Power Conversion®

M90 & M90L Modular Online Three-Phase UPS

15kVA, 20kVA, 30kVA, 40kVA, 45kVA, 60kVA Models

Service Manual

Table of Contents

General Information

Getting started

This manual is for the M90 and M90L 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 includes 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.

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.

Electronic Specifications

Model	**M90**		
Power kVA	20	40	60
Power kW	18	36	54
Mains Input (Rectifier input Line)			
Input Topology	Three Phase, Neutral + Ground		
Nominal Voltage	208/220		
Voltage Range (Full Load)	156 ~ 253 100% load;		
Voltage Range (Derating)	121V~ 253V with <70% Load		
Voltage Comeback	**Low Loss Voltage +10V, High Loss Voltage -10V**		
Nominal Frequency	50Hz/60Hz(Auto-selectable)		
Frequency Range	40Hz ~ 70Hz		
Synchronized Range	+/- 1Hz, +/- 2Hz, +/- 4Hz (default: 4Hz)		
Power Factor	> 0.99 at 100% load, >0.98 at 50% load		
THD i (100% load)	< 3%		
Mains Input (Bypass)			
Input Topology	Three Phase, Neutral + Ground		
Nominal Voltage	208V/220V		
Voltage Range	Upper limit: +10, +15, default: +15% Lower limit: -10, -20, default:-20%		
Nominal Frequency	50Hz/60Hz		
Frequency Range	+/- 1Hz, +/- 2Hz, +/- 4Hz (default: 4Hz)		
Transfer Time (between Bypass and Inverter)	Synchronous transfer: <= 1ms Asynchronous transfer: < 1 cycle		

Model	M90
Output	
Output Topology	Three Phase, Neutral + Ground
Nominal Voltage	208V/220V L-L
Voltage Regulation	< 1% Typical (balanced load)
(Steady state)	< 2% Typical (unbalanced load)
Voltage DC Offset	< +/-50mV
Synchronized Range (Synchronize to Bypass)	+/- 1Hz, +/- 2Hz, +/- 4Hz (default: 4Hz)
Overload Capability	1 hour for 105 ~110%, 10 mins for 111~125%, 1 min for 126~150%, 200ms for >150%
Crest Factor	3:1
V THD	100% linear load: <2% 100% nonlinear load: <4% (PF = 0.8 ~ 1)

Efficiency	> 92.5 % at over 50% load (Power Module Measurement)

Model	M90
Battery	
Nominal Voltage	+/- 120V
Battery Charger	
Floating Voltage	2.3V/cell
Boost Charging	2.35V/cell
Temperature compensation (Option)	-3mV/°C/cell
Charger Voltage Regulation	< 1%
Ripple Voltage	< 1%
Ripple Current	< 5%
Charger Power*	20% of nominal power
Maximum charging current*	8A
*At low input voltage the UPS recharge capability increases with load decrease.	

Environmental Parameters

Model	M90
Operating Temperature Range	0°C ~ 40 °C (Output Capacity will be de-rated when temperature is over 30°C, @ 35°C de-rated to 90%; @ 40°C, de-rated to 80%)
Storage Temperature	-15°C~60°C(UPS)
	0~35°C(Battery)
Relative Humidity	0-95%(No condensing)
Altitude	<1000m for Nominal power (Over 1000m the power derating is 1 % every 100m)

Mechanical Requirements

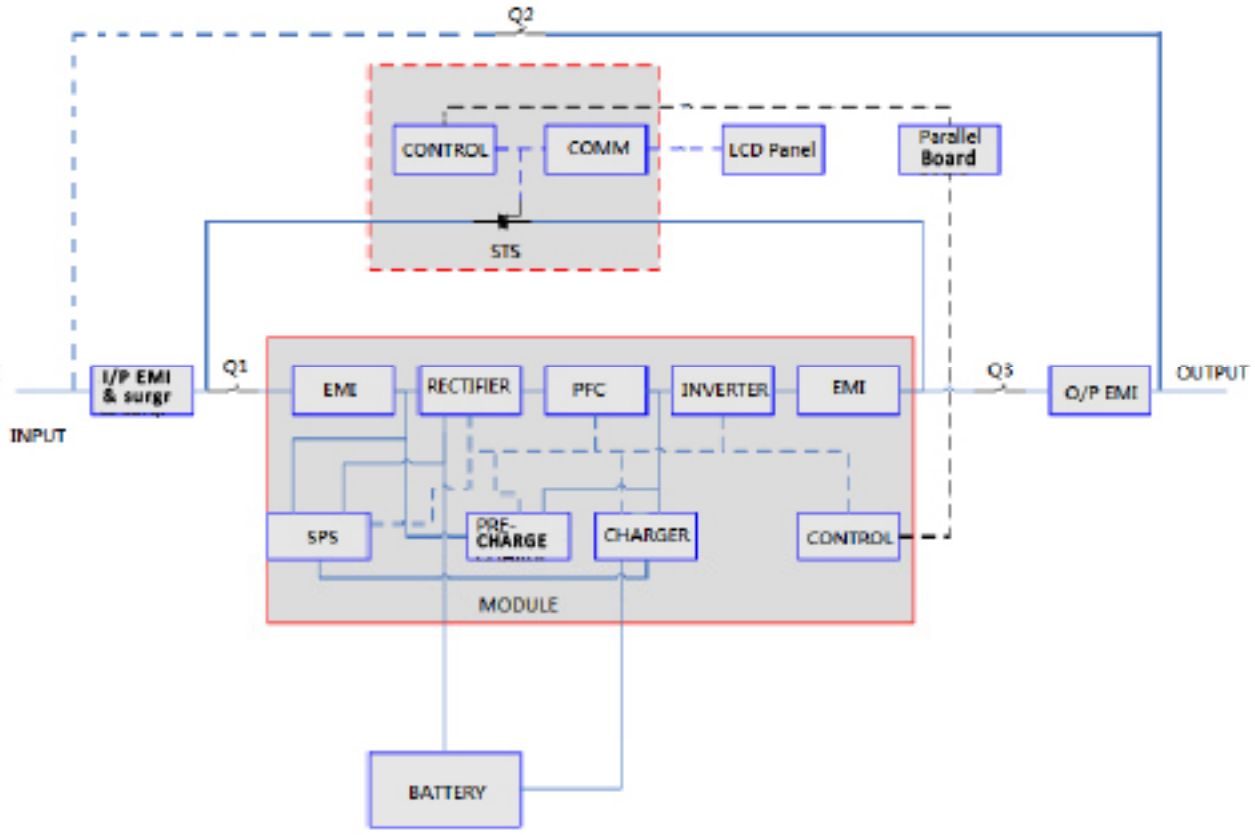
Model	M90
Dimensions (WxHxD)	515mm x 760mm x 1000mm
Noise (1m) full load	Max. 70 dB
IP protection	IP20

Module	Specification
Power Module	

Dimensions (WxHxD)	490 x 130 (3U) x 736.5 mm
Net Weight	34.5 kg

Functional Block

As a true online UPS, the product applies a double conversion topology, comprising functional blocks as shown in the figure below.



Function Block Diagram

The CONTROL block in the module controls the action of the UPS system. The control board detects the voltage and current to control PFC and inverter, also they supply the protection for the UPS, when the UPS becomes abnormal. In most case, the CNTL can provide basic information indicating the status of the UPS.

The CONTROL block in the STS controls the action of Bypass SCR. It works with COMM board and LCD panel to be user interface as well.

The COMM block provides the communication interface for receiving and executing command from users.

The IPOP 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 mean time, 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 shutdown 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 utility is normal. The charger converts AC input power to DC power for recharging the battery.

The Input and Output EMI section provides EMI filter function. The input and output 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.

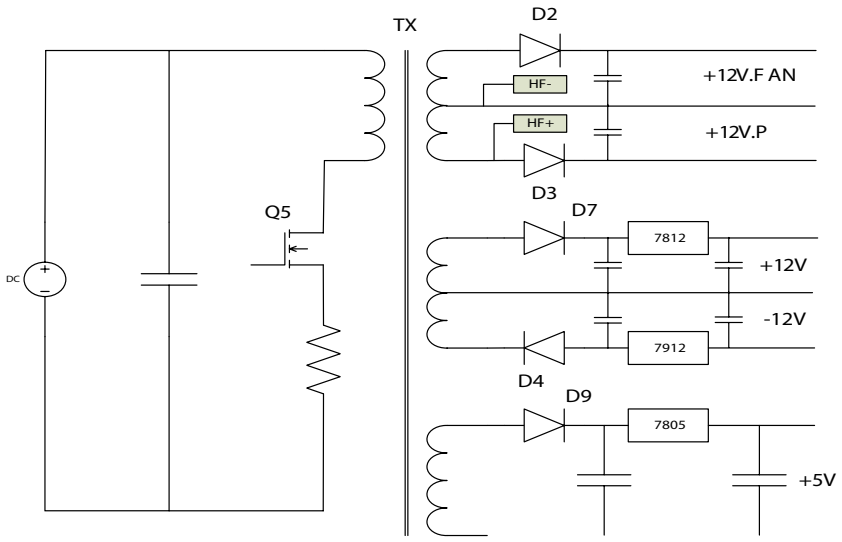
The SPS generates DC power supply needed by operation of the circuit of the UPS itself. The Bypass provides a path that utility can power the output directly when the Inverter is not executed.

The Maintenance Bypass provides another path that utility can power the output directly when UPS is in maintenance status.

Working Principle of the Major Functional Block

Switch Power Supply

The Switch Power Supply (SPS) supplies DC power for UPS operation. The input source of the SPS is the battery, or the AC input.

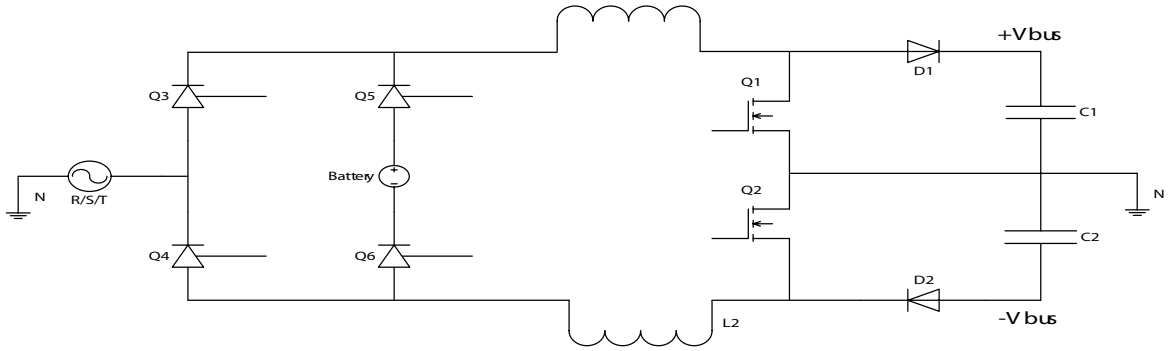


Basic circuit of power supply

The figure above is a flyback converter. When Q5 is on, all rectifier diodes (D2/D3/D4/D9) are on open status and all output capacitors 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 Q5 is off, primary current will stop and all rectifier diodes (D2/D3/D4/D9) 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 +12V, -12V, +5V, +12V.P, +12V.Fan, and HF-power.

The power of +12V, -12V, +5V, +12V.P, +12V.Fan 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.

PFC/Booster

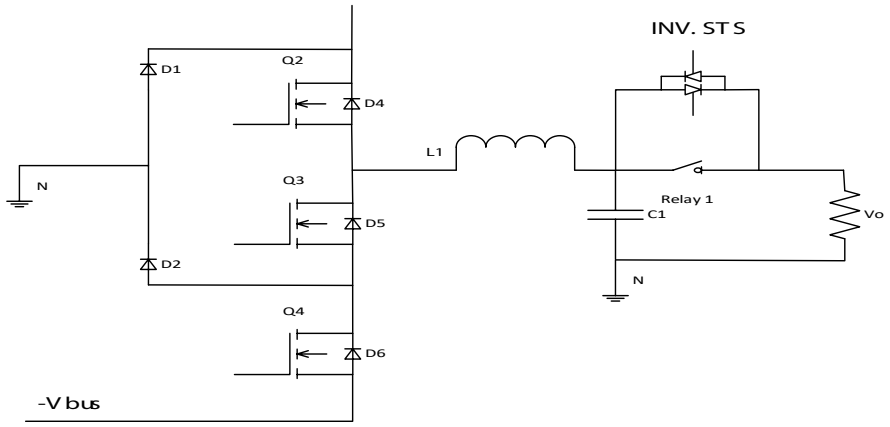


PFC/Booster

As shown in the Figure4.2, when Q3/Q4is on and D1/D2 is off, the current will increase to store energy in choke (L1/L2). When the Q3/Q4 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 Q3/Q4 on and off. There are three independent PFC/ Booster for each phase.

Inverter

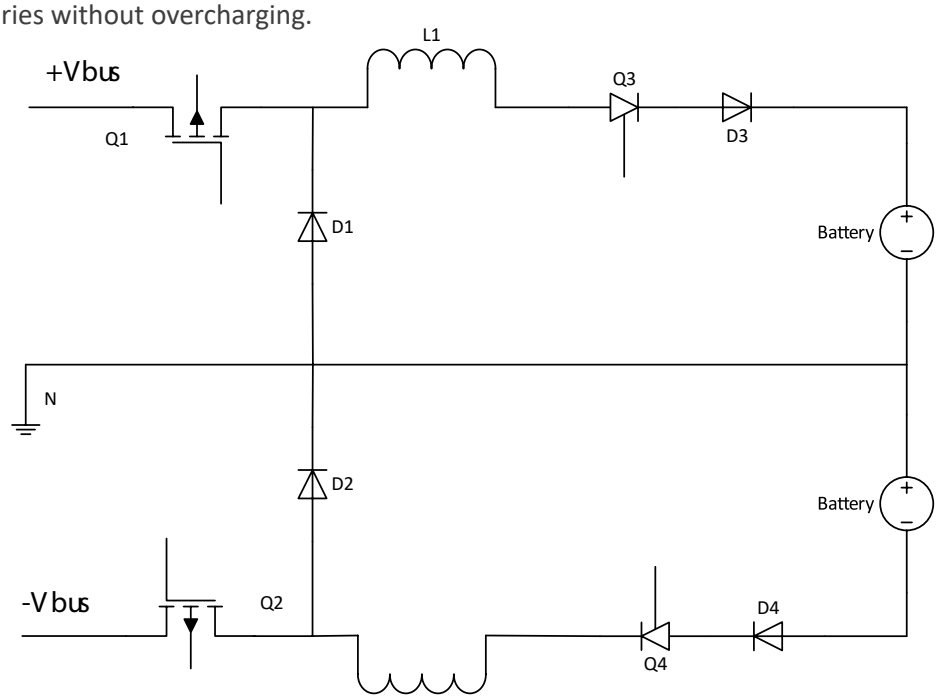
The input of the Neutral Point Clamped(NPC) Inverter topology is two DC voltages, and the output is an AC voltage, as shown in the Figure4.3.When Q2is on and Q4 is off, the Q3 and Q1 are continued on and off for on upper of sine wave. When Q3 is on and Q1 is off, the Q4 and Q2 are continued on and off for on lower of sine wave. The L1 and C1 are AC
power filter.



Neutral Point Clamped Inverter

Charger

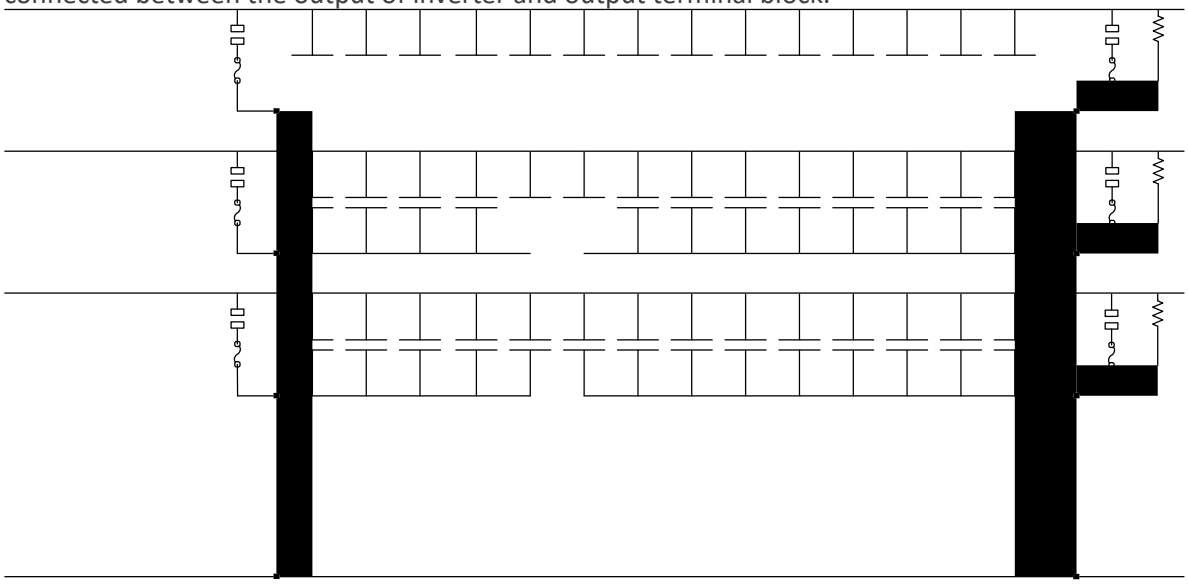
The function of charger is to charge and maintain the batteries at fully charged condition. The charger charges the batteries with a constant current at initial stage. At the same time, the battery voltage keeps increasing until reaching the constant charge voltage point. Then, the charge current will decrease accordingly, now it's in second stage. After 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 to optimize battery recharge time and prolong the life time of batteries without overcharging.



Topology of the charger

EMIBoard

Input EMI board is connected between utility and the input of rectifier. Output EMI board is connected between the output of inverter and output terminal block.



Topology of the input/output EMI

Function explanations for each PCBA

PCB information of Power module

M90				
Item	PCBA Name	PCBA serial number	Quantity	Remark
1	STS Main Board	71-301695-xxG	1	
2	Communication Board	71-300826-xxG	1	
3	SPS Board	71-301616-xxG	2	
4	Interface Board	71-300869-xxG	1	
5	EMI Board	71-301675-xxG	1	
6	Panel Main Board	71-301704-xxG	1	
7	Panel Key Board	71-300846-xxG	1	
8	Panel LED Board	71-300528-xxG	1	
9	Parallel Board	71-300821-xxG	1	

PFC board (Power Factor Correct Board)

The PFC board consists of Rectifier and PFC/Booster.
When UPS works in line mode, the Rectifier and PFC will work, It changes the AC power to DC power stored in the BUS capacitor. When works in Battery mode, the PFC will only work as boost to get the higher DC power.

INV board (Inverter Board)

The INV Board includes STS and Inverter. It supplies the power for the system, and it converts the DC power to a pure sine waveform, in the purpose of less or no transfer time, there is one STS.

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.

COMM board (Communication Board)

The COMM board is charged of display of the LED/LCD, the communication with the computer, and other important tasks

IPOP board

There are charger, input and output EMI on IPOP board. The charger is fully charged the battery capacity. Input EMI and output EMI are interference prevention at conducted and radiated.

Pre-charger board

The Pre-charger board function is Pre-charging BUS capacity.

Parallel board

The Parallel board is used for parallel communication when the UPS system is running in parallel mode.

Panel Main/LED/key board

The Panel board provides LED and LCD display to the users.

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.

SPS board

The SPS board is DC power supply. It used to provide power to all function board.

STS main board

The STS main board is control the bypass SCR and FAN control and communication.

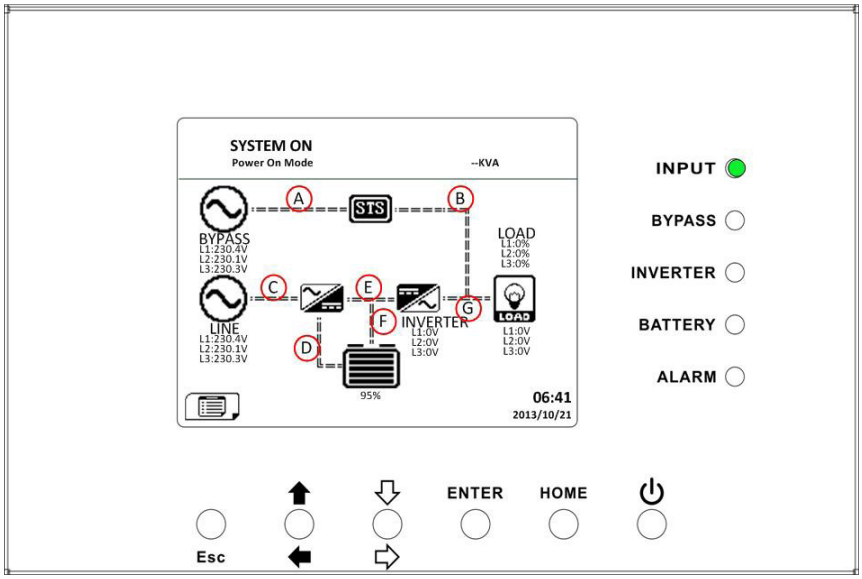
Interface board

The interface board is Dry Contact board. Dry contact refers to a contact of a relay which does not make or break a current. Usually some other relay or device has the job of starting or stopping the current.

Function Flow Chart

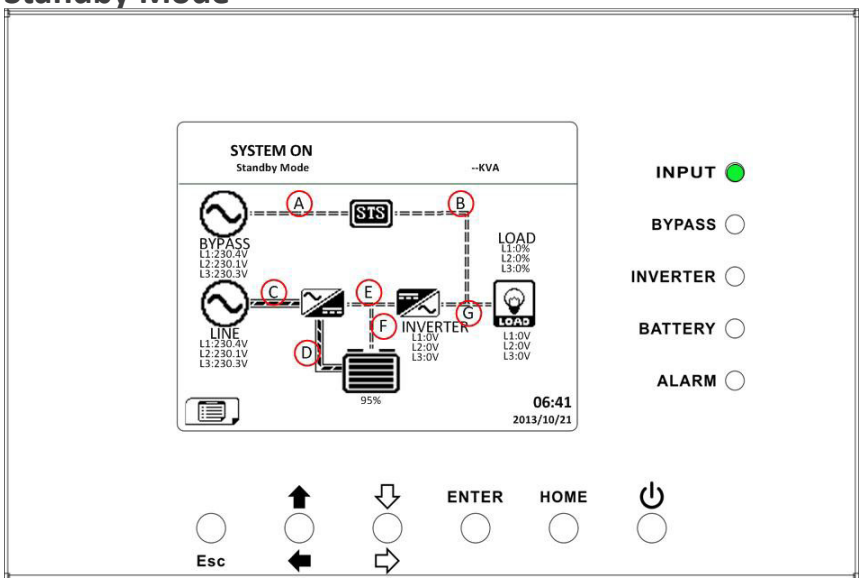
This chapter describes the various functional states on front panel.

Power on Mode



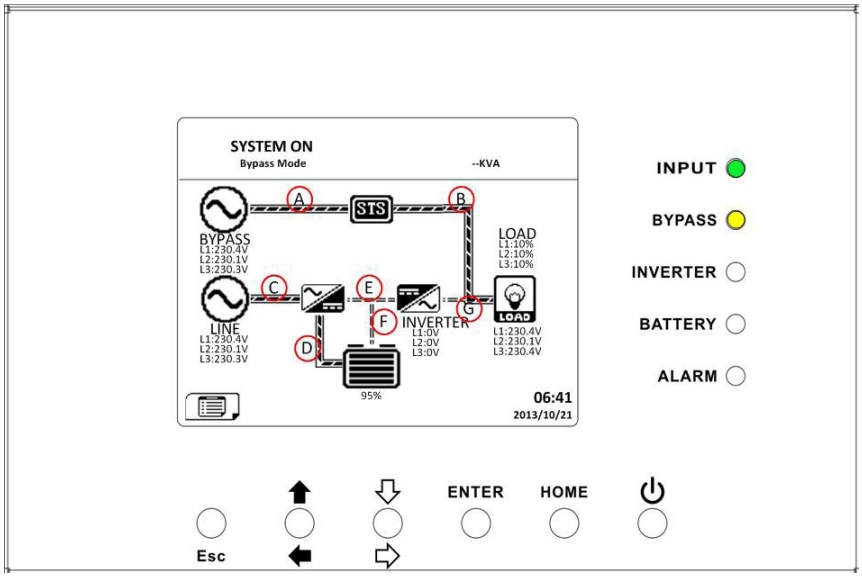
UPS Mode	Description
Power On Mode	A:Off, B:Off, C:Off, D:Off, E:Off, F:Off, G:Off

Standby Mode



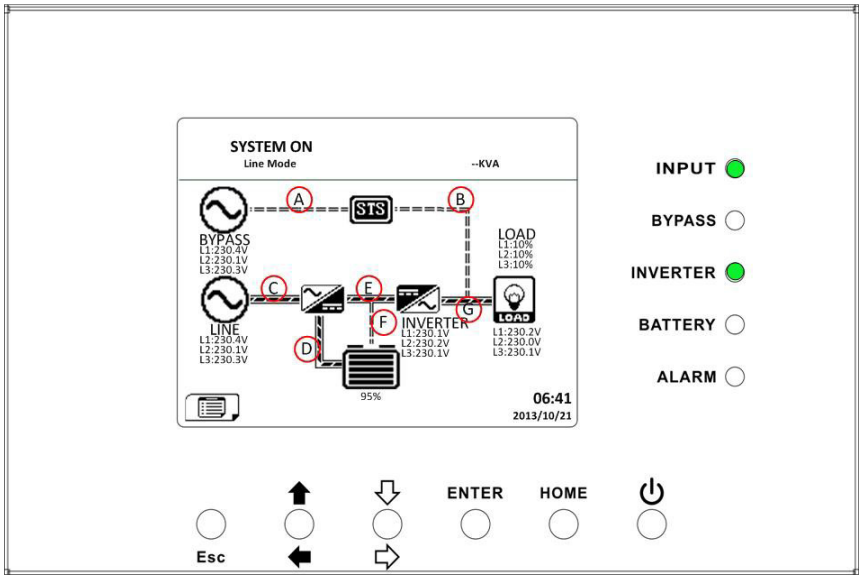
UPS Mode	Description
Power On Mode	A:Off, B:Off, C:Off, D:Off, E:Off, F:Off, G:Off

Bypass Mode



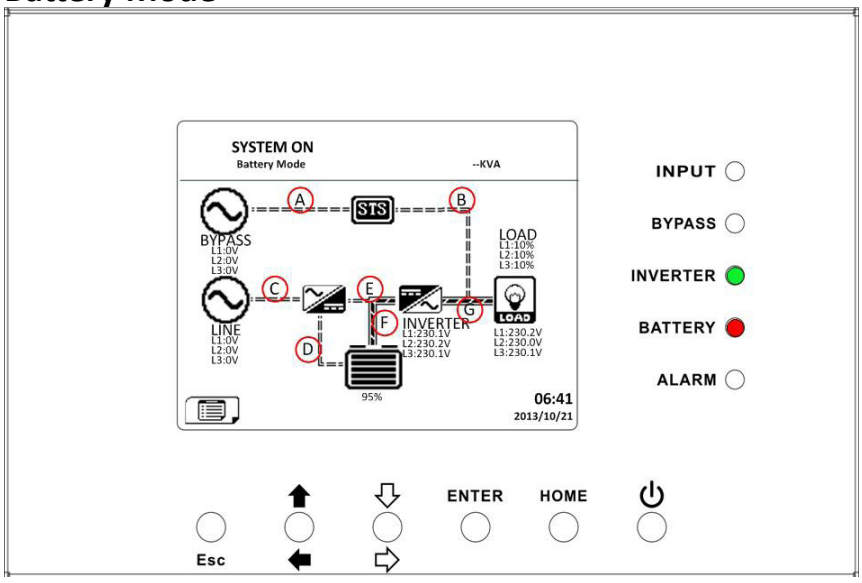
UPS Mode	Description
Bypass Mode	A:On, B:On, C:On, D:On, E:Off, F:Off, G:Off

Line Mode



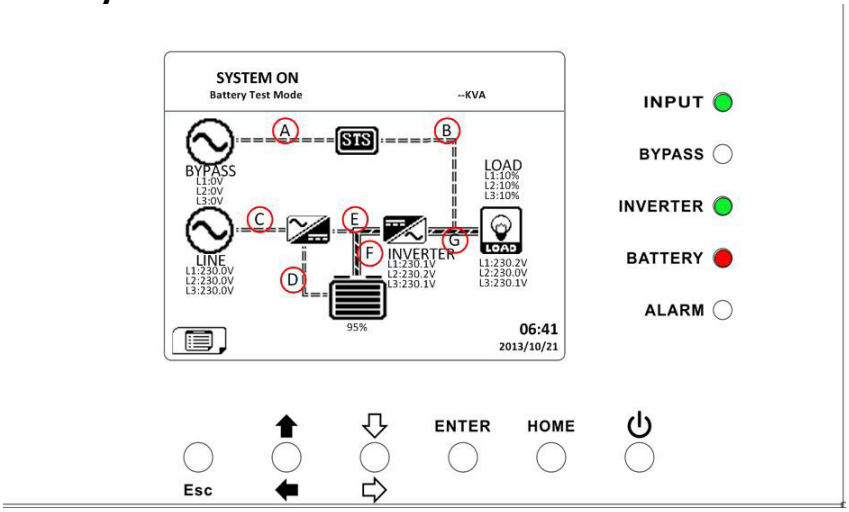
UPS Mode	Description
Line Mode	A:Off, B:Off, C:On, D:On, E:On, F:Off, G:On

Battery Mode



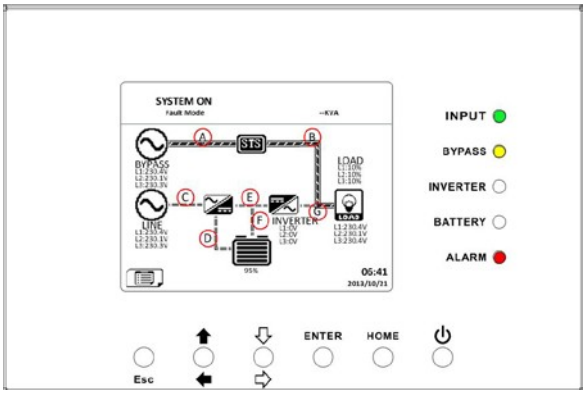
UPS Mode	Description
Line Mode	A:Off, B:Off, C:Off, D:Off, E:Off, F:On, G:On

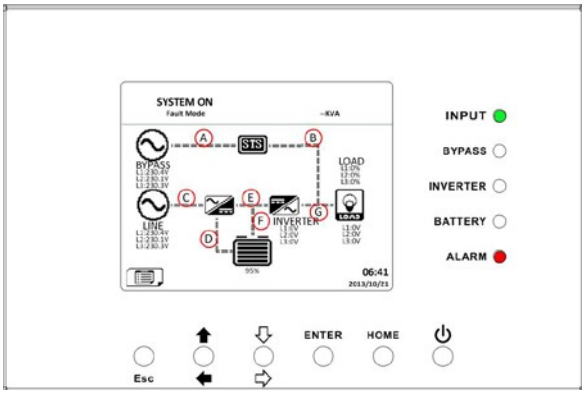
Battery Test Mode



UPS Mode	Description
Battery Test Mode	A:Off, B:Off, C:Off, D:Off, E:Off, F:On, G:On

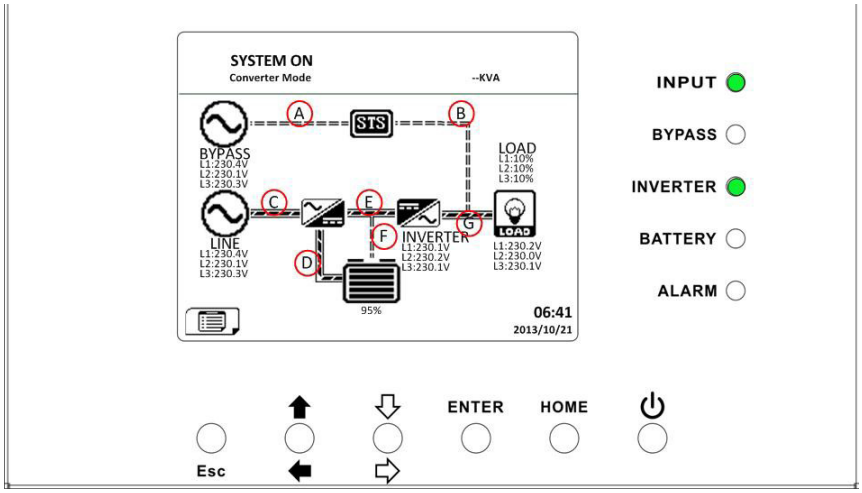
Fault Mode





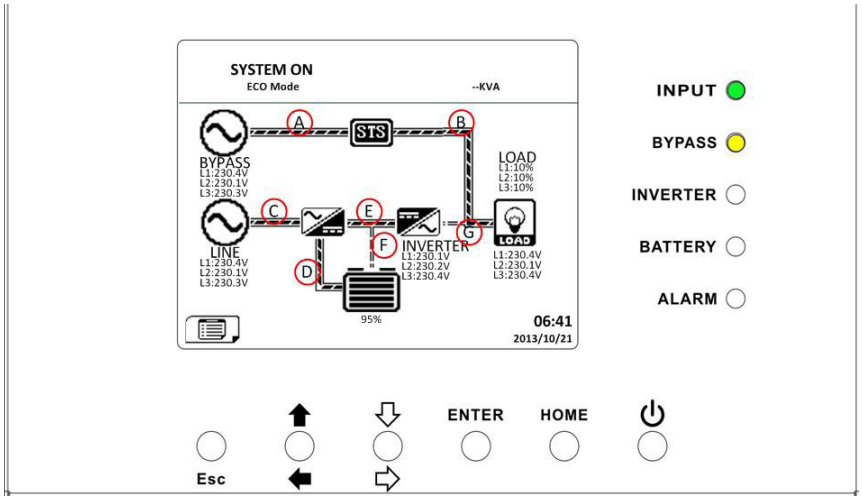
UPS Mode	Description
Fault Mode	A:On, B:On, C:Off, D:Off, E:Off, F:Off, G:Off
	A:Off, B:Off, C:Off, D:Off, E:Off, F:Off, G:Off

Converter Mode



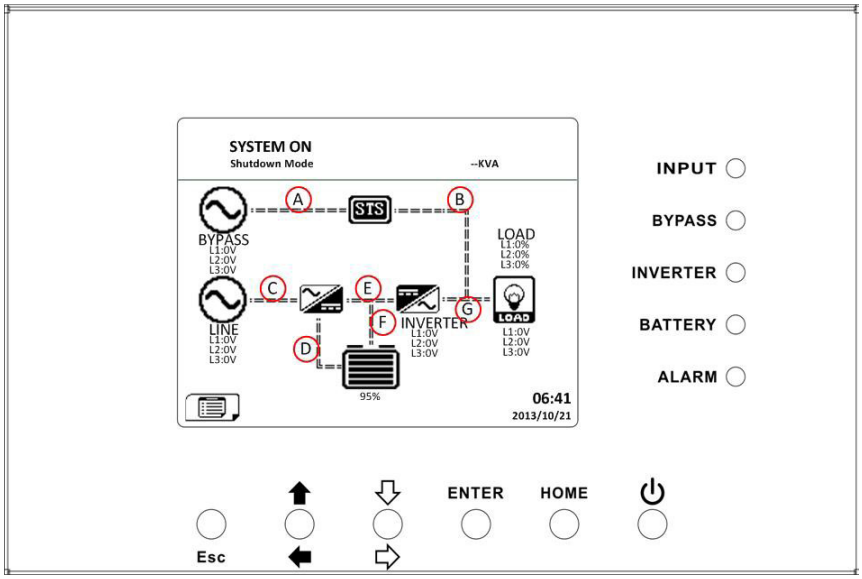
UPS Mode	Description
Converter Mode	A:Off, B:Off, C:On, D:On, E:On, F:Off, G:On

ECO Mode



UPS Mode	Description
ECO Mode	A:On, B:On, C:On, D:On, E:On, F:Off, G:Off

Shutdown Mode



UPS Mode	Description
Shutdown Mode	A:Off, B:Off, C:Off, D:Off, E:Off, F:Off, G:Off

Trouble Shooting

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 and get the warning or fault code via theRS232 if possible, otherwise 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 the most problems.

LCD Panel Display Pattern Definition

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.

Trouble shooting for fault codes in LCD display

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

Representation in display LCD	Explanation	Conduct item
Fault! Bus Over Voltage	DC bus voltage is too high	Shutdown and remove this power module Check have any problem this module
Fault! Bus Under Voltage	DC bus voltage is too low	Shutdown and remove this power module Check have any problem this module
Fault! Bus Voltage Unbalance	DC bus voltage is not balanced	Shutdown and remove this power module Check have any problem this module
Fault! Bus Short	DC bus is short	Shutdown and remove this power module Check have any problem this module
Fault! Bus Soft Start Time Out	The rectifiers could not start due to low DC bus voltage within specified duration	Shutdown and remove this power module Check pre-charge of PFC PCBA
Fault! Inverter Soft Start Time Out	Inverter bus voltage cannot reach desired voltage within specified duration	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! Inverter Voltage High	Inverter Voltage is too high	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! Inverter Voltage Low	Inverter Voltage is too Low	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! R Inverter Voltage Short	R phase inverter Output is shorted	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! S Inverter Voltage Short	S phase inverter Output is shorted	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! T Inverter Voltage Short	R-S inverter Output is shorted	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! ST Inverter Voltage Short	S-T inverter Output is shorted	Shutdown and remove this power module Check IPOP and Inverter PCBA

Fault! TR Inverter Voltage Short	T-R inverter Output is shorted	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! Inverter R Negative Power	R phase inverter Output Negative Power over range	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! Inverter S Negative Power	S phase inverter Output Negative Power over range	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! Inverter T Negative Power	T phase inverter Output Negative Power over range	Shutdown and remove this power module Check IPOP and Inverter PCBA
Fault! Over Load Fault	The load devices are demanding more power than the UPS can supply.	Check output load
Fault! Battery Fault	Battery reverse	Check battery input wire(+ N -)
Fault! Over Temperature	Make sure adequate space is allowed for air vents and the fan is working	Shutdown and remove this power module Check IPOP and Inverter and PFC PCBA
Fault! Can Fault	CAN communication fault	Shutdown and remove this power module Check IPOP and Control PCBA
Fault! TRIG0 Fault	Trigger signal fault	Shutdown and remove this power module Check IPOP and Control PCBA
Fault! Relay Fault	Inverter relay fault	Shutdown and remove this power module Check IPOP and Control PCBA
Fault! Line SCR Fail	Line scr short circuit fault	Shutdown and remove this power module Check IPOP and PFC PCBA
Fault! Eeprom Fault	Eeprom operation error	Test again or Shutdown and remove this power module Check Control PCBA
Fault! Parallel Cable Loosen Fault	As stated.	Shutdown Rack UPS Check Parallel PCBA and the wire
Fault! DSP MCU Stop Communicate	As stated.	Shutdown and remove this power module Check Control PCBA
Fault! Bypass SCR Fault	As stated.	Check main PCBA of STS module Check SCR of STS module
Warning! EPO Active	Check the EPO connector	Check EPO connector and wire
Warning! Over Load Fail	The load devices are demanding more power than the UPS can supply.	Check output Load-Capacity and specification

Warning! Communicate Can Fail	CAN communication error	Shutdown and remove this power module Check Control and Parallel PCBA
Warning! Over Load	The load devices are demanding more power than the UPS can supply.	Check over load have >100%
Warning! Battery Open	Battery not connected	Check battery breaker or battery units
Warning! Battery voltage High	Battery voltage is too High	Check battery number Check charger voltage
Warning! Module Un-Lock	As stated.	Check Module Un-Lock
Warning! Turn On Abnormal	As stated.	Check input voltage or frequency
Warning! Charge Fail	As stated.	Shutdown and remove this power module Check IPOP PCBA
Warning! Eeprom Fail	Eeprom operation error	Shutdown and remove this power module Change Control PCBA
Warning! Fan Lock	As stated.	Check FANs of power module or STS module
Warning! Line Phase Error	As stated.	Check input Phase and sequence
Warning! Bypass Phase Error	As stated.	Check input Phase and sequence of STS
Warning! N Loss	Neutral loss	Check N phase
Warning! Internal Initial Fail	As stated.	Shutdown and remove this power module Change Control PCBA
Warning! CommSyn Signal Fail	Communicate Synchronization Signal Fail	Shutdown and remove this power module Change Control PCBA or wire of RACK
Warning! Comm TRIG0 Fail	Communicate Trigger signal fault	Shutdown and remove this power module Change Control PCBA or wire of RACK
Warning! Redundancy Set Fail	As stated.	Set-up again
Warning! Parallel Sys Config Wrong	Parallel System Configure error	Shutdown and remove this power module Change Control PCBA or wire of RACK

Repair

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

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 screw drivers(150mm/75mmlength), flat screw drivers (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;

QuickStart

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.

Power module

IPOP Board

Component Type	Checked components	Failure condition
SCR	Q7,Q8,Q12,Q16,Q4,Q6,Q13,Q15,Q3,Q5,Q9,Q14,Q1,Q2,Q10, Q11,Q19,Q20,Q21,Q24,Q17,Q18,Q22,Q23,Q46,Q47,Q48,Q49,Q50,Q51,Q28,Q29,Q32,Q36	A-K Short or open
Diode	D36,D7,D9,D35,D11,D32,D13,D25,D2,D1,D3,D4,D5,D7,D8,D10,D12,D14,D16,D21,D22	Short or open
MOSFET	Q27,Q30,Q35,Q31,Q52,Q53	D-S short or open
FUSE	F15,F14,F10,F11,F12,F13,F22,F23,F24,F19,F20,F21,F16,F17,F18	open

PFC Board

Component Type	Checked components	Failure condition
IGBT	Q4,Q10,Q17,Q1,Q7,Q14,Q5,Q16,Q12,Q2,Q8,Q15,Q6,Q11,Q18,Q3,Q13,Q9	C-E short or open

Inverter Board

Component Type	Checked components	Failure condition
IGBT	IGBT1,IGBT2,Q1,IGBT3,IGBT4,IGBT5 ,IGBT6,IGBT7,IGBT8,Q2 ,IGBT9,OGBT10,Q3,IGBT11,IGBT12, IGBT13,IGBT14,IGBT15,I GBT16,Q4I GBT17,IGBT18,Q5,IGBT19,IGBT20,I GBT21,IGBT22,IGBT23,IGBT24,Q6	C-E shortor open
MOSFET	Q19	D-S shortor open

SPS Board

Component Type	Checked components	Failure condition
MOSFET	Q6,Q5	D-S shortor open
Diode	D2,D11,D3,D7,D4,D9,D6	Short or open

Fuse Board

Component Type	Checked components	Failure condition
FUSE	F1,F2,F3,F4,F5,F6,F7,F8,F9,F10,F11	open

STS

Main Board

Component Type	Checked components	Failure condition
MOSFET	Q1,Q2,Q3,Q5,Q6,Q7,Q8	D-S shortor open
FUSE	F10,F11,F12,F13,F16,F17,F14,F15	OPEN
Diode	D35,D34,D17,D28,D29,D31,D47,D4 8,D46,D39,D40,D38,D62	Short or open

Communication Board

Component Type	Checked components	Failure condition
MOSFET	Q2	D-S short or open
Diode	D12,D4,D2,D11	Short or open

Major parameters of IPOP Board section

The most likely problems occur on IPOP board section including: open fuse, broken MOSFET, broken Diode, broken SCR, and broken SCR driver resistor.

IPOP Board

Checked components		Instrument function	Reference Value	Failed Condition
Q7,Q8,Q12,Q16,Q4,Q6,Q13, Q15,Q5,Q3,Q9,Q14,Q1,Q2,Q1 0,Q11,Q19,Q20,Q21,Q24,Q17 ,Q18,Q22,Q23	(A,K)	Resistance	>2MΩ	Short
	(G,K)	Resistance	•20Ω	Short
Q28,Q29,Q32,Q36,Q46,Q47,Q 48,Q49,Q50,Q51	(A,K)	Resistance	>2MΩ	Short
	(G,K)	Resistance	•30Ω	Short

R400,R399,R398,R404,R401,R403,R408,R405,R407		Resistance	49.9kΩ±0.1%	Value change
R323,R319,R321,R318,R344,R315		Resistance	402kΩ±0.1%	Value change
R389,R402,R406		Resistance	200KΩ±0.1%	Value change
R331,R332,R333,R355,R334,R293,R335,R296,R328,R329,R330,R354,R346,R306,R347,R308,R325,R326,R327,R353,R342,R343,R356,R357		Resistance	750KΩ±0.1%	Value change
R24,R23,R33,R45,R18,R16, R40,R39,R17,R15,R28,R42,R8,R9,R32,R31,R54,R53,R57,R65,R48,R49,R60,R61		Resistance	47Ω±1%	Value change
R19,R20,R27,R41,R11,R13, R36,R34,R12,R10,R26,R35,R6,R7,R29,R30,R50,R51,R56,R62,R46,R47,R58,R59		Resistance	510Ω±1%	Value change
Q35,Q31	(D,S)	Diode Voltage Droop	•0.24V	Short or open
	(G,S)	Resistance	>50kΩ	Short or open
D36,D7,D9,D35,D11,D32,D13,D25,D2,D1,D3,D4,D5,D6,D8,D10,D12		Diode Voltage Droop	•0.38V	Short or open
D14,D16,D22,D21		Diode Voltage Droop	•0.24V	Short or open
F10,F11,F12,F13,F15,F14,F22,F23,F24,F19,F20, F21,F16,F17,F18		Diode Voltage Droop	•0V	open

Note: If MOSFET/SCR is OK, but the parameter is not close to the reference value, it is very possible that the corresponding driver is damaged, so please try to change the IGBT driver component.

Major parameters of PFC Board section

The most likely problems occur on PFC board section including: broken IGBT, broken Diode, and broken IGBT driver resistor.

PFC Board

Checked components	Instrument function		Reference	Failed
R66,R84,R127,R62,R123,R82,R64,R80,R125	Resistance		30Ω±1%	Value change
R73,R89,R148,R58,R76,R106,R70,R146,R88,R57,R74,R105,R72,R87,R147,R56,R104,R75	Resistance		10Ω±1%	Value change
R54,R71,R92,R55,R69,R91,R53, R90, R68	Resistance		2.2Ω±1%	Value change
R67,R85,R128,R60,R79,R115,R63,R124,R83,R59,R77,R114,R65,R81,R126,R61,R113,R78	Resistance		49.9kΩ±1%	Value change
Q4,Q10,Q17,Q1,Q7,Q14,Q5,Q16,Q12,Q2,Q8,Q15,Q6,Q11,Q18,Q3Q13,Q9	(C,E)	Diode Voltage Droop	•2.0V	Short or open
	(G,E)	Resistance	>25kΩ	Short or open

R17,R49,R13,R45,R9,R29,R5,R25,R1 ,R21, R20, 52,R16,R48,R12,R32,R8,R2 8,R4,R24, R18,R19,R50,R51,R14,R46,R 15,R47,R10,R30,R11,R31,R6,R26,R7,R 27,R2,R22,R3,R23	Resistance	162kΩ±0.1%	Value change

Note: If IGBT is OK, but the parameter is not close to the reference value, it is very possible that the corresponding driver is damaged, so please try to change the IGBT driver component.

Major parameters of INVERTER Board section

The most likely problems occur on Inverter board section including: broken IGBT, broken Diode and broken IGBT driver resistor.

Inverter Board

Checked components	Instrument function		Reference	Failed
R3,R12,R11,R16,R22,R26,R32,R36,R 45,R44,R49,R58,R57,R62,R68,R72,R7 8,R82,R91,R90,R97,R107,R106,R114 ,R120, R124,R130,R134,R143,R142	Resistance		15Ω±1%	Value change
R4, R13, R8, R17, R23, R27, R33, R37, R46, R42, R50, R59, R54, R63, R69, R73, R79, R83, R92, R88, R98, R108, R103, R115, R121, R125, R131, R135, R144,R140	Resistance		3Ω±1%	Value change
R10,R9,R7,R18,R21,R31,R28,R43, R38, R41, R56, R55, R53, R67, R64, R77, R74, R89, R84, R87, R104 ,R105, R102,R119,R116,R129, R126, R141, R136 , R139	Resistance		49.9kΩ±1%	Value change
IGBT1,IGBT2,Q1,IGBT3,OGBT4 ,IGBT5, IGBT6, IGBT7, IGBT8, Q2 , IGBT9, IGBT10, Q3, IGBT12, IGBT11, IGBT14, IGBT13, IGBT10, IGBT15, Q4, Q5, IGBT18, IGBT17, IGBT19, IGBT20, IGBT22, IGBT21, IGBT24, IGBT23	(C,E)	Diode Voltage Droop	•2.0V	Short or open
	(G,E)	Resistance	>25kΩ	Short or open

Note: If IGBT is OK, but the parameter is not close to the reference value, it is very possible that the corresponding driver is damaged, so please try to change the IGBT driver component.

Major parameters of SPS Board section

The most likely problems occur on Inverter board section including: broken MOSFET, broken Diode , and broken MOSFET driver resistor.

SPS Board

Checked components		Instrument function	Reference Value	Failed Condition
Q95,Q90,Q94,Q87		Resistance	30kΩ±1%	Value Change
R77,R76,R73,R72,R75,R70,R69,R92, R93,R91,R97		Resistance	1MΩ±1%	Value Change
R79,R78,R71		Resistance	49.9kΩ±1%	Value change
R84,R96,R83,R82,R85		Resistance	20kΩ±1%	Value change
R86		Resistance	15kΩ±1%	Value change
R88,R89		Resistance	1.5MΩ±1%	Value change
Q5,Q6	(D,S)	Diode Voltage Droop	•0.25V	Short or open
	(G,S)	Resistance	>50kΩ	Short or open
D2,D3,D7,D4,D9,D11,D5,D6		Diode Voltage Droop	0.3~0.7V	Short or open

Note: If MOSFET is OK, but the parameter is not close to the reference value, it is very possible that the corresponding driver is damaged, so please try to change the IGBT driver component.