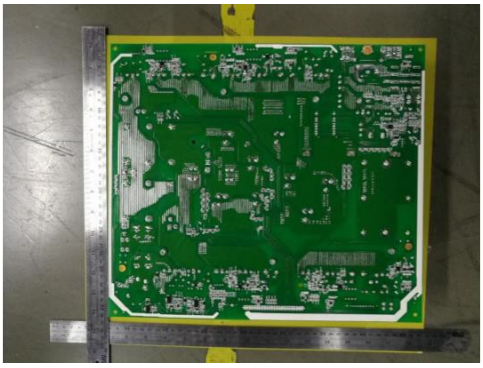
The EMI board can prevent the UPS from external electronic/magnetic noise generated by other electronic systems, and also prevent other systems from the noise generated inside of the UPS system. And the MOV is also on the EMI board which can absorb the surge to protect the UPS system.

6k		
10k		

5.5 Main Power board

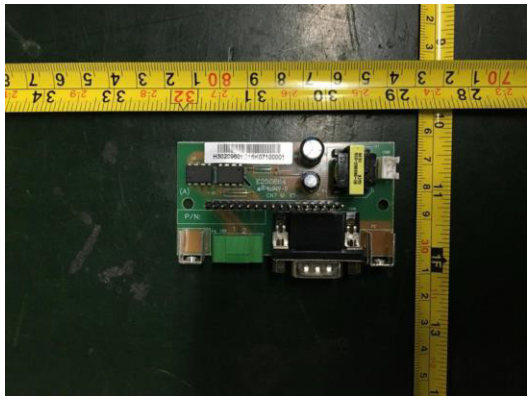
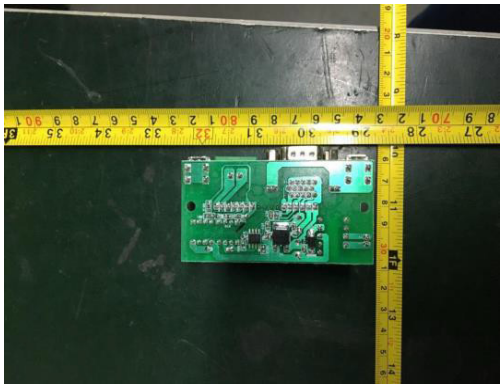
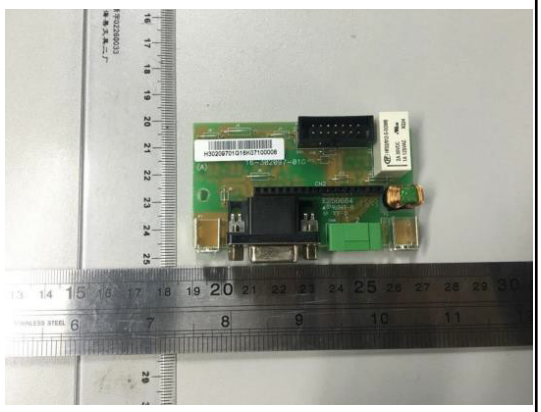
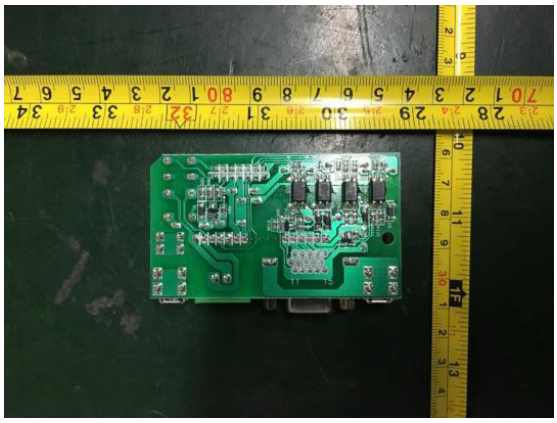
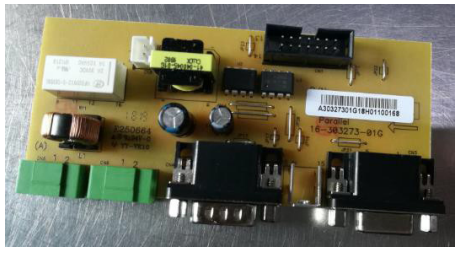
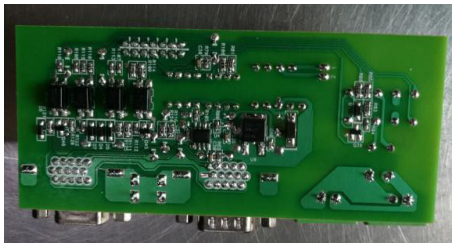
The Main converts the AC/DC power to a pure sine waveform. And then it converts the DC/AC power. There are many semiconductors and easy-failure components on the board, so it's required to pay more attention when UPS is abnormal.

	component side	10k
6k		

10k		

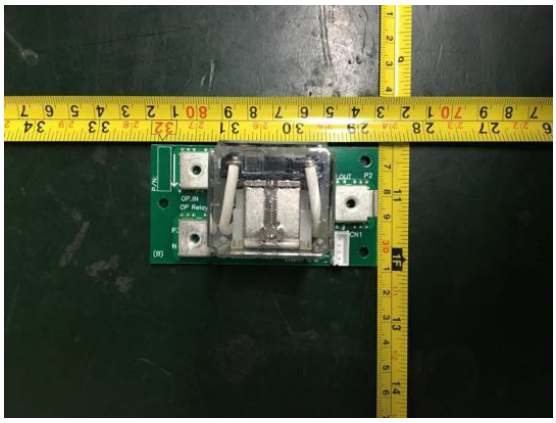
5.6 Para board

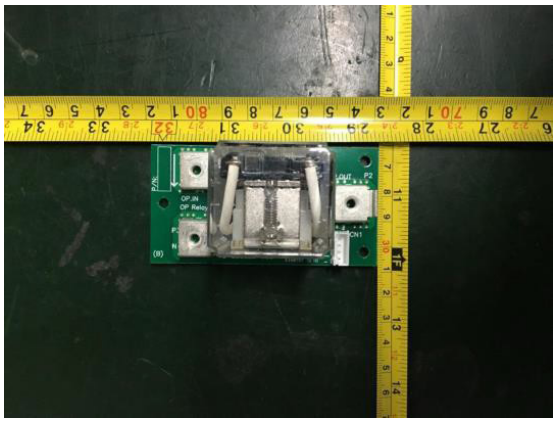
The Para(A) board and Para(B) board is used for parallel communication when the UPS system is running in parallel mode.

Board 1		
Board 2		
Board 3		

5.7 O/P Relay board

The O/P Relay board should be installed for parallel system. For single system, it can be removed. The board can disconnect the UPS from the output (parallel system).





6. Interface

6.1 LED Display

Table 6.1 LED Display

Mode LED	Bypass	Line	Battery	Fault
UPS Startup	●	●	●	●
No Output mode	○	○	○	○
Bypass mode	●	○	○	○
AC mode	○	●	○	○
Battery mode	○	○	●	○
CVCF mode	○	●	○	○
Battery Test	●	●	●	○
ECO mode	●	●	○	○
Fault	○	○	○	●

Note: ● means LED is lighting, and ○ means LED is faded.

6.2 LCD Display

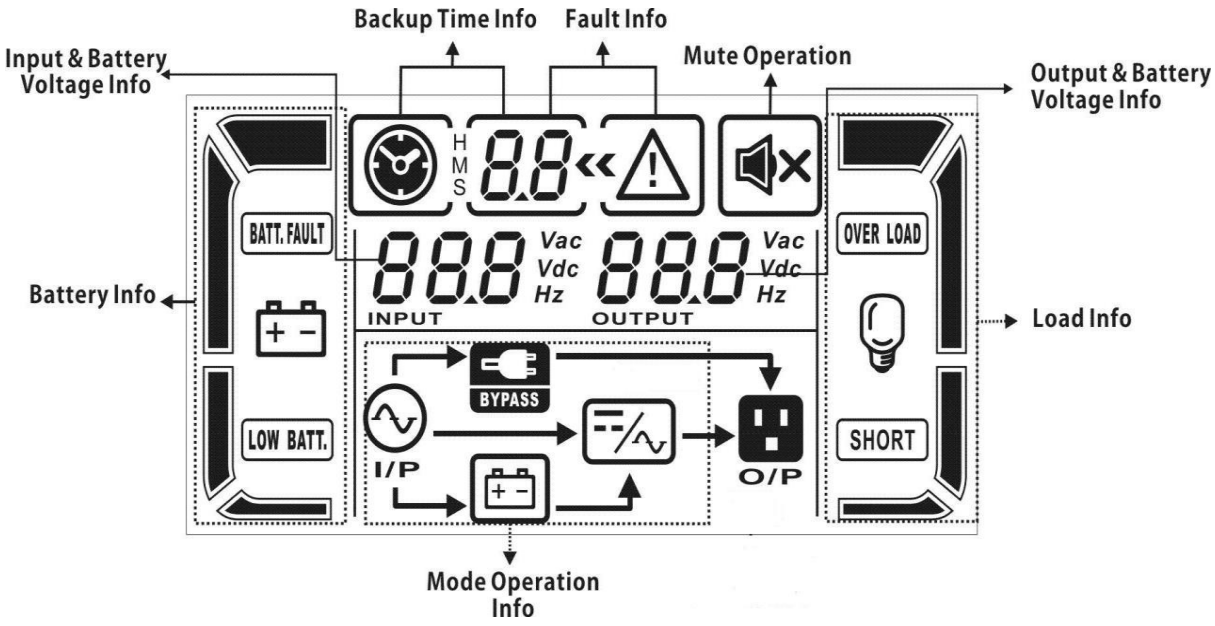


Figure 6.1 LCD Display

6.3 LCD Display Icon

Display	Function
Backup time information	
	Indicates the backup time in pie chart.
	● Indicates the backup time in numbers. H: hours, M: minutes, S: seconds ● When UPS is in Bypass mode, these two numbers indicating the power capacity; 06 for 6K model and 10 for 10K model.
Fault information	
	Indicates that the warning and fault occurs.
	Indicates the fault codes, and the codes are listed in details in section 7-1.
Mute operation	
	Indicates that the UPS alarm is disabled.
Output & Battery voltage information	
	Indicates the output voltage, frequency or battery voltage. Vac: output voltage, Vdc: battery voltage, Hz: frequency
Load information	
	Indicates the load level by 0-25%, 26-50%, 51-75%, and 76-100%

OVER LOAD	**Indicates overload.**
SHORT	Indicates the load or the output is short.
Mode operation information	
I/P	Indicates the UPS connects to the utility.
	Indicates the battery is working.
BYPASS	Indicates the bypass circuit is working.
ECO	Indicates the ECO mode is enabled.
	Indicates the Inverter circuit is working.
O/P	Indicates the output is working.
Battery information	
	Indicates the Battery capacity by 0-25%, 26-50%, 51-75%, and 76-100%.
BATT. FAULT	Indicates the battery is fault.
LOW BATT.	Indicates low battery level and low battery voltage.
Input & Battery voltage information	
88.8 Vac Vdc Hz INPUT 12	Indicates the input voltage or frequency or battery voltage. Vac: Input voltage, Vdc: battery voltage, Hz: input frequency

7. Troubleshooting

This section describes how to find the troubles when UPS is abnormal. We suggest you to follow the service procedure below:

1. Check the UPS status via LED and LCD display, the sound of the buzzer, or listen to the description of end users.
2. Inspect failure board for static checking.
3. Replace failure components.
4. Static checking.
5. Power-on checking.
6. Test after repair.

Following section will help service person to solve most problems.

7.1 LCD Panel Display Pattern Definition

7.1.1 Trouble shooting for warning icon in LCD display

Any warning display implies some abnormity happened to the UPS, indicating that some situation that may endanger the reliability of the UPS has occurred, but these situations don't immediately lead to interruption of power supply.

LCD icon (Flashing)	Alarm	Possible cause	Action
⚠ LOW BATT.	1 Beeping / second	Low battery	Check the battery voltage
⚠ OVER LOAD	2 Beeping / second	Over load	Check the loads
⚠ BATT. FAULT	1 Beeping / second	Battery disconnected	Check the battery wiring
⚠	1 Beeping / second	Battery/Charger voltage too high	Check the output voltage of the battery and the charger
⚠ EP	1 Beeping / second	EPO plug or cable not connected	Check the EPO plug and EPO cable
⚠	1 Beeping / second	Fan failure, or high internal temperature	Check the fans, loads, ventilation, ambient temperature
⚠	1 Beeping / second	Charger broken or low output voltage	Check the charger
⚠ →	1 Beeping / second	I/P fuse broken	Check the I/P fuse
⚠	1 Beeping / second	Overload 3 times in 30min	Check the loads

Note: When the UPS alarms, the UPS is still working on the original mode.

7.1.2 Trouble shooting for fault codes in LCD display

When the UPS is fault, it will transfer to Fault mode.

Code	LCD icon	Fault Event	Description	Action
01	None	BUS soft start failure	When the bus voltage can't reach the setting value in 30s, the fault signal will be displayed.	Check if power components such as PFC/ INV IGBT and PFC SCR are well. Meanwhile, check if the components on the drive circuit are well.
02	None	BUS voltage high	When one of the following conditions occurs, the fault signal will be displayed. 1. +Bus voltage remains higher than 450V or the –BUS voltage remains lower than –450V for more than 50 ms. 2. +Bus voltage remains higher than 400V or the –BUS voltage remains lower than –400V for more than 1.5s.	Maybe the main board is damaged; Check if power components such as IGBT and SCR for the PFC and the utility power SCR are well. Meanwhile, check if components on the drive circuit are well.
03	None	BUS voltage low	When +Bus voltage remains lower than 230V or the –BUS voltage remains higher than –230V for more than 200ms, the fault signal will be displayed.	Maybe the main board is damaged. Check if power components such as IGBT and SCR for the PFC and the utility power SCR are well. Meanwhile, check if components on the drive circuit are well.
04	None	BUS voltage unbalance	When the difference between the ±Bus voltage absolute value remains more than 40V for 2 minutes, the fault signal will be sent.	Maybe the main board is damaged. Check if power components such as IGBT and SCR for the PFC and the utility power SCR are well. Meanwhile, check if components on the drive circuit are well.
11	None	INV soft start failure	Inverter voltage can't reach the setting value in 30s.	Check the inverter drive circuit.
12	None	INV voltage high	When INV voltage remains higher than 276V for 128 ms, the fault signal will be displayed.	Check if power components in power INV and on the drive circuit are normal. Check if IGBT protective circuit and some PFC components are normal.
13	None	INV voltage low	When INV voltage remains lower than 140V for 128 ms, the fault signal will be displayed.	Maybe the main board is damaged; Check if power components in power INV and on the drive circuit are normal. Check if IGBT protective circuit and some PFC components are normal.

Code	LCD icon	Fault Event	Description	Action
14	SHORT	Output short circuited	When INV output voltage remains lower than 50V and output current keeps lower than 20A for over 3 periods, the fault signal will be displayed.	Remove all the loads. Turn off the UPS. Check whether the output of UPS and loads are short circuited. Make sure the short circuit is removed, and the UPS has no internal faults before turning on again.
1A	None	Negative power fault	When the output power on the INV terminal is over -800W, the fault signal will be displayed.	Check if input and output connections are correct. And then check if INV relay RY5 or STS(Q13, Q14, Q20,Q25 and their driver circuits) are OK.
60	None	Inverter over current	Inverter voltage > 100V, and (Inverter voltage - bypass or line voltage) < 20V, and detected inverter current > 75A (10K) or 45A (6K)	Check if the heavy load or unique load is connected to the UPS.
6D	None	Inverter current detection error	The sample average value of Inverter current/ output current/share current is too high.	Check if the INV and output current detecting circuit is OK.
77	None	Transformer over temperature	Transformer is over temperature limit for 1 minute	Just for cTUVus model Check if the Transformer Fan is damaged or the transformer NTC wire is shorted. If not, continuous 1minute. Maybe you need to replace the dry board and the communication board. AT worst, the transformer is damaged.
21	None	Battery SCR short circuited	When battery voltage is more than 310V, the fault signal will be displayed.	main board is probably damaged. Replace the board.
24	None	INV relay short circuited	After Bus soft start completes and INV PWM is off, more than 50V INV voltage is detected, the fault signal will be displayed.	INV relay on the main board is shorted. Replace the main board
2A	None	Charger short circuited	Detecting battery voltage less than 100V	If the charge 2P wire and battery voltage are ok, charger circuit may be faulty. Replace the PSDR board

Code	LCD icon	Fault Event	Description	Action
31	None	No communication fault	No communication fault	Check if the parallel wire is connected well.
41	None	Over temperature	Detecting NTC temperature more than 90°C	Check if UPS is overloaded, air vents are blocked, and ambient temperature is over 40° After overload or block is removed, please keep UPS cool down for 10 minutes before turning on again. It is not recommended to operate the UPS under over 40°C temperature environment.
42	None	Internal fault	CPU can not build communication or the control board is damaged.	Replace the CNTL board. Or replace the CNTL board and COMMU board or update the firmware.
43	OVER LOAD	Overload	The load over 100%	Check the loads and remove some non-critical loads. Check whether some loads are failed.
6A	None	Battery Turn-on failure	During on UPS by battery, the bus voltage is high or having high current	PFC or INV components are probably damaged. Replace the main board.
6B	None	PFC current failure in battery mode	The detected value of two sides PFC current unbalance over 30A	HCT and detecting circuit of PFC on main board is faulty. Replace the main board.
6C	None	Bus voltage changes too fast	The bus voltage fluctuated more than 50V in one period.	Check if detecting circuit of Bus or the IGBT of PFC/INV is OK. Maybe you also need to check to see if the load is normal or not.
6E	None	SPS 12V abnormal	the 12V output of SPS is abnormal	Something is wrong with SPS circuit. Replace the SPS-Charger board.

Warning code	Warning event
01	Battery unconnected
07	Over charge
08	Low battery
09	Overload
0A	Fan failure
0B	EPO enable
0D	Over temperature
0E	Charger failure
44	Failure on parallel redundancy
10	L1 IP fuse broken
21	Line situations are different in parallel system
22	Bypass situations are different in parallel system
33	Locked in bypass after overload 3 times in 30min
3A	Cover of maintain switch is open
3D	Bypass unstable
3E	Boot loader is missing
42	Over-temperature on transformer
45	Overload on parallel redundancy

Warning	Icon (flashing)	Alarm
Battery low	⚠ LOW BATT.	Beeping every second
Overload	⚠ OVER LOAD	Beeping twice every second
Battery unconnected	⚠ BATT. FAULT	Beeping every second
Over charge	⚠	Beeping every second
EPO enable	⚠ EP	Beeping every second
Fan failure/Over temperature	⚠	Beeping every second
Charger failure	⚠	Beeping every second
I/P fuse broken	⚠ →	Beeping every second
Overload 3 times in 30min	⚠	Beeping every second

7.1.3 Troubleshooting

Problem	Possible cause	Action
Battery backup time is short	Battery not yet been fully charged.	Keep UPS connected to utility power continuously for more than 10 hours to recharge the batteries.
	UPS overload.	Check the loads and remove some non-critical loads.
	Battery aged	Replace the batteries
	Charger fails	Replace the charger
The UPS cannot power on after pressing the button	The button is not pressed and held long enough	Press and hold the button continuously for more than 0.5s
	Battery is not connected or battery voltage is too low, or charger fails.	Check the charger and battery.
	UPS failure.	Repair the UPS.

7.2 Repair

In this section, some debug skills are listed to help you find the failed components and problems as soon as possible. Before taking the following steps, we strongly suggest reading previous section for trouble shooting first.

Then check the components listed in section 7.2.4 to find out which block fails

7.2.1 Basic Instruments and tools

1. One computer with RS232 port and one standard RS232 cable;
2. Wire cutters and clamps;
3. One electric soldering iron;
4. One multimeter;
5. One oscilloscope(voltage and current probe needed);
6. Diagonal pliers, snipe nose pliers, cross screwdrivers (150mm/75mm length), flat screwdrivers (75mm length) and PVC insulating tapes etc;
7. Make-self tools including Balance voltage test equipments, current limiting resistors, tubes and clamp terminals with different specifications;

7.2.2 Configuration of the Model Port on the Control Board

The Model Port (JP1) on the CNTL board should be configured as follows:

Table 7.1 Model Port Setting List

Model Type	pin1&pin2	pin3&pin4	Battery Number	pin5&pin6	pin7&pin8	pin9&pin10
6K	0	1	16	1	0	0
6KL	0	0	17	0	1	1
10K	1	1	18	0	1	0
10KL	1	0	19	0	0	1
			20	0	0	0

Note: “1” indicates that the jumper is connected;
“0”indicates that nothing is connected

7.2.3 Configuration of the charger current on the LCD or by command

Set charger current on LCD:

There are two parameter 2 and parameter 3, you can set charger current form 1A/2A/3A/4A by setting parameter 2. (See the Figure 7.1).

If you want to adjust charger current, please adjust parameter 3. (See Figure 7.1).

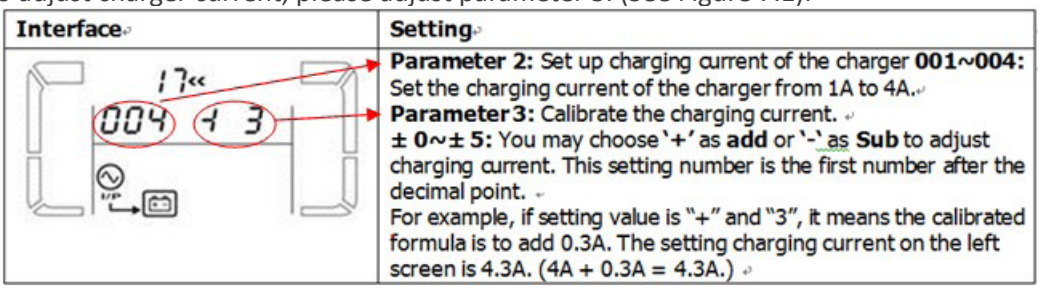


Figure 7.1 Set charge current on LCD

Set charge current by command:

You need set charger current command as follow

7.2.4 Configuration of charging voltage on the Charger Board or through command

Set 5 jumpers (JP01, JP02, JP03, JP04 and JP05) on the charger mode according to the following table, to match the actual battery number in series per string.

Table 7.3 Charge Voltage Setting List

Battery Number in series	Charge voltage (V)	JP01	JP02	JP03	JP04	JP05
16	218	0	0	0	1	0
17	232	0	0	1	0	0
18	245	0	1	0	0	0
19	259	1	0	0	0	0
20	273	0	0	0	0	0

Note: 0 = no jumper; 1 = connect with jumper.

7.2.5 Regulation of the system

Parameter Setting Method:

1. Connect the RS232 port of the UPS to the RS232 port of the computer with RS232 cable. Open Communication Test Tool software. You will see software interface as shown in Figure 7.2.

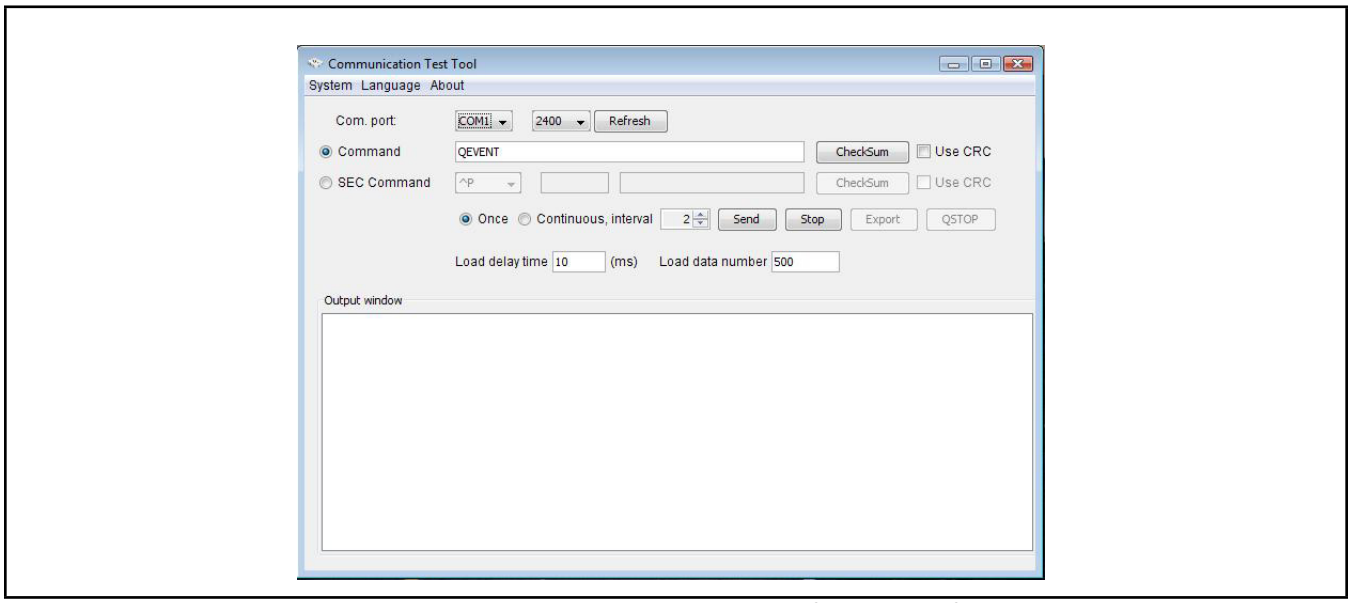


Figure 7.2 Communication Test Tool software interface

2. After completing the setting, you can type the command in the command area.
3. +BUS voltage regulation: Type “BUSP+/- XX” command (XX is two digits from 00 to 99). Then press the “ENTER” key, and +BUS voltage will rise (drop) about X.XV.
4. -BUS voltage regulation: Type “BUSN+/- XX” command (XX is two digits from 00 to 99). Then press the “ENTER” key, and -BUS voltage will rise (drop) about X.XV.
5. INV output voltage regulation: Type “V+/- XX” command (XX is two digits from 00 to 99) Then press the “ENTER” key, and output voltage will rise (drop) about X.XV.
6. INV output voltage setting: Type “VXXX” command (XXX is 208/220/230/240). Then press the “ENTER” key, and INV output voltage will be set to 208V/220V/230V/240V.
7. Output current regulation: Type “OC+/-XX” command (XX is two digits from 00 to 99). Then press the “ENTER” key, and output current will rise (drop) about X.X A.

Regulation Process for Single UPS

1. BUS voltage regulation: When the UPS runs in AC mode, measure ±BUS voltage with the multimeter, and then regulate ±BUS voltages to 360±0.5V by using BUS regulation command. (BUS voltage can be regulated about 0.1V every point by using BUS regulation command).

2. INV output voltage regulation: When the UPS runs in the Inverter mode, measure the output voltage with the multimeter, and regulate the output voltage to 230±0.5V by using output voltage regulation command. (INV output voltage can be regulated about 0.1V every point by using output voltage regulation command).

3. Output current regulation: When the UPS runs in the Inverter mode with full R load, measure the output current, and rread UPS sampled output current value by QGS command. Use OC command to regulate the UPS sampled output current value to match your measured value. (Output current can be regulated about 0.1A every point by using output voltage regulation command).

Notes:

1. Make sure the ground of the UPS connects to earth safely during parameter regulation.
2. New assembly UPS must be regulated.
3. UPS which have been replaced CNTL and / or SPS-Charger board must be regulated again.
4. All the commands use capital letters.
5. All the above parameter regulation cannot be accumulated.
6. All the regulation will be saved in the flash memory of the CNTL when UPS shutdown with battery connected.

7.2.6 Quick Start

Before any detail check for UPS, please check the components listed in the following table. This action could help you find problem quickly and make debug procedures go smoothly.
Note: Make sure that the capacitor voltage is lower than the safety voltage before disassembling any parts to do checking procedure.

10k Main Power Section

Circuit Block	Checked components	Component Type	Failure condition
DC FUSE	F3, F4	Fuse	Open
Rectifier	Q27, Q18, Q21	SCR	A-K Short or open
PFC	D33, D35	Diode	Short or open
	Q22, Q23, Q24, Q25	IGBT	C-E short or open
INV	D52, D62	Diode	Short or open
	Q7, Q8, Q9, Q10, Q12, Q15	IGBT	C-E short or open
STS	Q13, Q14, Q20, Q46	SCR	A-K Short or open

6k Main Power Section

Circuit Block	Checked components	Component Type	Failure condition
FUSE	F3,F4	Fuse	Open
Rectifier	Q17, Q18, Q21	SCR	A-K Short or open
PFC	D33, D35	Diode	Short or open
	Q22, Q23	IGBT	C-E short or open
INV	D62, D52	Diode	Short or open
	Q7, Q8, Q9, Q10	IGBT	C-E short or open
STS	Q1, Q2, Q3, Q4	SCR	A-K Short or open

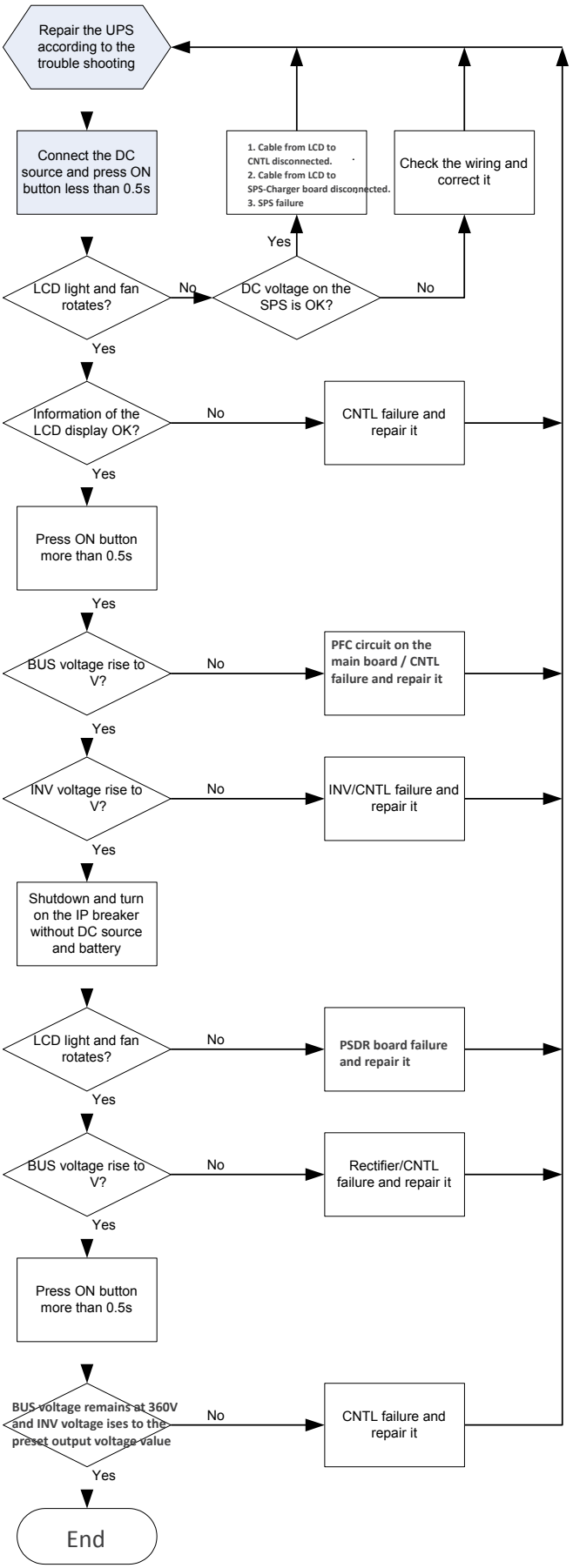
SPS-Charger Section

Circuit Block	Checked components	Component Type	Failure condition
	D2, D3, D7, D8, D11	Diode	Short or open
	Q1, Q2	MOSFET	D-S short or open
	IC1	Power IC	I-O short or open
Others	Q28	MOSFET	D-S short or open
	F1	Fuse	Open
	REC1	Rectifier Bridge	Short or open
	Q6, Q15, Q28	MOSFET	D-S short or open
	D8, D16, D13, D7, D17, D18 ,D33	Power Diode	Short or open
	U1, U4	Power IC	I-O short or open
	U9, U10	Power Control IC	Vcc short to GND

Note: If the fuse is in “open” status, don’t replace the fuse only. In most of cases, open fuse is caused by other failed components. Therefore, before restarting the UPS, you must find all failed components and replace them.

8. Test Step

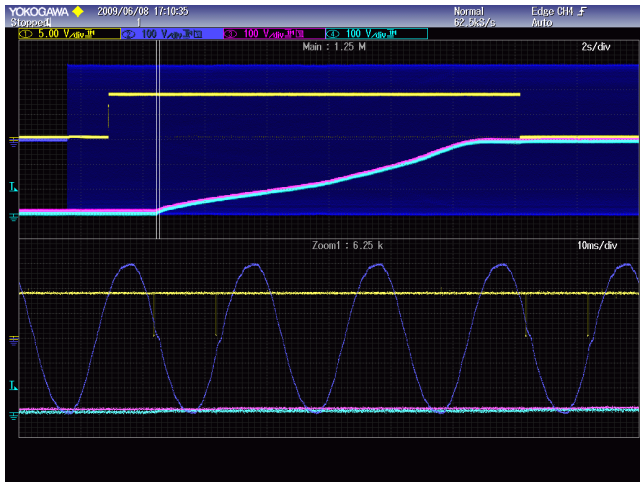
After replacing all defected components, follow this flow chart to verify the repair result and the reliability of the UPS.

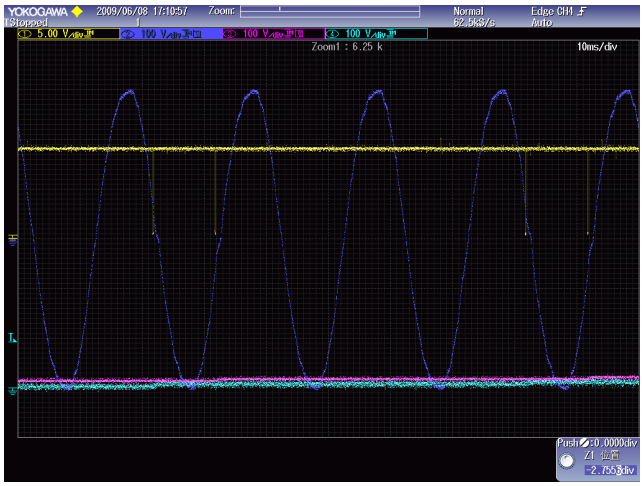


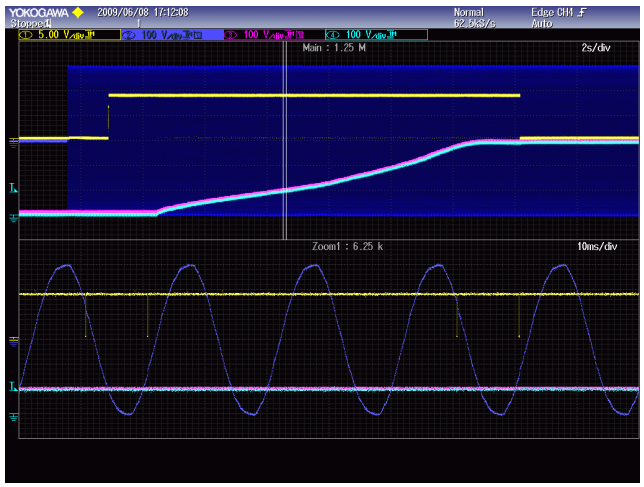
9. Appendix

9.1 Reference Waveforms

Below are some waveform charts to show normal UPS operation. It’s a very useful reference to verify the test result in section 8.







CH1: IP SCR driver
CH2: IP voltage
CH3: -BUS voltage
CH4: +BUS voltage

Figure 9.1 Switch on the input breaker without turn on

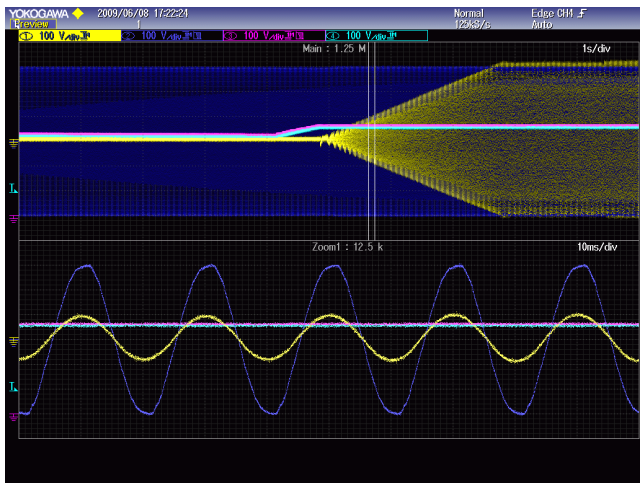
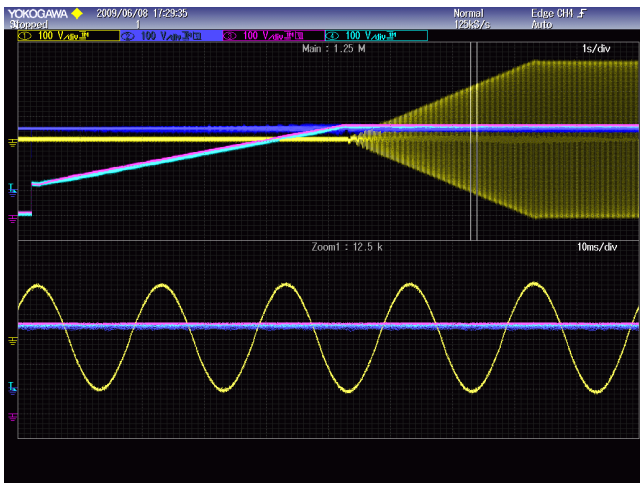
	
CH1: INV voltage CH2: IP voltage CH3: -BUS voltage CH4: +BUS voltage	CH1: INV voltage CH2: Battery voltage CH3: -BUS voltage CH4: +BUS voltage
AC mode (transfer from Bypass mode)	Battery mode

Figure 9.2 Turn on the UPS

	
CH1: IP voltage CH3: VGE-(PFC PWM-) CH4: VGE+(PFC PWM+)	CH1: INV voltage CH2: Battery voltage CH3: VGE-(PFC PWM-) CH4: VGE+(PFC PWM+)
AC mode	Battery mode

Figure 9.3 PFC PWM

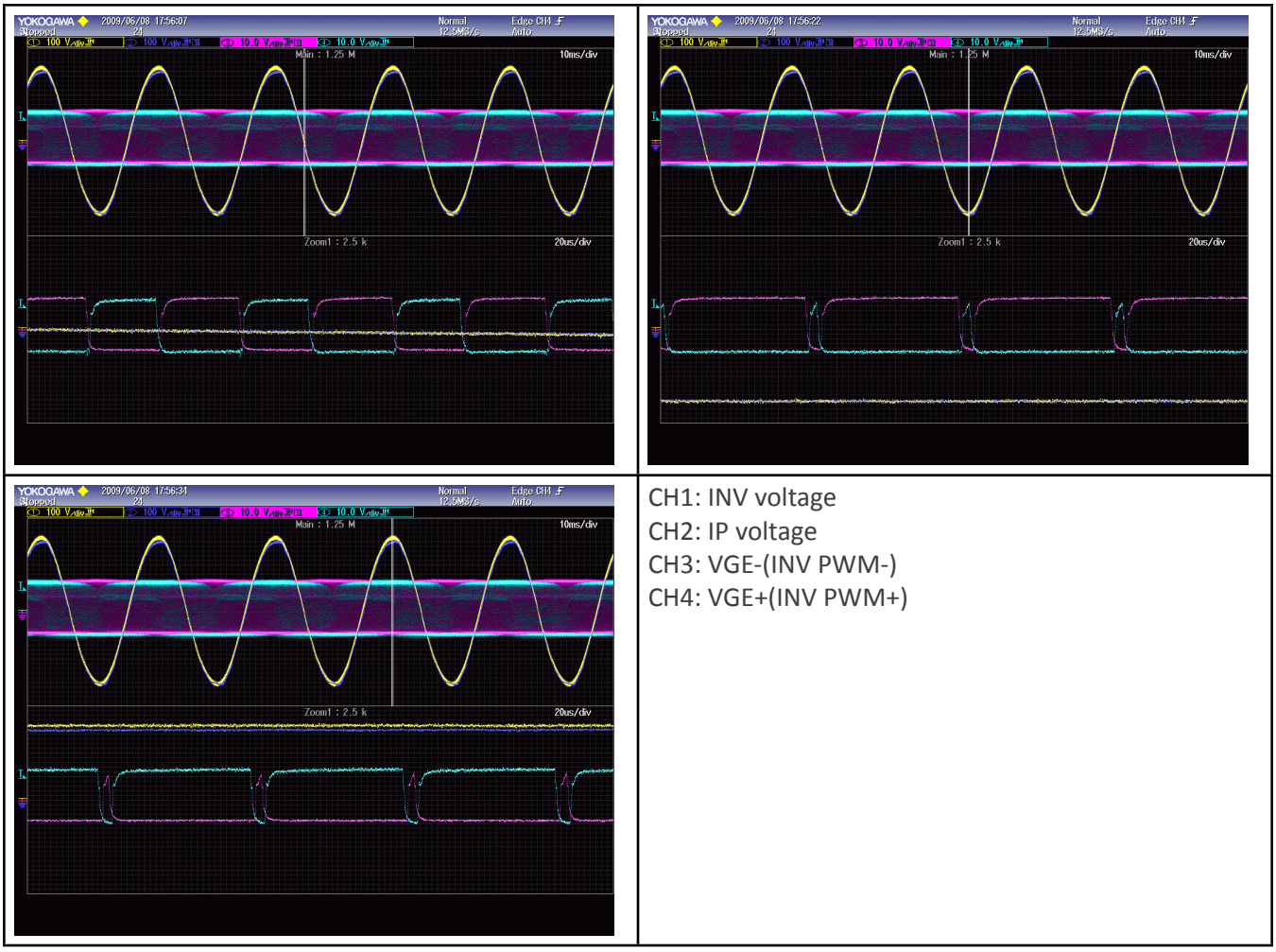


Figure 9.4 INV PWM

9.2 Basic communication command

In this section, we will show you some basic communication commands that will help you debug or regulate the UPS system.

9.2.1 QGS

QGS means to request general status parameters of the system. The command format is: Computer: QGS<cr>
UPS: (MMM.M HH.H LLL.L NN.N QQQ.Q DDD KKK.K VVV.V SSS.S XXX.X TTT.T b9b8b7b6b5b4b3b2b1b0a0a1<cr>

	Data	Description	Notes
a	(	Start byte	
b	MMM.M	Input voltage	M is an Integer number 0 to 9. The units is V.
c	HH.H	Input frequency	H is an Integer number 0 to 9. The units is Hz.
d	LLL.L	Output voltage	L is an Integer number 0 to 9. The units is V.
e	NN.N	Output frequency	N is an Integer number from 0 to 9. The units is Hz.
g	QQQ.Q	Output current	Q is an Integer number from 0 to 9. The units is A.
h	DDD	Output load percent	For Off-line UPS: DDD is a percent of maximum VA, not an absolute value. For On-line UPS: DDD is Maximum of W% or VA%. VA% is a percent of maximum VA. W% is a percent of maximum real power.
j	KKK.K	Positive BUS voltage	K is an Integer ranging from 0 to 9. The units is V.
k	VVV.V	Negative BUS voltage	V is an Integer ranging from 0 to 9. The units is V.
l	SSS.S	P Battery voltage	S is an Integer ranging from 0 to 9. The units is V.
m	XXX.X	N Battery voltage	X is an Integer ranging from 0 to 9. The units is V.
n	TTT.T	Max Temperature of the detecting pointers	T is an integer ranging from 0 to 9. The units is °C
o	b 9 b 8 b 7 b 6 b 5 b 4 b 3 b 2 b1b0 a0a1	Ups status	B9,b8: 00: standy; 01: line-interactive; 10: on-line. B7: Utility Fail b6: Battery Low b5: Bypass/Boost Active b4: UPS Failed b3: EPO b2: Test in Progress b1: Shutdown Active b0: bat silence a0: Bat test fail a1: Bat test OK

Example:

Computer: QGS<cr>

UPS: (220.2 50.0 220.0 50.0 027.0 100 345.8 344.9 241.0 241.5 045.0 100011000000<cr> Means:
I/P voltage is 220.2V. I/P frequency is 50.0Hz O/P voltage is 220.0V O/P frequency is 50.0Hz. O/P current is 27.0A O/P load 100%

Positive BUS voltage is 345.8V Negative BUS voltage is 344.9V P Battery voltage is 241.0V.
N Battery voltage is 241.5V.

Temperature is 45.0 degrees of centigrade.

On-line mode, Utility OK, Bypass Active, UPS failed.

9.2.2 V<n>
This command is to set the nominal output voltage. The format is: Computer: V<n><Enter>
UPS: (ACK or (NAK*

*: If UPS accepts this command, responds ACK. Otherwise, responds NAK Output Voltage: <n>. n is 208,220,230,240.
Default status: Nominal output voltage 220V. (It can be set only in bypass mode)

For example:
Computer: V230<Enter> UPS: (ACK
Meanings: set output nominal voltage to 230V.

9.2.3 V±<n>
This command is to adjust the nominal inverter voltage. The format is: Computer: V±<XX><Enter>, XX is two digits: 00, 01,...,99
UPS: (ACK or (NAK*

*: If UPS accepts this command, responds ACK. inverter output voltage will then rise (drop) about X.XV
Otherwise, responds NAK Voltage

For example:

Computer: V+01<Enter> UPS: (ACK
Meanings: Inverter voltage will increase about 0.1Volt.

9.2.4 BUSP±<n>
This command is to adjust the positive BUS voltage, the format is: Computer: BUSP±<n><Enter> , XX is two digits: 00, 01,...,99
UPS: (ACK or (NAK*

*: If UPS accepts this command, responds ACK +BUS voltage will then rise (drop) about X.XV. Otherwise, responds NAK

For example:

Computer: BUSP-01<Enter> UPS: (ACK
Meanings: Positive BUS voltage will decrease about 0.1Volt.

9. 2.5 BUSN±<n>
This command is to adjust the negative BUS voltage, the format is: Computer: BUSN±<XX><Enter>
UPS: (ACK or (NAK*

*: If UPS accepts this command, responds ACK +BUS voltage will then rise (drop) about X.XV. Otherwise, responds NAK

For example:

Computer: BUSN+01<Enter> UPS: (ACK
Meanings: Negative BUS voltage will increase about 0.1 Volt.

9. 2.6 VB±<n>

This command is to adjust the UPS sampled battery voltage value (the battery voltage displayed on LCD) to match the battery voltage you measure with a multimeter. The format is:
Computer: VB±<n><Enter> UPS: (ACK or (NAK*
*: If UPS accepts this command, responds ACK. Otherwise, responds NAK Voltage adjustment step: <XX>, XX is two digits: 00, 01,...,99

For example:

Computer: VB-01<Enter> UPS: (ACK
Meanings: Battery sampling voltage will decrease about 0.1Volt.

9.2.7 QVFW
QVFM means to request the version of the firmware. The command format is: Computer: QVFM<Enter>
UPS: (VERFW: <NNNNN.NN>
<N> is a HEX number from 0...9 or A…F.
Example:
Computer: QVFW<Enter> UPS: (VERFW: <00123.01>
Meanings: 00123 is the firmware series number and 01 is the version.

9.2.8 OC±<n>
This command is to regulate the UPS sampled output current value (which you can ready by QGS command) to match your measured value. The format is:

Computer: OC+<XX>< Enter >
UPS: (ACK<cr> if UPS accepts this command, otherwise, responds (NAK<cr> Computer: OC-<XX>< Enter >
UPS: (ACK<cr> if UPS accepts this command, otherwise, responds (NAK<cr>
<XX> is two digits which ranging from 00, 01…… to99. 99 means 9.9A For example:
Computer: OC-01<Enter> UPS: (ACK
Meanings: Output current sampling value will decrease about 0.1A.