# Axpert Charger/ Inverter

# Service manual

| Revision | Description | Prepared by | Approved by |
|---|---|---|---|
| V00 | Initial draft release | Rondo<br>2016-3-25 | |
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# Table of contents

# 1. General information

## 1.1 Getting start

This manual is for Axpert MEX 1.5KVA 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 (63A, 65VDC *3pcs for MEX-1500-12/MEX-3000-24 and *2pcs for MEX-1500-24) 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 trouble shooting table, please send this inverter/charger back to local dealer or service center for maintenance.

# 2. Functional block

Axpert MEX 1.5KVA 3KVA series production employ a double conversion topology, comprise following functional blocks, as shown in figure 2.1

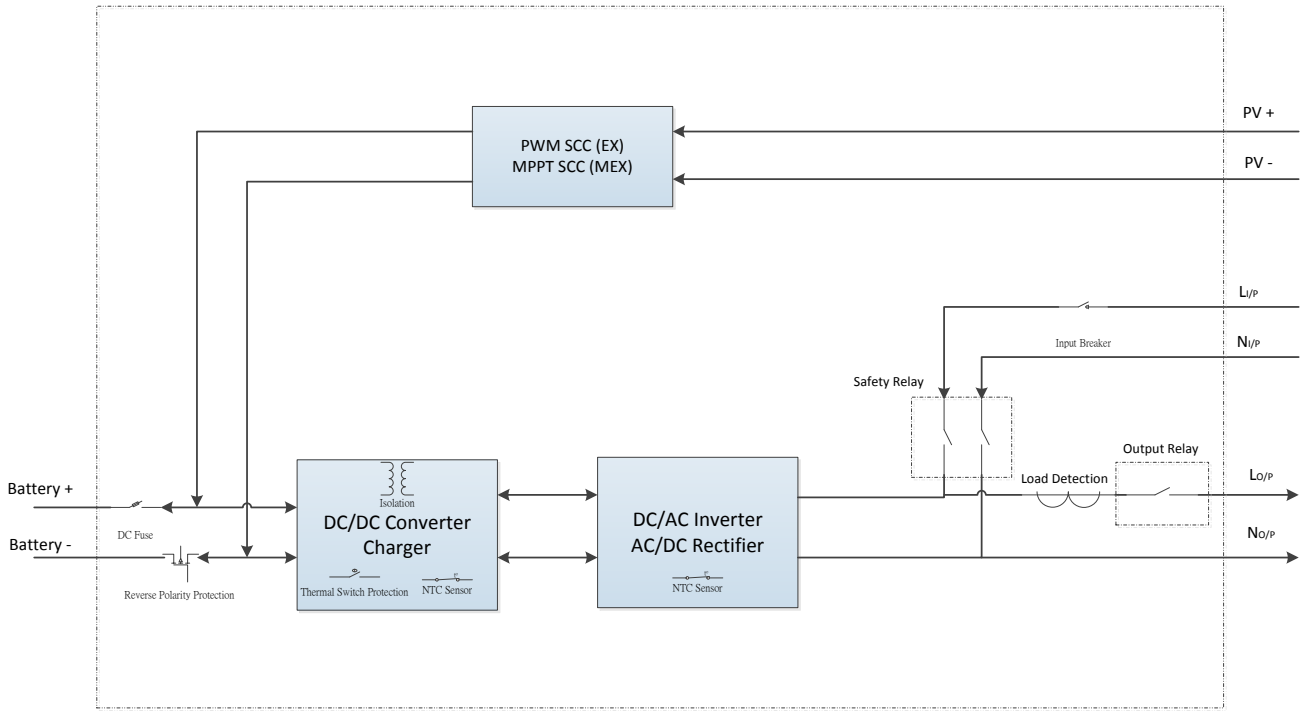



Figure 2.1 function block diagram

# 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.

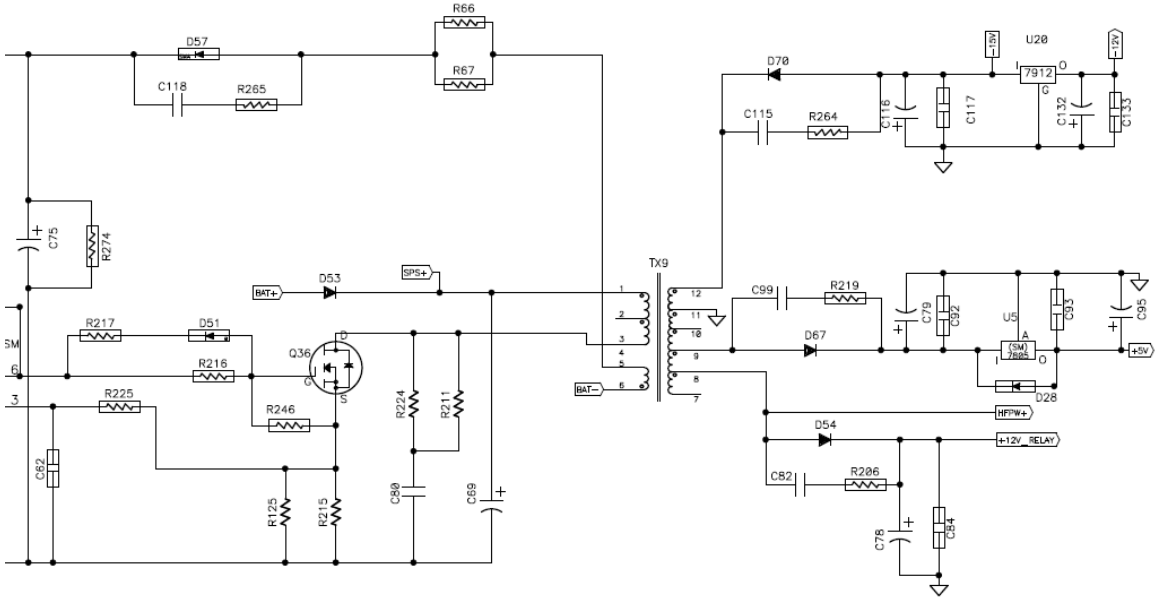



Figure 3.1 basic circuit of power supply

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 Q36 is ON, the dot ends of all winds are positive with respect to their no-dot ends. Output rectifier diodes D70, D67, D54 and D57 are reverse-biased and all the output load currents are supplied from storage filter capacitors C116, C79, C78 and C75.The primary coil of the transformer acts as an inductor and stored energy.

When Q36 is OFF, the stored energy in the primary coil is delivered to secondary filter capacitors C116, C79, C78 and C75.

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

## 3.2 DC TO DC converter (full bridge)

The full bridge topology is a transformer isolated forward-mode regulator. Unlike the fly-back transformer, the push-pull transformer does not store any energy and output current is drawn when power switches are conducting.

A full bridge topology is shown in figure 3.2, power switch (Q11,Q17,Q20,Q24,Q40,Q26,Q25,Q39) and (Q38,Q21,Q22,Q63,Q13,Q18,Q23,Q35) receive 180 out-of-phases. Refer to figure 3.2, the battery voltage is transformed through a full bridge 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 (DC BUS) must be higher than the input voltage (BAT+) .It mentioned by the primary turns and secondary turns. In this circuit, BAT+ =12VDC with MEX-1500-12, BAT+ =24VDC with MEX-1500-24/MEX-3000-24, DC BUS voltage above 330Vdc.

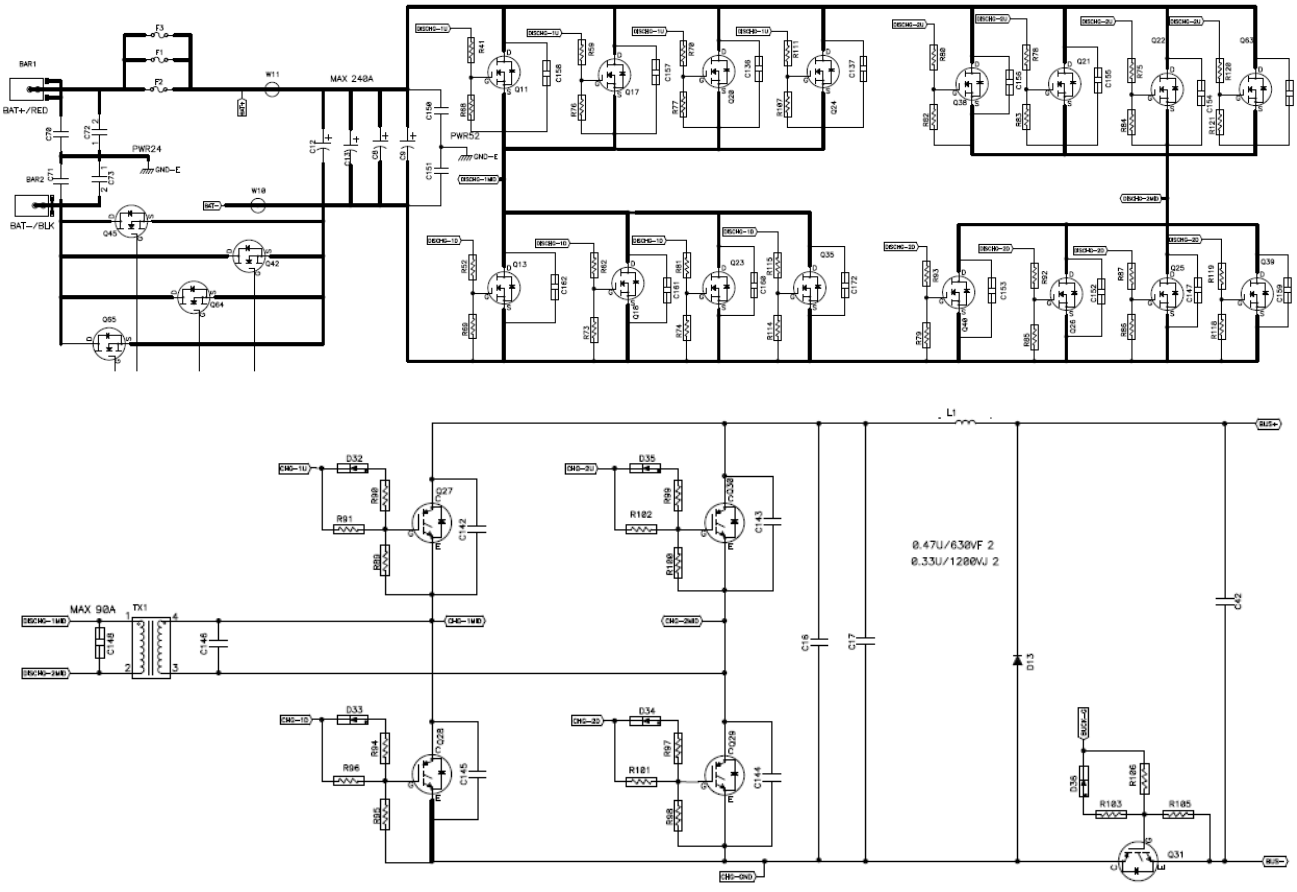



Figure 3.2 full bridge topology

## 3.3 DC TO AC inverter (full-bridge)

The Inverter circuit (Figure 3.3) of Axpert MEX 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.

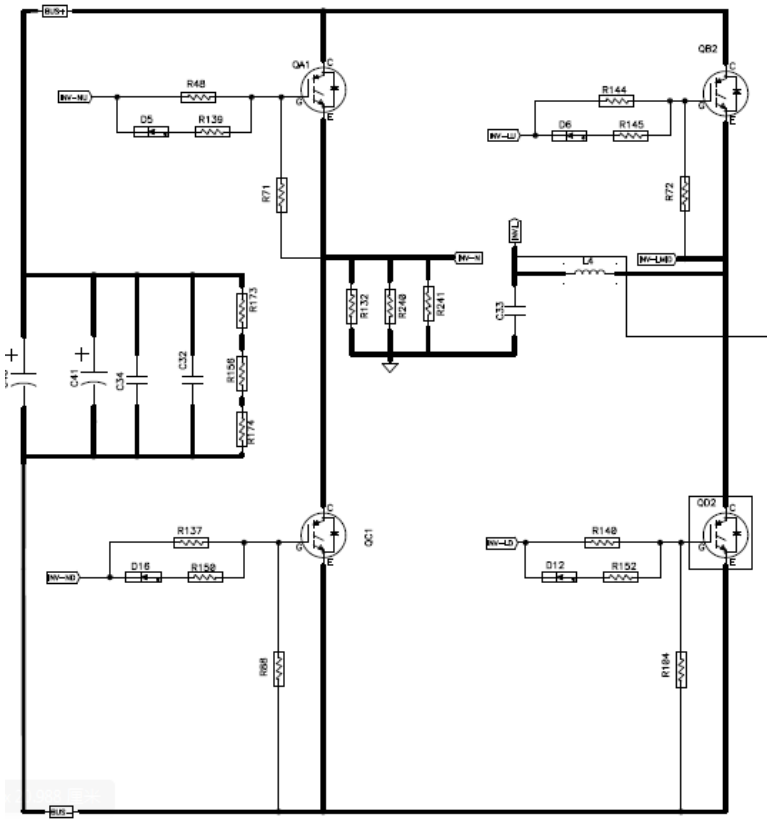



Figure 3.3 Full-bridge topology

## 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 buck and full bridge topology.

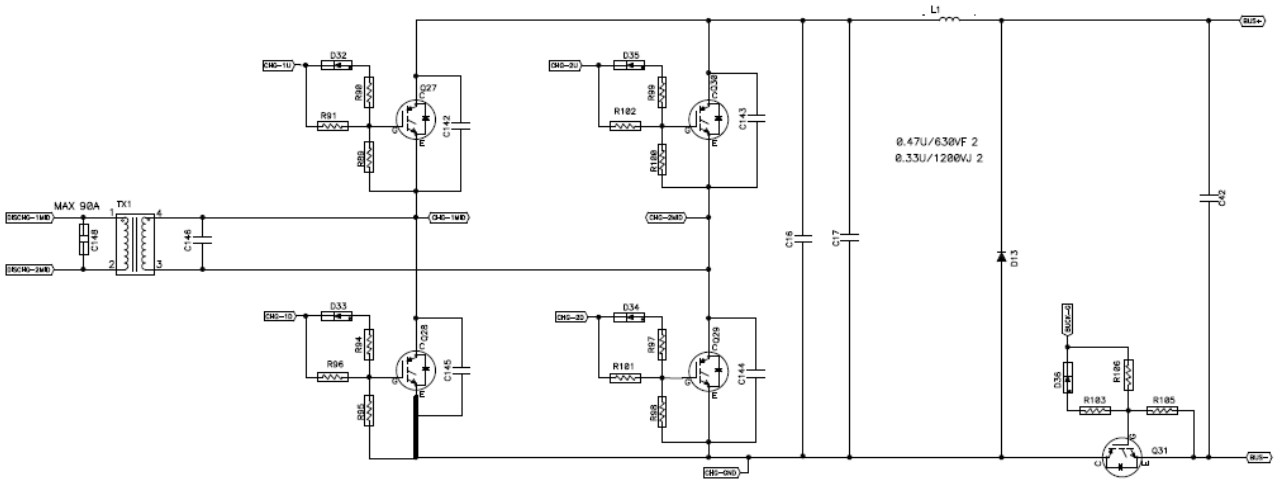



Figure 3.4 buck and full bridge topology

# 4. Functional explanations for each PCB

| Item | Series name | PCB name | PCB serial number | Quantity | Remark |
|---|---|---|---|---|---|
| 1 | MEX-1500-12 | Main | 71-500540-XXG | 1 | |
| 2 | | CNTL | 71-500500-XXG | 1 | |
| 3 | | SCC | 71-500565-XXG | 1 | |
| 4 | | COMM | 71-500567-XXG | 1 | |
| 5 | | LED | 71-500238-XXG | 1 | |
| 6 | MEX-1500-24 | Main | 71-500541-XXG | 1 | |
| 7 | | CNTL | 71-500500-XXG | 1 | |
| 8 | | SCC | 71-500565-XXG | 1 | |
| 9 | | COMM | 71-500567-XXG | 1 | |
| 10 | | LED | 71-500238-XXG | 1 | |
| 11 | MEX-3000-24 | Main | 71-500535-XXG | 1 | |
| 12 | | CNTL | 71-500500-XXG | 1 | |
| 13 | | SCC | 71-500565-XXG | 1 | |
| 14 | | COMM | 71-500567-XXG | 1 | |
| 15 | | LED | 71-500238-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, and charger. Many semiconductors and easy-failure components on the board, so it should be play more attention when the system is abnormal.

## 4.2 CNTL board

The CNTL board consists of signal detecting circuit, logic control and driver based on DSP.

## 4.3 SCC board

The solar current control (SCC) board based on a MPPT control mode .When the solar source is presented, battery charged from solar source; MAX charge current is 40A if solar panel with enough energy.

## 4.4 COMM board

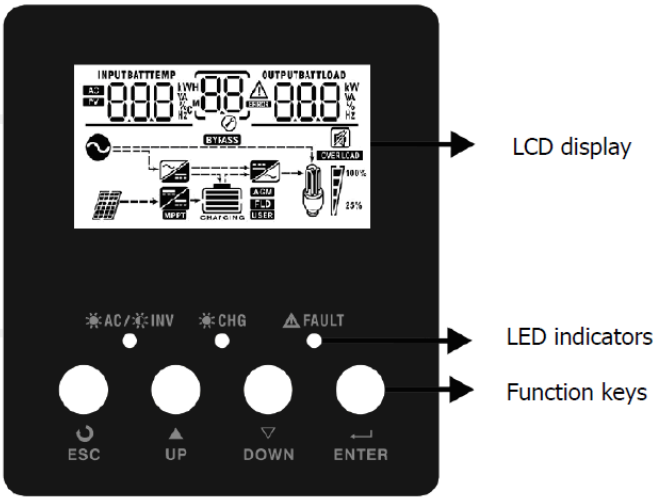
This inverter/charger is equipped with a communication port to communicate with a PC with corresponding software. Please use supplied communication cable to connect to communication port of this inverter and USB port of the PC.

## 4.5 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.



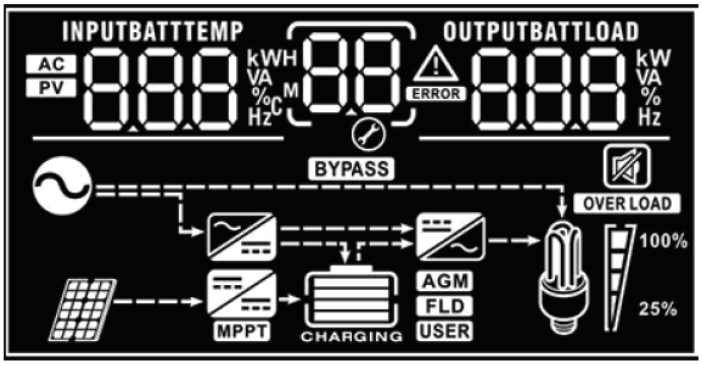

## 5.1 LED Indicator

| LED Indicator | | | Messages |
|---|---|---|---|
| AC / INV | Green | Solid On | Output is powered by utility in Line mode. |
| | | Flashing | Output is powered by battery or PV in battery mode. |
| CHG | Green | Solid On | Battery is fully charged. |
| | | Flashing | Battery is charging. |
| ⚠ FAULT | Red | Solid On | Fault occurs in the inverter. |
| | | Flashing | Warning condition occurs in the inverter. |

**Function Keys**

| Function Key | Description |
|---|---|
| ESC | To exit setting mode |
| UP | To go to previous selection |
| DOWN | To go 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 kW VA % Hz | Indicate input voltage, input frequency, PV voltage, battery voltage and charger current. |
| **Configuration Program and Fault Information** | |
| | Indicates the setting programs. |
| ERROR | Indicates the warning and fault codes.<br>Warning: flashing with warning code.<br>Fault: ERROR lighting with fault code |
| **Output Information** | |
| OUTPUTBATTLOAD kW VA % Hz | Indicate output voltage, output frequency, load percent, load in VA, load in Watt and discharging current. |
| **Battery Information** | |
| CHARGING | Indicates battery level by 0-24%, 25-49%, 50-74% and 75-100% and charging status. |

| | |
|---|---|
| AGM FLD USER | Indicates the battery type, AGM, Flooded or User-defined battery. |

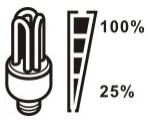
Battery level icon will present battery when unit is charging.

| 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. |

Battery level icon will present battery capacity when unit is discharged.

| Load Percentage | Battery Voltage | LCD Display |
|---|---|---|
| Load >20% | < 1.817V/cell |  |
| | 1.817V/cell ~ 1.9V/cell |  |
| | 1.9 ~ 1.983V/cell |  |
| | > 1.983 V/cell |  |
| Load < 20% | < 1.867V/cell |  |
| | 1.867V/cell ~ 1.95V/cell |  |
| | 1.95 ~ 2.033V/cell |  |
| | > 2.033/cell |  |

**Load Information**

| | | | | |
|---|---|---|---|---|
| OVER LOAD | Indicates overload. | | | |
|   | 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. |
|  | Indicate the solar 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:

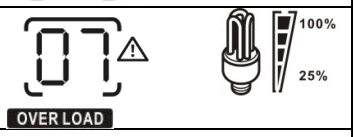
a. Check the system status by LED and LCD display, the sounds of buzzer.
b. Observe the failure board, static checking.
c. Replace the failure components.
d. Static checking.
e. Power up checking.
f. Test after repair.

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 |  |
| 02 | Over temperature |  |
| 03 | Battery voltage is too high |  |
| 04 | Battery voltage is too low |  |
| 05 | Output short circuited or Over temperature |  |
| 06 | Output voltage is abnormal |  |
| 07 | Over load time out |  |
| 08 | Bus voltage is too high |  |
| 09 | Bus soft start failed |  |
| 11 | Main relay failed |  |

## 6.2 Warning Indicator

| Warning Code | Warning Event | Audible Alarm | Icon flashing |
|---|---|---|---|
| 01 | Fan is locked | Beep three times every second |  |
| 03 | Battery is over charged | Beep once every 1second |  |
| 04 | Low battery | Beep once every 1 second |  |
| 07 | Overload | Beep once every 0.5 second |   |
| 10 | Power limitation | Beep twice every 3 seconds |  |

## 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.<br>2. Replace battery. |
| No response after power on. | No indication. | 1. The battery voltage is far too low. (<1.4V/Cell)<br>2. Battery polarity is connected reversed. | 1. Check if batteries and the wiring are connected well.<br>2. Re-charge battery.<br>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.<br>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.<br>2. Return to repair center |
| | Fault code 08. | Internal components failed. | Return to repair center |
| | Fault code 09. | | |

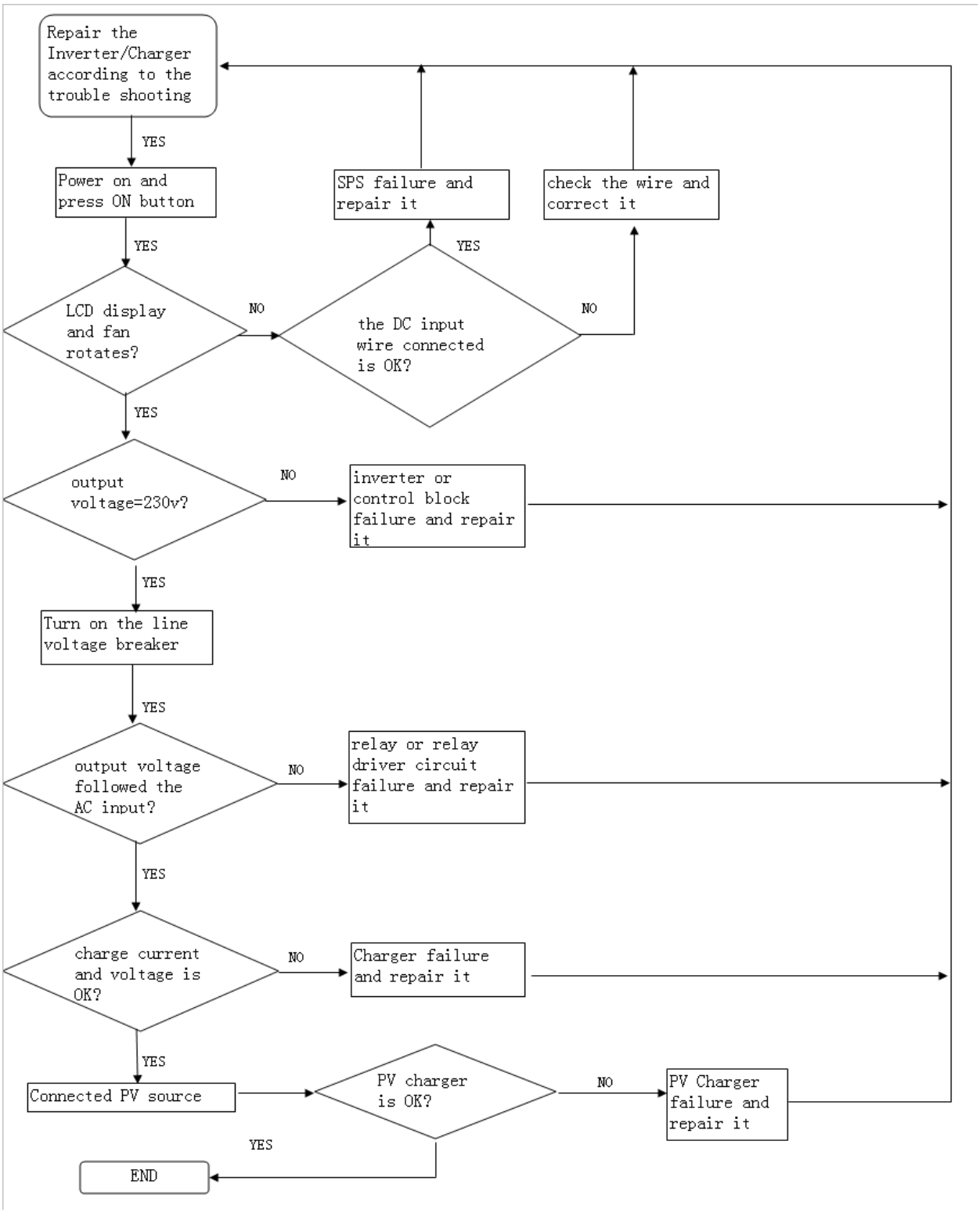
## 6.4 Quick start

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,F2,F3 | Resistance | 0.15 ohm | short or open |
| | MOSFET(IRFB3206 or IRLB8314) | Q11,Q17,Q20,Q24 Q38,Q21,Q22,Q63 Q13,Q18,Q23,Q35 Q40,Q26,Q25,Q39 | Resistance | 218k DS | short or open |
| | | | | 230k GD | short or open |
| | | | | 11.7k GS | short or open |
| | Converter IGBT(STGW45HF60) | Q27,Q28,Q29,Q30 | Resistance | 392k CE | short or open |
| | | | | 182k GC | short or open |
| | | | | 23ohm GE | short or open |
| | Resistance | R41,R59,R70,R111 R80,R78,R75,R120 R52,R62,R81,R115 R93,R92,R87,R119 | Resistance | 22 ohm | short or open |
| DC-AC Inverter | IGBT(4063DPBF) | QA1,QB2,QC1,QD2 | Resistance | 206K CE | short or open |
| | | | | 237K GC | short or open |
| | | | | 46K GE | short or open |
| | Resistance | R48,R144,R137,R140 | Resistance | 47 ohm | short or open |
| | Photo-coupler | U1,U2,U3,U4 | Resistance (pin2 – pin 3) | 5.4K | short or open |
| Charger | BUCK IGBT(STGW45HF60) | Q31 | Resistance | 198K CE | |
| | | | | 247K GC | |
| | | | | 22K GE | short or open |
| | Photo-coupler | U12 | Resistance (pin2 – pin 3) | 5.4K | short or open |
| | Diode (RHRP1560 or RHRP860) | D13 | Voltage | 0.38V K-A | short or open |
| SPS | Control IC | UC3845 | Resistance | >4K PIN5-PIN7 | short or open |
| | Diode | D70,D67,D54,D53 | Resistance | >4K | short or open |
| MPPT | MOSFET | Q1,Q2,Q3,Q5,Q6,Q7 | Resistance | 83K DS | short or open |
| | | | | 270K GD | short or open |
| | | | | 49K GS | short or open |
| | MOSFET | Q27,Q37 | Resistance | >1M DS | short or open |
| | | | | 377K GD | short or open |
| | | | | 100K GS | short or open |
| | Op Amp | U2 PIN8-PIN4 | Resistance | 5.2K | short or open |
| | DSP | U7 PIN33-PIN35 | Resistance | >0.4K | short or open |

# 7. Test Step


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

# 8. Electrical specification

**Table 1 Line Mode Specifications**

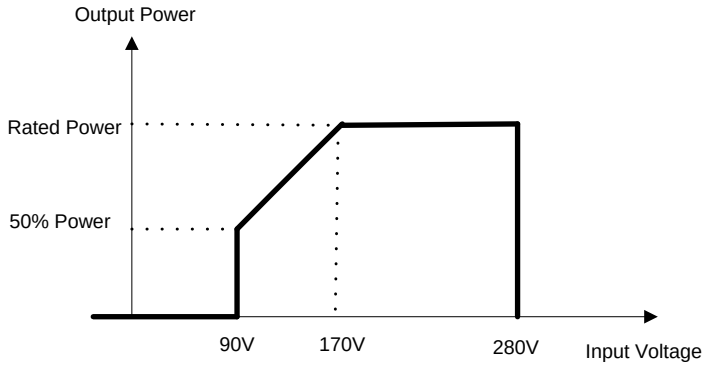
| **Line Mode (Utility Bypass Mode)** | | | |
|---|---|---|---|
| Axpert Model | MEX-1500-12 | MEX-1500-24 | MEX-3000-24 |
| Input Voltage Waveform | Sinusoidal (utility or generator) | | |
| Nominal Input Voltage | 230Vac | | |
| Low Loss Voltage | 170Vac±7V(UPS); **90Vac±7V(Appliances)** | | |
| Low 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, 55Hz as boundary) | | |
| 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 | >95% (Rated R load, battery full charged) | | |
| Transfer Time | 10ms typical, 12ms maximum @50Hz (UPS);<br>**20ms typical, 25ms maximum @50Hz (Appliances)** | | |
| Power Limitation |  | | |

**Table 2 Invert Mode Specifications**

| **Inverter Mode** | | | |
|---|---|---|---|
| Axpert Model | MEX-1500-12 | MEX-1500-24 | MEX-3000-24 |
| Rated Output Power | 1500VA/1200W | | 3000VA/2400W |
| 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 5sec | | |
| Nominal DC Voltage | 12Vdc | 24Vdc | |
| Cold Start Voltage | 11.5Vdc | 23.0Vdc | |
| Low DC Warning Voltage<br>@ load < 20%<br>@ load ≥ 20% | <br>11.0Vdc<br>**10.7Vdc** | <br>22.0Vdc<br>**21.4Vdc** | |
| Low DC Warning Recovery Voltage<br>@ load < 20%<br>@ load ≥ 20% | <br>11.5Vdc<br>**11.2Vdc** | <br>23.0Vdc<br>**22.4Vdc** | |
| Low DC Cut-off Voltage<br>@ load < 20%<br>@ load ≥ 20% | <br>10.5Vdc<br>**10.2Vdc** | <br>21.0Vdc<br>**20.4Vdc** | |
| High DC Recovery Voltage | 15.0Vdc | 31.0Vdc | |
| High DC Cut-off Voltage | **16.0Vdc** | **32.0Vdc** | |
| DC Voltage Accuracy | +/-0.3%V@ no load | | |
| THDV | <3% for linear load,<5% for non-linear load<br>@ nominal voltage | | |
| DC Offset | ≦100mV | | |
| No Load Power Consumption | <25W | | |
| Saving Mode Power Consumption | <10W | | |

**Table 3 Charge Mode Specifications**

| **Utility Charging Mode** | | | |
|---|---|---|---|
| Axpert Model | MEX-1500-12 | MEX-1500-24 | MEX-3000-24 |
| Charging Current | 60Amp (170Vac~280Vac) *1 | | |
| Charging Floating Voltage | 13.5Vdc | 27Vdc | |
| Charging Algorithm | 3-Step | | |

*1. Charging current = 30Amp ~ 60Amp (@ 90Vac~170Vac)

| **Solar Charging Mode (MPPT)** | | | |
|---|---|---|---|
| Axpert Model | MEX-1500-12 | MEX-1500-24 | MEX-3000-24 |
| Charging Current | 40Amp | | |
| Max. PV Array Open Circuit Voltage | 100Vdc | | |
| PV Array MPPT Voltage Range | 15Vdc ~ 80Vdc | 30Vdc ~ 80Vdc | |
| High PV cut-off voltage | 102Vdc | | |
| High PV Recovery Voltage | 95Vdc | | |
| Standby Power Consumption | 2W | | |
| Charging Algorithm | 3-Step | | |
| Over-temperature Protection | Yes | | |
| Overload, Short-circuit Protection | Yes | | |
| Prevents reserve current from battery at night | Yes | | |