Power Conversion®

P80 Online UPS

1000VA - 5000VA Models

Service Manual

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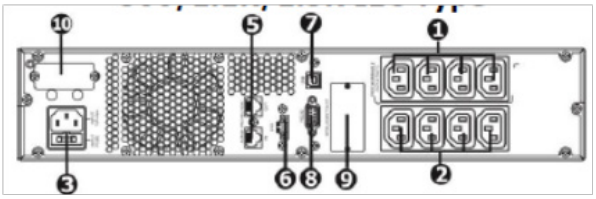
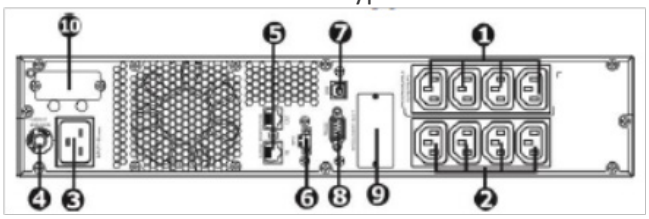
Overview and introduction

Rear Panel View

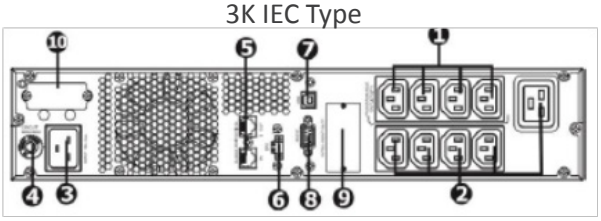
800/1.1K/1.5K IEC Type



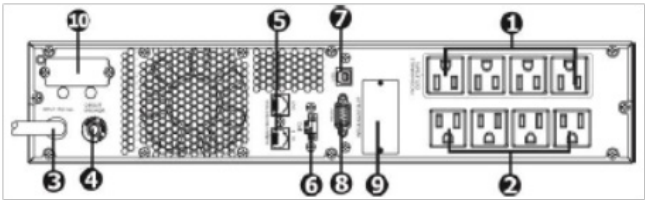
2K IEC Type



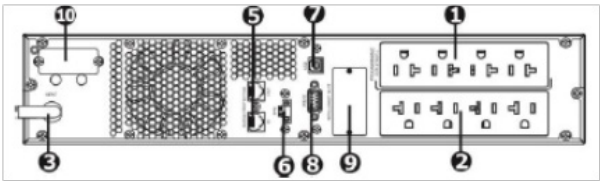
3K IEC Type



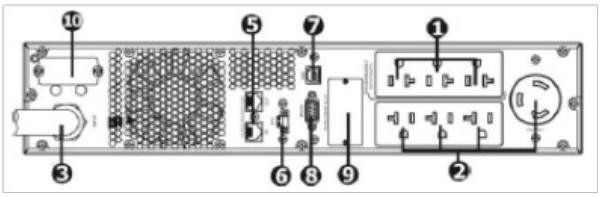
800/1.1/1.5K NEMA Type



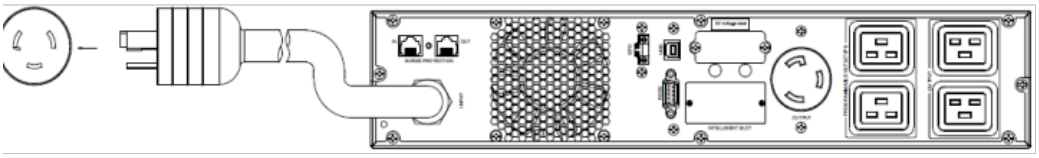
2K NEMA Type



2.5K/3K NEMA Type



5K



1. Programmable outlets: connect to non-critical loads.
2. Output receptacles: connect to mission-critical loads.
3. AC input
4. Input circuit breaker
5. Network/Fax/Modem surge protection
6. Emergency power off function connector (EPO)
7. USB communication port
8. RS-232 communication port
9. SNMP intelligent slot
10. External battery connector (only available for L model)

UPS range

Standard models: 800/1000/1500/2000/3000/5000VA, 120/230V

Topology

- Line interactive type.
- Sine waveform output voltage
- High frequency transformer for DC/DC conversion and DC/AC conversion
- Low frequency transformer for buck-boost (AVR)

Charger features

- Charger works even if the UPS is in standby mode.
- 3 stage charging management.
- OVP and short-circuit protection
- Charger smart controlled by CPU.

Battery features

- Cold start: the unit can start on battery.
- Battery deep discharge protection: minimum battery level linked with customer load level.
- Battery test: at each start-up and then, once every week.

Additional features

- Nominal voltage: output voltage can be set through the UPS LCD panel (208/220/230/240V) (110/115/120/127V).
- Emergency Power Off (EPO): EPO connector at rear panel allow to turn off the output voltage.
- Green function: when autonomy, the UPS will shut down automatically when equipment power consumption less than 5%.
- Programmable Outlet: when autonomy, the programmable outlet power supply time can be set through the monitor software or the UPS LCD panel.
- High Surge level immunity
- Smart fan speed control
- RS232/USB and Slot operation simultaneous.
- Dry contact signal in DB9 port(optional)

Attentions

For all series of UPS, they are strictly tested and carefully designed. We always do our best to make our products more reliable and safer; this is also the goal of our company. However, due to the lifetime of electrical components and some unpredictable reasons, there will be unavoidable failures of this UPS. If this situation occurs, service of qualified person is needed. This service manual will guide the technicians to repair and adjust a problematic UPS. If the UPS still does not work properly, please contact with us and we will be glad to solve any problems you met.

Because of the following unique features of this series UPS (Uninterruptible Power System), it is very easy to maintain and service.
* All major power components are put on POWER PCB.
* POWER PCB and CONTROL PCB are interconnected with connectors.
* Major parts are simply connected with flexible insulated wires and plugs.

This service manual consists of 4 major parts:
- Introduction.
- Principle of operation: It describes the functions and principles of each part.
- Alignments: It describes the locations and methods needed to adjust this UPS.
- Trouble shooting: This part describes the possible failure conditions and procedures to repair it.

Before starting to serve this UPS, be sure to read this manual carefully for a correct and safe operation.

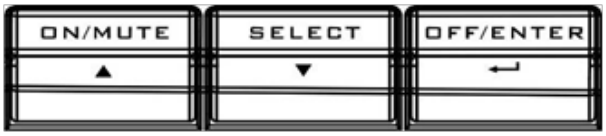
Important Safety Instructions

1. For qualified service personnel only.
2. DO NOT perform any internal service or adjustment of this product unless another person is capable of rendering first aid and resuscitation is present.
3. Dangerous voltage exists at several points in this product. To avoid personal injury, don't touch any exposed connections or components while UPS is active.
4. Turn off the UPS and disconnect input power cord before removing outside protective cover.
5. AC voltage is always present if the input AC power is still available.
6. High voltage may present at DC capacitors. Before opening the outside cover, wait for at least five minutes after turning off the UPS.
7. Verify input source (voltage and frequency) before service.

1. DO NOT make internal batteries short-circuited.
2. If the battery connectors are disconnected, be sure to plug in the input power cord and the input power is available before re-connect the battery connectors.
3. After service, verify the polarity of batteries, the tightness of all screws and connectors before restarting the UPS.

After opening the cover, please always check the tightness of all wires, connectors and screws first. Then check if there are any de-colored components inside.

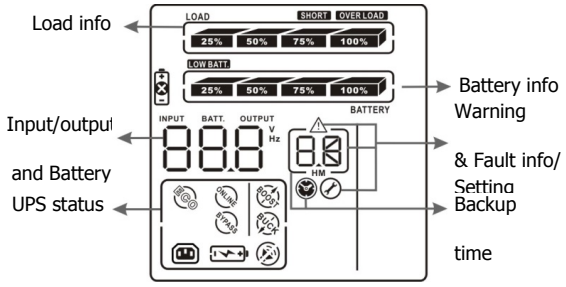
Operation and setting
Switch panel



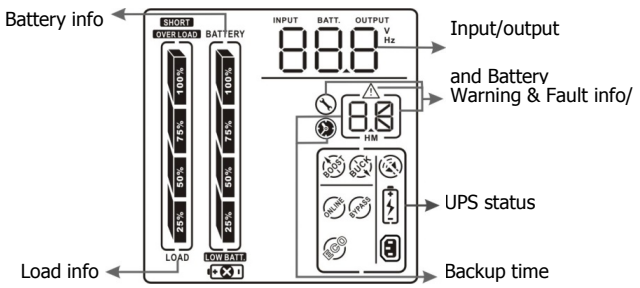
Button	Function
ON/MUTE Button	• Turn on the UPS: Press and hold ON/Mute button for at least 2 seconds to turn on the UPS. • Mute the alarm: After the UPS is turned on in battery mode, press and hold this button for at least 3 seconds to disable or enable the alarm system. But it's not applied to the situations when warnings or errors occur. • Up key: Press this button to display previous selection in UPS setting mode. • Switch to UPS self-test mode: Press and hold ON/Mute button for 3 seconds to enter UPS self-testing while in AC mode
OFF/ENTER Button	• Turn off the UPS: Press and hold this button at least 2 seconds to turn off the UPS • Confirm selection key: Press this button to confirm selection in UPS setting mode.
SELECT Button	• Switch LCD message: Press this button to change the LCD message for input voltage, input frequency, battery voltage, output voltage and output frequency. • Setting mode: Press and hold this button for 3 seconds to enter UPS setting mode when UPS is off. • Down key: Press this button to display next selection in UPS setting mode.
Select + OFF/Enter Button	• Rack or Tower display switch: Press Select and OFF/Enter buttons simultaneously for 3 seconds. The display change from/to Rack to/from Tower.

LCD Panel

Rack Display



Tower Display

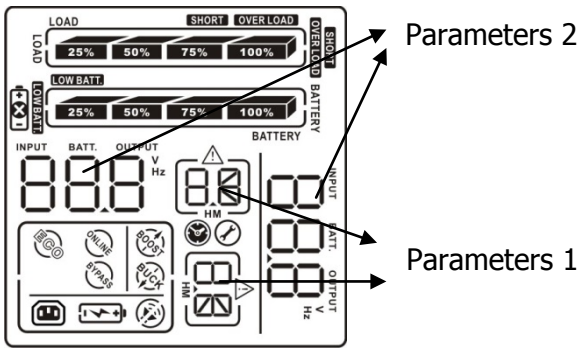


Backup time information	
	Indicates the backup time in pie chart.
	Indicates the backup time in numbers. H: hours, M: minute
Warning & Fault information	
	Indicates that the warning and fault occurs.
	Indicates the warning and fault codes, and the codes are listed in details in 3-5 section.
Setting Operation	
	Indicates the setting operation.
Input/Output & Battery information	
	Indicates the output/input voltage, output/input frequency or battery voltage. V: voltage, Hz: frequency
Load information	
	Indicates the load level by 0-24%, 25-49%, 50-74%, and 75-100%.
	Indicates overload.
	Indicates the load or the UPS output is short circuited.
UPS status	
	Indicates that programmable management outlets are working.
	Indicates that the UPS alarm is disabled.
	Indicates the UPS powers the output directly from the mains
	Indicates the battery charger is working.
	Indicates the UPS is working in boost mode
	Indicates the UPS is working in buck mode
Battery information	
	Indicates the Battery level by 0-24%, 25-49%, 50-74%, and 75-100%.
	Indicates low battery.
	Indicates there is something wrong with battery.

LCD display wordings index

Abbreviation	Display content	Meaning
ENA	ENA	Enable
DIS	dIS	Disable
ESC	ESC	Escape
ON	ON	ON
OK	OK	OK
EP	EP	EPO
AO	AO	Active open
AC	AC	Active close
TP	tP	Temperature
CH	CH	Charger
RAC	rAC	Rack display
TOE	toE	Tower display
SF	SF	Site Fault
EE	EE	EEPROM error
BR	bF	Battery Replacement

UPS Setting



There are two parameters to set up the UPS.
Parameter 1: It's for program alternatives. Refer to below table for details.
Parameter 2: It's setting options or values for each program.

Output voltage setting

Interface	Setting
	For 208/220/230/240 VAC models, you may choose the following output voltage: 208: presents output voltage is 208Vac 220: presents output voltage is 220Vac 230: presents output voltage is 230Vac (Default) 240: presents output voltage is 240Vac For 110/115/120/127 VAC models, you may choose the following output voltage: 110: presents output voltage is 110Vac 115: presents output voltage is 115Vac 120: presents output voltage is 120Vac (Default) 127: presents output voltage is 127Vac

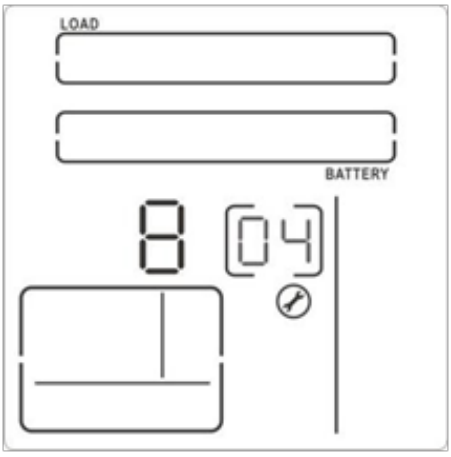
Programmable outlets enable/disable

Interface	Setting
	ENA: Programmable outlets enable (Default) DIS: Programmable outlets disable

Programmable outlets setting

Interface	Setting
	Setting the backup time limits in minutes from 0-999 for programmable outlets which connect to non-critical devices on battery mode.

Maximum charger current setting

Interface	Setting
	Set up the maximum charger current. 1/2/4/6/8: setting the maximum charger current at 1/2/4/6/8 Ampere. (Default: 8A) Note: This setting is only effective for super charger.

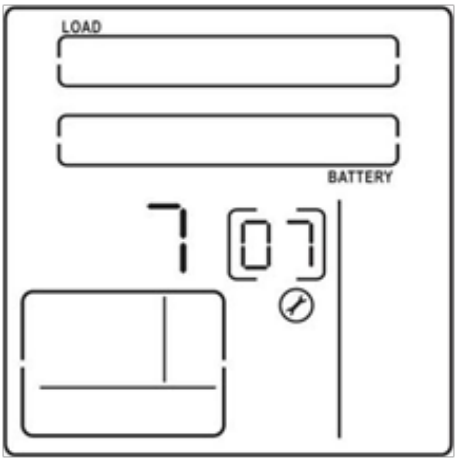
LCD display direction setting

Interface	Setting
	RAC: the LCD display is horizontal. TOE: the LCD display is vertical.

Autonomy limitation setting

Interface	Setting
	Parameter 2: Set up backup time on battery mode for general outlets. 0-999: setting the backup time in minutes from 0-999 for general outlets on battery mode. DIS: Disable the autonomy limitation and the backup time will depend on battery capacity. (Default) Note: When setting as “0”, the backup time will be only 10 seconds.

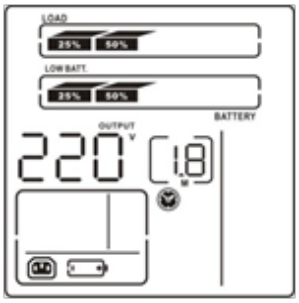
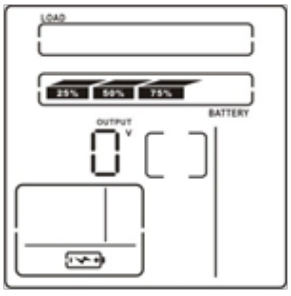
Battery total AH setting

Interface	Setting
	Parameter 2: Set up the battery total AH of the UPS. 7-999: setting the battery total capacity from 7-999 in AH. Please set the correct battery total capacity if external battery bank is connected.

EPO logic setting

Interface	Setting
	Set up the EPO function control logic. AO: Active Open (Default). When AO is selected as EPO logic, it will activate EPO function with Pin 1 and Pin 2 in open status. AC: Active Close. When AC is selected as EPO logic, it will activate EPO function with Pin 1 and Pin 2 in close status.

Operating Mode Description

Operating mode	Description	LCD display
ECO mode	When the input voltage is within voltage regulated range, UPS will power the output directly from the mains. ECO is an abbreviation of Efficiency Corrective Optimizer. In this mode, when battery is fully charged, the fan will stop working for energy saving.	
Buck mode when AC is normal.	When the input voltage is higher than the voltage regulation range but lower than high loss point, the buck AVR will be activated.	
Boost mode when AC is normal.	When the input voltage is lower than the voltage regulation range but higher than low loss point, the boost AVR will be activated.	
Battery mode	When the input voltage is beyond the acceptable range or power failure and alarm is sounding every 10 seconds, UPS will backup power from battery.	
Standby mode	UPS is powered off and no output supply power, but still can charge batteries.	

Faults Reference Code

Fault event	Fault code	Icon	Fault event	Fault code	Icon
Bus start fail	01	x	Inverter output short	14	x
Bus over	02	x	Battery voltage too high	27	x
Bus under	03	x	Battery voltage too low	28	x
Inverter soft start fail	11	x	Over temperature	41	x
Inverter voltage high	12	x	Overload	43	
Inverter voltage Low	13	x	Charger failure	45	x

Warning indicator

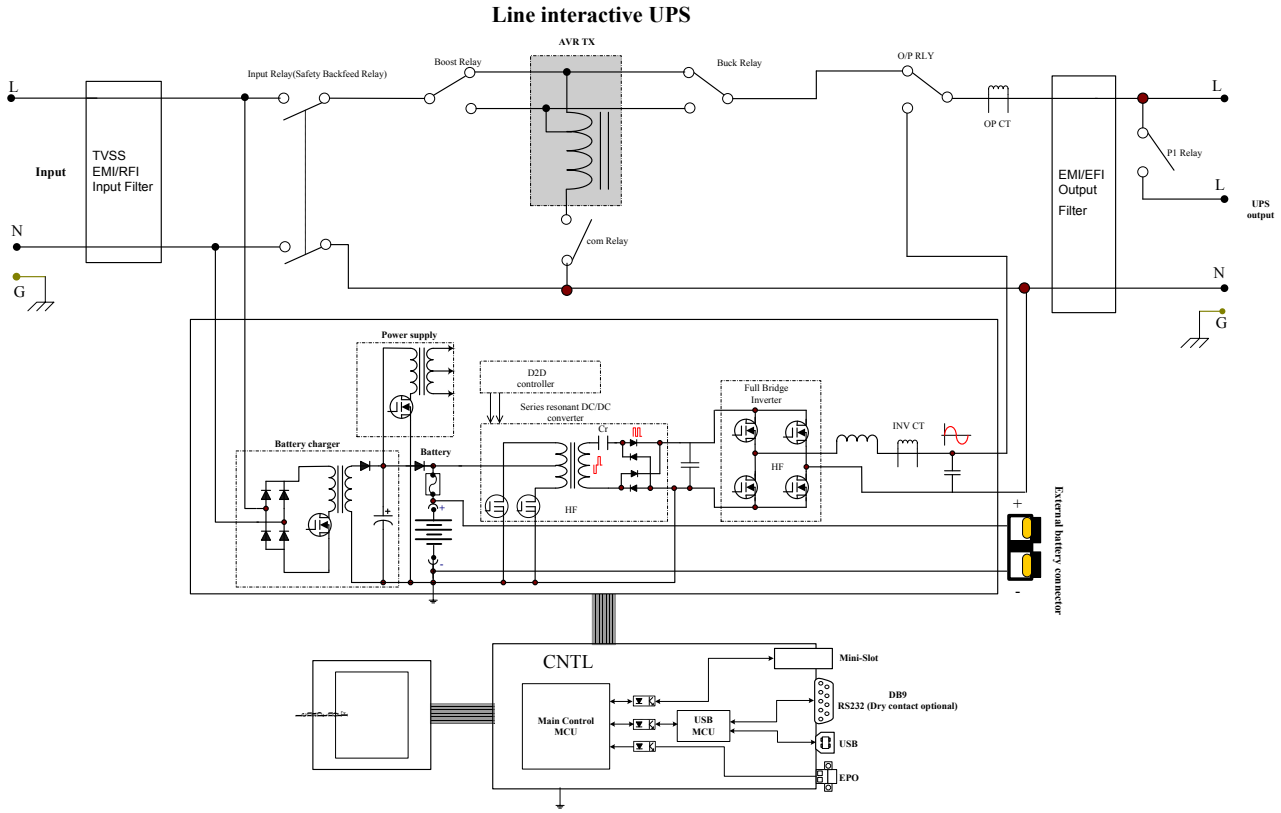
Warning	Icon (flashing)	Alarm
Low Battery		Sounding every 2 seconds
Overload		Sounding every second
Battery is not connected		Sounding every 2 seconds
Over Charge		Sounding every 2 seconds
Site wiring fault		Sounding every 2 seconds
EPO enable		Sounding every 2 seconds
Over temperature		Sounding every 2 seconds
Charger failure		Sounding every 2 seconds
Battery fault		Sounding every 2 seconds
EEPROM error		Sounding every 2 seconds (At this time, UPS is off to remind users of something wrong with battery)
Battery replacement		Sounding every 2 seconds

Audible Alarm

Battery Mode	Sounding every 5 seconds
Low Battery	Sounding every 2 seconds
Overload	Sounding every second
Fault	Continuously sounding

Circuit principle

Functional diagram



800 / 1000 / 1500 / 2000 / 3000/ 5000 VA

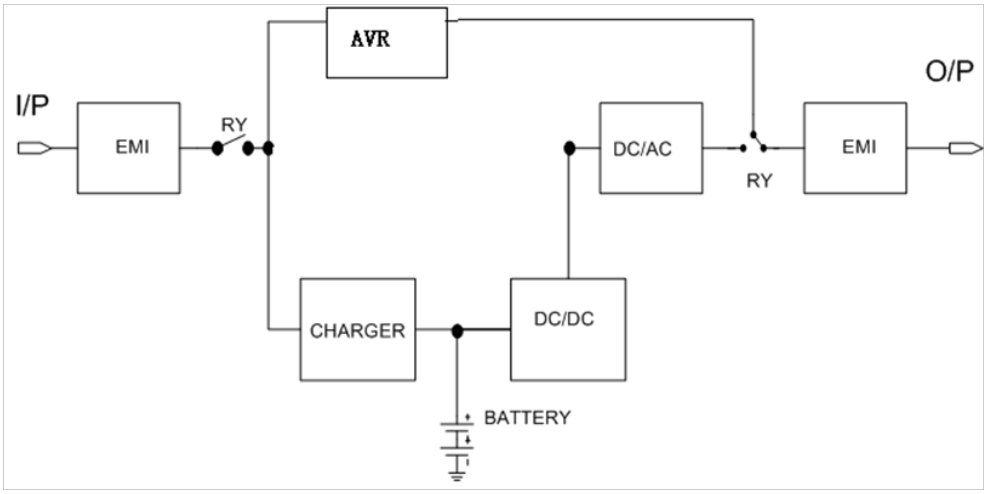
Subsystem instruction

This Otima series UPS system contains two major PCB assemblies. They are including:

1. Power board	Contains major parts of (1) Charger, (2) Auxiliary power supply, (3) DC-DC converter, (4) Inverter, (5) Output filter.
2. Control board	Contains major parts of protection, signaling circuits, regulation and control circuits of inverter

The functional diagram shows how the major circuits are connected and illustrates the overall system functions.

The block diagram shows the UPS at normal operation from left to right. this Line-interactive UPS system utilizes AVR TX to achieve high efficient performance. This UPS can deliver a clean, regulated sine-wave output in case the input voltage is loss and UPS transfer to battery mode at any load under full load. The sub-systems are described as below:

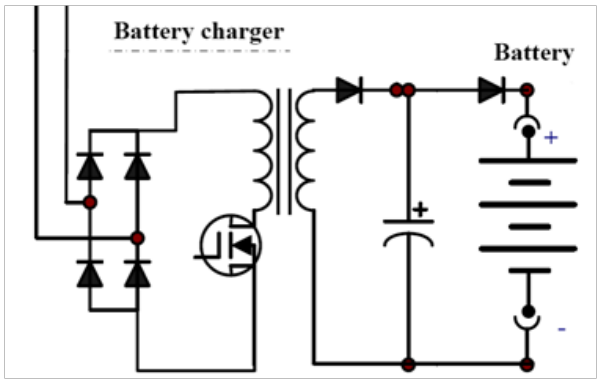


Block Diagram for UPS

As shown in functional diagram, the power stage consists of charger, DC power supply, DC-DC converter, inverter and output filter.

Charger Sub-System:

The purpose of charger is to charge and to maintain the batteries at full charged condition. Refer to circuit diagram, the voltage fly back switching power supply provides a constant DC voltage (13.65Vdc/PCS battery) for batteries. Besides providing constant voltage, the power supply also limits the current flowing into batteries and therefore protects and prolongs the life time of charged batteries.

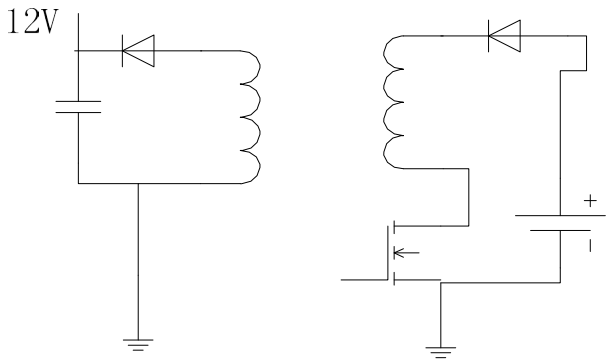


Charger Circuit Diagram

Note: For detail circuit diagram and key waveforms and values, see Annexures-circuit diagram.

Auxiliary Power Supply Sub-System:

The input of the auxiliary power supply is connected to the battery bus, i.e., the output of the charger. The output of auxiliary power supplies provides +12 Vdc for the bias supply of IC's working voltage and the fan(s) voltage. The DC power supply works only when the 12 Vdc regulator supplies Vcc to its control IC. To have proper operation of 12 Vdc regulators, its input power is controlled by the switch as indicated in circuit diagram.

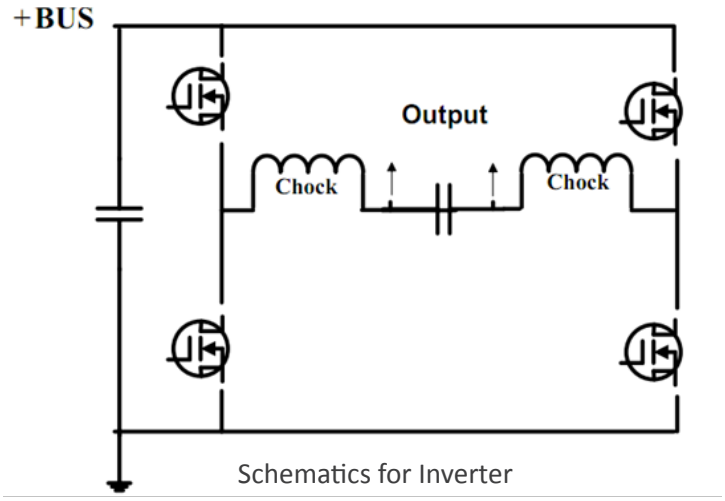


Auxiliary power supply circuit diagram

Note: For detail circuit diagram and key waveforms and values, see Annexures-circuit diagram.

Inverter Sub-System:

The UPS transfers DC bus voltages to the AC output voltage through an inverter of full bridge configuration at normal operation. The schematic diagram of inverter is shown below. To construct a high frequency (19.2 kHz) 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.



Schematics for Inverter

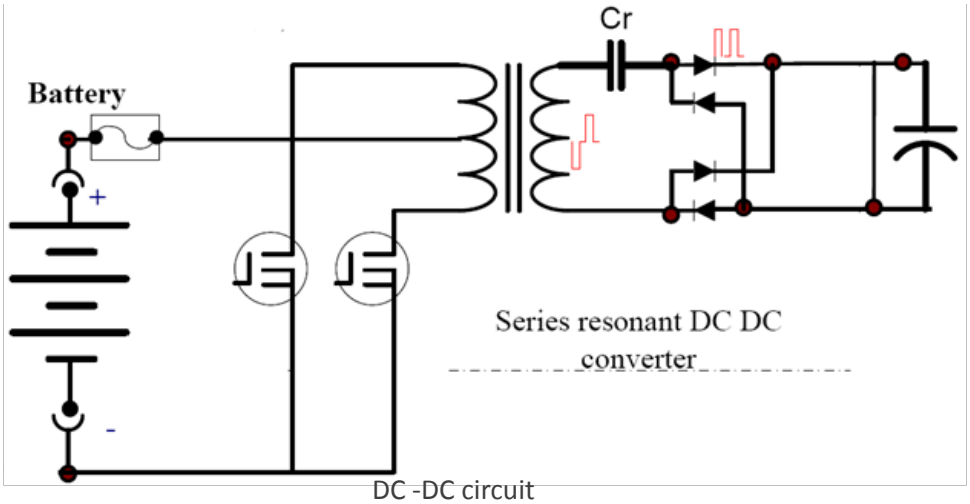
Note: For detail circuit diagram and key waveforms and values, see Annexures-circuit diagram.

Output and filter Sub-System:

The bypass relay receives signal from control circuit to switch the output of the UPS from ECO to inverter, and vice versa. The output noise filter circuit blocks EMI noise to the loads. Note: For detail circuit diagram and key waveforms and values, see Annexures-circuit diagram.

DC-DC Converter Sub-System:

The major function of the UPS is to deliver accurate AC power to the loads connected to it whenever the AC line is correct or fails. In this system, the batteries release the stored energy to supply inverter immediately upon AC line fails.
Refer to circuit diagram, the battery voltage is transformed through a push-pull DC-DC converter to 360Vdc(180V for LV model) as DC buses for inverter. When the line fails, the 360Vdc (180V for LV model) DC sources are caught up to supply the power needed by the inverter immediately.



DC -DC circuit

Note: For detail circuit diagram and key waveforms and values, see Annexures-circuit diagram.

Control Board

These assemblies are the control center of UPS. It is composed of three major circuits as following.

REGULATION & CONTROL SUB-SYSTEM:

This portion can be seen as brain of the UPS. It provides the control pulses to the switching elements which deliver power to the output. The sub-system also regulates the output to ensure that the UPS is delivering constant AC voltage to the loads.

The inverter signal is sensed directly by resistor division. It is compared with a reference signal from sine wave generator. The difference of these two signals (error signal) alter the pulse widths of PWM signals which control the duty cycles of switching elements to regulate the output voltage within specification

PROTECTION SUB-SYSTEM:

The UPS provides the following protection circuits:

Overload protection

The load detector senses the load current. I.e. the inverter current, and sends the signal by two paths. In battery mode, the UPS will go to failure mode if overload condition happened. The panel will indicate the fault condition. There are two kinds of protection in our UPS:

A. Overload Protection: The UPS collects the continuous overload signals through CPU switch the output relay.
In line mode, if the output load is higher than 103% and lower than 110% of rated load (VA ,or Wattage) the UPS will warning, after 5minutes go to fault mode. If the output load is between 110% and 130% of rated load (VA ,or Wattage) the UPS will warning, after 10seconds go to fault mode.. If the output load is higher than 130% of rated load, the UPS will go to fault mode after 1second.
In battery mode, if the output load is higher than 110% and lower than 120% of rated load (VA ,or Wattage) the UPS will warning, after 0.5minutes go to fault mode. If the output load is between 120% and 130% of rated load (VA ,or Wattage) the UPS will warning, after 10seconds go to fault mode.. If the output load is higher than 130% of rated load, the UPS will go to fault mode after 1 second.

B. Cycle by Cycle Current Limit: When output loads sink a high surge current for a short time, a high inverter current is detected and the inverter switches, i.e. the IGBTs, are turned off pulse by pulse to protect themselves from thermal runaway. The output relay stays at inverter output position unless a continuous overload is detected or an abnormal inverter operation occurs.]

Battery over or under shut down
Upon the battery voltage declines to battery-under/over level, the UPS will warning and the LCD will display the fault code, then shut down.
In case of the battery voltage is high voltage, the UPS will warning and the LCD will display the fault code.

Inverter output abnormal protection
The inverter failure signal shuts down the inverter immediately, makes the buzzer a continuous alarm, and the LCD displays the fault code.
“The failure signal latches itself unless SW off or battery is empty”.

Over temperature protection
The thermal switch detects the temperature of PSDR heat sink. The thermal switch is electrically connected to the CPU. An opened thermal switch is thought as temperature failure by the UPS. The LCD will display the fault code.

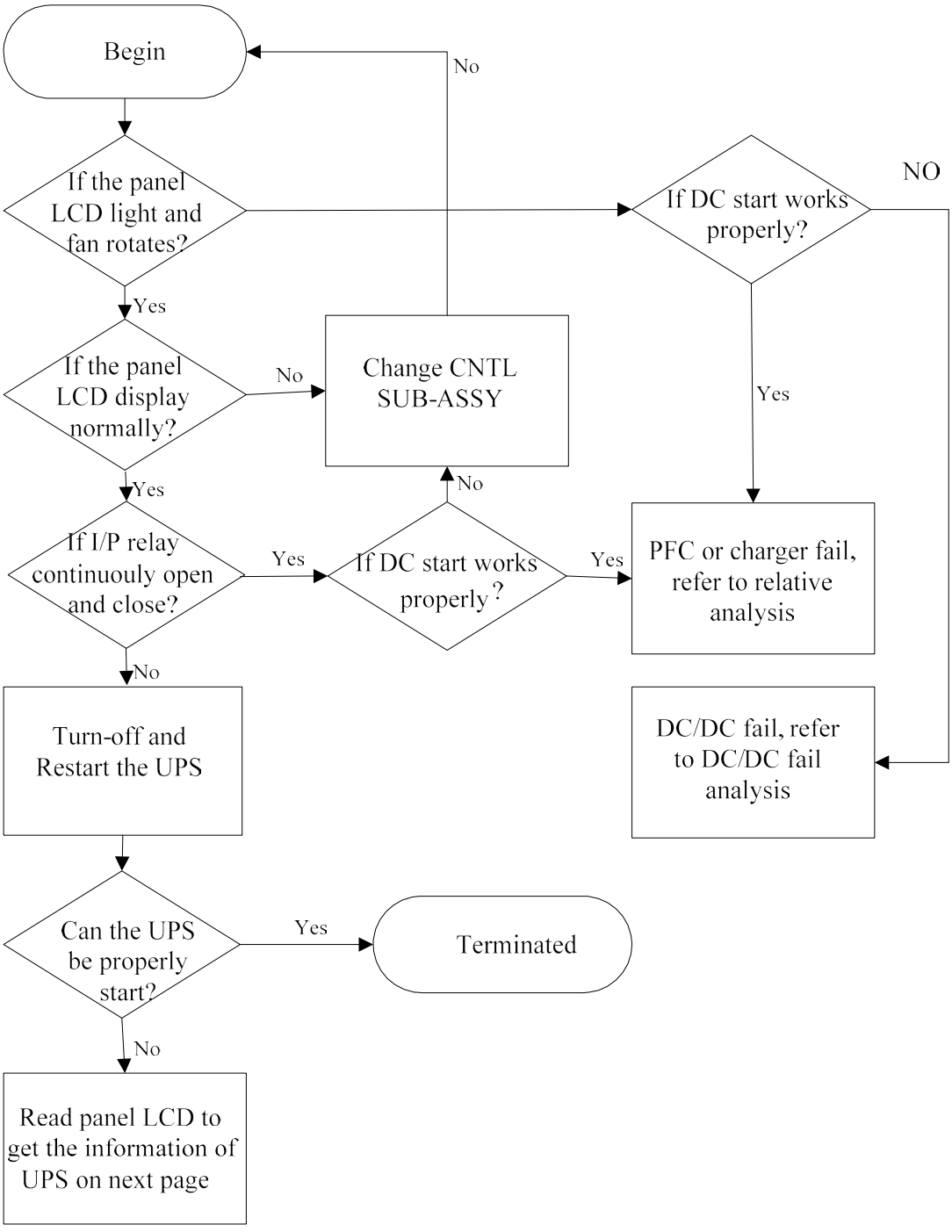
Bus over/under/unbalance-voltage protection
To protect any BUS over/under voltage condition. The LCD will display the fault code.

Signaling Sub-System
When the AC line is unable to supply, the batteries release energy inside to supply the inverter immediately. At the same time, the buzzer beeps every 5 seconds.
Upon the batteries are discharged to battery-low level, the battery-low signal is activated and the buzzer beeps every 2 second.

Trouble Shooting

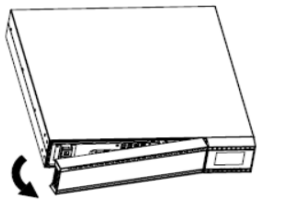
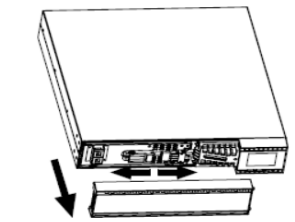
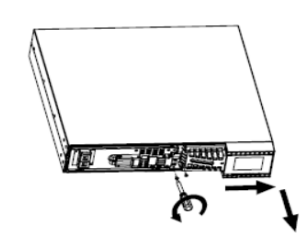
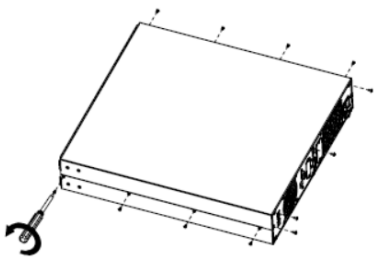
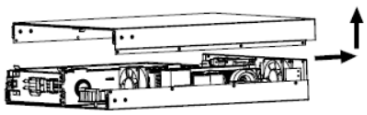
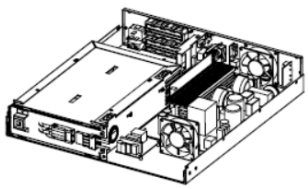
Due to careful design and strict tests of our products, fail of UPS seldom occurs. However, once they do fail in some situations, please check them according to Trouble Shooting Chart that will help you solve the most problems on UPS.

Trouble Shooting Chart



Failure Diagnosis

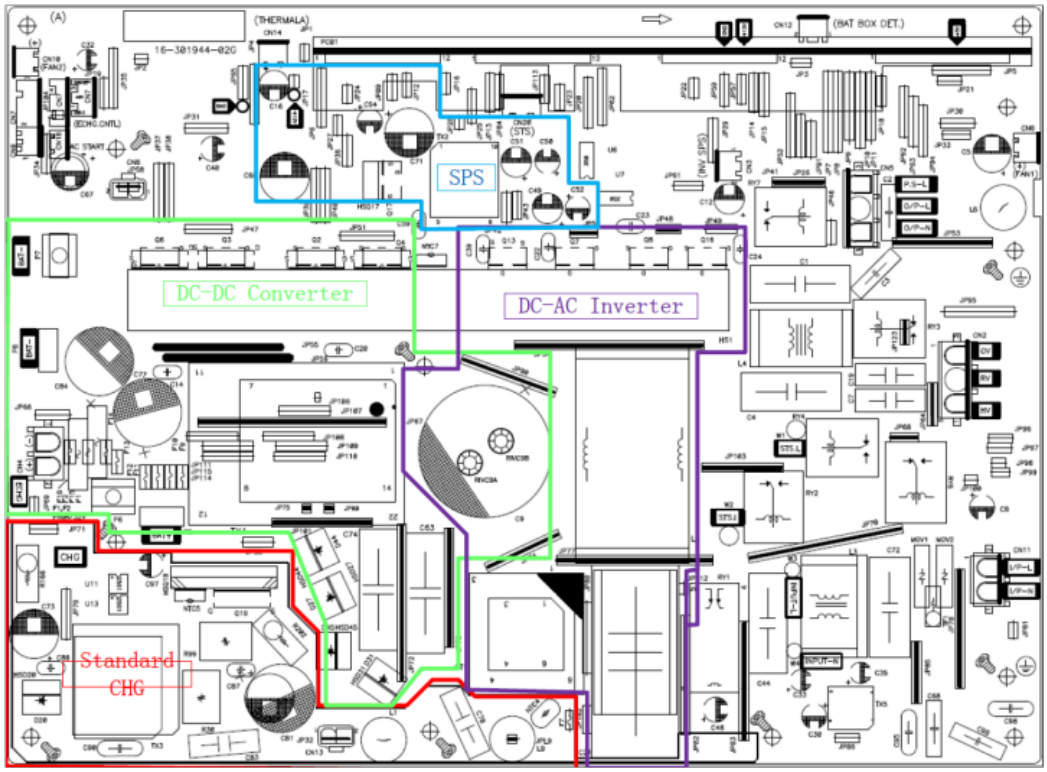
Steps to open the case

STEP1	
	
	
STEP2	
STEP3	
STEP4	

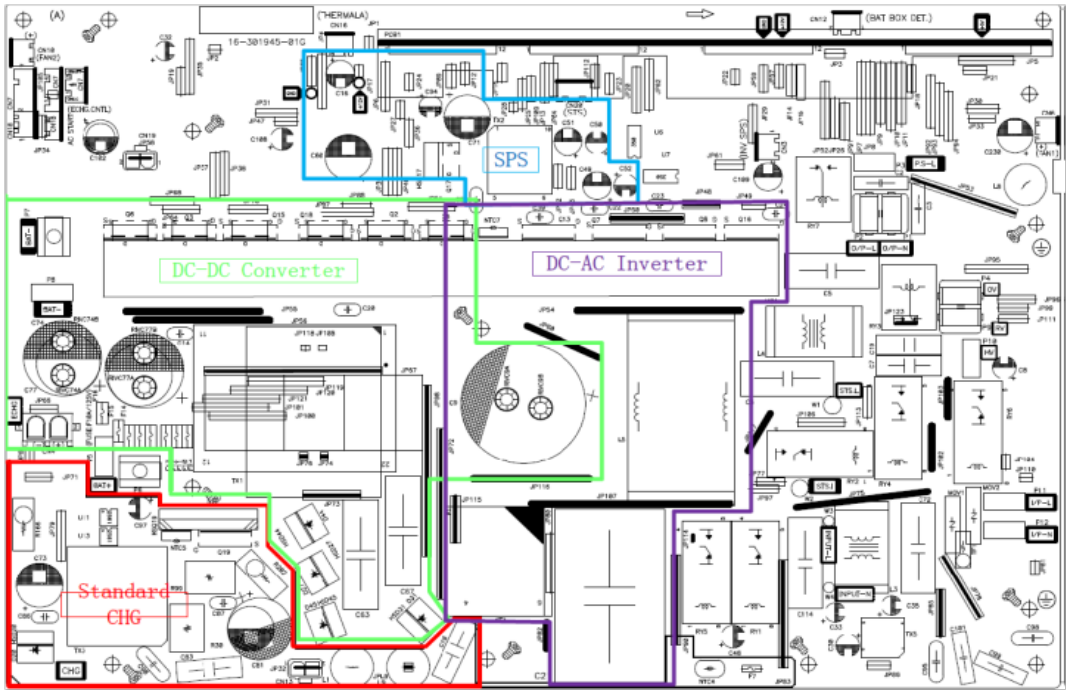
Critical component list

We must use multi-meter to check the value, the following is PCB block diagram.

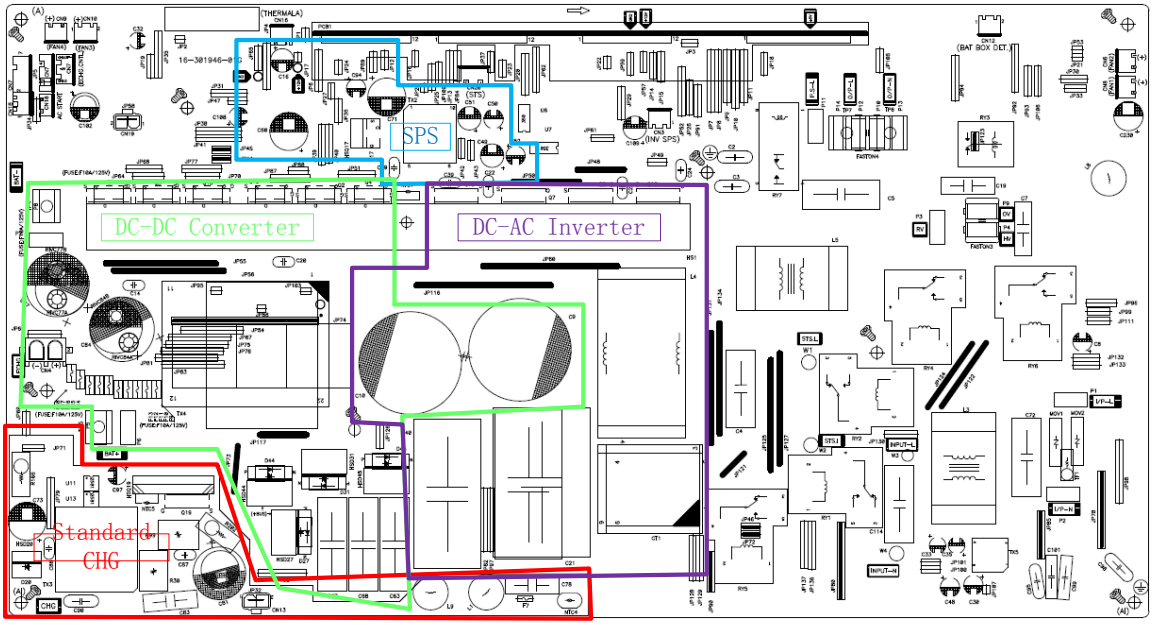
1K PCB



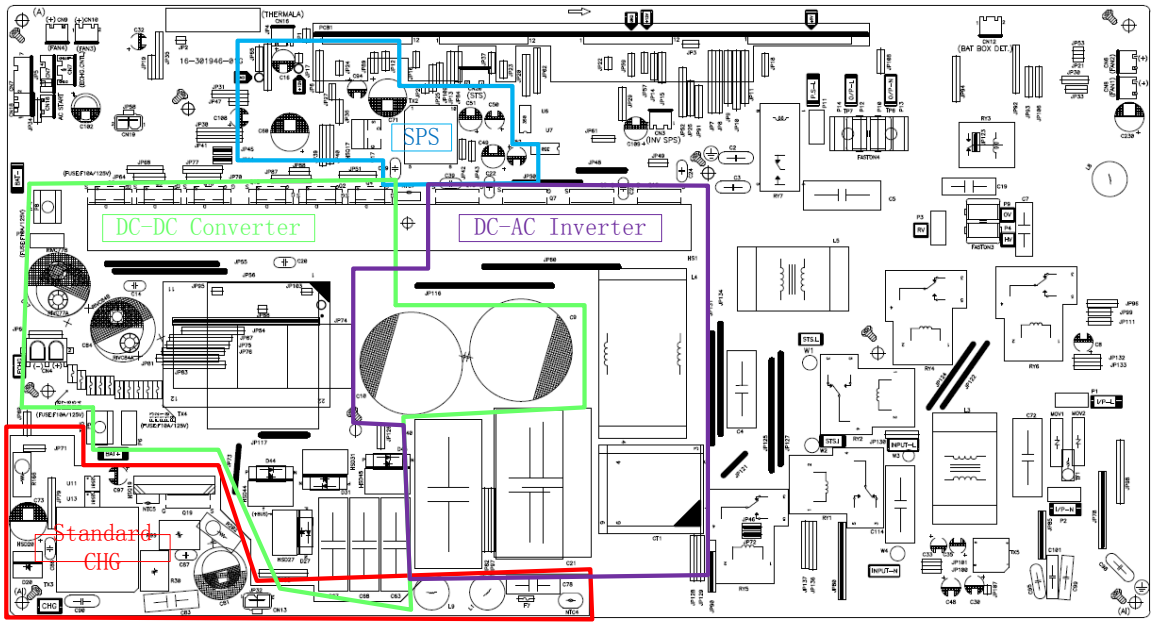
2K PCB



3K PCB


SPS
DC-DC Converter
DC-AC Inverter
Standard
CHG

5K PCB


SPS
DC-DC Converter
DC-AC Inverter
Standard
CHG

Overview

Circuit Block	Components to be checked	Fail condition
Power board	Fuse	open
	Diode	short or open
	MOSFET	G-D-S short or open
	IGBT	G-C-E short or open
Control board	5V voltage regulator (78M05)	Input and output short
	MCU	I/O port breakdown
Charger	Fuse	open
	Diode	short or open
	MOSFET	G-D-S short or open

DC-DC CONVERTER

Step	Checked components	Instrument function	Reference Value	Failed condition
1	MOSFET Q2,Q3,Q4,Q6 Q15,Q18 S,D D,S; G,S; G,D	Diode Diode	~0.46 >0.6	Short Short or <0.6
2	Fuse F9~F15	Resistance	0 ohm	Open
3	Diode D27, D31, D44, D45,	Diode	~0.42	Short or open
4	Resistor R56,R32,R64,R66,R31,R54	Resistance	~22 ohm	>25 ohm or Open

DC/AC INVERTER

Step	Checked components	Instrument function	Reference Value	Failed condition
1	IGBT Q7, Q8 ,Q13,Q16 (E,C) (G,E; C,E)	Diode Diode	~0.47 Open	Short or open Short
2	Resistor R113, R69 R108, R246	Resistance	-22 ohm	>25 ohm or Open

DC POWER SUPPLY

Step	Checked components	Instrument function	Reference Value	Failed condition
1	MOSFET Q17 S,D D,S; G,S; G,D	Diode	~0.53 >0.6	Short Short or <0.6
2	Diode D22, D28	Diode	~0.34	Short or open
3	Resistor R191, R192	Resistance	~0.2	>1 ohm
4	Resistor R146	Resistance	~22 or47 ohm	>100 ohm or Open
5	Diode D7, D8, D9	Diode	~0.49	Short or open

CHARGER (POWER BOARD)

Step	Checked components	Instrument function	Reference Value	Failed condition
1	MOSFET Q19 S,D D,S; G,S; G,D	Diode Diode	~0.49 >0.6	Short Short or <0.6
2	Fuse F7	Resistance	0 ohm	Open
3	Diode D14 D20	Diode Diode	~0.57 ~0.57	
4	Resistor R202	Resistance	~0.1	>1 ohm
5	Resistor R155	Resistance	~33 ohm	>60ohm
9	U14(1252) PIN 5-6 5-7 5-8 6-8	Ω	38k 4K 412k 415K	too low

After you have replaced all defect components on power stage (PSDR), connect with control board. Supply appropriate DC voltage 3Amp (limited current) with DC power via BAT+ and BAT-, then turn on the switch on panel, you will see “current limit” on the DC power supply for about 2 seconds (If not, there are some defective components you have not found).

When everything seems good, turn off the switch on panel and remove DC power supply. Plug in the power cord and supply UPS with the mains. Test the output voltage of charger is OK or not. The fan will also active. If there is no problem in charger, connect the batteries via BAT+ and BAT-. Finally, turn on the switch on panel again and follow the maintenance circuit diagram to check the voltage on DC bus, output voltage, or other signals.

CAUTION: DO NOT supply UPS with the mains or batteries unless you are sure that you have replaced all defective components.

APPENDIX I: COMMUNICATION

1. RS232 PORT

The RS232 provides proprietary command sequence for the computer to monitor the line and UPS status and to control the UPS. The data format is listed as following:

BAUD RATE.....: 2400 bps
DATA LENGTH.....: 8 bits
STOP BIT.....: 1 bit
PARITY.....: NONE

The interface configuration is indicated in figure VI-1 and the pin assignment and description are listed in the following table.

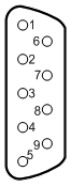


Figure VI-1 9 pins female D-type connector

PIN #	Description	I/O type
1,4,6,7,8,9	not connected	
3	UPS RS232 receiver Rx from computer.	input
2	UPS RS232 transmitter to computer	output
5	GND	

Note that, the computer will control information exchange by a query followed by <cr> (Character Return). UPS will respond with information followed by a <cr> or action. All the information is provided in ASCII format.

2. USB PORT

The USB is compatible to USB2.0 specification, and implemented for customized HID and self-powered device. The customized HID bi-directionally transfers the UPS protocol from USB to serial communication so that the monitor software can support the 2 communication ports (USB & RS232) with less effort.

The USB connector is “B” receptacles, seeing the following figure VI-2. The signal definition of USB interface is listed following table.

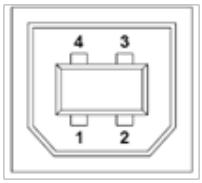


Figure VI-2 USB "B" receptacles

PIN#	SIGNAL
1	VBUS
2	D-
3	D+
4	GND