Axpert Charger/ Inverter

Service manual

Revision	Description	Prepared by	Approved by
V00	Initial draft release	Jing Fang 2013-06-10	Francis Fu 2013-06-11

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1. General information

1.1 Getting start

This manual is for Axpert MKS 1KVA-3KVA series, it can help service personal perform the basic maintenance and repair service.

This manual focus on the service, so you should get the basic operation of the Inverter/Charger from the user manual, and make sure you had read and understood user manual before you use this service manual.

The manual include 8 sections, as follows

- General Information, this section show you the general information of the service manual
- Functional Block, this section show you the major functional block of the Inverter/Charger
- Working Principle of the major Functional Block, this section show you the major functional block
- Function explanations for each PCB, this section show you all the PCBs of the Inverter/Charger
- Interface, this section show you the LCD interface, include display and setting
- Trouble shooting, this section will give you the way to find the trouble
- Test step ,this section tell you how to test the Inverter/Charger after you repair the unit
- Electric Specifications, this section show you the basic electric specification of the Inverter/Charger

1.2 Important safety instructions

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

1. Before using the unit, read all instructions and cautionary markings on the unit, the batteries and all appropriate sections of this manual.
2. **CAUTION** --To reduce risk of injury, charge only deep-cycle lead acid type rechargeable batteries. Other types of batteries may burst, causing personal injury and damage.
3. Do not disassemble the unit. Take it to a qualified service center when service or repair is required. Incorrect re-assembly may result in a risk of electric shock or fire.
4. To reduce risk of electric shock, disconnect all wirings before attempting any maintenance or cleaning. Turning off the unit will not reduce this risk.
5. **CAUTION** – Only qualified personnel can install this device with battery.
6. **NEVER** charge a frozen battery.
7. For optimum operation of this inverter/charger, please follow required spec to select appropriate cable size. It's very important to correctly operate this inverter/charger.

8. Be very cautious when working with metal tools on or around batteries. A potential risk exists to drop a tool to spark or short circuit batteries or other electrical parts and could cause an explosion.

9. Please strictly follow installation procedure when you want to disconnect AC or DC terminals. Please refer to INSTALLATION section of this manual for the details.

10. Fuses (40A, 32VDC *4pcs for 1KVA/2KVA and *6pcs for 3KVA) are provided as over-current protection for the battery supply.

11. GROUNDING INSTRUCTIONS -This inverter/charger should be connected to a permanent grounded wiring system. Be sure to comply with local requirements and regulation to install this inverter.

12. NEVER cause AC output and DC input short circuited. Do NOT connect to the mains when DC input short circuits.

13. **Warning!!** Only qualified service persons are able to service this device. If errors still persist after following troubleshooting table, please send this inverter/charger back to local dealer or service center for maintenance.

2. Functional block

Axpert MKS 1KVA-3KVA series production employ a double conversion topology, comprise following functional blocks, as shown in figure 2.1
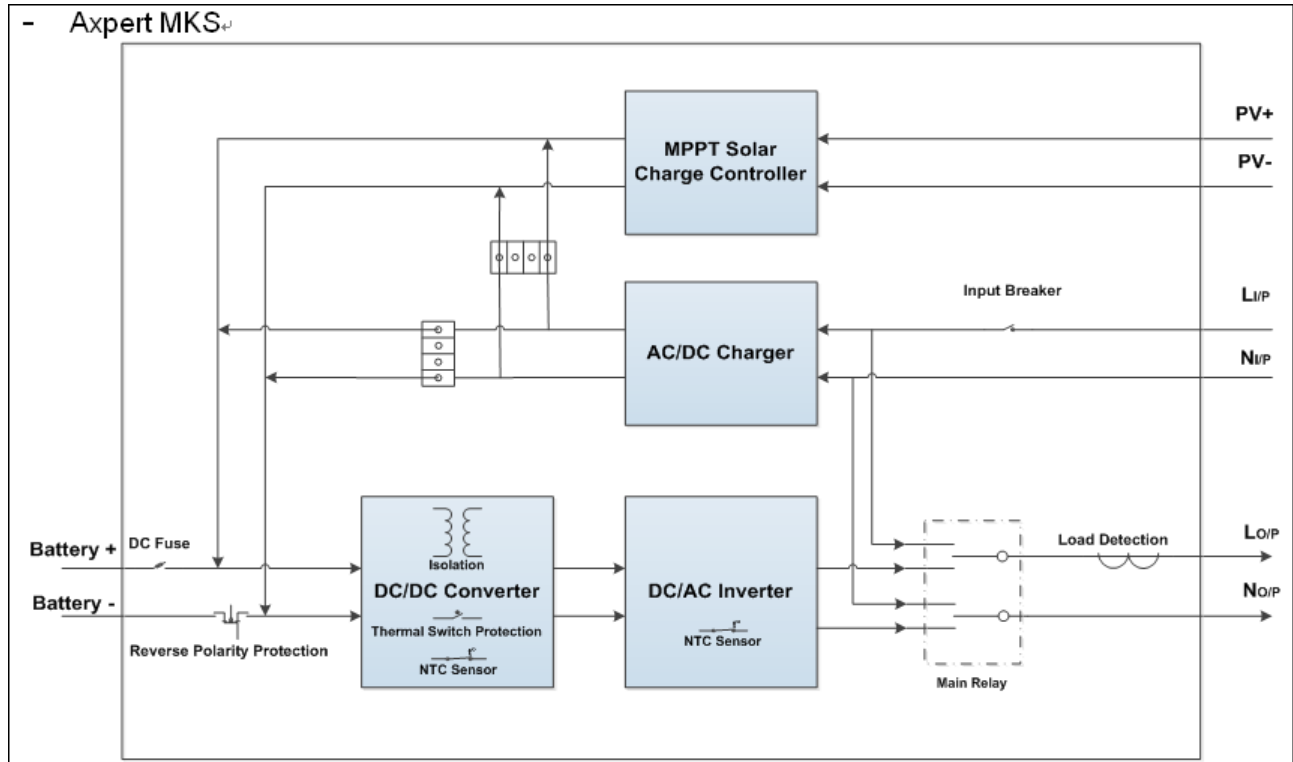

Figure 2.1 function block diagram

3. Working principle of the major functional block

3.1 Switch Power Supply

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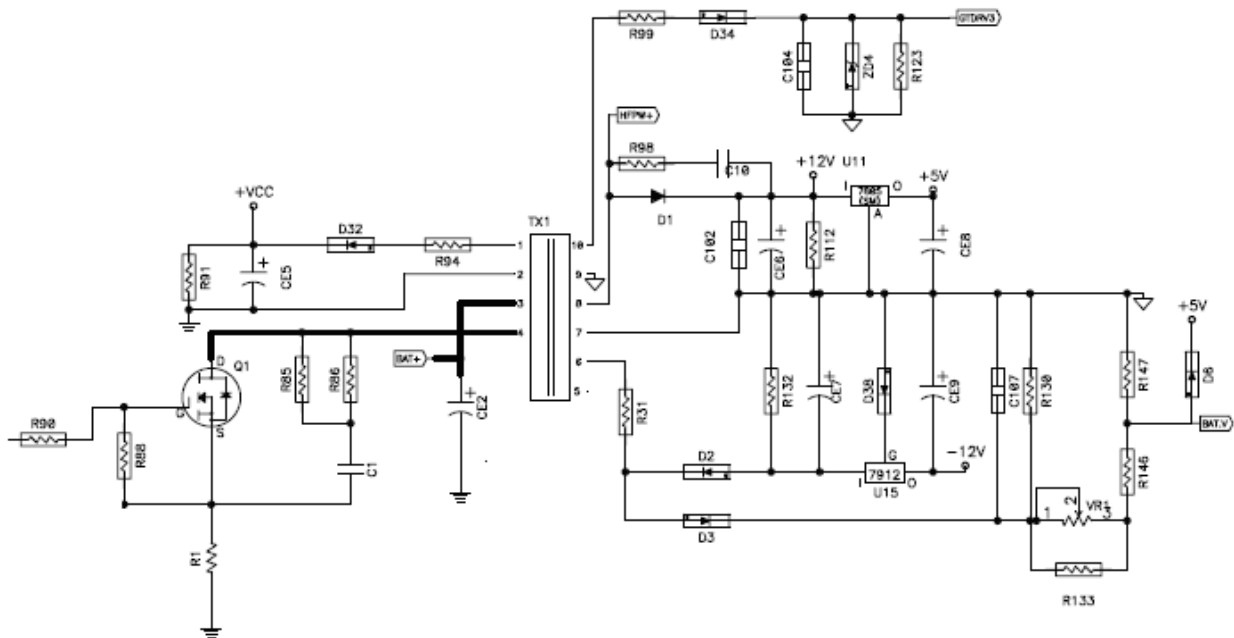

Figure 3.1 basic circuit of power supply

This is the fly-back DC-DC converter, fly-back operation can be easily recognized from the position of the dots on the transformer primary and secondary(these dots show starts of the winds). When Q1 is ON, the dot ends of all winds are negative with respect to their no-dot ends. Output rectifier diodes D1, D2, D32 and D34 are reverse-biased and all the output load currents are supplied from storage filter capacitors C1, C2, C3 and C4.The primary coil of the transformer acts as an inductor and stored energy.

When Q1 is OFF, the stored energy in the primary coil is delivered to secondary filter capacitors CE5, CE6, CE7and C104.

As shown in figure 3.1, this circuit may generate several output voltage, such as +12V,-12V, +VCC, +5V, HFPW+, GTDRV3.

3.2 DC TO DC converter (push-pull)

The push-pull topology is a transformer isolated forward-mode regulator. Unlike the
Fly-back transformer, the push-pull transformer does not store any energy and output current is drawn
when either power switches (Q7-Q11 or Q2-Q6) is conducting.
A push-pull topology is shown in figure 3.2, power switch Q7-Q11 and Q2-Q6 receive 180 out-of-phases.
Refer to figure 3.2, the battery voltage is transformed through a push-pull DC-DC converter to >330Vdc
as DC BUS for inverter. When the line fails, the DC BUS voltage is caught up to supply the power needed
by the inverter immediately.
The output voltage (DCBUS) must be higher than the input voltage (BAT+) .It mentioned by the primary
turns and secondary turns. In this circuit,   BAT+ =24VDC with MKS1000/2000/3000,DC BUS voltage
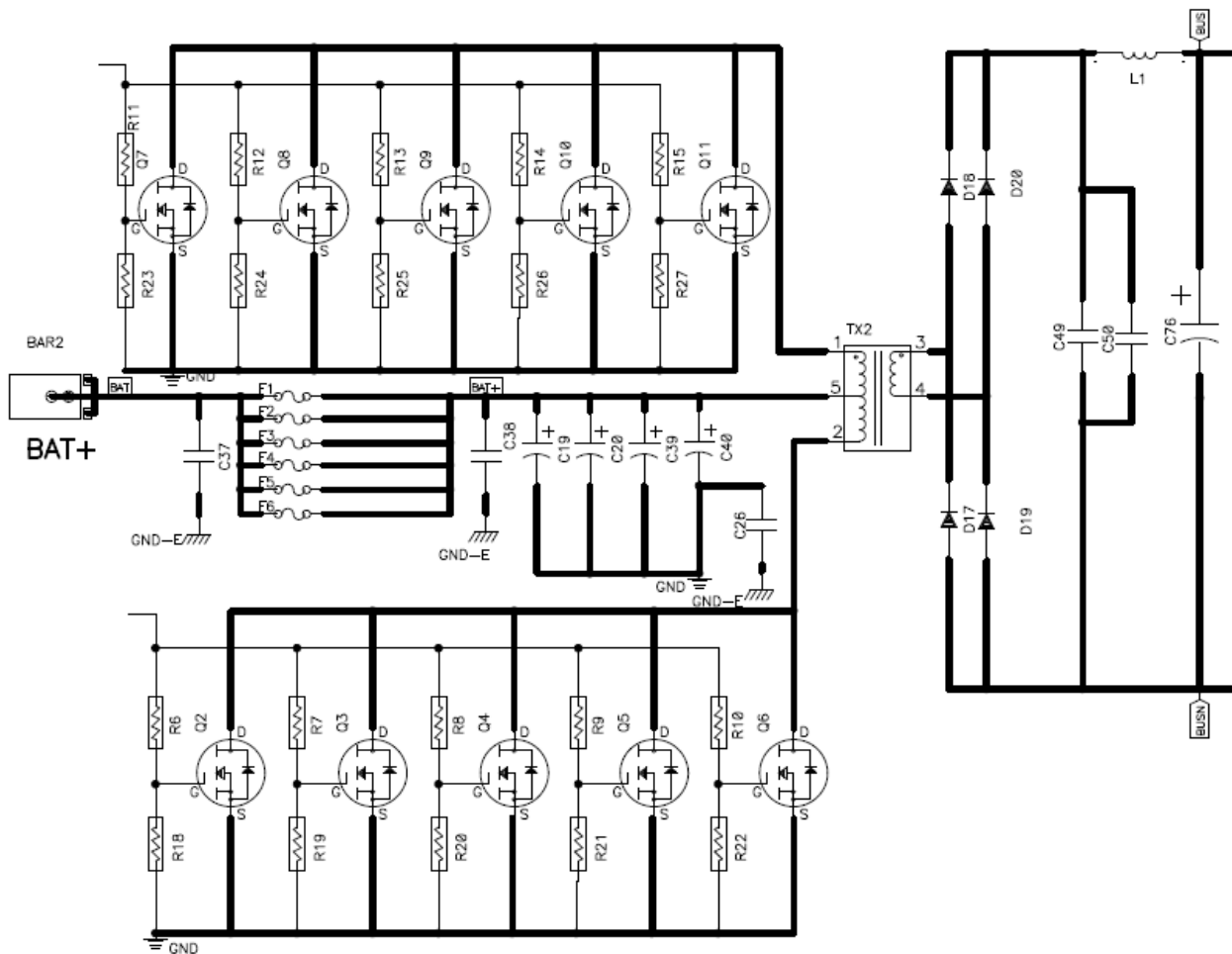above 330Vdc.

Figure 3.2 Push-pull topology

3.3 DC TO AC inverter (full-bridge)

The Inverter circuit (Figure 3.3) and PWM control are only active under battery mode. The Inverter circuit of Axpert MKS series is based on a full-bridge circuitry and its output is driven by photo-couplers. The photo-couplers are capable to drive high energy and high speed power of MOSFET and IGBT with independent high and low referenced output channels.

To construct a high frequency PWM inverter, the drivers receive switching signals from PWM generation circuit through a pair of photo-couplers to trigger the upper IGBT and the lower IGBT alternately. The output of IGBT's is filtered by an LC circuit to reduce the o/p voltage harmonics distortion.
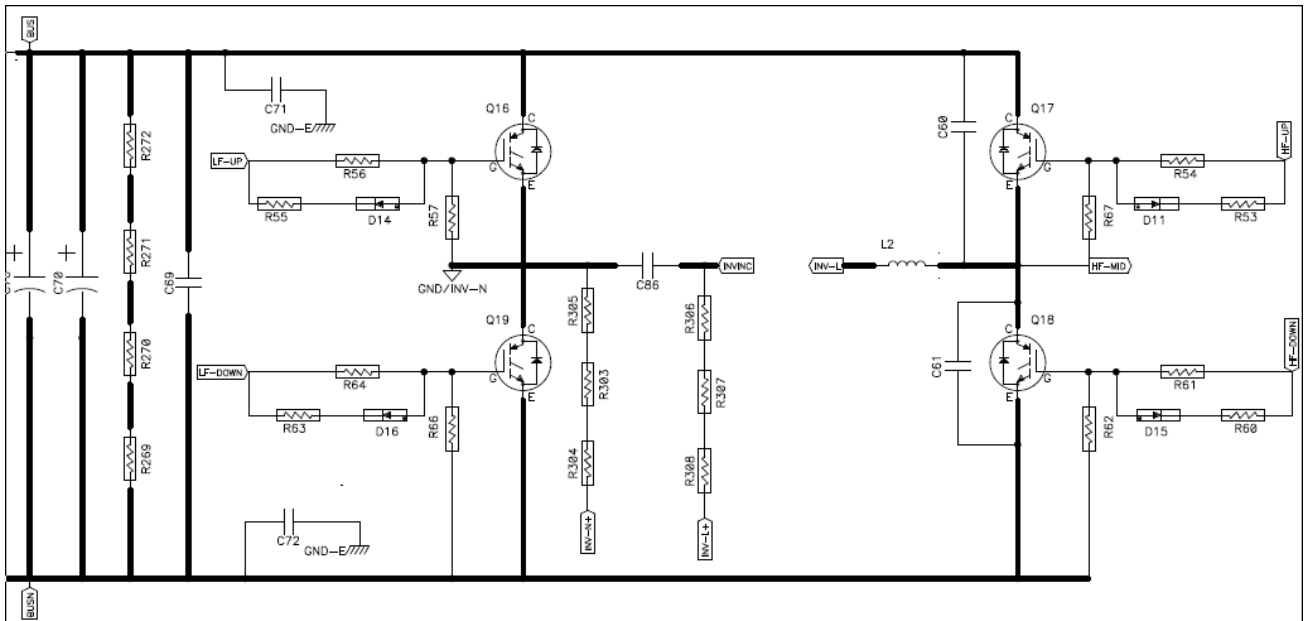
Figure 3.3 Full-bridge topology

3.4 Charger

The Charger of utility is to recharge and maintain the batteries at fully charged condition .The charger charges the batteries with a constant current at initial stage, and as battery voltage keep increasing, the charge current decrease accordingly until the charge voltage reached the constant voltage level, and then the charger turn to the floating charge mode.

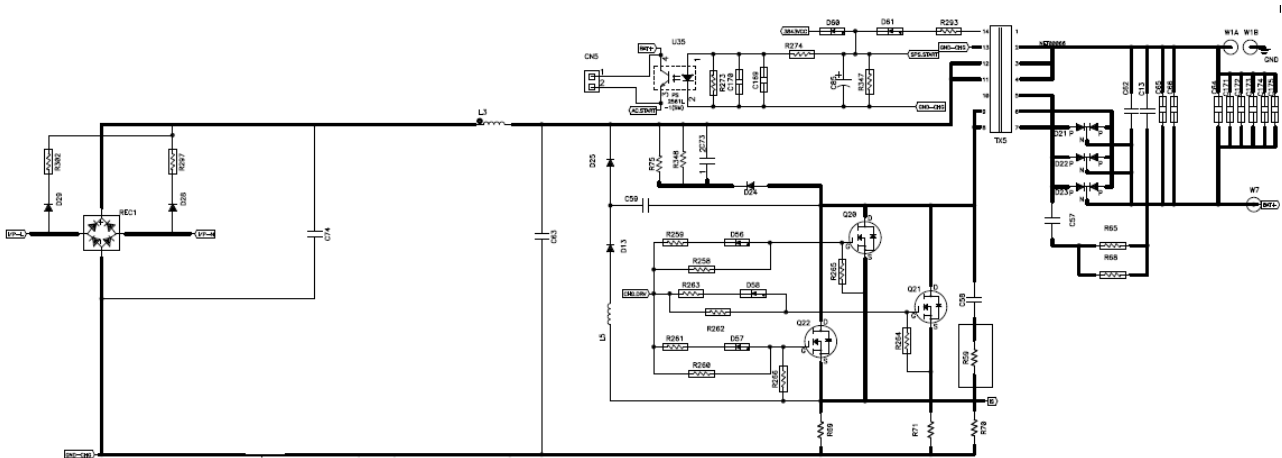As shown in figure 3.4, the charger also employed a fly-back topology like the SPS.

Figure 3.4 Charger fly-back topology

4. Functional explanations for each PCB

Item	Series name	PCB name	PCB serial number	Quantity	Remark
1	MKS-1000-24	Main	71-500324-XXG	1	
2		MPPT	71-600084-XXG	1	
3		COMM	71-500237-XXG	1	
4		LED	71-500238-XXG	1	
5		MPPT COMM	71-500323-XXG	1	
6	MKS-2000-24	Main	71-500349-XXG	1	Item 2~5 is common used PCBA.
7	MKS-2000-24	Main	71-500348-XXG	1	

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

4.1 Main board

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

4.2 MPPT board

The MPPT solar charge controller uses PWM-based DSP controller to keep batteries regulated and prevent batteries from overcharging and discharging. Applying intelligent MPPT algorithm, it allows MPPT solar charge controller to extract maximum power from solar arrays by finding the maximum power point of the array.

4.3 COMM board

This inverter/charger is equipped with a communication port to communicate with a PC with corresponding software. Please use supplied communication cable to connect to communication port of this inverter and RS-232 port of the PC.

4.4 LED board

The LED display panel includes there indicators and four functional keys.

5. Interface

The operation and display panel, shown in below chart, is on the front panel of the inverter. It includes three indicators, four function keys and a LCD display, indicating the operating status and input/output power information.
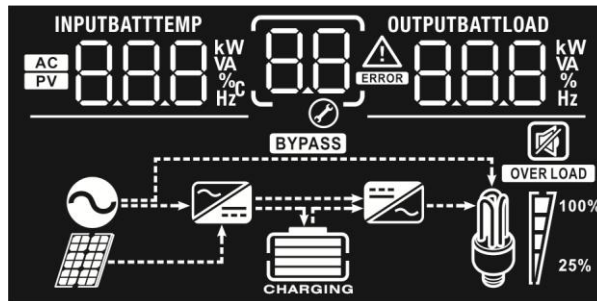

LCD display

LED indicators

Function keys
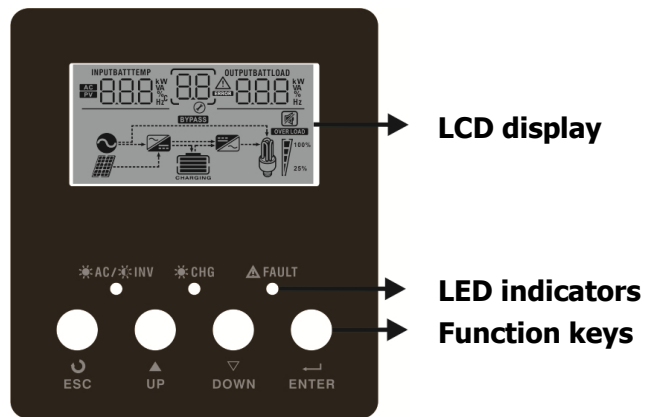
5.1 LED Indicator

LED Indicator			Messages
☀AC/☀INV	Green	Solid On	Output is available in bypass mode
		Flashing	Output is powered by battery in inverter mode
☀CHG	Green	Solid On	Battery is fully charged
		Flashing	Battery is charging.
⚠FAULT	Red	Solid On	Fault mode
		Flashing	Warning mode

Function Keys

Function Key	Description
ESC	Exit setting mode
UP	To previous selection
DOWN	To next selection
ENTER	To confirm the selection in setting mode or enter setting mode

5.2 LCD Display Icons

Icon	Function description
Input Source Information	
AC	Indicates the AC input.
PV	Indicates the PV input
INPUTBATT 888 kW VA %C Hz	Indicate input voltage, input frequency, PV voltage, battery voltage and charger current.
Configuration Program and Fault Information	
88	Indicates the setting programs.
88 ERROR	Indicates the warning and fault codes. Warning: 88 ⚠ flashing with warning code. Fault: 88 ERROR lighting with fault code
Output Information	
OUTPUTBATTLOAD 888 kW VA % Hz	Indicate output voltage, output frequency, load percent, load in VA and load in Watt.

Battery Information	
![battery CHARGING icon]	Indicates battery level by 0-24%, 25-49%, 50-74% and 75-100% in battery mode and charging status in line mode.
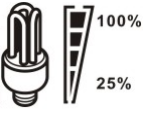
In AC mode, it will present battery charging status.

Status	Battery voltage	LCD Display
Constant Current mode / Constant Voltage mode	<2V/cell	4 bars will flash in turns.
	2 ~ 2.083V/cell	Bottom bar will be on and the other three bars will flash in turns.
	2.083 ~ 2.167V/cell	Bottom two bars will be on and the other two bars will flash in turns.
	> 2.167 V/cell	Bottom three bars will be on and the top bar will flash.
Floating mode. Batteries are fully charged.		4 bars will be on.

In battery mode, it will present battery capacity.

Load Percentage	Battery Voltage	LCD Display
Load >50%	< 1.717V/cell	
	1.717V/cell ~ 1.8V/cell	
	1.8 ~ 1.883V/cell	
	> 1.883 V/cell	
50%> Load > 20%	< 1.817V/cell	
	1.817V/cell ~ 1.9V/cell	
	1.9 ~ 1.983V/cell	
	> 1.983	
Load < 20%	< 1.867V/cell	
	1.867V/cell ~ 1.95V/cell	
	1.95 ~ 2.033V/cell	
	> 2.033	

Load Information				
OVER LOAD	Indicates overload.			
100% 25%	Indicates the load level by 0-24%, 25-50%, 50-74% and 75-100%.			
	0%~25%	25%~50%	50%~75%	75%~100%
Mode Operation Information				
∿	Indicates unit connects to the mains.			
▦	Indicates unit connects to the PV panel.			
BYPASS	Indicates load is supplied by utility power.			
▧	Indicates the utility charger circuit is working.			
▨	Indicates the DC/AC inverter circuit is working.			
Mute Operation				
🔇	Indicates unit alarm is disabled.			
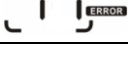
6. Troubleshooting

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

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

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

6.1 Fault Reference Code

Fault Code	Fault Event	Icon on
01	Fan is locked	01 ERROR
02	Over temperature	02 ERROR
03	Battery voltage is too high	03 ERROR
04	Battery voltage is too low	04 ERROR
05	Output short circuited or Over temperature	05 ERROR
06	Output voltage is abnormal	06 ERROR
07	Over load time out	07 ERROR
08	Bus voltage is too high	08 ERROR
09	Bus soft start failed	09 ERROR
11	Main relay failed	11 ERROR

6.2 Warning Indicator

Warning Code	Warning Event	Audible Alarm	Icon flashing
01	Fan is locked	Beep three times every second	01 ⚠
03	Battery is over charged	Beep once every 1second	03 ⚠
04	Low battery	Beep once every 1 second	04 ⚠
07	Overload	Beep once every 0.5 second	07 ⚠ OVER LOAD 100% 25%
10	Power limitation	Beep twice every 3 seconds	10 ⚠
12	MPPT Stop charging as battery too low		12 ⚠
13	MPPT charger PV voltage high loss		13 ⚠
14	MPPT charger overload fault		14 ⚠

6.3 Trouble shooting according to fault indication

Problem	LCD/LED/Buzzer	Explanation / Possible cause	What to do
Unit shuts down automatically during startup process.	LCD/LEDs and buzzer will be active for 3 seconds and then complete off.	The battery voltage is too low (<1.91V/Cell)	1. Re-charge battery. 2. Replace battery.
No response after power on.	No indication.	1. The battery voltage is far too low. (<1.4V/Cell) 2. Battery polarity is connected reversed.	1. Check if batteries and the wiring are connected well. 2. Re-charge battery. 3. Replace battery.
Mains exist but the unit works in battery mode.	Input voltage is displayed as 0 on the LCD and green LED is flashing.	Input protector is tripped	Check if AC breaker is tripped and AC wiring is connected well.
	Green LED is flashing.	Insufficient quality of AC power (Shore or Generator)	1. Check if AC wires are too thin and/or too long. 2. Check if generator (if applied) is working well, or

			check if input voltage range setting is correct (UPS→Appliance)
	Green LED is flashing.	Set Solar power as the priority of output source	Change output source priority to Utility first.

When the unit is turned on, internal relay is switched on and off repeatedly.	LCD display and LEDs are flashing.	Battery is disconnected.	Check if battery wires are connected well.
Buzzer beeps continuously and red LED is on.	Fault code 07.	Overload error. The inverter is loaded with more than 110% load and time is up	Reduce the connected load by switching off some equipment.
	Fault code 05.	Output short circuited.	Check if wiring is connected well and remove abnormal load.
		Temperature of internal converter component is over 120°C.	Check whether the air flow of the unit is blocked or whether the ambient temperature is too high.
	Fault code 02.	Internal Inverter component over 100°C	
	Fault code 03.	Battery is over charged.	Return to repair center.
		The battery voltage is too high.	Check if spec and quantity of batteries are meet requirements.
	Fault code 01.	Fan fault	Replace the fan.
	Fault code 06.	Output abnormal (Inverter voltage below than 190Vac or is higher than 260Vac)	1. Reduce the connected load. 2. Return to repair center
	Fault code 08.	Internal components failed.	Return to repair center
	Fault code 09.		

6.4 Quick start

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

Functional block	Checked components		Instruction function	Reference value	Failed status
DC-DC Converter	Fuse	F1---F6	Resistance	0.14 ohm	short or open
	MOSFET(IRF1407/IRF3205)	Q2---Q11	Resistance	310k DS	short or open
				290k GD	short or open
				4k GS	short or open
	Diode(RHRP1560/RHRP860)	D17---D20	Resistance	165k	short or open
	Driver IC	TC4427	Resistance	4.8K PIN6-PIN3	short or open
	Resistance	R6---R15	Resistance	10 ohm	short or open
DC-AC Inverter	IGBT(STGW45HF60WD)	Q16---Q19	Resistance	178K-200K DS	short or open
				220K-250K GD	short or open
				50K GS	short or open
	Resistance	R54, R56, R61, R64	Resistance	100 ohm	short or open
	Photo-coupler	U24---U27	Resistance	2K	short or open
Charger	Rectifier	REC1	Resistance	0.5M PIN1-PIN2	short or open
				0.43M PIN1-PIN3	short or open
				160K PIN1-PIN4	short or open
	MOSFET(2SK3878)	Q20---Q22	Resistance	162K DS	short or open
				210K GD	short or open
				12K GS	short or open
	Diode(MBR20200)	D21---D23	Resistance	>4M K->A	short or open
			Resistance	78K A->K	short or open
	Control IC	UC3843	Resistance	>4K PIN5-PIN7	short or open
	Resistance	R258, R260, R262	Resistance	100 ohm	short or open
S.P.S	Control IC	UC3845	Resistance	>4K PIN5-PIN7	short or open
	Diode	D2, D3, D32, D34	Resistance	>4K	short or open
		D1	Resistance	3.5K	short or open
	Resistance	R31, R94, R99	Resistance	2.2 ohm	short or open
MPPT	MOSFET	Q1, Q2	Resistance	430ohm DS	short or open
				>1M GD	short or open
				0.618K GS	short or open
	MOSFET	Q3, Q7	Resistance	256ohm DS	short or open
				>0.5M GD	short or open
				32.92K GS	short or open

	MOSFET	Q5, Q6	Resistance	430ohm	DS	short or open
				>1M	GD	short or open
				0.618K	GS	short or open
	MOSFET	Q27, Q37, Q29, Q39	Resistance	448ohm	DS	short or open
				>1M	GD	short or open
				100K	GS	short or open

7. Test Step
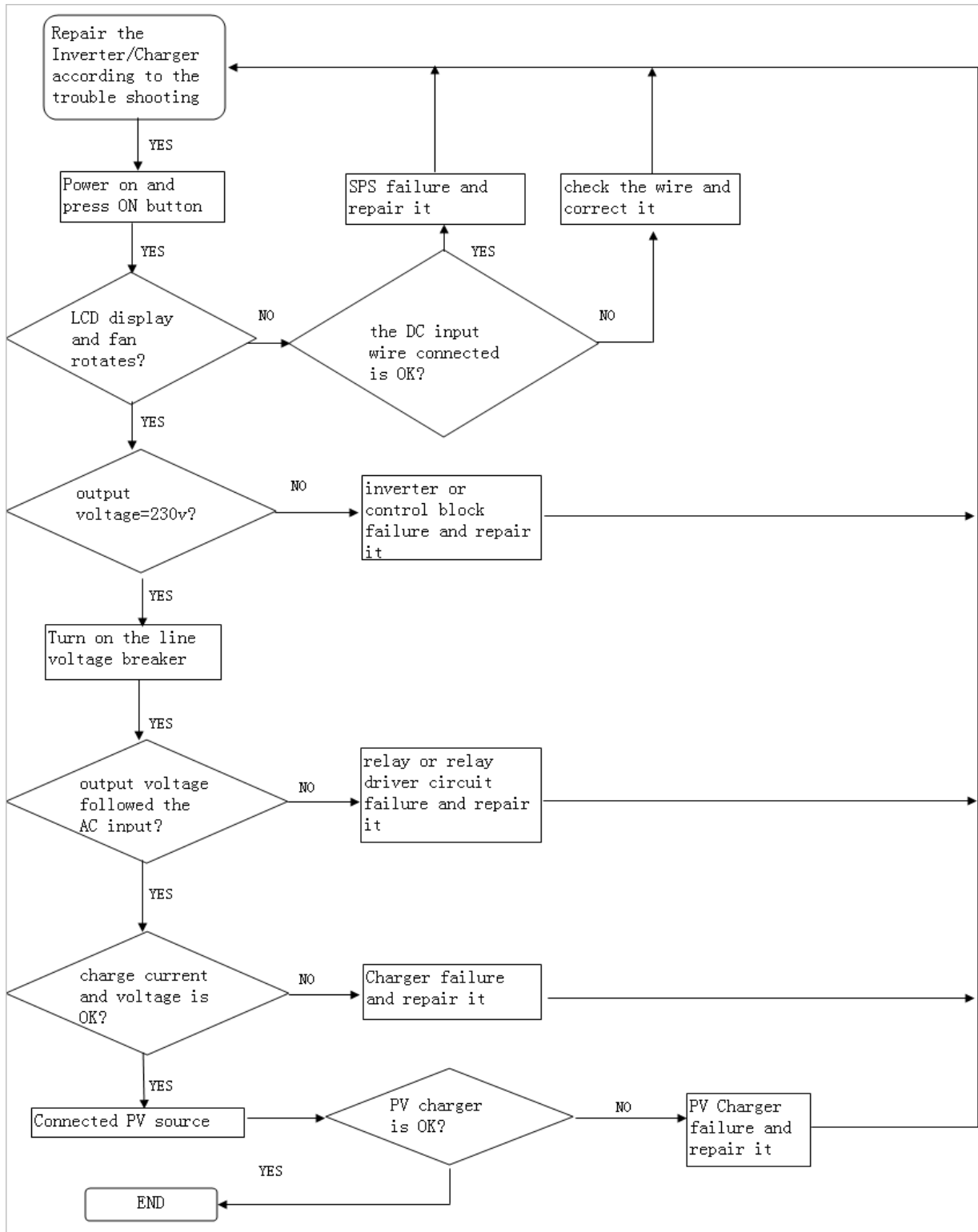
8. Electrical specification

Table 1 Line Mode Specifications
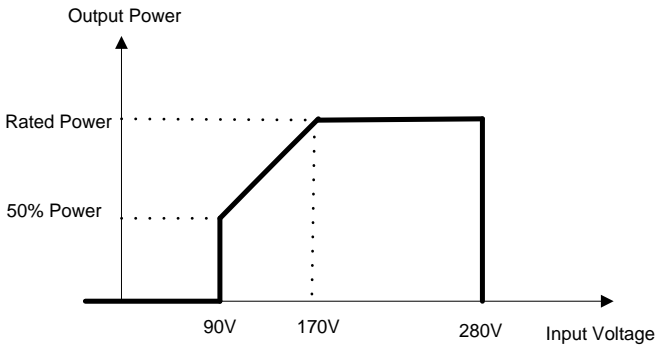
INVERTER MODEL	1KVA	2KVA	3KVA
Input Voltage Waveform	Sinusoidal (utility or generator)		
Nominal Input Voltage	230Vac		
Low Loss Voltage	170Vac±7V (UPS); 90Vac±7V (Appliances)		
Low Loss Return Voltage	180Vac±7V (UPS); 100Vac±7V (Appliances)		
High Loss Voltage	280Vac±7V		
High Loss Return Voltage	270Vac±7V		
Max AC Input Voltage	300Vac		
Nominal Input Frequency	50Hz / 60Hz (Auto detection)		
Low Loss Frequency	40±1Hz		
Low Loss Return Frequency	42±1Hz		
High Loss Frequency	65±1Hz		
High Loss Return Frequency	63±1Hz		
Output Short Circuit Protection	Circuit Breaker		
Efficiency (Line Mode)	>95% (Rated R load, battery full charged)		
Transfer Time	10ms typical (UPS); 20ms typical (Appliances)		
Power Limitation			

Table 2 Invert Mode Specifications

INVERTER MODEL	1KVA	2KVA	3KVA
Rated Output Power	1KVA/0.8KW	2KVA/1.6KW	3KVA/2.4KW
Output Voltage Waveform	Pure Sine Wave		
Output Voltage Regulation	230Vac±5%		
Output Frequency	50Hz		
Peak Efficiency	90%		
Overload Protection	5s@≥150% load; 10s@110%~150% load		
Surge Capacity	2* rated power for 5 seconds		
Nominal DC Input Voltage	24Vdc		
Cold Start Voltage	23.0Vdc		
Low DC Warning Voltage @ load < 20% @ 20% ≤ load < 50% @ load ≥ 50%	22.0Vdc 21.4Vdc 20.2Vdc		
Low DC Warning Return Voltage @ load < 20% @ 20% ≤ load < 50% @ load ≥ 50%	23.0Vdc 22.4Vdc 21.2Vdc		
Low DC Cut-off Voltage @ load < 20% @ 20% ≤ load < 50% @ load ≥ 50%	21.0Vdc 20.4Vdc 19.2Vdc		
High DC Recovery Voltage	29Vdc		
High DC Cut-off Voltage	30Vdc		
No Load Power Consumption	<20W		
Saving Mode Power Consumption	<10W		

Table 3 Charge Mode Specifications

INVERTER MODEL	1KVA	2KVA	3KVA
Charging Algorithm	3-Step		
Utility Charging Mode			
Charging Current (UPS)	20/30Amp (@$V_{I/P}$=230Vac)		
Charging Floating Voltage	27Vdc		
Solar Charging Mode			
Solar charger type	MPPT		
Rated power	600W		
Efficiency	98.0% max.		
Overload protection	Shutdown immediately@≥130% load; 5min@110%~130% load		
Max. PV Array Open Circuit Voltage	75V max.		
PV Array Voltage High Loss	79Vdc		
PV Array Voltage High Comeback	77Vdc		
PV Array Voltage Low Loss	Battery voltage + 1V		
PV Array Voltage Low Back	Battery voltage + 2V		
PV Array MPPT Voltage Range	30V~66V		
Min battery voltage for PV charge	17Vdc		
Standby Power Consumption	2W		
Battery Voltage Accuracy	+/-0.3%		
PV Voltage Accuracy	+/-2V		