INSTALLATION & OPERATING MANUAL

GRAVITAS SABRE SERIES
MODULAR INVERTER SYSTEM

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Manual No. SABRE-4
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Contents

1 System Information & Description

The UNIPOWER Telecom SABRE Series Inverter System utilizes Digital Signal Processing controlled, 1000/1500VA, modular inverters, contained in a 19/23inch shelf, to supply 120/230VAC to telecom equipments when 48VDC (nominal) is supplied.

The controller, allows the user to monitor real-time system status such as output voltage, output current, alarm status, and also allows system parameter settings to quickly be changed with the touch of a few keys.

The STS (Static Transfer Switch) increases system reliability by automatically switching between the inverter output and the AC utility supply, providing protection against interruptions caused by system failure. The STS can be programmed to provide the Utility supply to the load under normal conditions and switch to the inverters as a back-up in the event of utility failure; or alternatively the inverters can be the normal source of power to the load, using the Utility as a backup. This programmability of primary and backup source allows the SABRE system to be used in many different applications including traditional Telecom and 'Green Energy' such as solar or wind generation.

The MBS (Maintenance Bypass Switch) consists of a mechanical switch providing free maintenance for the safe removal of the STS module without interruption of power to the load. The inverter modules are fully hot-swappable and operate automatically in an N+1 redundant configuration.

The SABRE Series Inverter System can accommodate up to 12 inverter modules for an output capacity up to 50Amps when employing the STS while an output capacity of 100A is possible without the STS. Up to 12 shelves can be connected in parallel to supply AC power. The system can be installed in both 19-inch and 23-inch cabinet configurations.

1.1 Inverter Module Specification

1.1.1 Electrical Specification

Input		
Item	**Specification**	**Remarks**
Nominal voltage	48Vdc	
Operating range	40.5Vdc ~ 58.0Vdc	
Under voltage warning threshold	45Vdc	
Under voltage threshold	40Vdc	
Over voltage warning threshold	58.0Vdc	
Over voltage threshold	60Vdc	
Isolation AC-DC	Reinforced isolation (Pri-Sec) 4242Vdc/1min	
Inrush current	<2*Irated	IEC62040-3(1999)
Isolation DC-enclosure	707Vdc/1min	(Varistors and filter capacitor removed)
Input protection	Reverse Polarity Protection	
Psophometric noise voltage	≤1.0mV ITU-T O.41 (16.66~6000Hz)	
Reflected Psophometric noise current	According to YD /T 777-2006 less than 1%	
Reflected relative band wide current noise	According to YD/T 777~2006 less than 10%(0-2Mhz)	
Wide Band Noise	<1.0mVpsof (25Hz~5KHz) <20mVrms (25Hz~20KHz)	
Peak to peak noise	150mV up to 100MHz	

Output		
Item	**Specification**	**Remarks**
Waveform	Pure sine wave	
Output power	1000 VA/800W or 1500VA/1200W	Model Dependent
Power factor	0.8	
Nominal output voltage	110/115/120VAC or 208/220/230/240VAC	Model Dependent
Output voltage variation	Max ±2%	
Output Frequency	50/60Hz	Programmable
Frequency variation	Max ±0.5%	
Crest factor	3:1	
THD	<3%, linear load <5%, non-linear load	
Capacitive/inductive load	-0.8 to +0.8 without exceeding permissible distortion for resistive load	
Efficiency	Min 88% at rated load	
Current limitation	Electronic current limitation at overloads and short circuits.	
Isolation AC-enclosure	Basic isolation (Pri-Gnd) 2121Vdc/1min	
Surge protection	EN61000-4-5. Telcordia GR-1089 Core ANSI C62.41-IEEE, STD 587-1980	
Dynamic response	<±10%	
Over load protection	2*Inom ,5S max 1.5*Inom, 10S max 1.25*Inom temperature controlled Inom = 1000VA/output voltage	
Control		
Load sharing	< 5 %	
Display	3 LEDs installed at the front of faceplate	
Status/alarm information	Inverter failure (dry-contact) Remote info Inverter failure/Overload alarm/Low voltage disconnect alarm/ Fan Failure alarm/Thermal derating info/Power output/Input voltage/Output voltage/ Output current/Output frequency/Low input voltage shut off/Product info data Remote On/Off function	
Communication (internal to system)	CAN Bus	
Runtime info.	Handled through a maintenance feature in the controller	
Useful life	12 years	

1.1.2 Environmental Specification

Item	**Specification**
Operation temperature	-20°C (-4°F) to 70°C (158°F), absolute maximum -5°C (23°F) to 50°C (122°F) with full performance
Storage Temperature	-40°C (-40°F) to 85°C (185°F)
Noise	55dB ETS 300 753, class 3.1
Safety	UL60950-1/EN60950-1/IEC60950-1
EMC	EN300 386:2001. Class B compliance

1.1.3 Mechanical Specification

Items	**Specification**
Module Dimensions	Depth: ≤ 10.63” (270mm) Height, body: ≤ 1.59” (40.5mm) Height, front panel: ≤1.72” (43.8mm) (1U) Width: ≤ 8.46” (215mm) (5U)
Hot swappable	Inverter module can be changed in a live system
Hot pluggable	No wires need to be connected or tools required for installation of inverter into shelf
Force cooling	Smart control, easy replacement
# inverter modules in parallel	50A with STS, 100A without STS, see below.

SABRE Series Inverter Parallel Capacity

Module #		**With 50A STS**		**Without STS**	
		# Units	**Algorithm**	**# Units**	**Algorithm**
1	INV1048H (1000VA/230 Output) Module current = 4.4A	12	1000VA/230VAC=4.4A 50A/4.4A=11.36 units	24	Software protocol control
2	INV1048 (1000VA/120 Output) Module current = 8.3A	6	1000VA/120VAC=8.3A 50A/8.3A=6.02 units	12	System capacity limit 100A 100A/8.3=12 units
3	INV1548H (1500VA/230 Output) Module current = 6.5A	8	1500VA/230VAC=6.52A 50A/4.4A=7.66 units	15	System capacity limit 100A 100A/6.52=15.3 units
4	INV1548 (1500VA/120 Output) Module current = 12.5A	4	1500VA/120VAC=12.5A 50A/12.5A=4.0 units	8	System capacity limit 100A 100A/12.5=8.00 units

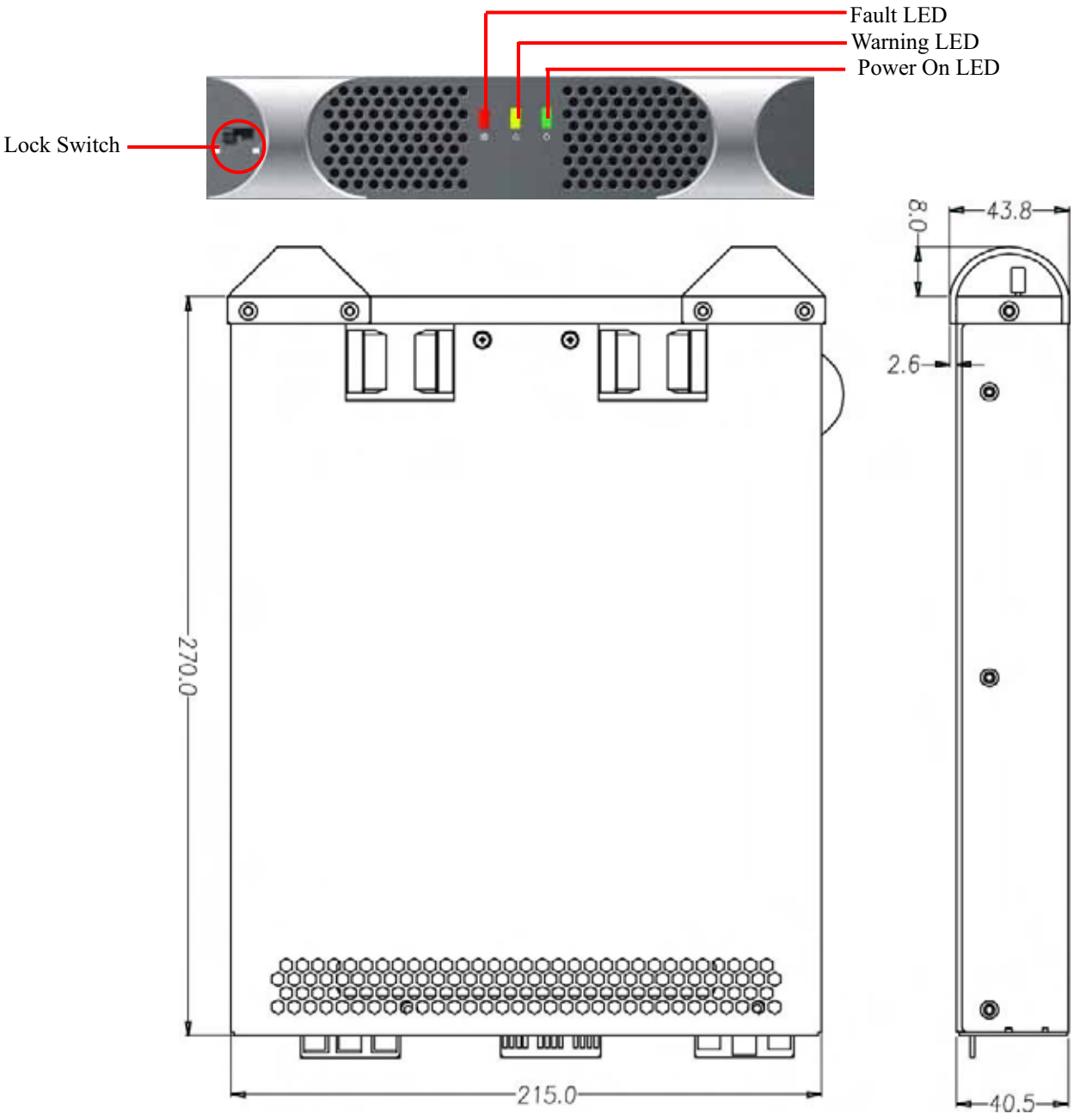
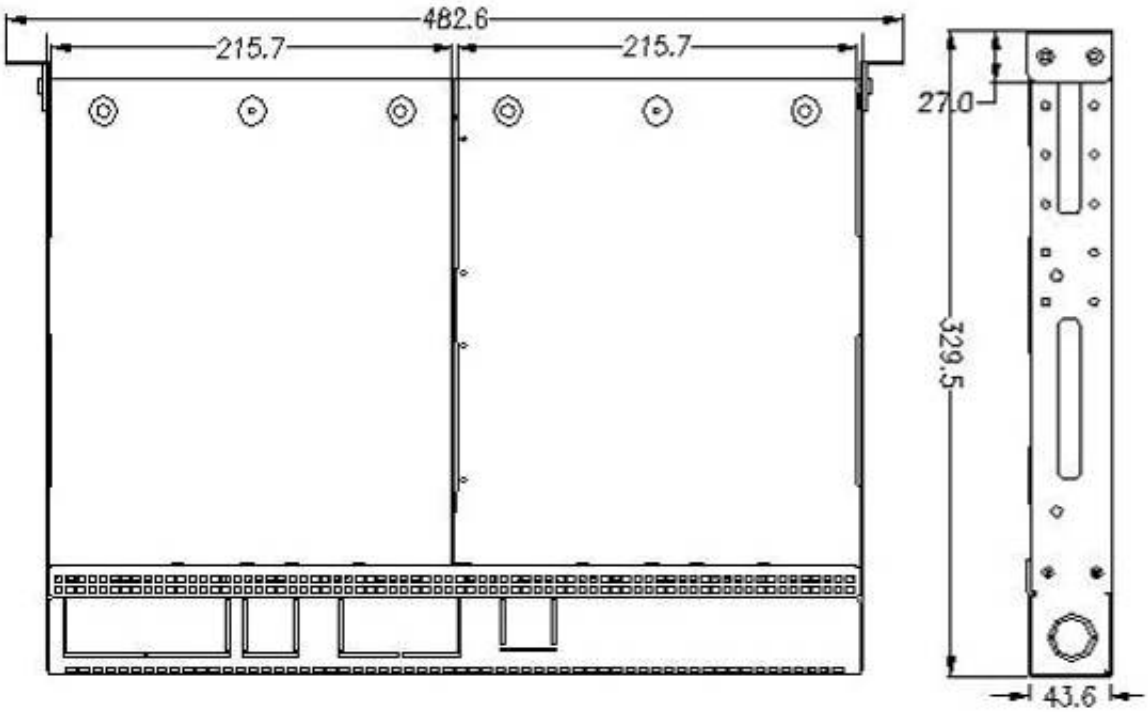


Figure 1 Inverter module dimensions (mm)



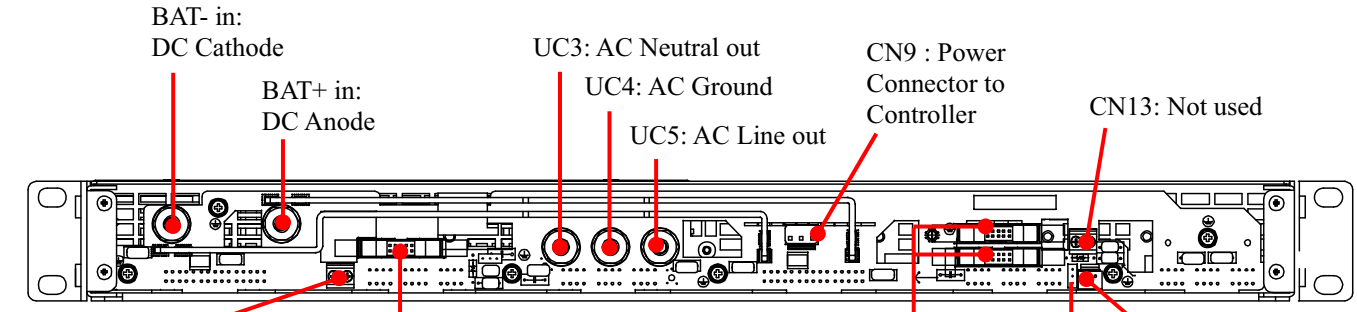


Figure 2 Inverter shelf dimensions (mm)

JP2 : Matching resistor selector Jumper installed positions 1-2 for single inverter shelf installations, removed or installed positions 2-3 for multiple inverter shelf installations.

1.2 STS Module Specification

1.2.1 Electrical features

1.2.1.1 Input

Item	Specification
AC voltage range	110/115/120 VAC: from89 to 138 VAC 208/220/230/240 VAC: 176 to 276 VAC
Over voltage threshold	Adjustable using controller: 220 to 240 VAC for 208 VAC systems 233 to 252 VAC for 220 VAC systems 244 to 264 VAC for 230 VAC systems 254 to 276 VAC for 240 VAC systems 117 to127 VAC for 110 VAC systems 122 to 132 VAC for 115 VAC systems 127 to 138 VAC for 120 ac systems
Under voltage threshold	Adjustable using controller: 176 to 198VAC for 208 VAC systems 176 to 209VAC for 220 VAC systems 185 to 218VAC for 230 VAC systems 193 to 228VAC for 240 VAC systems 89 to 105VAC for 110 VAC systems 93 to 110VAC for 115 VAC systems 100 to 114VAC for 120 VAC systems
Redundant power supply design	Startup power-on by priority source or alternative

Note: The over/under voltage settings are managed by the controller. If there is no controller installed, the STS module will adopt the widest range to set over/under voltage in order to guarantee its performance. For 110/115/120 VAC systems, the range is from 89VAC (under voltage point) to 138VAC(over voltage point); for 208/220/230/240 VAC systems, the range is from 176VAC(under voltage point) to 276VAC(over voltage point). However, once the STS module is set by the controller, it will retain the setting permanently so a controller can be installed to alter these settings and then removed if not required.

1.2.1.2 Output

Item	Specification	Remarks
Waveform	Sinusoidal	
Nominal output voltage	Same as mains AC or the output of inverter modules	
Permissible frequency area	Max. ±2.5% (Synchronize area of Inverter)	±1.5Hz for 60Hz Inverter ±1.25Hz for 50Hz Inverter
Transfer time	Typical 1/4cycle	
Rated current	50A	All voltage settings
Operation methods	Inverter priority or Utility priority	Programmable

1.2.1.3 Alarm Information

Item	Specification
STS Alarms Information	CAN communication failure Back-feed relay open SCR1 short circuit SCR2 short circuit Output short Over load Over temperature Mains unavailable Inv unavailable Output abnormal STS fan failure MBS position error EEPROM fault

1.2.1.4 Interface

Item	Specification
Human Interface	
LED Indicator	3-LED installed at the front of faceplate
Communication Interface	
Communication	Communicates with controller and Inverter modules through CAN Bus interface

1.2.1.5 Operating status for the various positions of the MBS

The operation mode of STS is closely linked with the position of MBS. The MBS has two main contacts and three auxiliary contacts, signals generated by the three auxiliary contacts are passed to STS for position detection. Once an auxiliary contact is closed, the signal is logic 0, in reverse it will be logic 1. The combination of logic 0 and 1 can produce five valid position statuses.

Position status of MBS

SW1/SW2/SW3 are the logic level signals detected by STS, the five valid status conditions are as follows:

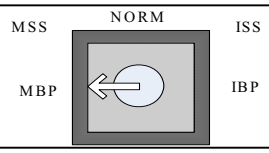
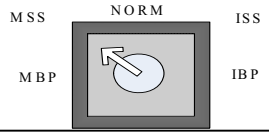
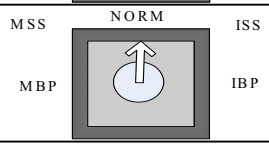
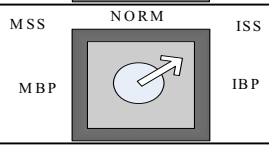
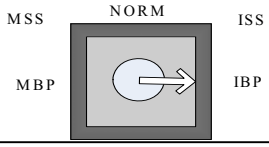
MBS Position	Contacts Signals			Mode Define	Postural Plot
	SW1	SW2	SW3		
P1	0	1	1	Mains Bypass (MBP)	
P2	0	0	1	Inverter Maintenance (MSS)	
P3	0	0	0	Normal Operation (NORM)	
P4	1	0	0	Mains Maintenance (ISS)	
P5	1	1	0	Inverter Bypass (IBP)	
Invalid	1	0	1	Reserved	
	0	1	0		
	1	1	1		

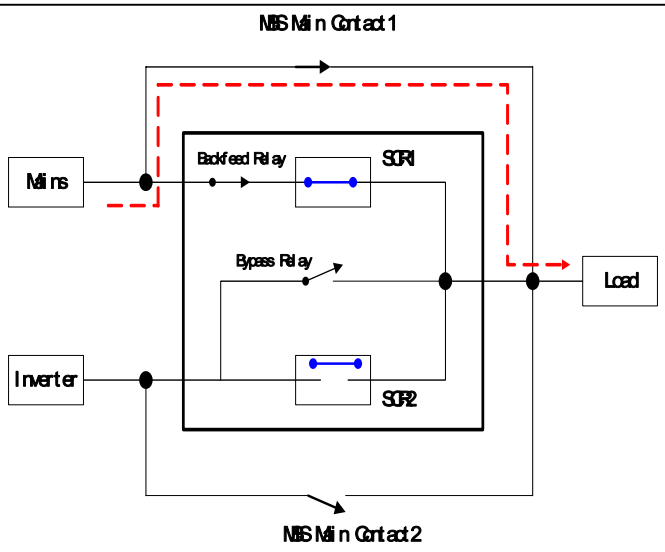
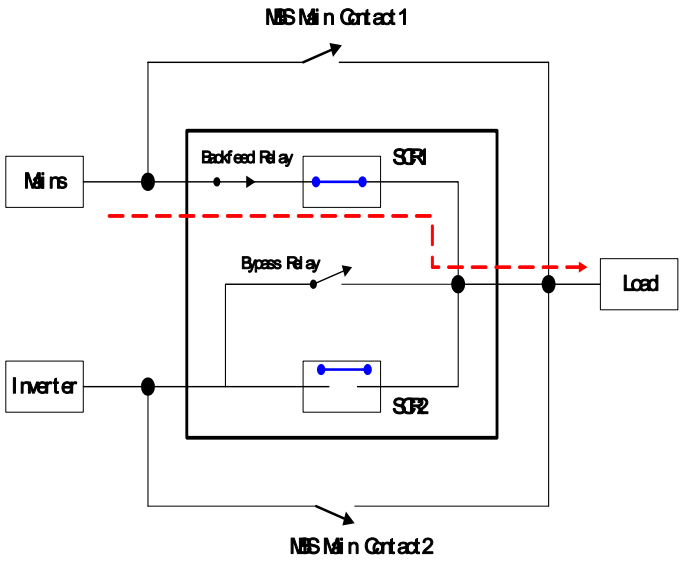
Figure 3 MBS positions (0 = Low, 1 = High)

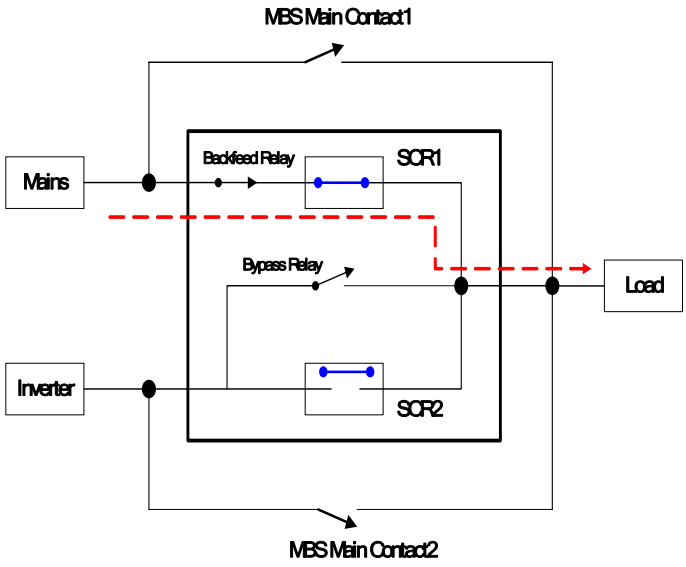
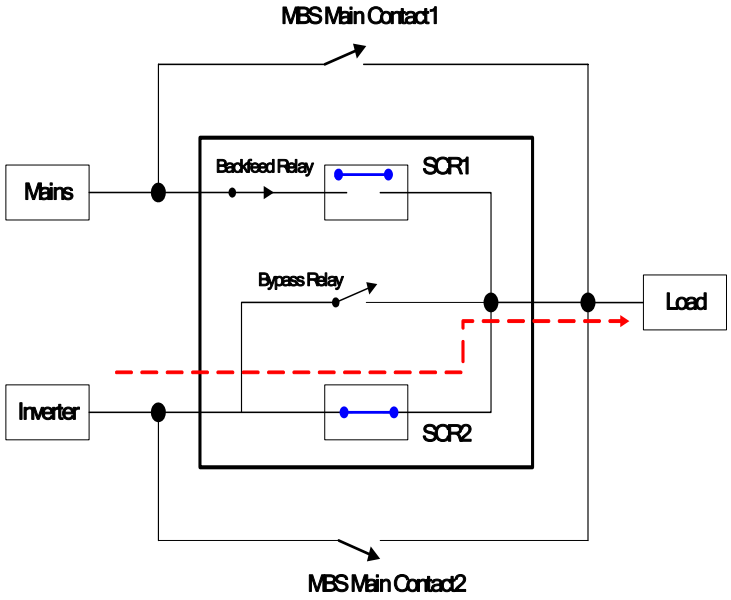
The STS will continuously detect the position of the MBS in order to decide the transferring action between different modes. The STS will continuously detect whether the position of the MBS is valid. If the status is invalid, the STS will consider the MBS faulty, it won't enter any operation mode, and the red LED will blink at 5Hz, at the same time the "MBS abnormal" alarm will be sent to the controller, this phenomenon won't disappear until the detection signal becomes normal. If the MBS is changed when the STS is running at one of the five valid positions, and this change happens between two adjacent positions, then the STS will transfer to a different mode based on current status, otherwise the STS won't take any action. For example, if the MBS is at P3, the STS will take action when the MBS is turned to P2 or P4.

Note: Be sure not to change the MBS position immediately after the STS is inserted into the rack; wait at least 5 seconds if you want to change it and ensure that the MBS remains in each consecutive position for at least 1 second at one position.

1.2.1.6 Operation principal of STS

The operation of the STS at each valid state is described below:

MBS Status	Schematic operation principle of STS	Description
Mains Bypass (P1)		**Mains Bypass(MBP):** ☐ Load is powered through the MBS by the Mains AC ☐ STS does not provide any load power, and can be removed from the system ☐ STS can be removed from the system ☐ MBS can only be switched from P1 to P2 position ☐ SCR2 open, SCR1 and Back-feed Relay closed
Inverter Maintenance (P2)		**Inverter Maintenance(MSS):** ☐ Mains AC powers the load through the static switch ☐ Inverters are on, but do not provide any load power ☐ Inverters can be removed from the system, but the static switch cannot ☐ MBS can be switched from P2 to P1 and P3 position ☐ SCR2 open, SCR1 and Back-feed Relay closed ☐ When SCR2 is short, the STS will stay in off-line mode

MBS Status	Schematic operation principle of STS	Description
Normal Operation (P3)		**Normal Operation(NORM)** **Mains priority:** ☐ Mains AC powers the load through the static switch ☐ MBS can be switched from P3 to P2 and P4 position ☐ SCR2 open, SCR1 and Back-feed Relay closed ☐ When the mains voltage or frequency is abnormal, and the inverter is normal, the STS transfers to on-line mode ☐ When SCR2 is short, the STS will keep the off-line mode
Normal Operation (P3)		**Normal Operation(NORM)** **Inverter priority:** ☐ Inverters power the load through the STS ☐ MBS can be switched from P3 to P2 and P4 position ☐ SCR1 open, SCR2 and Back-feed Relay closed ☐ When the Inverter's voltage or frequency is abnormal, and the mains is normal, the STS transfers to off-line mode ☐ When SCR1 is short, the STS will keep the on-line mode, and the Back-feed relay will open

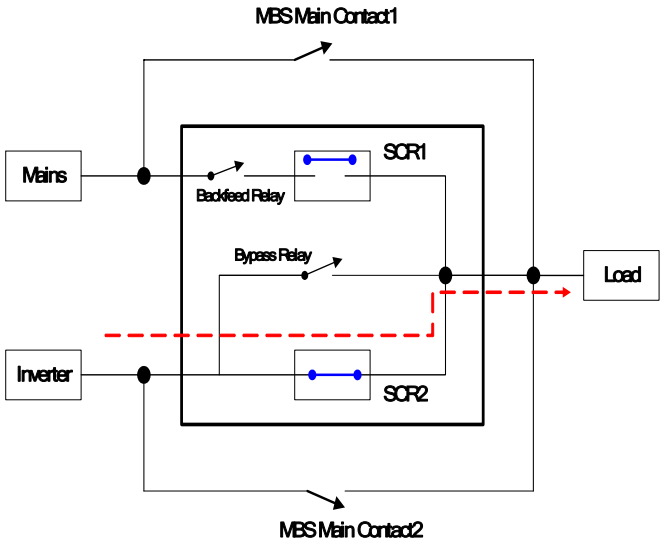
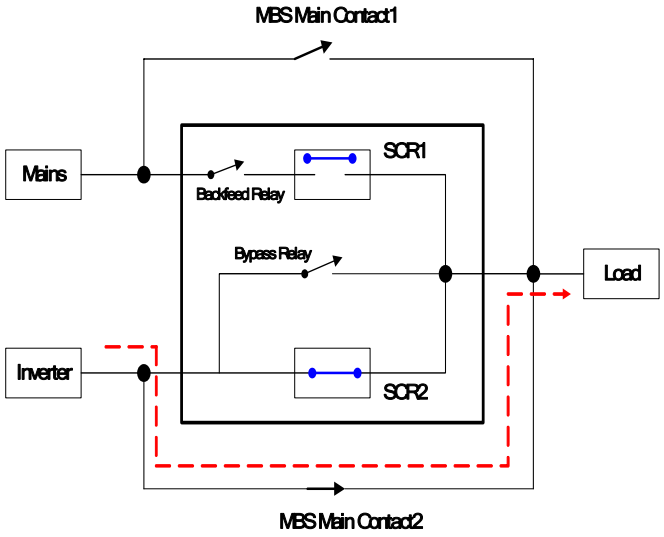
MBS Status	Schematic operation principle of STS	Description
Mains Maintenance (P4)		**Mains Maintenance(ISS):** ☐ Inverters power the load through the STS ☐ AC mains is disconnected from the system, and the STS cannot be removed from the system ☐ MBS can be switched from P4 to P3 and P5 ☐ Back-feed Relay and SCR1 open, and SCR2 closed
Inverter Bypass (P5)		**Inverter Bypass(IBP):** ☐ Load is powered through the MBS by the inverters. ☐ The STS does not provide any load power, and it can be removed from the system ☐ STS can be removed from the system ☐ MBS can only be switched from P5 to P4 position ☐ Back-feed Relay and SCR1 open, and SCR2 closed

Figure 4 STS operation principle

1.2.1.7 Voltage and frequency mode

The STS has two inputs and one output. The two inputs are from Mains Utility and Inverters; the output is the system output. The STS will continuously detect Mains voltage and Inverter voltage in order to decide the system's supply mode. If both Mains and Inverters are normal, the Mains has priority to decide the operation status of the system. In other words, the STS will firstly consider the Mains status to decide the system's running voltage and frequency. Following confirmation of the voltage and frequency, the over/under voltage and over/under frequency are set as follows:

Over/under voltage window

Default Voltage		**120VAC**	**240VAC**
		110V/115V/120V	208V/220V/230V/240V
Over Volt	Activate	138VAC	276VAC
	Recovery	134VAC	268VAC
Under Volt	Activate	89VAC	176VAC
	Recovery	93VAC	184VAC

Over/under frequency window

	System frequency	
	60Hz	50Hz
Frequency high threshold	61.5Hz	51.25Hz
Frequency high back	61.2Hz	51Hz
Frequency low threshold	58.5Hz	48.75Hz
Frequency low back	58.8Hz	49Hz

Voltage Transfer Window

The STS will transfer to the auxiliary source if the priority input voltage exceeds a preset value, the over voltage and under voltage limits are as follows:

Adjustable range		**120VAC**			**240VAC**			
		110V	115V	120V	208V	220V	230V	240V
Over volt	Adjustable range	117~127	122~132	127~138	220~240	233~252	244~264	254~276
	Default value	127	132	138	240	252	264	276
Under volt	Adjustable range	89~105	93~110	100~114	176~198	176~209	185~218	193~228
	Default value	89	93	100	176	176	185	193

1.2.1.8 Fan control

1.2.1.8.1 Fan speed control

The speed of STS fans is decided by the output current and the NTC temperature, with the NTC temperature taking priority. When the temperature of the NTC is above 80ºC, the fan will operate at maximum speed according to the valid fan number, otherwise, the fan will operate according to the load current. The following tables show the relationship between the fan speed and load current. In normal circumstances, where both fans are running, the speed is based on **definition -2** shown below. When one of the two fans is locked, the speed is based on **definition -1**. If both fans are locked for more than 2 minutes the STS will transfer to Inverter bypass mode and the STS module will shut down.

One fan---- **definition-1**

Load	Temperature of NTC	Speed level
Load < 25%	<80℃	Speed2
25% ≤ Load < 50%		Speed3
75% < Load ≤ 50%		Speed4
Load > 75%		Speed5
Any load	>=80℃	Speed6(full speed)

Two fans---- **definition-2**

Load	Temperature of NTC	Speed level
Any Load	<80℃	Speed1(the lowest speed)
Any Load	>=80℃	Speed5

1.2.1.9 Over temperature protection

On-line Mode (Inverters Providing Power)

When the temperature is over 85ºC, the STS will power the load through the bypass relay, and SCR2 will be open. If the temperature reaches 90ºC, the bypass relay will open, and the load will be disconnected until the STS is restarted. The system will re-establish power through the inverter with SCR2 closed and the relay open, when the temperature is under 65ºC and at least one fan is running. The STS will then return to normal mode.

Off-line Mode (Utility/Mains Providing Power)

When the temperature is over 85ºC, the STS will transfer to on-line mode if the Inverter is normal, then the over temperature protection is the same as on-line mode.

If the temperature is less than 65ºC and at least one fan is running, the system will re-establish the power through the inverter with SCR2 closed and the relay open and the system will return to off-line mode.

- Inverter bypass: 85ºC
- Inverter bypass back: 65ºC
- Temperature protection: 90ºC

1.2.1.9.1 Off-line mode

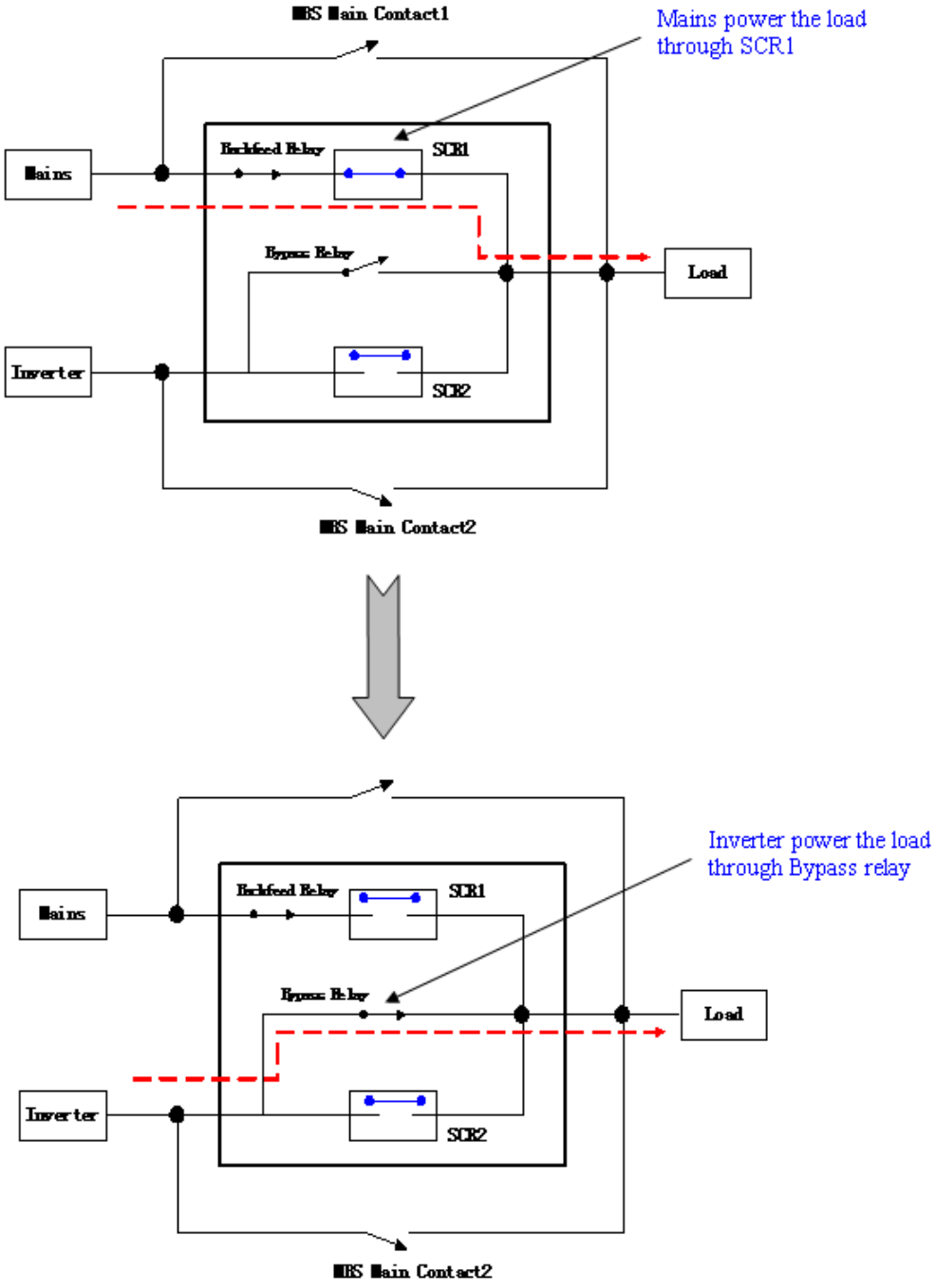


Figure 6 Off-line mode relay bypass transfer

1.2.1.9.2 On-line mode

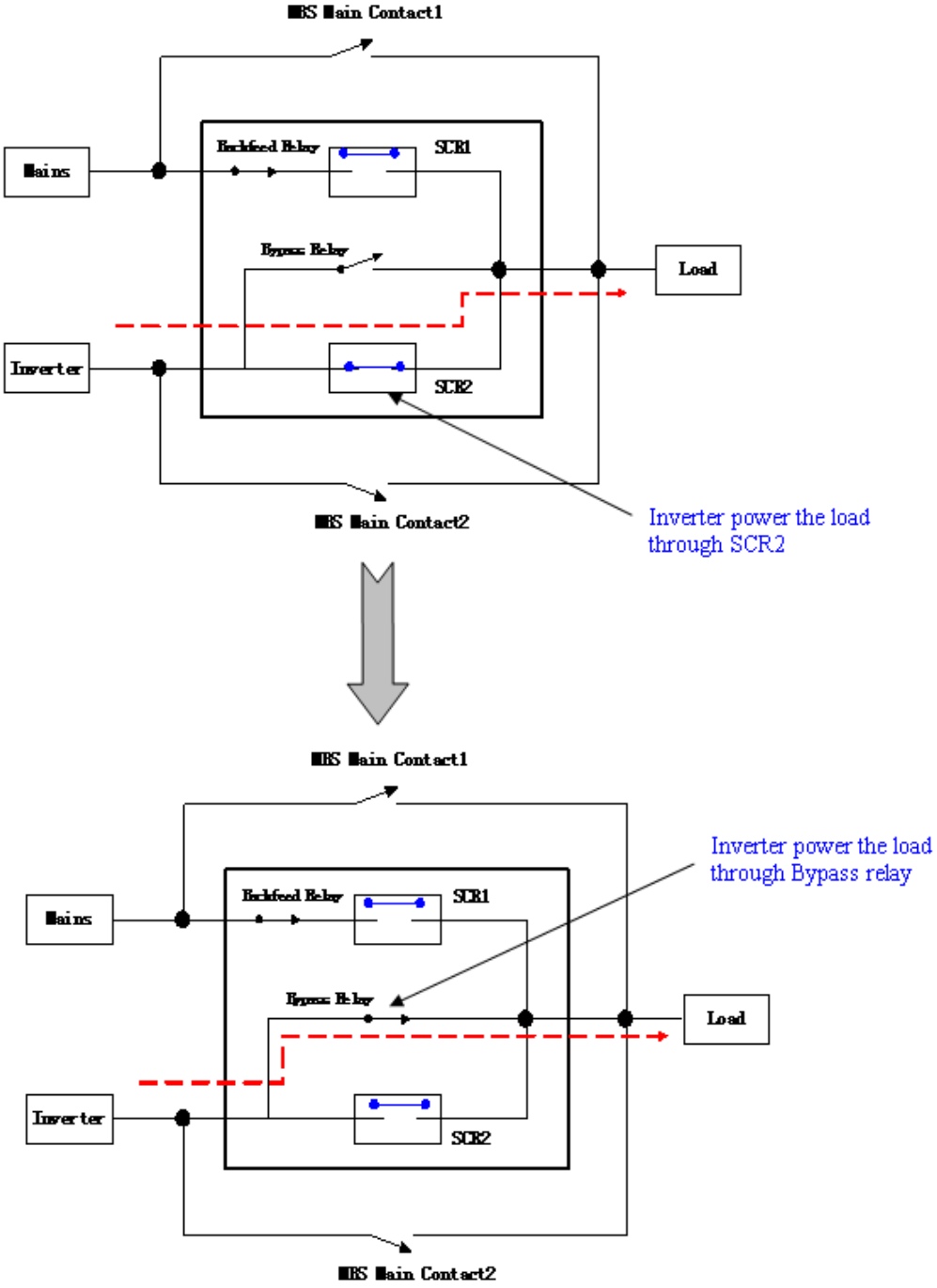


Figure 7 On-line mode relay bypass transfer

1.2.1.10 SCR short protection/Back-feed protection

1.2.1.10.1 On-line mode

The SCR1 on the mains side will be detected when the STS operates in on-line mode. If SCR1 is short, the back-feed relay will be open, and the system continues to power the load from the inverters. At this time, "SCR1 short alarm" will be sent to the controller via the CAN bus.

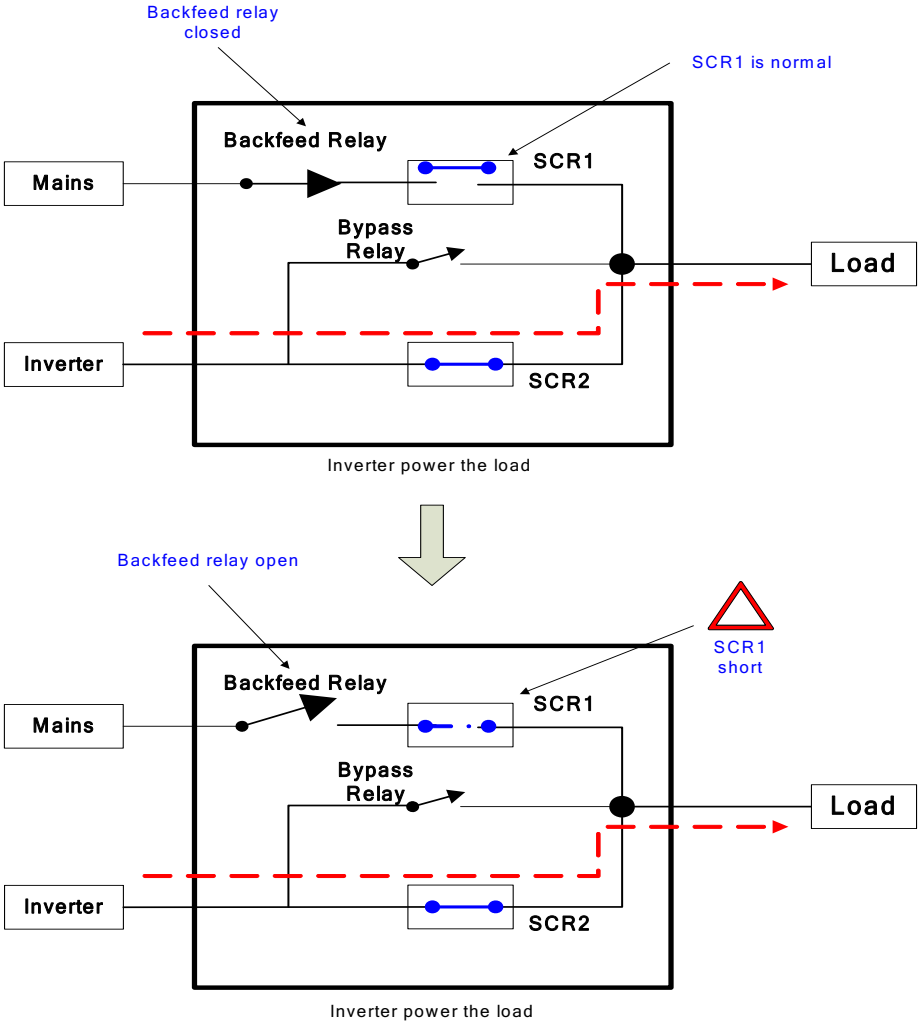


Figure 8 SCR1 short in on-line mode

1.2.1.10.2 Off-line mode

The SCR2 that is on the inverter side will be detected when the STS operates in off-line mode. When SCR2 is short, the system will continue to power the load from the Utility. An “SCR2 short alarm” will be sent to the controller via the CAN bus.

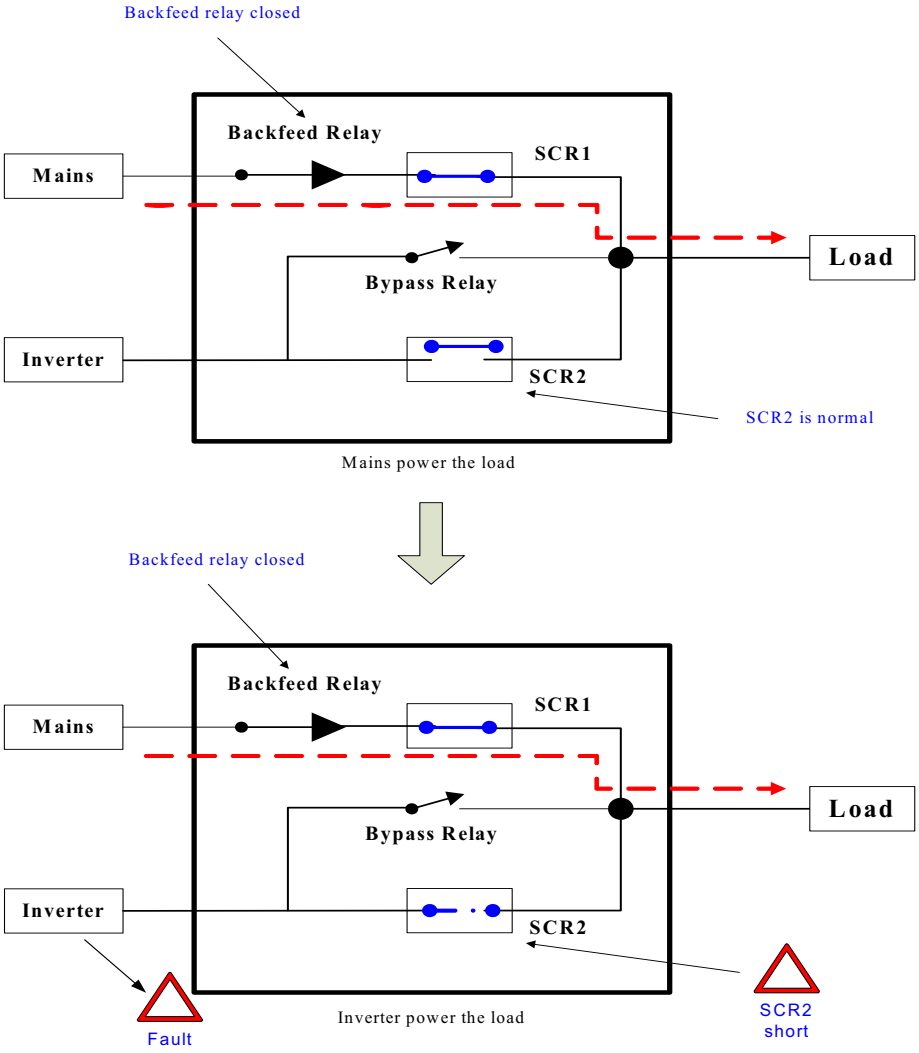


Figure 9 SCR2 short in off-line mode

1.2.1.11 Overload/output short circuit protection

1.2.1.11.1 Overload protection

<1> Method one

When the STS is operating in either On-line or Off-line mode, the load current will be calculated in the firmware automatically. This calculation will be used in the overload protection function. With 20S time of 120% overload, or 5S time of 160% overload, the system will cease to provide output power, and the static switch will send an "Overload" alarm to the controller. (Note: The STS will need to have all power recycled to restart from this condition).

<2> Method two

The STS will estimate the load capability of the system based on the number of installed inverters reported by the controller. For the INV1048 the definition of rated power in VA is "inverter number x 1000VA", with rated active power "VA x 0.8". For the INV1548 the definition of rated power in VA is "inverter number x 1500VA", with rated active power "VA x 0.8". When the Utility has priority the STS operates in off-line mode. With a change of priority to the Inverter the STS will estimate the load capability of the Inverters to decide whether to transfer to on-line mode. If the current load exceeds the load capability of the Inverters the STS won't transfer to on-line mode, otherwise it will transfer to on-line mode approximately 6 seconds later.
As an exception, the STS will immediately transfer to on-line mode without estimating the load capability of the Inverters when the utility voltage or frequency is abnormal.

1.2.1.11.2 Output short protection

Based on the different priorities, output short protection has different methods to deal with each situation.

<1> Mains priority

If the Inverter is operating normally when the output short happens the STS will transfer to Inverter mode, then "Output short protection" will be sent to controller and finally the STS will transfer to fault mode

If the Inverter is faulty or off when the output short happens the STS will shut off the output and an "Output short protection" message will be sent to controller (if present).

<2> Inverter priority

If the Mains is normal when the output short happens the STS will transfer to Mains mode, and then an "Output short protection" message will be sent to the controller.
If the Mains is abnormal or not present when the output short happens the STS will send an "Output short protection" message and then transfer fault mode.

Note：Damage to the STS will occur if the short current exceeds 2400A.

1.2.2 STS Module Environmental Specification

Item	Specification
Noise	55 dB, ETS 300 753, class 3.1
Operating temperature	-20°C (-4°F) to 70°C (158°F) -5°C (23°F) to 50°C (122°F) with full performance
Storage temperature	-40°C (-40°F) to 85°C (185°F)
Operating humidity	90% RH (non condensing)
Operating Attitude	1500m

1.2.3 STS Mechanical Specification

Item	Specification	Remarks
Dimensions W x H x D	8.46” (215mm) x 1.59” (40.5mm) x 10.63” (270mm)	
Weight	4.4lbs (2kg)	
Hot swappable	When MBS at Mains Bypass or Inverter Bypass position	Only when MBS installed
Mounting method	Plug-in type module	
Maintenance Bypass Switch (MBS)	The STS module used in combination with the mechanical Maintenance Bypass Switch module allows voltage free system maintenance. A mechanical interlock with the STS module ensures that the STS module cannot be removed without the MBS being activated.	MBS module must be installed immediately above the STS module
Cooling	2 Fans - easy replacement	

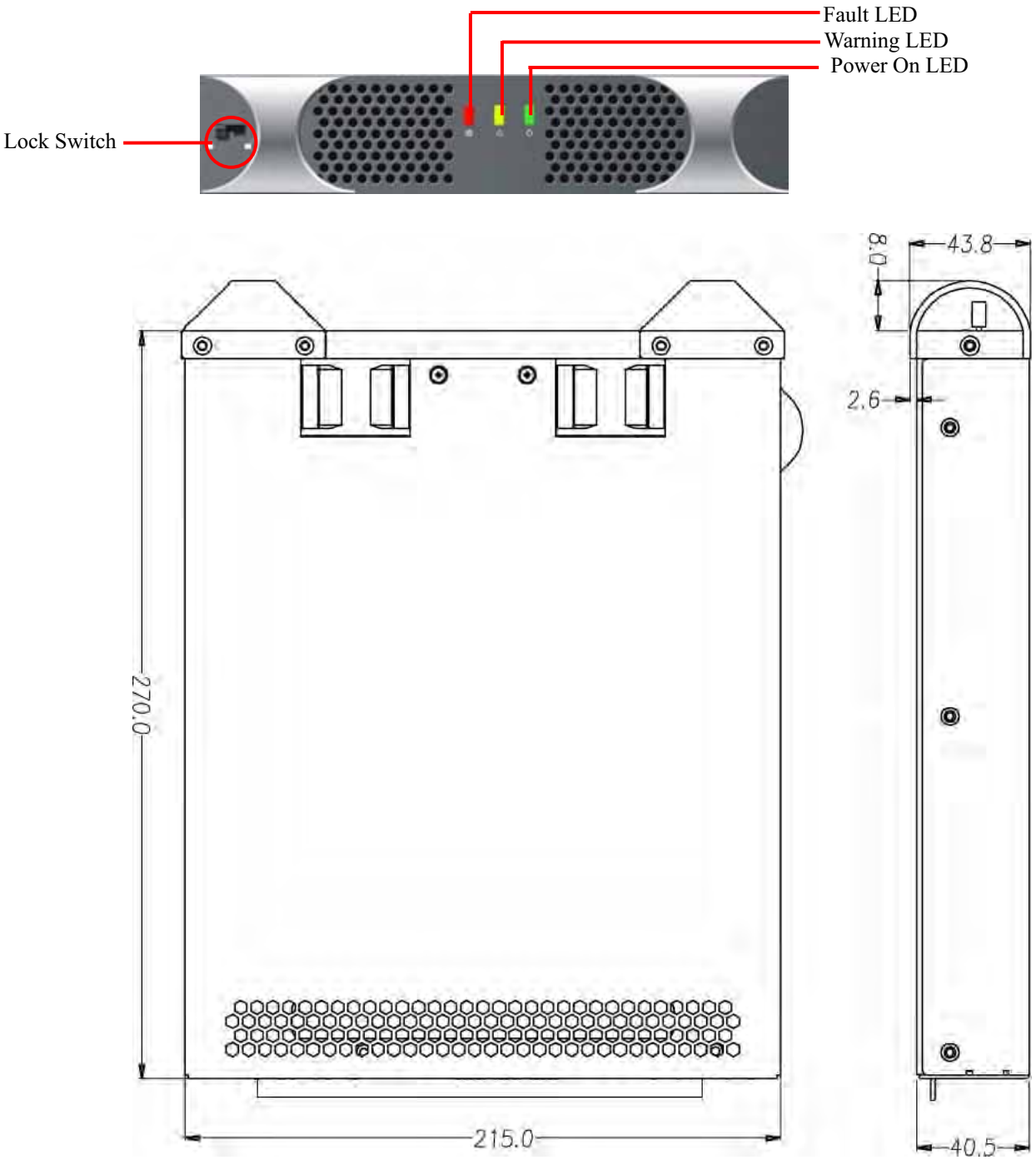
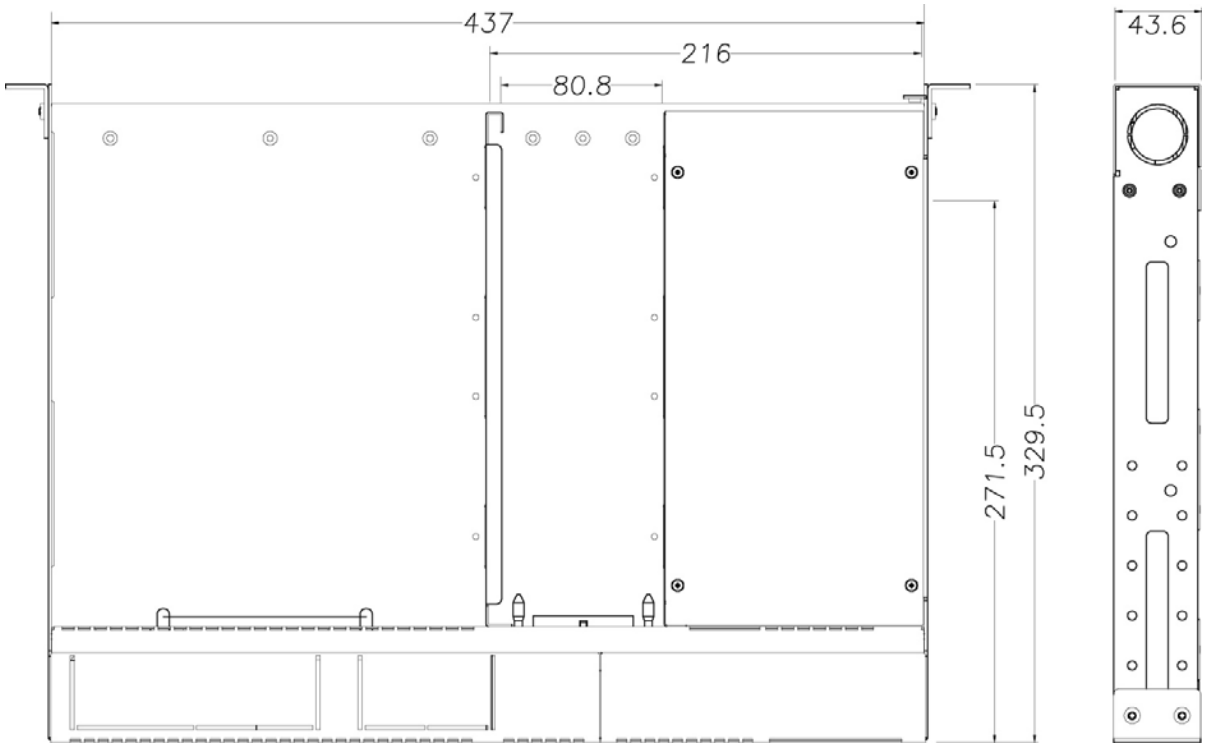


Figure 11 STS module dimensions (mm)



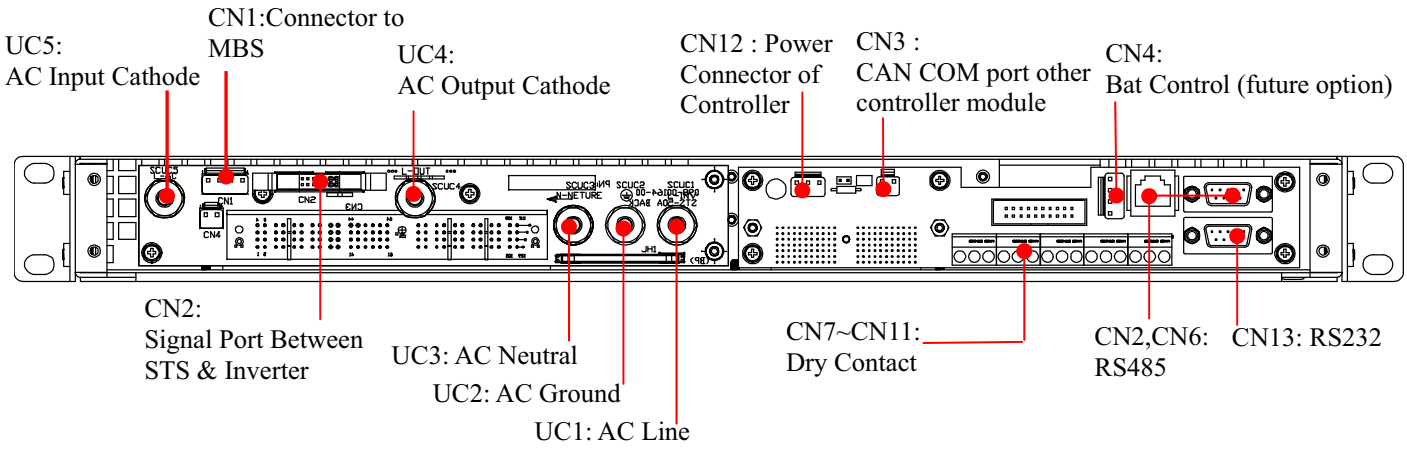


Figure 12 STS/Controller shelf dimensions (mm)

1.3 Maintenance Bypass Switch Module Specification

1.3.1 Electrical Specification

Item	Specification
AC Input	110/115/120 VAC or 208/220/230/240VAC
Selectable Input Frequency	50/60 Hz
Rating Power	6kW for 110/115/120 VAC
	12kW for 208/220/230/240 VAC
Type (mechanical switch, 5 positions)	**MBP** (mains bypass) Position The load is powered through the maintenance bypass switch by the mains AC. The STS can be removed from the system.
	ISS (inverter static switch) Inverters are ON, but do not provide any load power. Inverter tests can be made.
	Norm Position The load is powered through the STS by the Inverters.
	MSS (mains static switch) The mains AC is disconnected from the system. This is achieved by opening the back-feed contactor.
	IBS (inverter bypass) The load is powered through the MBS by the Inverters. The STS can be removed from the system.

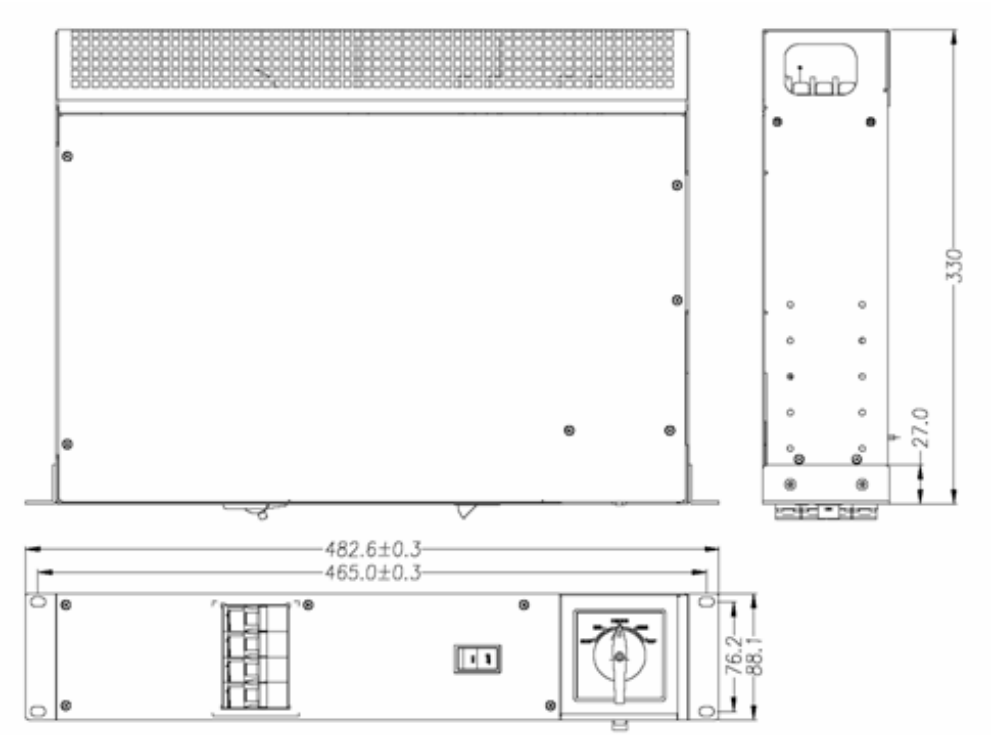


Figure 14 MBS+PDU shelf dimensions (mm)

1.4. Controller Module Specification

1.4.1 Input Specification

Item	Specification	Remarks
Nominal voltage	48Vdc	
Operating range	30Vdc -72Vdc	
Over Current Protection	2A Fuse	

1.4.2 Human Interface Specification

Item	Specification	Remarks
LCD	Resolution :Line * Array: 4 * 16	
LED Indicator	Green LED Red LED Yellow LED	
Function Keys	Enter Esc PgUp PgDn	
Buzzer	Alarm→ Beep continuously	Press ENTER to defeat

1.4.3 Alarm Mode

Alarm Type	Alarm Name	Level
Inverter	Inverter fault	Major
	Inverter Over-loading	Observe
	Inverter Fan fault	Major
	Inverter power limit	Major
	Inverter input abnormal	Major
	Inverter shut down due to low input volt	Major
	Inverter not respond	Critical
	Bus volt over the maximal level	Critical
	Bus volt under the minimal level	Critical
	Bus Soft Start Fail	Critical
	Inverter Output Short	Critical
	Inverter output volt low	Critical
	Inverter output volt high	Critical
	Inverter Temperature High	Critical
	Inverter negative power protection	Critical
	Sync Pulse Fault	Critical
	EPO	Critical
	Inverter soft start fail	Critical
	Inverter EEPROM fault	Major
	Reserved	

Alarm Type	Alarm Name	Level
STS	Bypass unavailable	Major
	STS priority Alarm	Major
	Back-feed relay open	Major
	SCR1 short circuit	Critical
	SCR2 short circuit	Critical
	STS running in fault mode	Critical
	STS fan fault	Major
	EEPROM fault	Major
	STS operation mode alarm	Major
	Inverter unavailable	Major
	Mains unavailable	Major
	Output over load	Major
	Output short circuit	Critical
	Inverter capacity limit	Major
	Inverter bypass mode	Critical
	STS temperature high	Major
	MBS in abnormal position	Critical
	Control power fail	Critical
	STS not respond	Critical
	Reserved	
Controller	Bat Volt Low	Critical
	Controller temperature High	Critical
	Controller EEPROM fault	Major
	Bat voltage high	Critical
	Controller CAN bus off	Critical
	Reserved	

Note : The relationship between the alarm level and controller indication:

Alarm Level	Controller indication	Remark
Observe	Yellow Led On	
Major	Red Led On	
Critical	Red Led On and Buzzer Beeping continuously	

1.4.4 Communications Interfaces

Item	Specification	Remarks
RS-232 × 1	Communicates with PC	
CAN Bus × 1	Communicates with Inverter and STS	
RS-485 × 2	Communicates with supervision / Battery supervision	
SNMP × 1	Communicates with PC	
Dry Contact × 5	Communicates with external Monitor	
USB × 1	Communicates with PC	

1.4.5 Mechanical Specification

Item	Specification	Remarks
Controller Dimensions W x H x D	2U x 1U x 6U (without optional interfaces) 3.15” (80mm) x 1.59” (40.5mm) x 10.63” (270mm)	Installed in Controller/STS shelf unit.
Weight	2.2lbs (1kg)	
Cooling & Ventilation	Natural cooling	

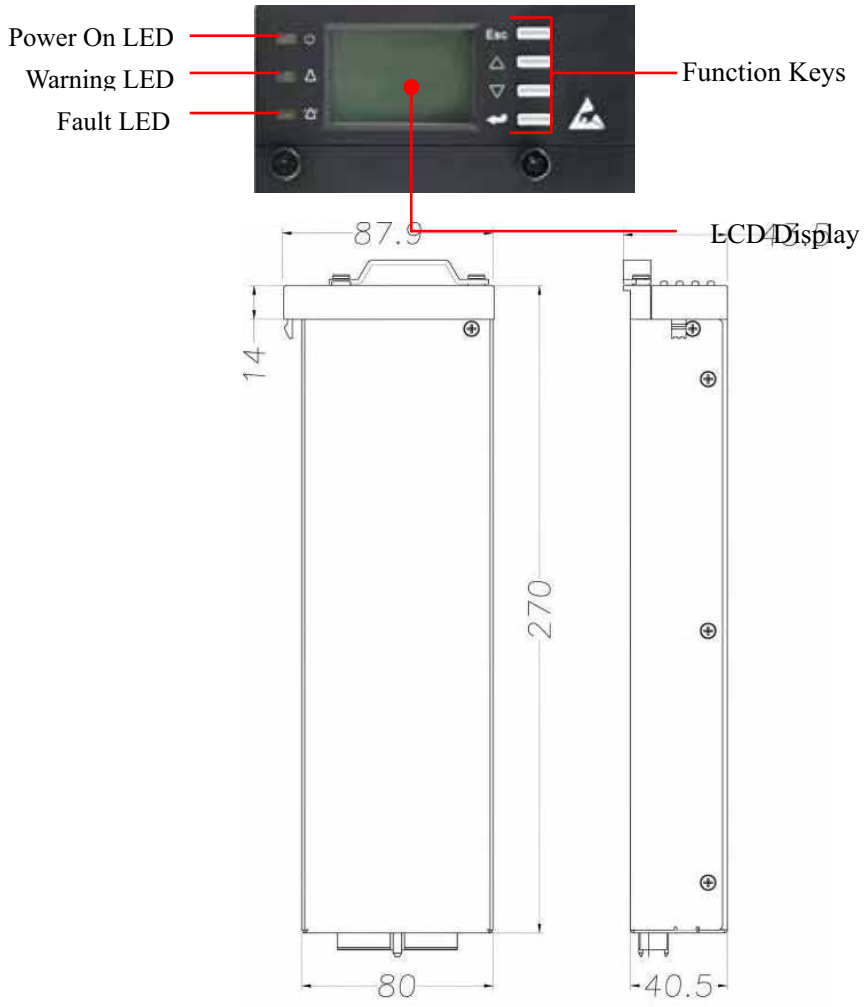


Figure 15 Controller module dimensions (mm)

1.4.6 Environmental Specification

Item	Specification
Operating temperature	-20°C (-4°F) to 70°C (158°F)
Storage temperature	-40°C (-40°F) to 85°C (185°F)
Operating humidity	90% RH (no condensing)
Operating Altitude	2000m

2. System Features

Compact Design
Inverter power density up to 5.24W/in³ (0.32W/cm^3) for 1000VA, 7.87W/in³ (0.48 W/cm^3) for 1500VA.

Modular design
System output capacity scaleable according to requirements.

Parallel operation and N+1 redundancy
Inverters operate in true N+1 redundant mode with load sharing.

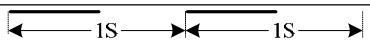
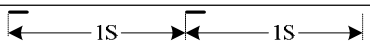
Hot swappable
Inverter modules can be swapped in a live system.

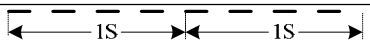
Reliability with optional STS module and MBS module
The STS increases system reliability by automatically switching between the Inverter output and the AC Utility, providing protection against interruptions caused by system or AC utility failure.
The MBS consists of a mechanical switch providing free maintenance for the safe removal of the STS module without load power interruptions.

LCD & Led Indicator
The Controller LCD has two functions. It can display the status of the system and each module and it can be used to set the parameters of the system and the individual modules.

The LEDs indicate individual module status as described in the following table.
The LEDs are either ON, OFF or flashing at one of 6 rates:

Flash 1 – once per second with 50% duty
Flash 2 – once per second with 10% duty
Flash 3 – 2 times per second with 50% duty
Flash 4 – 4 times per second with 50% duty
Flash 5 – 4 times per second with 20% duty
Flash 6 – 5 times per second with 50% duty

Inverter Module LED Display			
Priority	**Green LED**	**LED Signal**	**Status**
Low ↓ High	Solid		Inverter operating normally
	Flash 1		Inverter is being interrogated by the controller
	Flash 2		One of the status as follows: 1) Power On Sequence. Details refer to note. 2) Shut down remotely.
Priority	**Yellow LED**	**LED Signal**	**Status**
Low ↓ High	Flash 2		Power On Details refer to note.
	Solid		Over Load (Load percent > 100%)
	Flash 4		DC input abnormal (Vin<=45V or Vin>=58 V)
	Flash 5		Inverter shut down due to super low /super high input (Vin<=VLVSD or Vin>=VHVSD)

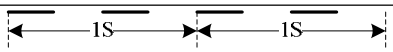
Priority	Red LED	LED Signal	Status
Low ↓ High	Flash 1		One of the alarms as follows: 1) EEPROM Fault; Inverter module cannot operate in parallel mode system, however, it can work in single mode system 2) Fan Fault Fan failed in operation
	Flash 4		One of the alarms as follows: 1) Internal DC Bus Over /Under/ Unbalance/soft start fail; The inverter will shutdown. 2) Over Temperature. The inverter will shut down. In both cases Recycle the power or remove and reinsert the module to restart.
	Solid		One of the alarms as follows: 1) Input reverse polarity; The DC input voltage polarity is reversed. 2) Inverter output short circuit; When a short circuit occurs the inverter will shut down. 3) Abnormal output voltage; The inverter will shut down when output voltage is out of operating voltage range. 4)Negative Power Protection The inverter will shut down. 5) Overload fault. When the time of overload exceeds the defined time, the inverter will shut down. In all cases recycle the power or remove and reinsert the module to restart.

Notes:

Power On Sequence:
When the inverter is in “Power On” mode, the green led and the yellow LED are blink synchronously.

Overload and overload fault:
When the overload fault alarm occurs the yellow and red LEDs turn on at the same time.
When an overload alarm occurs only the yellow LED turns on.

Priority:
If more than one warning exists at the same time, then the LED will display the highest priority condition.

STS Module LED Display			
Priority	**Green LED**	**LED Signal**	**Status**
Low	Solid		STS operating normally
	Flash 1		Running mode not according to the setting priority. For example, STS operating in off-line mode, but the priority is set to on-line.
	Flash 3		STS operating in inverter bypass mode
High			
Priority	**Yellow LED**	**LED Signal**	**Status**
Low	Solid		Mains or Inverter abnormal
	Flash 3		If the status of the green LED is the same as the yellow LED, then the STS is in Inverter bypass mode, otherwise the Back-feed relay open
	Flash 6		STS Output abnormal
High			
Priority	**Red LED**	**LED Signal**	**Status**
Low	Flash 1		Fan lock or Can communication fail or EEPROM fault
	Flash 3		SCR short or auxiliary power supply fault
	Flash 6		MBS position abnormal
	Solid		STS Fault mode, maybe overload or over temperature or output short
High			

Note: If more than one warning exists at the same time, then the LEDs will display the highest priority condition.

2.1 Principal of Operation

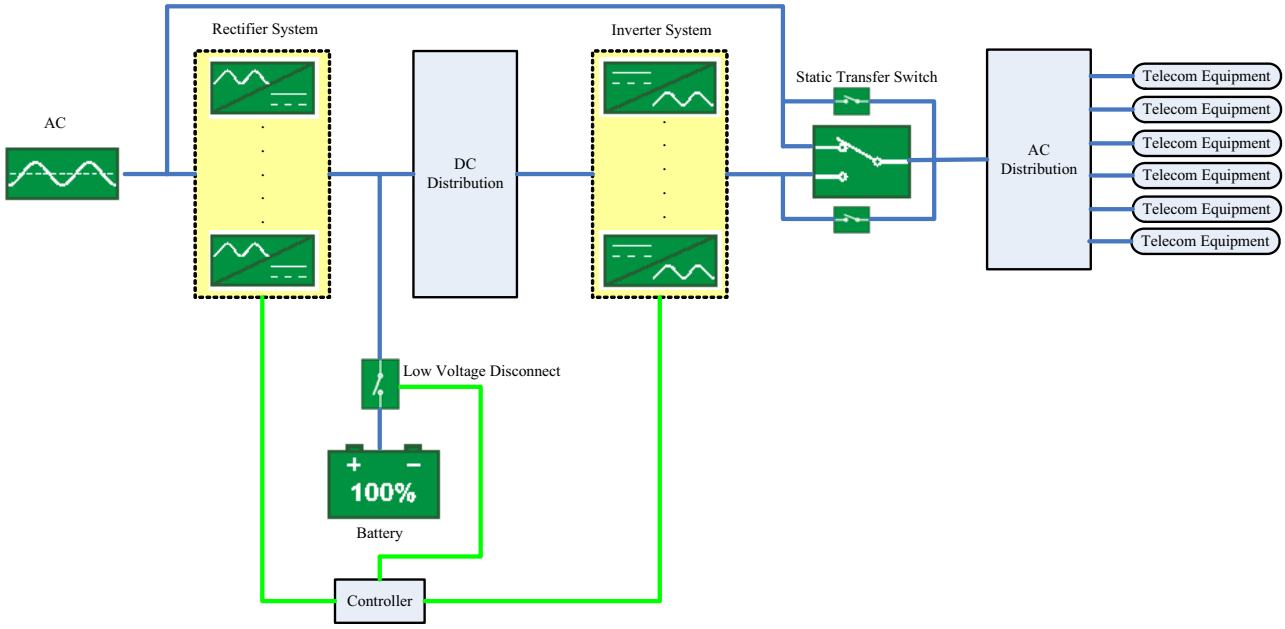


Figure 16 Telecom power system

The inverter system accepts 40.5 to 58VDC for normal operation; however it requires an input of at least 45VDC to start. This voltage is applied to the system through the BAT+ and BAT– input bus connections.

The system will supply nominal 120VAC or 230VAC to the loads.

2.2 Typical System Configurations

Configuration 1:
- Controller / Communications
- STS Module
- Inverter Modules
- AC Distribution Unit
- MBS Module

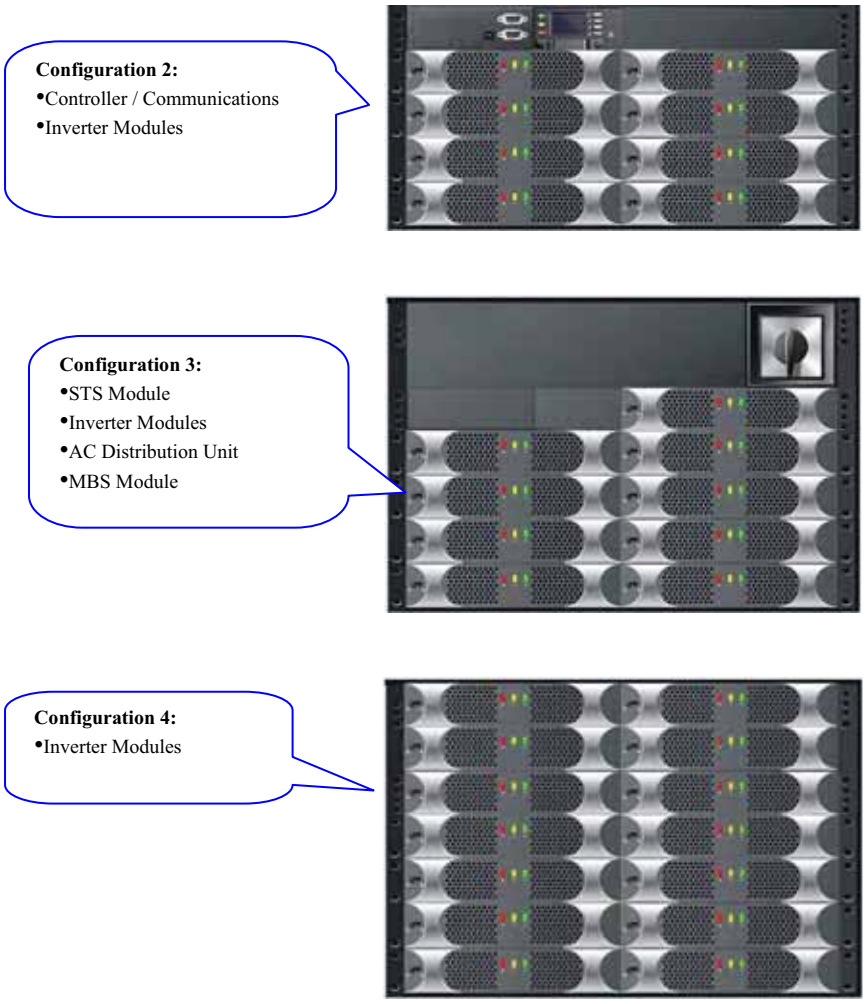


Figure17 Typical system configurations

3 Electrical Connections

3.1 Description

This chapter provides details for the installer for the electrical connections when installing the Gravitas SABRE Series inverter system.

Before making any electrical connections refer to Figure 20 below.

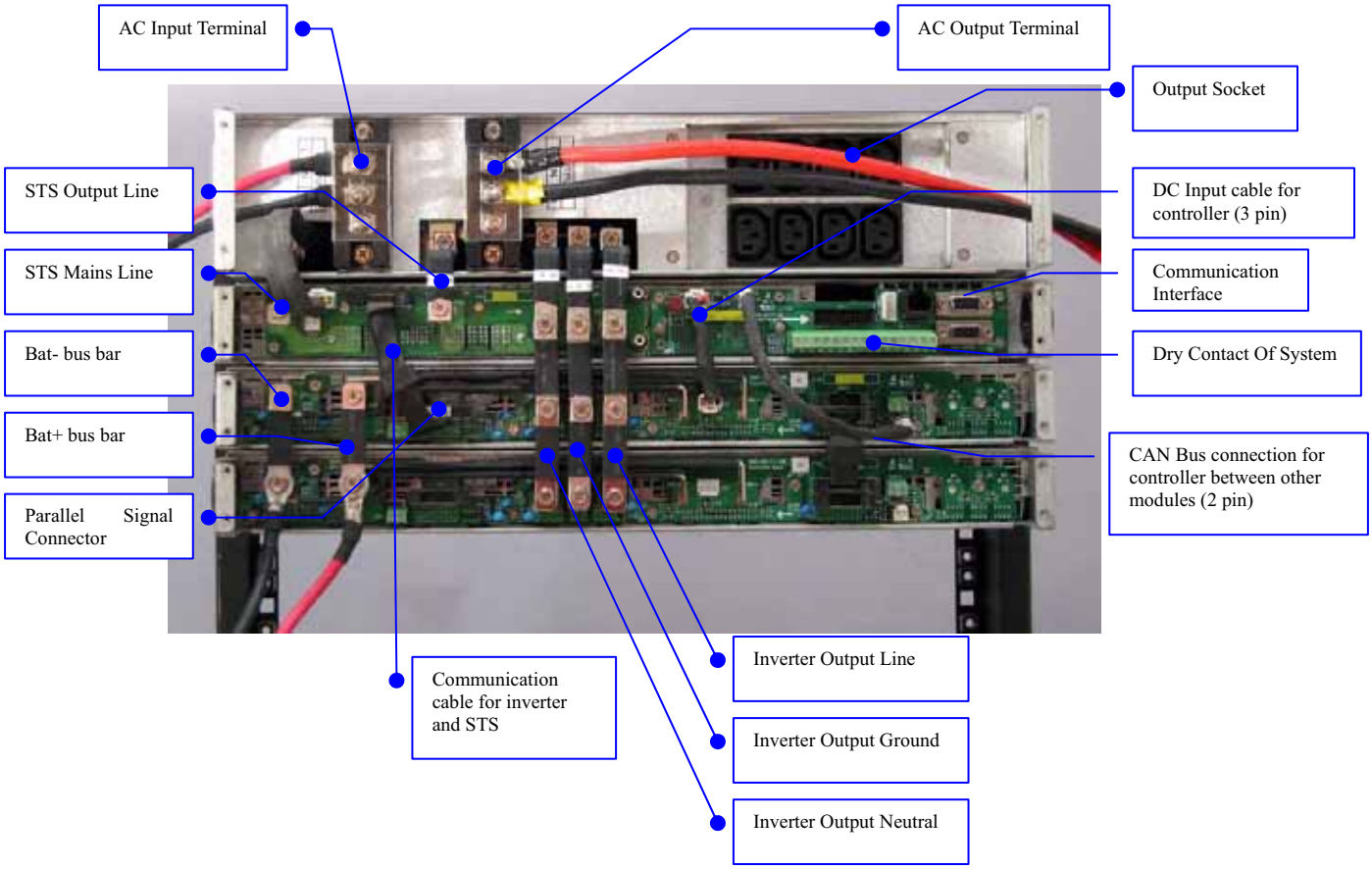


Figure 20 Electrical connections of inverter system

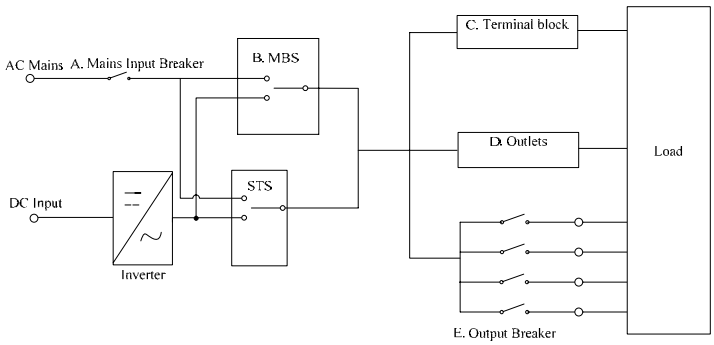


Figure 21 System block diagram

3.2 DC Input

Refer to Figures 20 & 21 for a pictorial view of the DC Input connections.

A. Attach Bat+ cables to Bat+ Bus Bar on inverter backplane.
B. Attach Bat- cables to Bat- Bus Bar on inverter backplane.

Note that the maximum input current to each shelf could be as high as 67A at minimum input voltage and maximum output power when using the INV1548 or INV1548H modules.

Each inverter shelf should be individually supplied with it's own DC feed via a suitably sized breaker to ensure maximum sufficient protection for the cables and also to maximize the overall system fault-tolerance.

3.3 AC Input

Refer to Figures 20 & 21 for a pictorial view of AC input connections.

A. Inverter Shelf only.
   Attach the Mains Line to the Inverter Input AC Line terminal on the Inverter shelf backplane.
   Attach Mains Neutral to the Output Neutral bus bar on the inverter shelf backplane.

B. AC Distribution Unit not installed. STS installed.
   Attach the Mains Line to the STS Input AC Line terminal on STS shelf backplane.
   Attach Mains Neutral to the Output Neutral bus bar on the inverter shelf backplane.

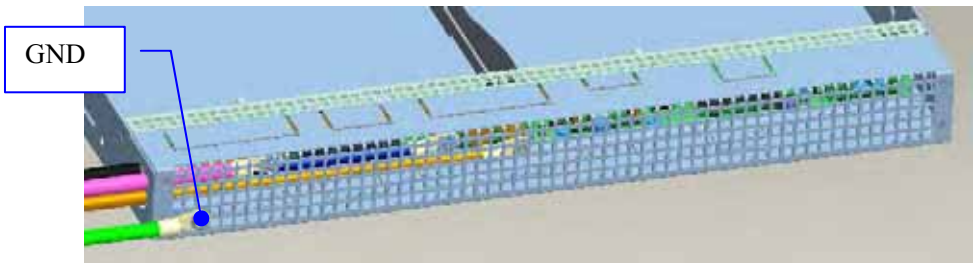
C. AC Distribution Unit installed.
   Attach the Mains Line and Neutral to the AC input terminals Line and Neutral.

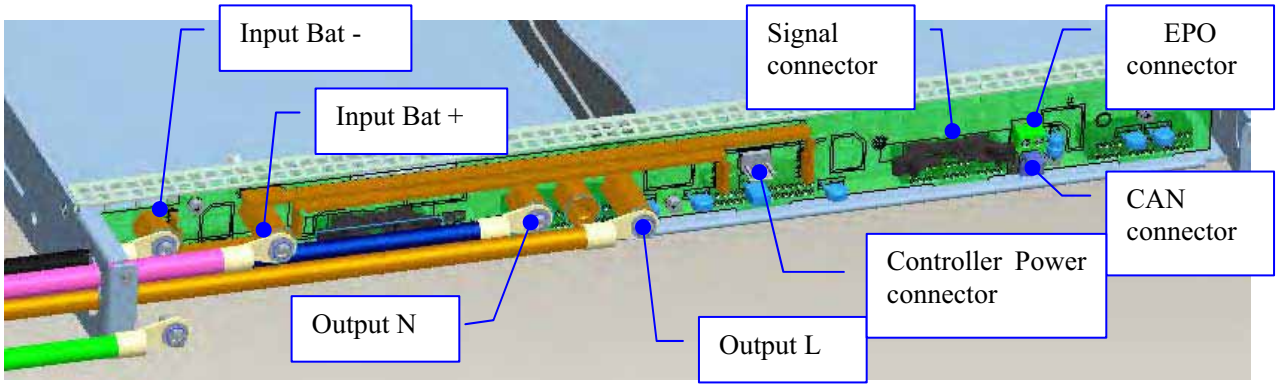
3.4 AC Output

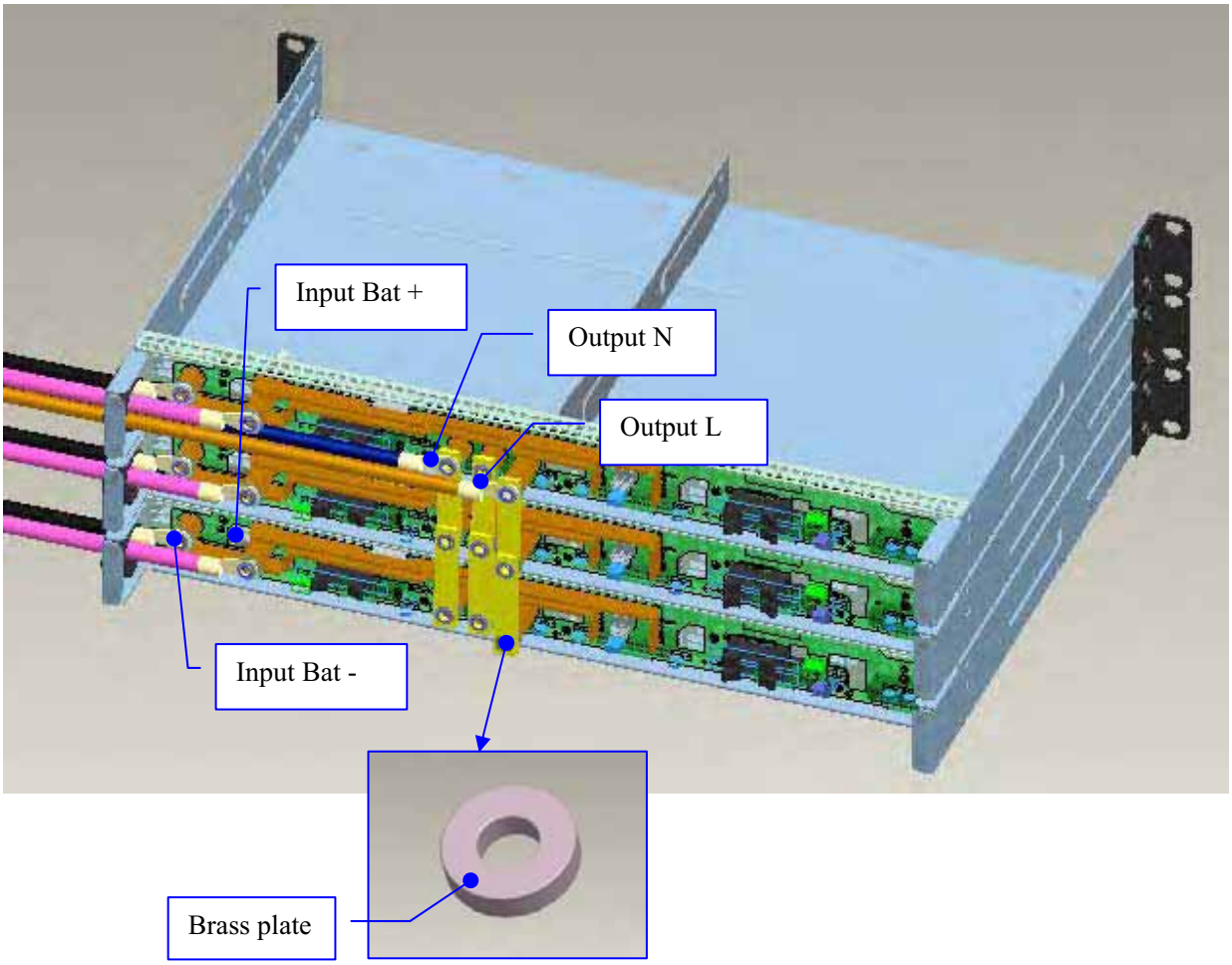
Refer to Figures 20 & 21 for a pictorial view of AC output connections.
Only when the MBS is at the IBP or the MBP two position and the STS module is removed from the rack, input breaker will control the output of the system.

A. Inverter shelf only.
   Attach the AC Output Line to AC Output Line bus bar on inverter shelf backplane.
   Attach the AC Output Neutral to the AC Output Neutral bus bar on the inverter shelf backplane.
   Note: The Neutral will be lifted by a bolt as shown in the below.

Note that cables employed for the AC output connections should be either 600V rated double insulated equipment wire or multicore cable of suitable size to carry the maximum expected load current.

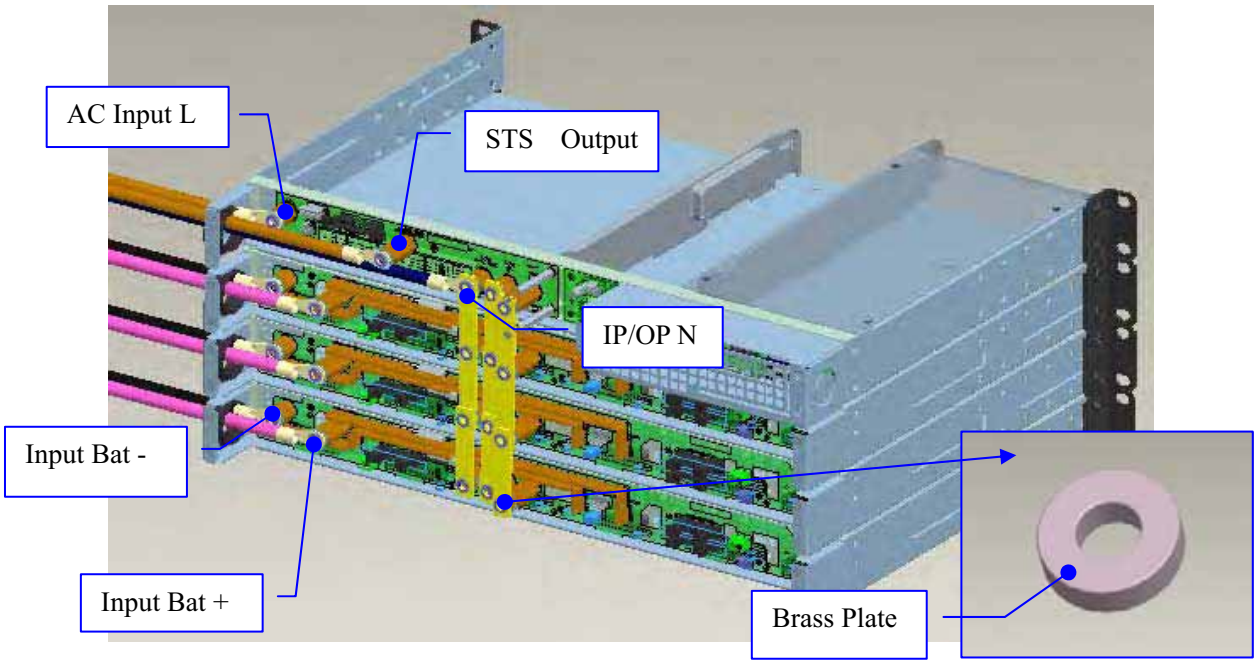




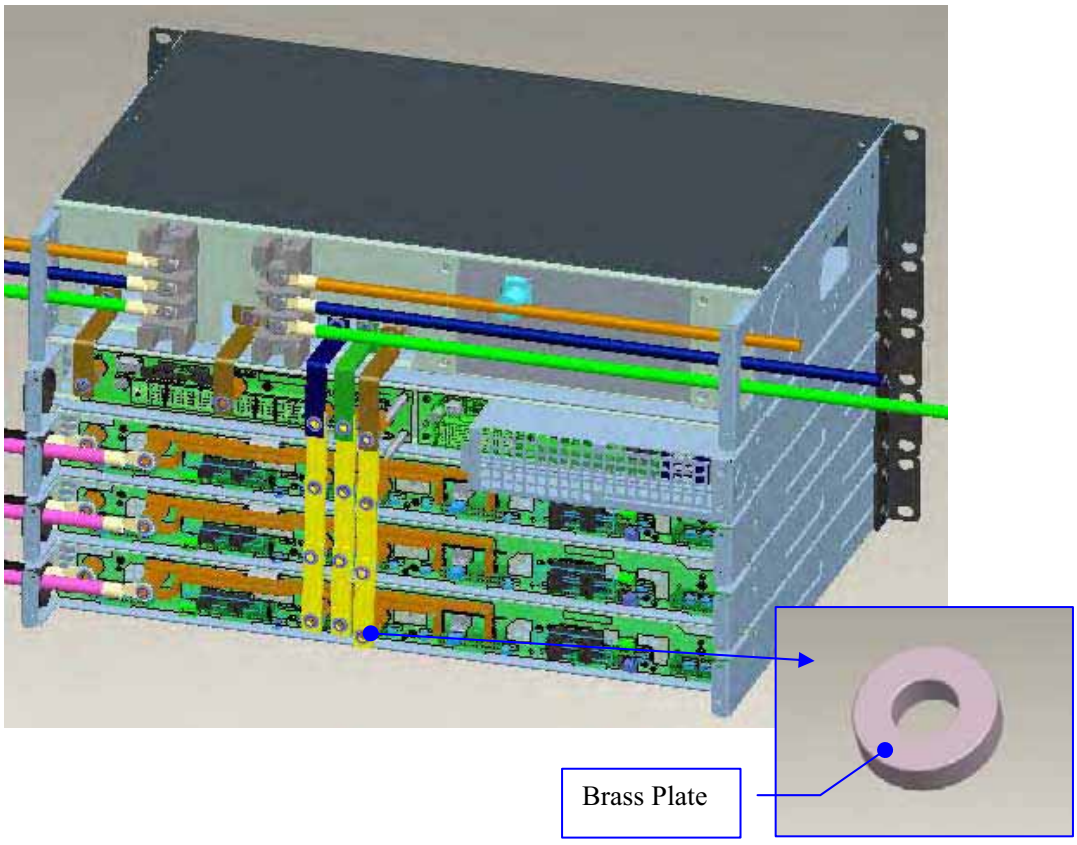


The brass plate shown above is required to act as a spacer under the interconnecting bus bars only when an odd numbered combination of inverter and STS/controller shelves is employed.

B. STS and Inverters installed.
Attach the AC Output Line to the STS Output AC Line terminal on STS shelf backplane.
Attach the AC Output Neutral to the inverter output Neutral bus bar on the inverter shelf backplane.



C. AC Distribution Unit installed.
Attach the Output AC Line and Neutral to the AC bulk output terminals or the socket outlets as desired.



3.5 DC Input for controller

A. Attach the supplied 3 pin cable for the Controller Input from inverter shelf backplane.

3.6 Internal Communications connections

A. Attach the supplied communication cable for the Inverters and STS module on the backplane of Inverter and STS shelves.
B. Attach the supplied 2 pin cable for the Controller CAN Bus.

3.7 External Communications Connections

3.7.1 Communications Connections of the Controller

- Dry contact
- RS-232
- RS-485
- SNMP (Optional)
- USB

A. Communications interfaces on the front plate of the Communications Interface option module.

Figure 22 Communications interfaces on the front plate of the controller

B. Communications interfaces on the rear of the controller

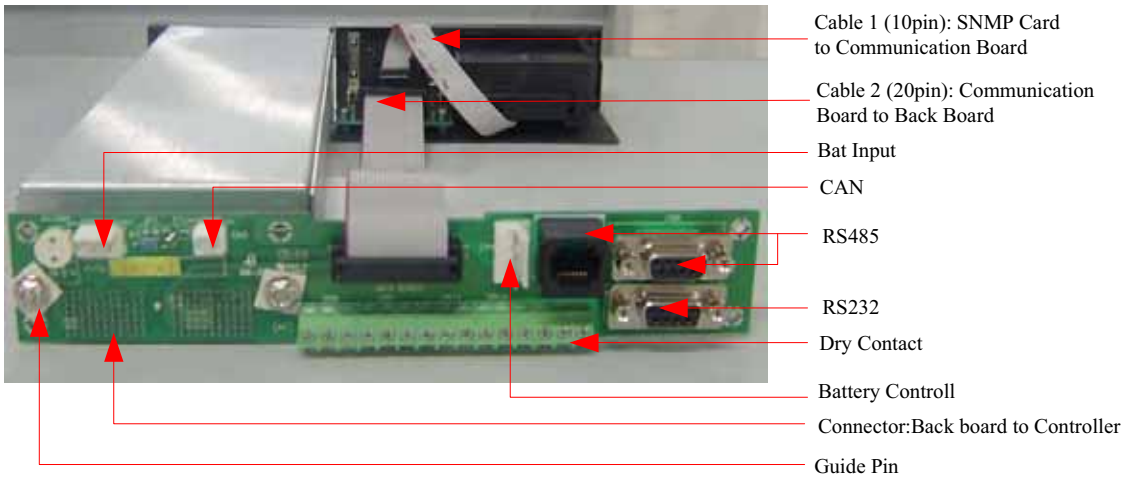


Figure 23 Communications interfaces on the rear of the controller

3.7.2 Dry contact Alarm Settings

A. Settings→System→Dry contact Press 'Enter' entry the follow menu

D	r	y	C	o	n	t	:	1	↕						
A	l	a	r	m		T	y	p	e	:	I	N	V		
A	l	a	r	m		N	O	:	0	2					
I	n	v		o	v	e	r		l	o	a	d			

B. Press 'Up' or 'Down' to select the dry contact, then enter the menu to set the alarm mode of the dry contact.

	⦿	I	n	v											
	○	S	T	S											
	○	C	o	n	t										
	○	S	m	r											

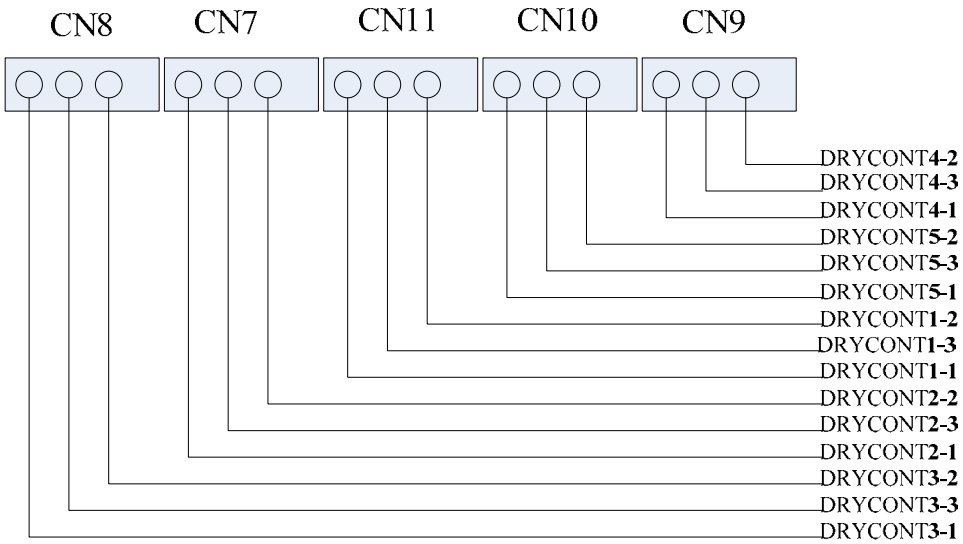
A	l	a	r	m		T	y	p	e	:	I	n	v		
A	l	a	r	m		N	o	:	0	1	↕				
I	n	v		f	a	u	l	t							

Press 'Up' or 'Down' to select alarm mode of the dry contact relay outputs.
The default alarm mode is programmed as follows:

No.	**Inverter**	**No.**	**Static Transfer Switch**
01	Inverter fault	01	STS failure
02	Inverter over load	02	STS K2 off
03	Inverter fan fault	03	STS SCR1 short circuit
04	Inverter power limit	04	STS SCR2 short circuit
05	Inverter input fault	05	STS bypass can not user
06	Inverter low volt off	06	STS backfeed
		07	STS fan failure
		08	STS EEPROM failure
		09	STS not respond
No.	**Controller**	**No.**	**SMR**
01	Bat voltage low	01	Over Voltage
02	Controller temperature high	02	Over temperature

03	Controller EEPROM fault	03	Rectifier fuse broken
04	Controller CAN bus off	04	Rectifier fault
05	Bat voltage high	05	Fan failure
		06	EEPROM failure
		07	AC power limiting
		08	Power limitation by temperature/status value
		09	AC default
		10	SMR lost

C. Dry Contact connection on STS/Controller shelf backplane.



Dry Contact #	**Alarm Mode**	**Dry Contact Normal Status**
Dry Contact 1	Inverter over load	Normally Open
Dry Contact 2	STS no bypass	Normally Open
Dry Contact 3	Inverter fan lock	Normally Open
Dry Contact 4	STS fan fault	Normally Open
Dry Contact 5	Inverter EEPROM fail	Normally Open

4 Mechanical Installation

Installation Equipment

Before installing the Inverter system, ensure the product received contains the components specified when it was ordered. Contact UNIPOWER Telecom immediately if there is a question about the configuration of the system.

Installation Tools

The tools necessary to install and test the Gravitas SABRE Series Inverter system include cross-head screwdrivers, torque wrenches, a ratcheting wrench set, wire cutters, etc. No unusual tools are required.

4.1 Inverter Shelf & Inverter Module Installation and Removal

4.1.1 Inverter shelf Installation

When adding or installing inverter shelves to a plant, proceed as follows referring to Figure 24.
It is essential to shut down the system.

A. Decide where the inverter shelf will be added or installed in the cabinet.
B. Insert the shelf.
C. Secure the shelf with the retaining screws.

4.1.2 Inverter shelf Removal

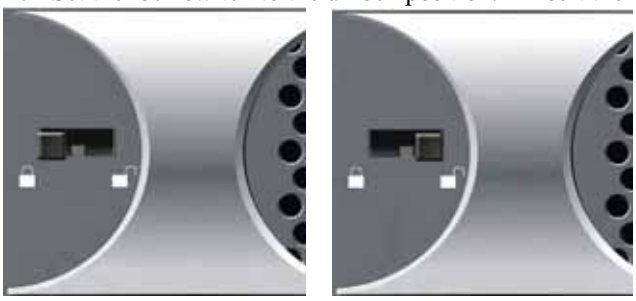
A. Determine which inverter shelf needs to be removed.
B. Remove the retaining screws.
C. Remove the shelf from the cabinet.

Figure 24 Install and remove inverter shelf

4.1.3 Inverter Module Installation

When installing Inverter modules in a working plant proceed as follows referring to Figure 25.
It is not necessary to shut down the system.

A. Decide where the inverter module will be installed.
   Before installing a new inverter module, remove the dummy plate if there is any covered the selected slot.
B. Set the lock switch to the unlock position. Insert the inverter module into the inverter shelf.



C. Push on the front of the module until it is fully home. Secure the module to the shelf by setting the lock switch to the lock position.

4.1.4 Inverter Module Removal

Referring to Figure 25.

A. Determine which inverter module needs to be removed.
B. Switch the lock switch to the unlock position.
C. Pull out the module out from the shelf with handles.
D. Once the inverter module is removed, recommend to replace with a dummy plate to avoid exposure to a hazardous voltage, or install a replacement inverter module.

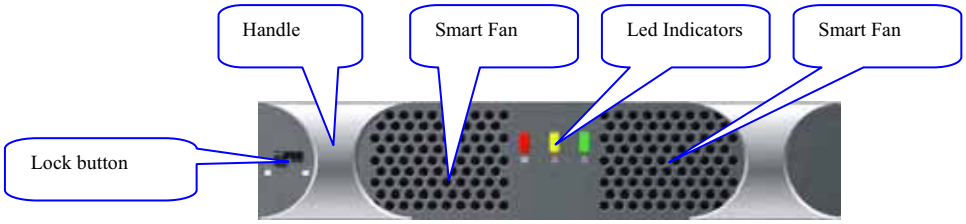


Figure 25 Install and remove inverter module

4.2 STS/Controller Shelf, STS Module & Controller Module Installation and Removal

4.2.1 STS/Controller shelf installation

When installing the STS shelf to a plant, proceed as follows referring to Figure 26.
It is essential to shut down the system.

A. Insert the shelf at the STS shelf position.
B. Secure the shelf with the retaining screw.

4.2.2 STS/Controller shelf removal

Referring to Figure 26.
It is essential to shut down the system.

A. Remove the retaining screws.
B. Remove the shelf from the cabinet.

Figure 26 Install and remove STS/controller module/communications interface shelf

4.2.3 Communication Interface module Installation

When installing the Communication Interface Module to a working plant proceed as follows referring to Figure 27.
It is essential to shut down the system.

A. Remove the dummy plate where the Communication Interface Module will be inserted.
B. Loosen the retaining screw.
C. Connect the cable to the communication board.
D. Insert the Communication Interface Module into the shelf.
E. Secure the module to the shelf with the retaining screw.

4.2.4 Communication Interface module Removal

Referring to Figure 27.
It is essential to shut down the system.

A. Loosen the retaining screw.
B. Remove the Communication Interface Module from the shelf.
C. Insert a dummy plate to avoid exposure to hazardous voltages.

Figure 27 Installing and remove the communication interface module

4.2.5 STS Module Installation

When installing STS module to a working plant, proceed as follows.
There is no need to power down the system when an MBS Module is also installed.

A. **WARNING:** Ensure that the Maintenance Bypass Switch is set to the MBP or the IBP position (as determined by mains and inverter output status position) otherwise it will damage the STS module frame due to the mechanical

interlock. . Refer to Figure 28.

Figure 28 MBS position when installing or removing the STS module

B. Remove the dummy plates where the STS module will be inserted.
C. Insert the STS module into the STS/Controller shelf.
D. Push on the front of the module until it is fully home. Secure the module to the shelf by setting the lock switch to the lock position.

4.2.6 STS Module Removal

A. **WARNING:** Ensure that the Maintenance Bypass Switch is set to the MBP or the IBP position (as determined by mains and inverter output status position) otherwise it will damage the STS module frame due to the mechanical interlock. . Refer to Figure 28.
B. Set the lock switch at the unlock position.
C. Remove the module from the shelf by pulling on the handle.
D. Once the STS Module is removed, replace with a dummy plate to avoid exposure to a hazardous voltages or replace with a new module.

Figure 29 Installing and removing the STS module

4.3 Controller Installation and Removal

4.3.1 Controller Module Installation

When installing the controller module to a working plant, proceed as follows.
There is no need to power down the system.

A. When adding a controller module, remove the dummy plate where the controller module will be inserted.

B. Loosen the retaining screw.
C. Insert the controller module into the controller shelf.
D. Push on the front of the module until it is fully home. Secure the module to the shelf with the retaining screw.

4.3.2 Controller Module Removal

A. Loosen the retaining screw.
B. Remove the module from the shelf.
C. Once the controller Module is removed, replace with a dummy plate or another controller to avoid exposure to a hazardous voltages.

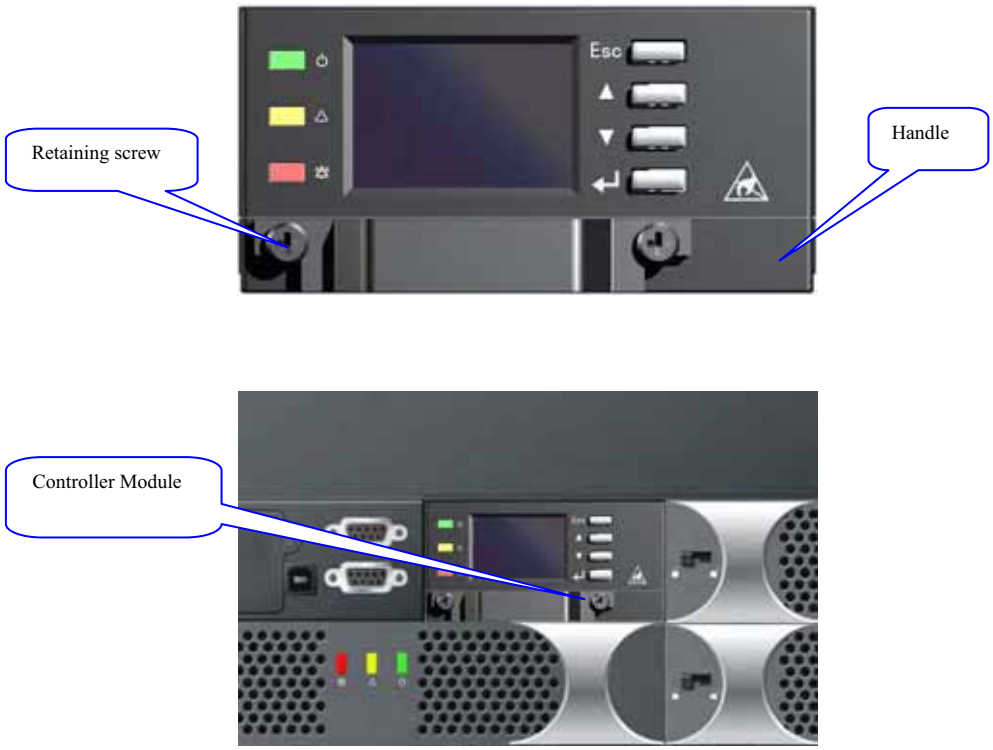


Figure 30 Installation and removal of the controller module

4.4 Inverter system Rear Installation and Removal

4.4.1 Inverter system Rear Installation

Inverter system rear installation is carried out once the MBS & AC distribution unit, STS/Controller Shelf and Inverter shelves have been installed in the cabinet along with the individual plug-in modules and the Communications Interface Module if this has also been specified.

A. Bus bar installation
Install the Mains Input bus bar, Mains Output bus bar, Battery Input+ bus bar, Battery Input- bus bar, Inverter Output Neutral, Line & Ground bus bars with the supplied retaining screws. All necessary parts are supplied as a kit with each shelf.

B. Cable Installation
Install the Signal cable, Controller Can Bus cable and Controller Input cable as required.

C. Communication Interface connection
Connect the communication cable between the PC and rear communication interface.

D. Rear Cover Installation
Install the rear safety covers.

4.4.2 Inverter system Rear Removal

Remove the rear cover then remove the bus bars & signal cables.

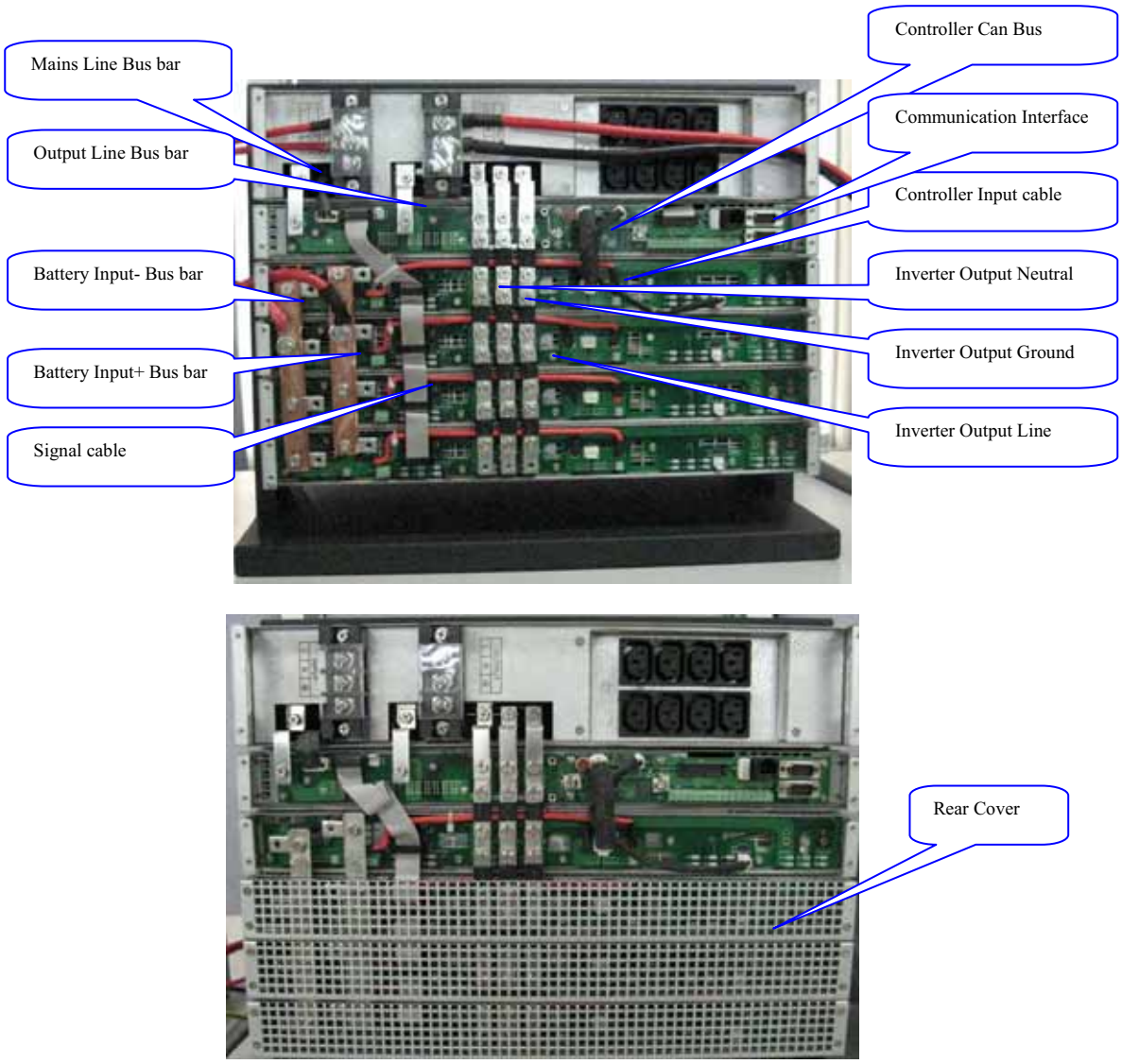


Figure 31 Rear installation and removal of inverter system

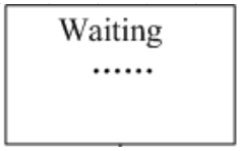
5 Operation

This section provides the procedures necessary for checking out operation of the system.

5.1 Start up Operation

Follow steps 1-4 before power up:

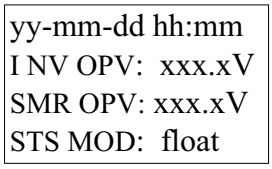
1. Check power wiring for errors. Measure inputs and outputs to GND for shorts.
2. Apply 48-60VDC power to the DC input terminal of inverter system.
3. The Inverter system will run after 20 seconds.
   Verify if the green LED of Inverter modules, STS module and Controller module are on.
4. During the start up of the system, controller will display:



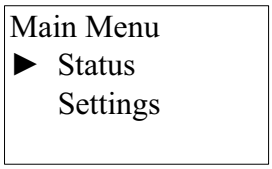
5.2 Operation in Running with a Controller Installed

5.2.1 Status & Settings for the System

After 10 seconds the controller will display as follows,

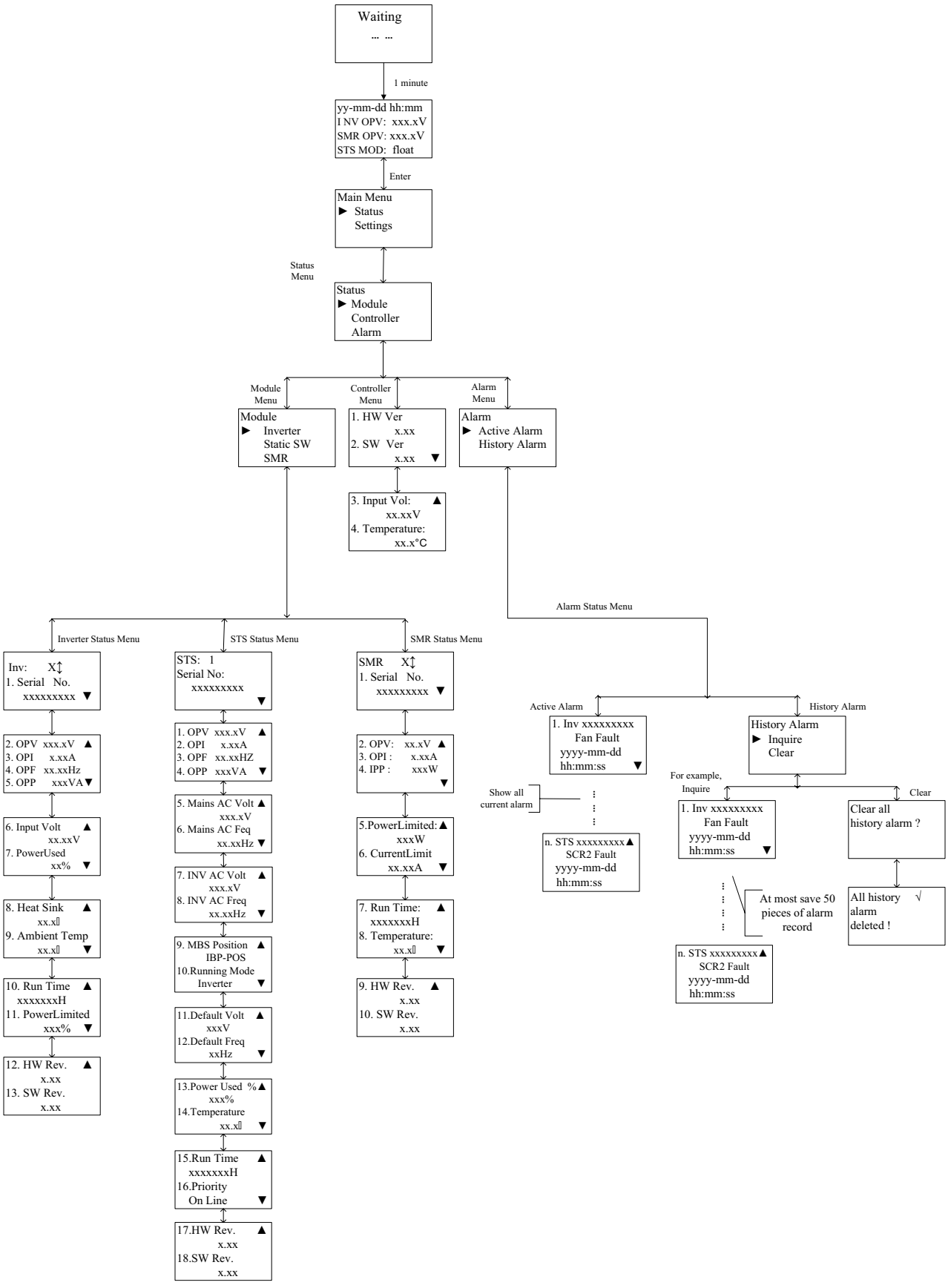


Then press “ENTER” key, user can query and set the parameters of system and all modules:

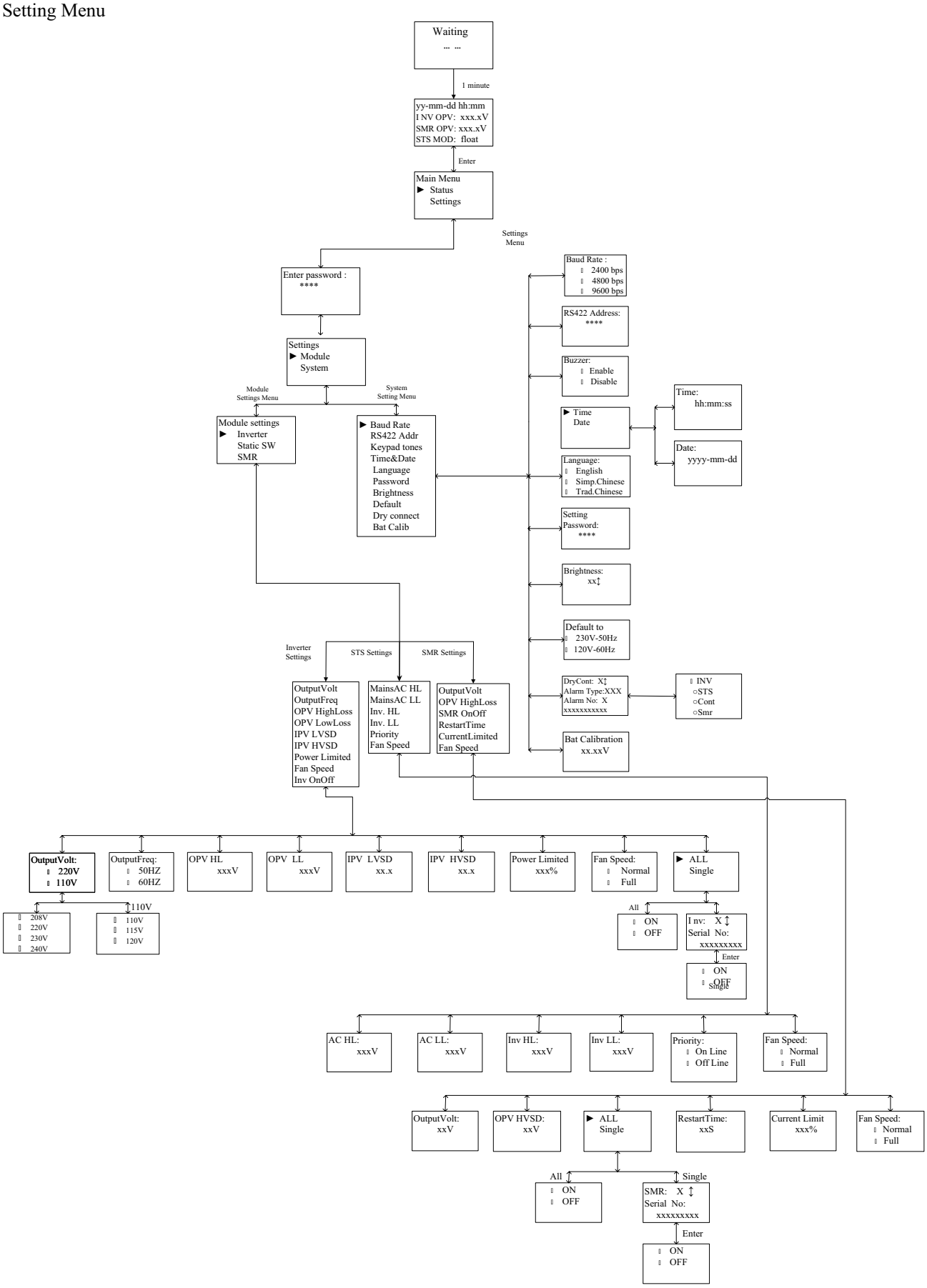


The green LED on the module will blink while being interrogated by controller.
The LCD display menu structure is given as follows:

Status Menu


Waiting
... ...
1 minute
yy-mm-dd hh:mm
I NV OPV: xxx.xV
SMR OPV: xxx.xV
STS MOD: float
Enter
Main Menu
▶ Status
Settings
Status Menu
Status
▶ Module
Controller
Alarm
Module Menu
Controller Menu
Alarm Menu
Module
▶ Inverter
Static SW
SMR
1. HW Ver
x.xx
2. SW Ver
x.xx
3. Input Vol:
xx.xxV
4. Temperature:
xx.x°C
Alarm
▶ Active Alarm
History Alarm
Alarm Status Menu
Inverter Status Menu
STS Status Menu
SMR Status Menu
Inv: X
1. Serial No.
xxxxxxxxx
2. OPV xxx.xV
3. OPI x.xxA
4. OPF xx.xxHz
5. OPP xxxVA
6. Input Volt
xx.xxV
7. PowerUsed
xx%
8. Heat Sink
xx.x
9. Ambient Temp
xx.x
10. Run Time
xxxxxxxH
11. PowerLimited
xxx%
12. HW Rev.
x.xx
13. SW Rev.
x.xx
STS: 1
Serial No:
xxxxxxxxx
1. OPV xxx.xV
2. OPI x.xxA
3. OPF xx.xxHZ
4. OPP xxxVA
5. Mains AC Volt
xxx.xV
6. Mains AC Feq
xx.xxHz
7. INV AC Volt
xxx.xV
8. INV AC Freq
xx.xxHz
9. MBS Position
IBP-POS
10.Running Mode
Inverter
11.Default Volt
xxxV
12.Default Freq
xxHz
13.Power Used %
xxx%
14.Temperature
xx.x
15.Run Time
xxxxxxxH
16.Priority
On Line
17.HW Rev.
x.xx
18.SW Rev.
x.xx
SMR X
1. Serial No.
xxxxxxxxx
2. OPV: xx.xV
3. OPI : x.xxA
4. IPP : xxxW
5.PowerLimited:
xxxW
6. CurrentLimit
xx.xxA
7. Run Time:
xxxxxxxH
8. Temperature:
xx.x
9. HW Rev.
x.xx
10. SW Rev.
x.xx
Active Alarm
History Alarm
1. Inv xxxxxxxxx
Fan Fault
yyyy-mm-dd
hh:mm:ss
Show all current alarm
n. STS xxxxxxxxx
SCR2 Fault
yyyy-mm-dd
hh:mm:ss
History Alarm
▶ Inquire
Clear
For example,
Inquire
Clear
1. Inv xxxxxxxxx
Fan Fault
yyyy-mm-dd
hh:mm:ss
At most save 50 pieces of alarm record
n. STS xxxxxxxxx
SCR2 Fault
yyyy-mm-dd
hh:mm:ss
Clear all history alarm ?
All history alarm deleted ! √

Setting Menu



5.2.2 Hot Swap Operation

5.2.2.1 Inverter module

A. Locate the lock switch at the unlock position.
B. Install or remove the Inverter module from the shelf.

5.2.2.2 STS module

A. **WARNING:** Ensure that the Maintenance Bypass Switch is set to the MBP or the IBP position (as determined by mains and inverter output status position) otherwise it will damage the STS module frame due to the mechanical interlock. . Refer to Figure 28.
B. Set the lock button at the unlock position.
C. Install or remove the STS module from the shelf.

5.2.2.3 Controller module

A. Loosen the retaining screw.
B. Install or remove the Controller module from the shelf.

6 Maintenance, Adjustments and Troubleshooting

If you encounter a problem in the operation of the Inverter system and need UNIPOWER Telecom to service your equipment it is recommended to leave the system in its current state and record any system message on the Controller LCD display along with the conditions of the LED indicators on the individual module front panels; then contact UNIPOWER Telecom for assistance.
Leaving the unit in its current state will facilitate the engineers in troubleshooting more easily.

For an immediate remedy you may wish to consider the following troubleshooting tips.

If the system fails to operate properly, use the troubleshooting table to determine the probable cause and obtain suggestions on how to proceed.

It is not possible to anticipate all symptoms in the guide, but those listed are the most likely.

Symptom	Possible Cause	Recommended procedure
Inverter modules are in the cabinet, DC power is applied, but one or more modules do not operate.	The module(s) may not be fully inserted into the shelf.	Install the module once more.
System is working, But you can not enter module status menu.	The communication cable between the controller and inverter and STS module is not properly connected.	Check if the communication cable is properly connected.
System is working, but yellow LED is on.	Overload.	Check the system load and reduce if necessary.
The fans of a module have stopped working and red LED on the module is blinking.	Fan fault.	Replace the fans.
System has stopped working, yellow and red LED are on.	Overload fault.	Check the system load and reduce if necessary, then restart the system.