Leading AC Backup Technology

TSI MIPS 75 KVA - PARALLEL CABINETS

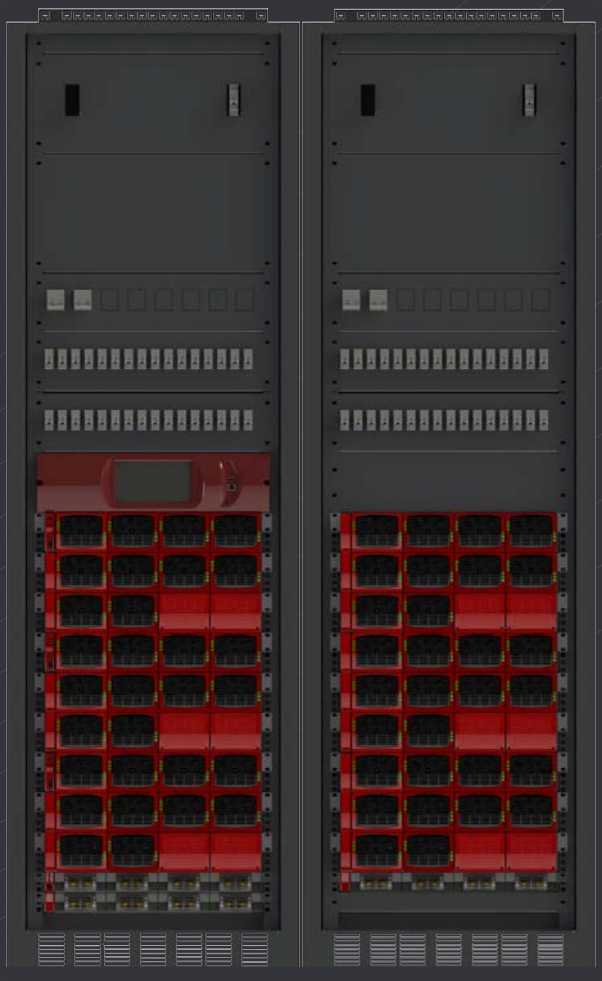
Modular Inverter Power System

User Manual V7.1

BEYOND THE INVERTER

THE NEW GENERATION OF POWER CONVERTERS

- **DUAL INPUT INVERTER**
  The Commercial Power as default source
- **AC BACKUP IN A DC ENVIRONMENT**
  Leverage your existing DC infrastructure
- **ONE STOP SHOP**
  Wide output power range
- **HARSHEST AC INPUT CONDITIONS**
  Without compromising the quality of the AC output



Important Safety Instructions
Save these Instructions

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Release Note:

Version	Release date (DD/MM/YYYY)	Modified page number	Modifications
7.0	14/01/2016	-	First release of the Manual.
7.1	14/05/2020	-	Amendment and correction.

1. CE+T at a glance

CE+T Power designs, manufactures and markets a range of products for industrial operators with mission critical applications, who are not satisfied with existing AC backup systems performances, and related maintenance costs.

Our product is an innovative AC backup solution that unlike most used UPS's

- Maximizes the operator's applications uptime;
- Operates with lowest OPEX;
- Provides best protection to disturbances;
- Optimizes footprint.

Our systems are:

- Modular
- Truly redundant
- Highly efficient
- Maintenance free
- Battery friendly

CE+T puts 60+ years expertise in power conversion together with worldwide presence to provide customized solutions and extended service 24/7 - 365

2. Abbreviations

TSI	Twin Sine Innovation
EPC	Enhanced Power Conversion
REG	Regular
DSP	Digital Signal Processor
AC	Alternating current
DC	Direct current
ESD	Electro Static Discharge
MET	Main Earth Terminal
MBP	Manual By-pass
TCP/IP	Transmission Control Protocol/Internet Protocol
USB	Universal Serial Bus
PE	Protective Earth (also called Main Protective Conductor)
N	Neutral
PCB	Printed Circuit Board
TRS	True Redundant Structure
MCB	Miniature Circuit Breaker
MCCB	Molded Case Circuit Breaker
CB	Circuit Breaker
THD	Total Harmonic Distortion

3. Safety Instructions*

Important Safety Instructions. Save these Instructions.

3.1 Disclaimer

- The manufacturer declines all responsibilities if equipment is not installed, used or operated according to instructions by skilled technician according to local regulations.
- Warranty does not apply if the product is not installed, used and handled according to the instructions in the manuals.

3.2 Technical care

- This electric equipment can only be repaired or maintained by “qualified employee” with adequate training. Personnel in charge of simple repair or maintenance are required to have knowledge and experience of electrical maintenance.
- Please follow the procedures contained in this Manual, and note all the “DANGER”, “WARNING” AND “NOTICE” marks contained in this manual. Warning labels must not be removed.
- Qualified employees should have the knowledge to recognize and to avoid any dangers that might be present when working on or near exposed electrical parts.
- To avoid accidents involving live and operational parts, employees should have knowledge and adhere to lock-out tag-out practices.
- Qualified employees also should know safety related work practices, including those by OSHA and NFPA, as well as knowing what personal protective equipment should be worn.
- All operators are to be trained to perform the emergency shut-down procedure.
- This product is intended to be installed only in a restricted access area as defined by UL 60950 and in accordance with the National Electrical Code ANSI/NFPA 70, or equivalent local agencies.
- Maximum operating ambient temperature is 40°C (104°F).
- This unit is intended for installation in a temperature-regulated, indoor area that is relatively free of conductive contaminants.
- Never wear metallic objects such as rings, watches, bracelets during installation, service or maintenance of the product.
- This product is suitable for use in a computer room.
- CAUTION – Risk of electric shock. Capacitors store hazardous energy. Do not remove cover until 5 minutes after disconnecting all sources of supply.
- CAUTION – Risk of electric shock. This Inverter / UPS receives power from more than one source. Disconnection of the AC source and DC source is required to de-energize this unit before servicing.
- CAUTION - For continued protection against risk of fire, replace only with same type and rating of fuse.
- Insulated tools must be used at all times when working with live systems.
- When handling the system/units pay attention to sharp edges.

* These instructions are valid for most CE+T Products/Systems. Some points might however not be valid for the product described in this manual.

3.3 Installation

- Inverter System may contain output over current protection in the form of circuit breakers. In addition to these circuit breakers, the user must observe the recommended UL listed upstream and downstream circuit breaker requirements as defined in this manual.
- UL listed (DIVQ) branch overcurrent protections have to be provided by others / by customer.
- Please use extreme caution when accessing circuits that may be at hazardous voltages or energy levels.
- The modular inverter rack is a dual input power supply. The complete system shall be wired in a way that both input and output leads can be made powerless.
- When AC Mains is not connected, the output AC circuit is considered as a separately-derived source. If local codes require grounding of this circuit, use the identified terminal for bonding this circuit to the enclosure. Ground the enclosure to a suitable grounding electrode in accordance with local code requirements.
  Ground the enclosure to the electrode terminal (see section 8.6.3, page 27).
- Remove output neutral-to-ground jumper when input AC MAINS is connected (see section 8.6.4, page 28).
- Use 90°C copper wires / conductors only.
- AC and DC circuits shall be terminated with no voltage / power applied.
- The safety standard IEC/EN62040-1-1 requires that, in case of output short circuit, the inverter must disconnect in maximum 5 seconds. Parameter can be adjusted on T2S; however, if the parameter is set at a value >5 seconds, an external protection must be provided in order that the short circuit protection operates within 5 seconds. Default setting is 60s.
- The rack shall be secured to the building structure before operation.
- Supplementary protectors for AC-DC power supply, DC-DC converters and Transformers should not be turned off at the same time.
- Use external 3-Phase, UL-Listed, UPS Accessory, Paralleling Cabinet, rated minimum 208 Vac, and as follows:

Total Number of Paralleled UPS Cabinets	Minimum Current Rating of Paralleling Cabinet
2	400 A
3	600 A

- Further instructions on proper interconnection and routing are provided in this manual. See section 8.

3.3.1 Handling

- The cabinet shall not be lifted using lifting eyes.
- Remove weight from the rack by unplugging the inverters. Mark inverters clearly with shelf and position for correct rebuild. This is especially important in dual or three phase configurations.
- Empty inverter positions must not be left open. Replace with module or cover.

3.3.2 Surge and transients

The mains (AC) supply of the modular inverter system shall be fitted with suitable Lightning surge suppression and Transient voltage surge suppression for the application at hand. Manufacturer's recommendations of installation shall be adhered. It is advisory to select device with alarm relay for function failure.

Indoor sites are considered to have a working lightning surge suppression device in service.

- Indoor sites Min Class II.
- Outdoor sites Min Class I + Class II or combined Class I+II.

3.3.3 Other

- Isolation test (Hi-Pot) must not be performed without instructions from the manufacturer.

3.4 Maintenance

- The modular inverter system/rack can reach hazardous leakage currents. Earthing must be carried out prior to energizing the system. Earthing shall be made according to local regulations.
- Prior to any work conducted to a system/unit, make sure that AC input voltage and DC input voltage are disconnected.
- Prior to accessing the system or modules, make sure all supply source are disconnected.
  CAUTION – Risk of electric shock. Capacitors store hazardous energy. Do not remove cover until 5 minutes after disconnecting all sources of supply.
- Some components and terminals carry high voltage during operation. Contact may result in fatal injury.

3.5 Replacement and Dismantling

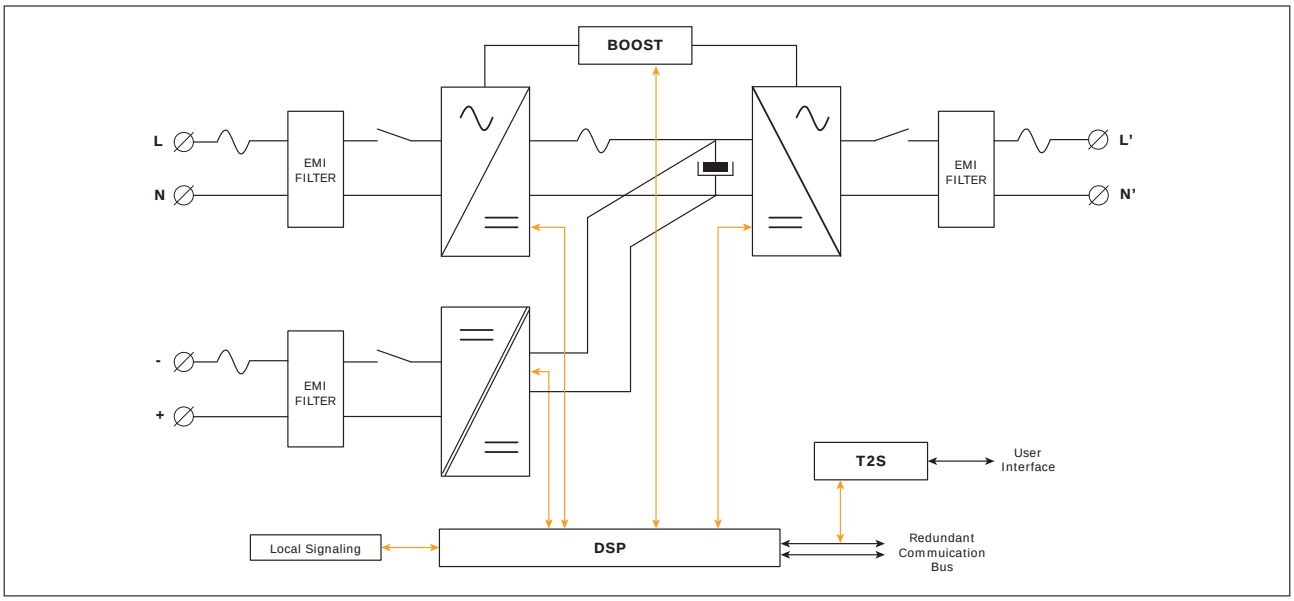
- ESD Strap must be worn when handling PCB's and open units.
- CE+T cannot be held responsible for disposal of the Inverter system and therefore the customer must segregate and dispose the materials which are potentially harmful to the environment, in accordance with the local regulations enforced in the country of installation.
- If the equipment is dismantled, to dispose of the products it consists of, you must stick to the local regulations enforced in the country of destination and in any case avoid causing any kind of pollution.

To download the latest documentation and software, please visit our website at www.cet-power.com.

4. TSI TECHNOLOGY [1]

Inverter modules carrying the TSI logo and the EPC mark are triple port converters (AC in, DC in, AC out). Sinusoidal output is converted from Mains or/and DC.

The block diagram here below gives an explicit description of the topology and operation.



The module is built around the following sub-converters

- AC to DC at input
- DC to DC at input
- DC to AC at output

The energy can flow either from the AC source or the DC source under the control of the local DSP controller. Thanks to internal energy buffering, the output sine wave is constant and disturbance free regardless of the active source.

The BOOST functionality multiplies the nominal current for a period of 20ms(max) in the event of down stream current surge. The upstream breakers do not have to be oversized to prevent tripping. After the boost has been activated or if the AC input is not present the overload capacity is 150% for 15 seconds regardless of the source currently used.

The TSI works according to True Redundant Structure (TRS) that features decentralized and independent logic, redundant communication bus and three internal levels of disconnection to isolate a module after internal failure.

The functionality is included in every inverter module. Running them in parallel provides a modular system with, no single point of failure, always conditioned output, high system efficiency and 0ms source transfer time.

1 | Information and data given in this chapter intend to for an overview on the technology. Detailed features and parameters for each individual module type of the range may differ and should be referred in the dedicated data sheet.

4.1 EPC-mode

- AC input (mains) is the primary source while DC works as secondary source of supply.
- The TSI is designed to operate on Mains on permanent basis and to deliver output voltage conditioned with low THD.
- There is no physical difference on the output sine wave whether the source is AC (or) DC. If the Mains is out of tolerance or goes down, the converter seamlessly switches to DC and the converter operates in “Back-up mode” (Switching time back and forth is 0ms).
- As soon as the Mains returns in to valid range, the EPC mode is automatically resumed.
- The EPC mode offers higher efficiency (up to 96% depending on the model) without compromising the purity of the output sine wave.

4.2 On-line Mode

- DC is the primary source of supply while Mains (AC) works as the secondary source of supply. Switching time between DC input and AC input is 0ms (source transfer).
- The power delivered by the DC source (usually a battery , but it could be any other type of DC generator) is converted to provide regulated and transient free power to the load.
- In case of short circuit at the load side, the boost is automatically, timely and energized for a specific duration to trip downstream protective devices.

4.3 Safe mode

- Safe mode uses DC as primary source of supply while Mains (AC) is in standby.
- Mains (AC) is normally disconnected through internal inlet relay and is only connected when down stream clearance is required (boost) or if DC is unavailable.
- The transfer between DC and AC results in typical transfer time of 10ms.
- Typically the safe mode is used in extremely harshed environments such as railways. Under such conditions it provides extra isolation against disturbances carried by the Mains.

4.4 Mix Mode & Walk-in-mode

- Under some circumstances DC and AC source can be combined. The sequence is defined by a user selectable set of parameters, start, control and exit are fully automatic .
- A specific example of Mix-mode is the Walk-in mode where the transfer from DC source to AC source is ramped up within a fix and adjustable period of time.
- Setting for Walk -in -Mode and Mix Mode can be made through the T2S supervisor configuration file. See section 10, page 36 for more information on T2S supervisor.

Note: REG modules:

Inverter modules carrying the TSI logo together with REG mark are modules working only with DC input . Sinusoidal output is converted from DC and the module operates as a traditional inverter. EPC mode and the boost are not available with REG modules.

5. System Components

A typical system consists of modular components, accessories and subsystems that work together to provide reliable solutions.

5.1 Inverter Module

BRAVO:	-48VDC / 120VAC, 60Hz (50 Hz)
	125VDC / 120VAC, 60Hz (50 Hz)

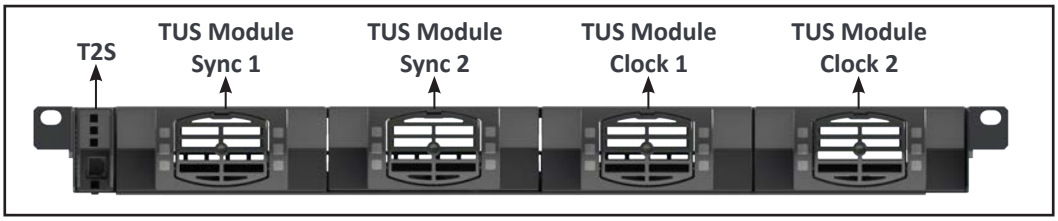
- The TSI Bravo is a 2500 VA / 2000 W converter based on the TSI technology (see section 4, page 10).
- The TSI inverter modules are hot swappable and hot pluggable. They are featured with self setting capabilities for easy plug-and-play operation.
- LED's on module front plate display the status of converter and output power.
- Inverter modules can be combined to build any single or multi-phase structures.
- The inverter modules are equipped with soft start.
- The fan is equipped with alarm and run time meter. It is field replaceable.
- 17.13" (D) x 4.02" (W) x 3.46" (H). [435mm (D) x 102mm (W) x 88mm (H)].
- 11 Lbs [5 kg].

5.2 Sub-rack (Shelf)

- The cabinetized enclosure is built from supporting shelves (sub-rack) designed according to 19inch standard.
- The BRAVO shelf houses max four (4) inverter modules and one (1) T2S interface. Max 10kVA per shelf.
- Additional shelves can be stacked and interconnected to build more powerful structures.
- The BRAVO shelf is designed with individual DC input, common AC input and common AC output.
- Optional rear cover can be provided for enhanced safety in cabinet.
- 18.9" (D) x 19" (W) x 2U (H). [480mm (D) x 19" (W) x 2U (H)].
- 13 Lbs [6 Kg] empty.

5.3 Synchronization Component - TUS

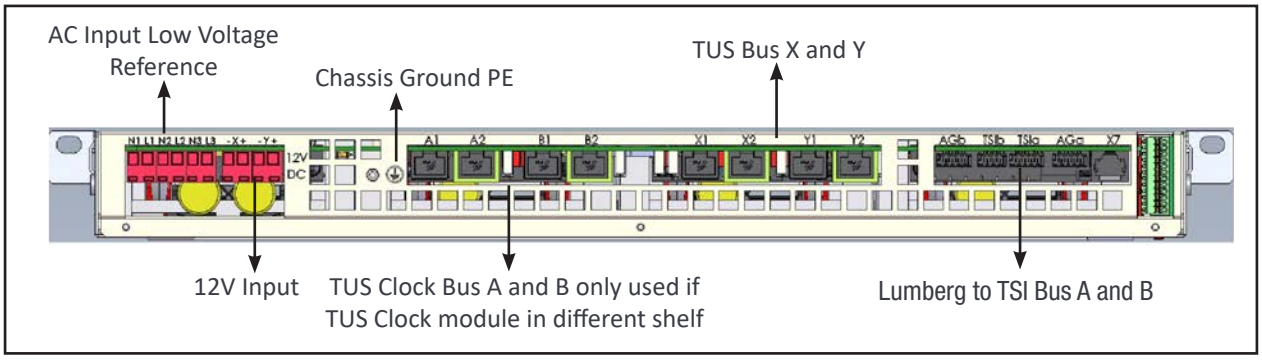
- TUS (TSI Universal synchronization) allows the synchronization of more than 32 TSI inverter modules to create a "large system."
- One large system with TUS consist of several « groups » of maximum each 30 TSI inverter modules equipped with TUS module.
- Each group of max 30 TSI inverter will require:
  - One TUS shelf that can receive up to 4 TUS modules. The 2 left slots are reserved for TUS Sync module and 2 right slots are reserved for TUS Clock module.



TUS Shelf

  - Two TUS Sync modules located in the left position of the TUS shelf. The TUS Sync module will be connected to the TSI bus A and B (lumberg connector). Minimum 1 TUS Sync per Group (recommended 2 for redundancy). The TUS module will take 2 address of the TSI system group and are identified as TUS modules.
- To complete the solution for a large system it will require:
  - Two TUS Clock module per system that creates the synchronization signal sent to the TUS Sync module.
  - One T2S module to monitor TUS module and report any alarm. The T2S software version must be 3.8 or higher to recognize TUS module.
- Each TUS Sync module receives the information sync signal from the TUS clock module.
- TUS shelves must be connected together through RJ45 cable bus X and Y (2 busses) looped between TUS shelves.
  All TUS module have the same hardware and software. The position of the TUS module in the shelf classifies it as a TUS clock or a TUS sync modules.

NOTE: Please refer to the TUS manual for more information about the TUS synchronization.
Appendix 17.4, page 57 provides more details on the TUS connections.



TUS Shelf - Rear View

6. Accessories

6.1 T2S ETH Interface

The T2S ETH is an interface giving access to the TSI modules that are connected together in any TSI systems.

The T2S ETH doesn't perform any control or management of the TSI system. It can be removed, replaced or moved to another live system without affecting the original TSI system operation nor the target system.

6.1.1 Parameters setting

- The T2S ETH interface is featured with a ETH port at the front. Connected to a laptop, it enables TSI system settings, modules and phase assignments, and other various adjustments to allow TSI best fit with actual site conditions. (Operation of T2S ETH is described in separate manual available on request)

6.1.2 System Diagnostic and Troubleshooting

- The T2S ETH is featured with built-in user interface to allow on-line diagnostic through laptop.
- Installers and maintenance technicians should always carry proper laptop to access/reconfigure the system on site. (Operation of T2S ETH is described in separate manual available on request)

6.1.3 System Monitoring

The T2S ETH monitors max of 32 system modules.

The T2S ETH is featured with

- 3 digital output alarm contacts.
- 2 digital input contacts.
- MODBUS.
- Alarm monitoring.
- Log file of the latest 2000 events as FIFO.
- SNMP V1 status monitoring.

Note: Operation of T2S is described in separate manual available on request.

6.2 Catena

Catena GUI Interface is a powerful web based touch screen graphical display, it allows users to easily access and monitor the system.

In addition to the touch screen display, users can also access the GUI by using an Ethernet port which is present on the Catena.

- Measures
  - AC In
  - DC In
  - AC Out
- Alarms
  - Major/Minor
  - System Level
  - Phase Information
  - Module Information
- 7” touchscreen
- Web browser with laptop (ETH)
- Height: 3U.

Note: Operation of Catena is described in a separate Monitoring manual.

6.3 Surge Arresters

The mains (AC) supply of the modular inverter system is fitted with suitable Lightning surge and Transient suppression. The surge protections are installed in the cabinet, unless otherwise requested by customer.

If surge arrester is separately purchased by customer, manufacturer's recommendations of installation shall be adhered. It is advisory to select device with alarm relay for function failure.

- Indoor sites: Min Class II.
- Outdoor sites: Min Class I + Class II or combined Class I+II.

Lightning currents conducted in inverter circuits can cause immediate and catastrophic equipment failure. Surges from induced lightning and power switching operations are smaller but are more numerous and can result in equipment misoperation, lockup or damage.

Some areas are more subjected to lightning than other whereas the intensity dramatically increases with the altitude.

The selection of the surge arresters as well as their installation obeys to strict rules. Not matching these rules could simply void their action. The selection of the surge arrester and its physical implementation cannot be covered in this document. The installer must analyze the local conditions and do the needful; eventually he should require the site to be inspected to cover his liability.

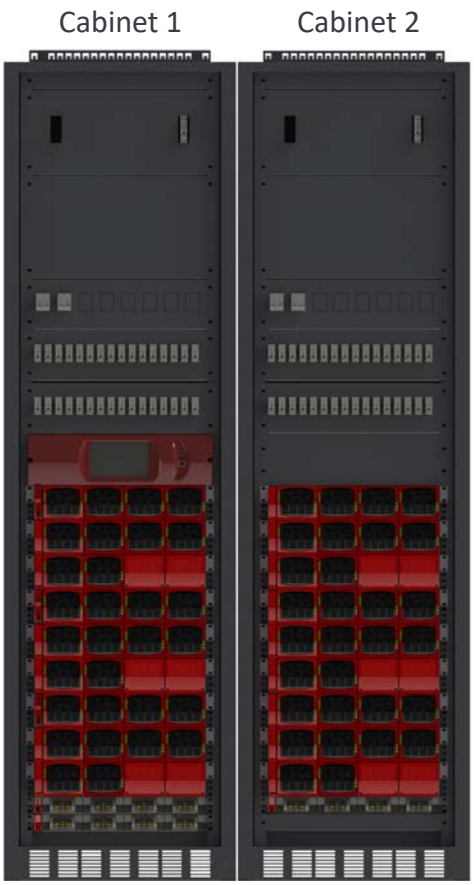
In any case inverter damages that could be related to improper protection are covered by CE+T product warranty

7. MIPS 75KVA - Parallel Cabinets Design and Description

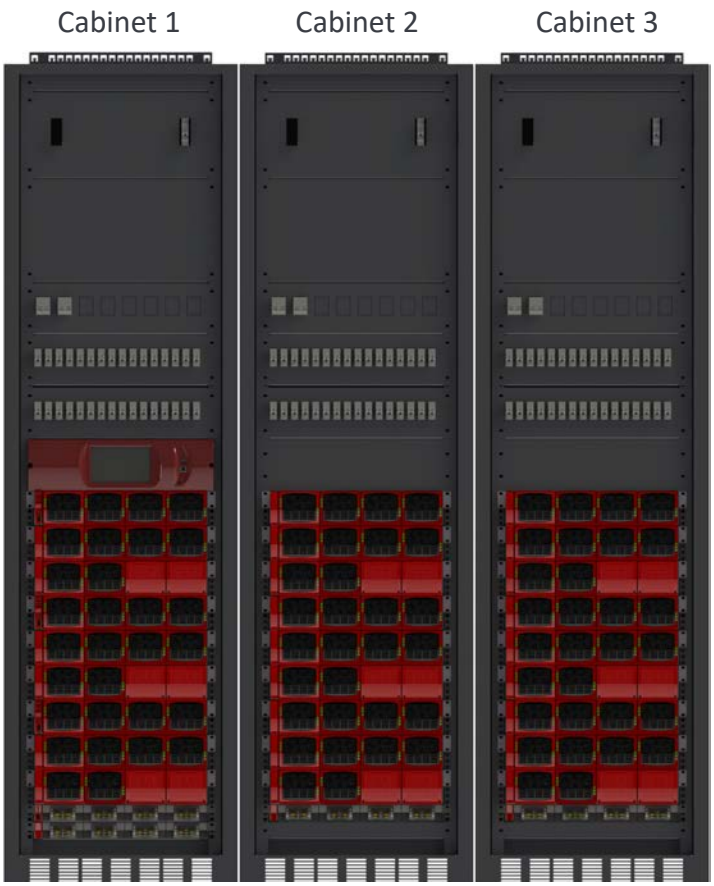
7.1 MIPS Design

MIPS 150/225 KVA is a modular inverter system made up of two/three MIPS 75KVA systems connected in parallel.
Details of each 75-KVA MIPS will be given in this section. The MIPS is specifically designed for clean and temperature controlled environments.

- Telecom grade design.
- Based on BRAVO 2500 kVA - 2000 kW TSI module.
- Fully modular.
- Support redundant configurations.
- Support EPC mode.
- Cabinet NEMA 1 (IP 20).



MIPS 2X75 KVA



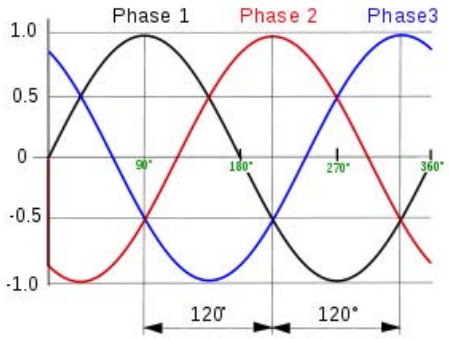
MIPS 3X75 KVA

7.1.1 TSI large system Concept

Parallel to build 3 phase systems with much higher power.

7.1.1.1 General Design

In a 3 phase system it is of the highest importance to insure that all 3 output phases L1-L2-L3 are all shifted by 120° from each other. This is to insure the right working of the given three phase load(s).



This condition must be achieved in all circumstances including possible failure of any of the system components (No Single Point of Failure).

Furthermore, the EPC mode can only be operated if the output is synchronized with the AC mains while at least one phase is present.

Let's note that the above considerations are only valid in case of real 3 phase loads.

While single phase loads are distributed on the three output phases above requirements are less critical and the TSI Bravo Inverter Systems may drift from each other without harming the load in any way. In this case, the only point to check is the correct sizing of the neutral wire that needs to be at least twice the size of the line wires.

7.1.1.2 Physical Structure.

The system is composed of 3 independent MIPS Cabinet adjacent to one another and synchronized together by the TSI Universal Synchronizer (TUS).

Each MIPS cabinet is designed with its own internal components: sub-racks, modules, communication bus, power bars (termination box), DC input protection breakers. They eventually provide the power to the load.

The TUS is composed of one "Clock" and one "Sync Generator" embedded in each system. All synchronizer components are made of idle working TSI Bravo modules linked together. It creates a redundant three phase time base used as a reference for each individual MIPS Cabinet.

7.1.1.3 Operation

Each power phase is connected to the corresponding phase from the grid.

Under normal conditions (grid present – EPC function activated) the MIPS take its energy from the grid (recommended operating mode).

The clock is preset so that priority is given first to L1 then L2 and L3 and generates a single time base for each sync generator, which generates three clock signals shifted by 120° to each MIPS Cabinet.

1. AC IN present and DC IN present.

   A) If L1 disappears or if the corresponding line probe fails, L2 is used as primary reference and the time base remains unchanged. Assuming that L2 and L3 remains sync, the system output remains also unchanged. If L1 is also down for the TSI Bravo Inverter System, the phase 1 runs on DC whereas the other phases remain in EPC mode without any further incidence.

   B) Same with L2 and L3.

   C) In the unlikely event that all three line probes fail, the clock generates a self running time base. The output voltages of TSI Bravo Inverter Systems L1, L2 and L3 will remain shifted by 120° but will slowly drift away from the grid reference signal. The EPC mode is not available and the whole system will switch in DC.

D) In case of grid outage (all 3 phases) the situation is similar as explained on point (c) but the EPC function is off course not active any longer. The load is now totally fed from the battery. When the grid comes back the synchronization is restored whilst the output is re-syncing with the grid.

E) In the unlikely event that both the clock and the grid fail together the synchronization is also down. The system will automatically stop after one minute unless some phase drift would be tolerable for the load. In this case the time out can be inhibited. If need be the clock can be featured with redundancy to overcome this uncertainty.

2. AC IN present and DC IN absent.

   A) The clock is fed only by DC. If the system is implemented with independent DC sources, the clock has a redundant energy sources (three battery strings are connected together through diodes) and the system can operate in back up mode while the battery is not empty.

3. DC IN present and AC IN absent

   A) In this case there is no reference signal from the grid but the clock still synchronizes the three TSI Bravo systems.

7.1.1.4 Inverter location and configured by system

Inverter for power and they respective SYNChronization inverters

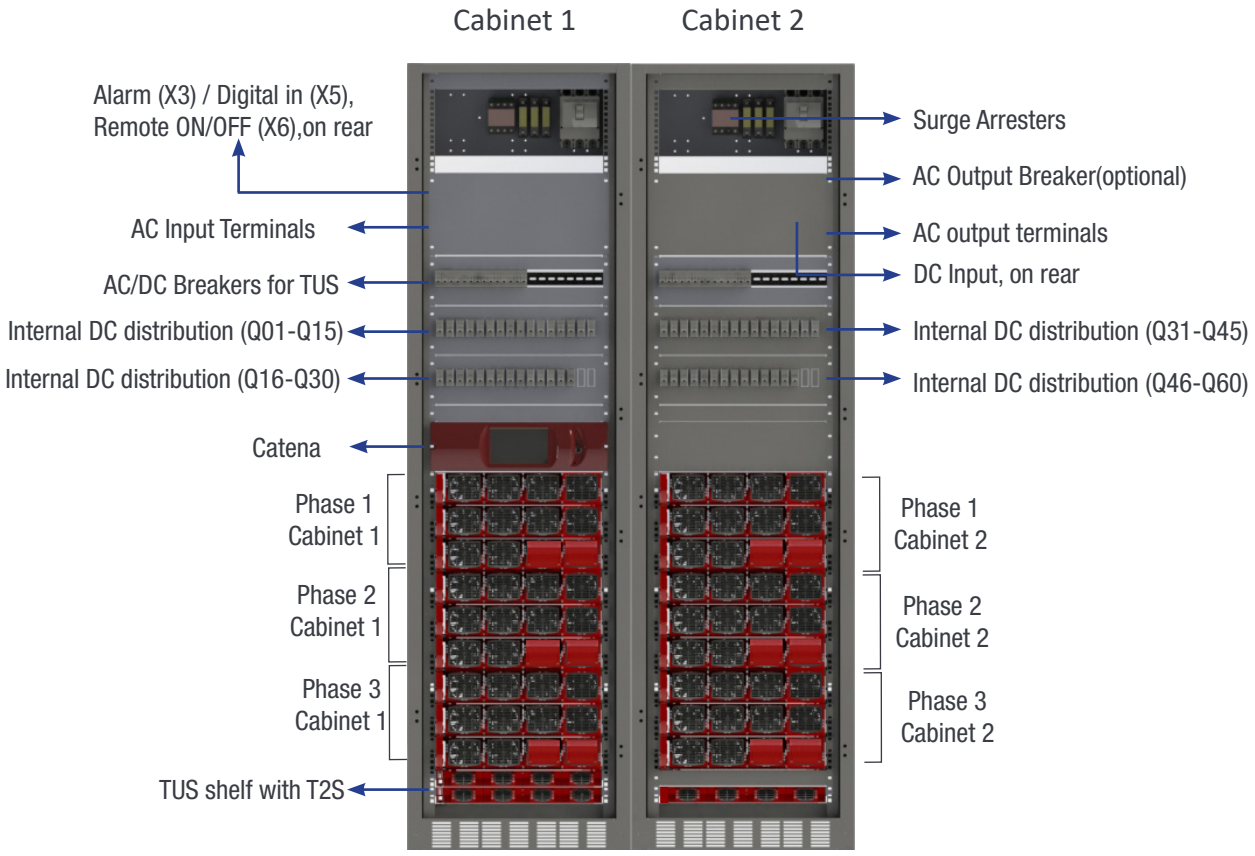
Nominal Power	Maximum inverters and power on each phase					
	Phase 1		Phase 2		Phase 3	
	Inverters	Power	Inverters	Power	Inverters	Power
90 KVA	12	30 KVA	12	30 KVA	12	30 KVA
120 KVA	16	40 KVA	16	40 KVA	16	40 KVA
150 KVA	20	50 KVA	20	50 KVA	20	50 KVA
180 KVA	24	60 KVA	24	60 KVA	24	60 KVA
210 KVA	28	70 KVA	28	70 KVA	28	70 KVA
225 KVA	30	75 KVA	30	75 KVA	30	75 KVA

7.2 System Description

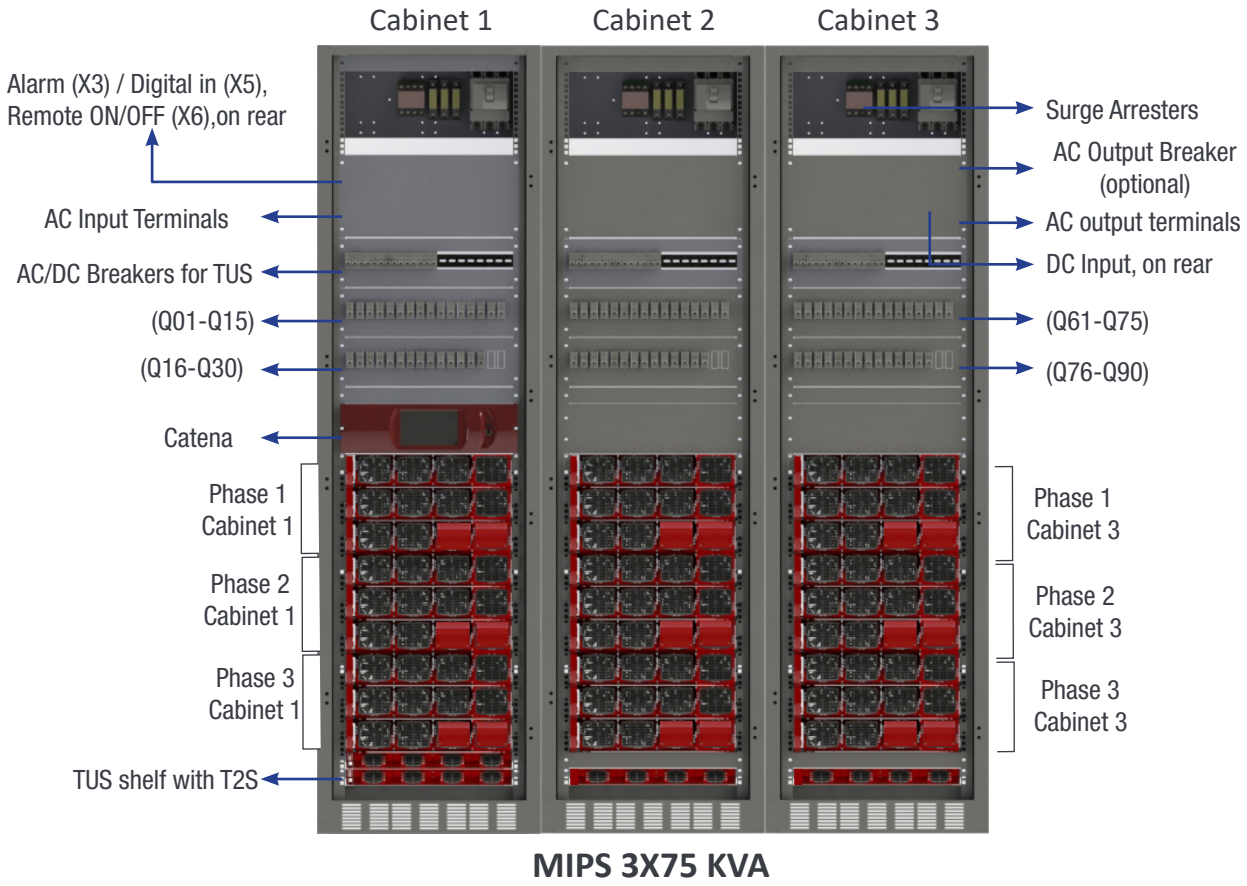
MIPS 75KVA - Parallel Cabinet is comprised of 2 X 75 KVA or 3 X 75 KVA MIPS systems. Each MIPS 75KVA comes fully equipped with:

- DC individual protection for modules.
- CATENA shelf and display.
- T2S ETH (SNMP).
- TUS (TSI Universal synchronizer).
- AC input breaker (bulk)-supplementary type (Optional).
- AC output breaker (bulk)-branch circuit protection (Optional).
- Required space at rear for TUS interconnection.

PLEASE ! Refer to the technical drawings received with your cabinet for exact positioning!



MIPS 2X75 KVA



MIPS 3X75 KVA

Options

- Surge Arrestors (Installed by default).
- Door.

7.3 MIPS Three phase configuration

Information in this section refers to the design of single MIPS 75KVA Cabinet.

A Three phase system is 120VAC from L to N and 208 VAC from L1 to L2, L1 to L3, L2 to L3.

All phases are phase shifted by 120 degree one to the other.

System Designation	Max Power (kVA)	Max power (KW)	Number of Shelves	Max number of Modules
MIPS-3-75-xx-30	75	60	9	30 *

* Number of modules must be multiple of 3, with same number in each phase in order to comply with UL recommendations.

System Designation	Bulk DC** input			3 DC** input		
	Fuse or Breaker	Cable Min	Cable Max	Fuse or Breaker	Cable Min (per feed)	Cable Max (per feed)
MIPS-3-75 48Vdc	2000 A	6 x 500kcmil or 8 x 300kcmil	9 x 500 kcmil	3x600 A	2 x 500 kcmil	2 x 500 kcmil
MIPS-3-75 125Vdc	800 A (double pole)*	4x 250kcmil	9 x 500 kcmil	3x 300 A (double pole)*	2 x 2/0	2 x 500 kcmil

Use 90°C copper wires / conductors only

* Double pole breakers must break both polarities, positive & negative

** Refer Section 8.6.5, page 29

System Designation	AC Input & AC Output				
	Branch Protection		Supplementary Protection		Cable Max Based on Terminal Size
	Breaker	Cable Min	Breaker	Cable Min	
MIPS-3-75-xx-30	250 A	300 kcmil	225 A	250kcmil	300kcmil

Note:

Input and output breakers are optional and can be requested by customer.

Recommended Branch Protection for External Panel Board

System Designation	Branch Protection	
	AC IN	AC OUT
MIPS-3-75-xx-30	250 A / 3P	750 / 3P - 3 X 75 KVA 500 / 3P - 2 X 75 KVA

NOTE: External Manual Bypass, if necessary, has to be installed and evaluated by customer.

8. System Installation

8.1 Site Preparation

Note: The following installation guidelines are to be applied to each MIPS-75KVA system.
External Manual Bypass, if necessary, has to be installed and evaluated by customer

- Refer to section 7 to identify type of system and configurations.
- Input and output protections

When installing MIPS inverter systems, UL489 listed AC upstream (input) and downstream (output) circuit breakers are required.

At input

Branch circuit protection breaker should be provided in upstream switchgear regardless of any protective device already installed at the input of the MIPS.

At output

Whenever the MIPS is supplied with supplementary output breaker or without any protective device at all (see option listed in 7.2), appropriate protection should be provided on site according to following table:

	Location of downstream distribution panel	
MIPS equipped with	**Same room**	**Different room**
No output protective device	Supplementary breaker	Branch circuit breaker
Supplementary breaker	Nothing	Branch circuit breaker
Branch Circuit breaker	Nothing	Nothing

Output distribution should be structured to guarantee tripping segregation. Contact manufacturer for recommendations and calculation methodology.

- Refer to Section 7 for sizing protections and connecting cables. All cables must be rated for min 75°C (167°F).
- Cables shall be halogen free.
- Wire all positions for future expansion.
- Input AC / Output AC / Input DC / Signal cables shall be separated.
- Cable crossings shall be done in 90 deg angles.
- Empty inverter positions shall be covered with blanks.
- System cooling - MIPS can be installed back to the wall. Air inlets at the front of the system must be in cold side. Air outlets are at the top of the cabinet. Alternatively the cabinet can be featured with front door. In this case it can be installed on raised floors with air inlets at the bottom.
- MIPS is designed for temperature controlled (max 40 °C/104°F) and clean environments. Presence of airborne particles such as urban dust, sand and metallic dusts are forbidden. Appropriate filters shall be installed.

Warning:

Filters mounted to the air inlets reduce the air pressure and may cause inverters cut off by thermal runaway. De-ratings should apply. Refer to supplier for specific recommendations and approvals.

Corrosive chemicals and contaminants in the air or in the vicinity of the system are forbidden. Refer to supplier for specific treatments in industrial and maritime areas.

Corrosive chemicals and contaminants in the air or in the vicinity of the system are forbidden. Refer to supplier for specific treatments in industrial and maritime areas.

8.2 Unpacking the system

CE+T cabinets are always fixed on a pallet, and then packed in a wooden crate.

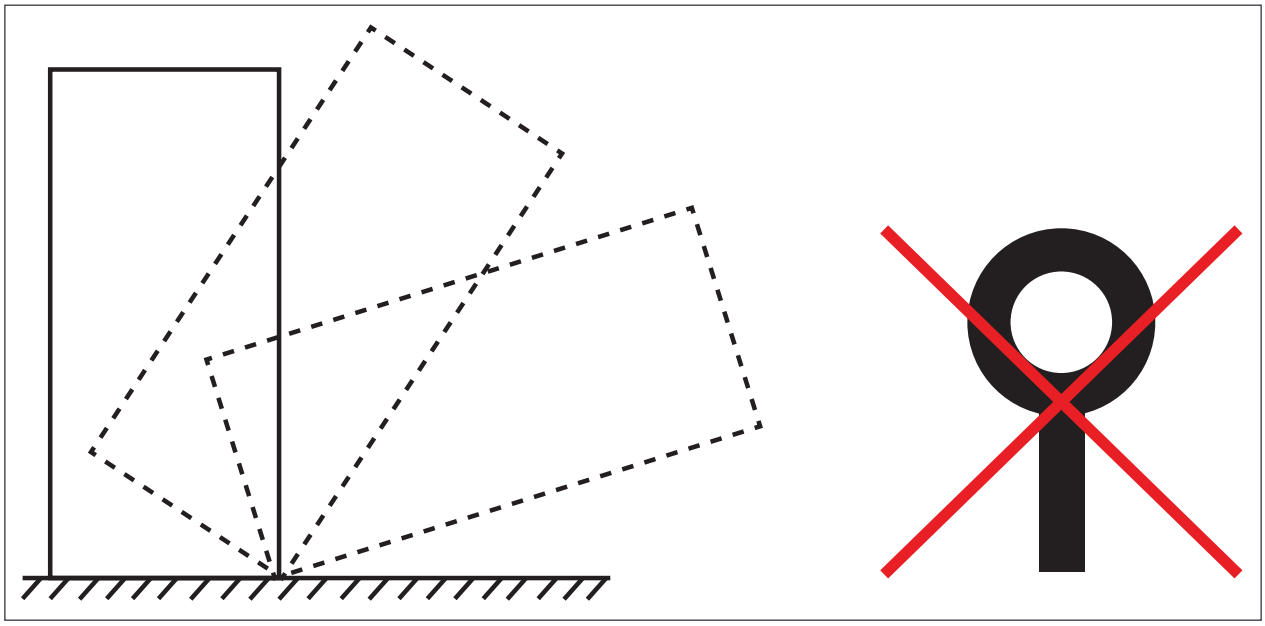
These crates are usually delivered laying flat, horizontally.

To unpack your cabinet, we recommend the following method:

1. Make sure that the crate is laying flat, with the correct side up. This side is identified by a double red arrow.
2. Remove the top cover in order to be able to identify the top and bottom sides of the cabinet.
3. Raise the crate vertically with the top side of the cabinet up. Make sure that the cabinet does not fall forward out of the crate while you do so.
4. Remove the cabinet and its attached pallet from the crate.

If you prefer to take the wooden crate apart before raising the cabinet, make sure you do not damage or dent the cabinet while doing so.

Warning : The top cover fixing bolts may NEVER be replaced with lifting eye bolts.



8.3 Module packing

Modules ordered with system are packed separately in a carton or a pallet. They come labeled. Please insert modules in the preassigned slots.

If the modules have been ordered separately they are packed in carton on pallet and identified to be replaced in the right slot (Important for dual or 3 phase system).

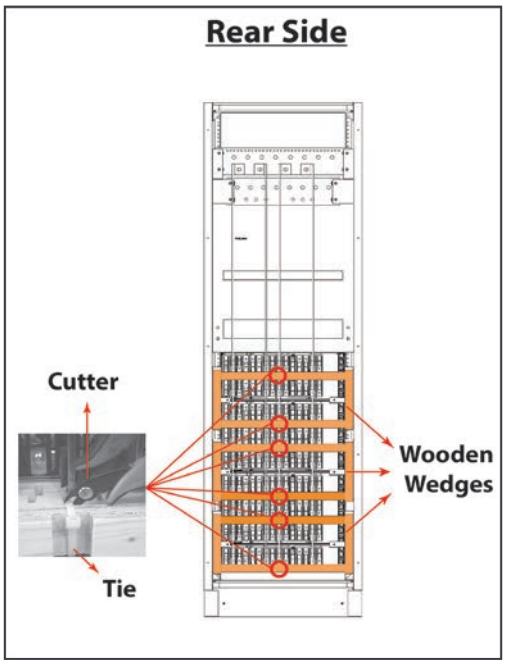
Module packing material shall be taken apart and stored in case of return under warranty. Improper packing of a returned module may void the warranty.

8.4 Removing the cabinet rear protection

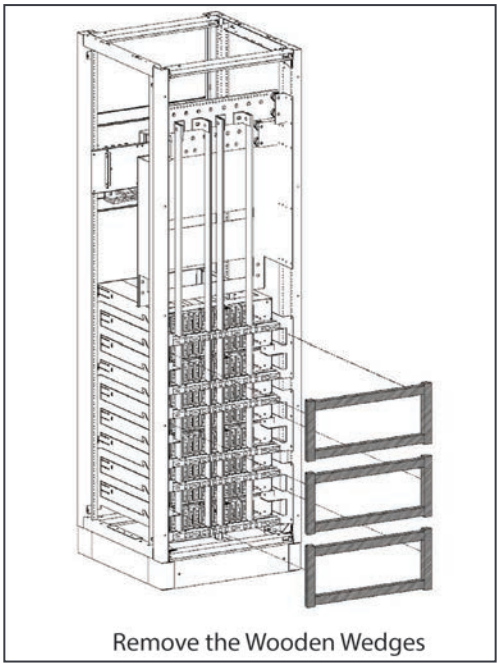
Wooden wedges are fixed at the back of the cabinet to make sure that no parts may move and be damaged during transportation.

These wooden wedges must be removed before going further with the cabinet's installation and commissioning.

1. Remove the rear panel.
2. Identify the protection (see the following figure).



3. Cut the tie wrap of the back wedges and remove them.

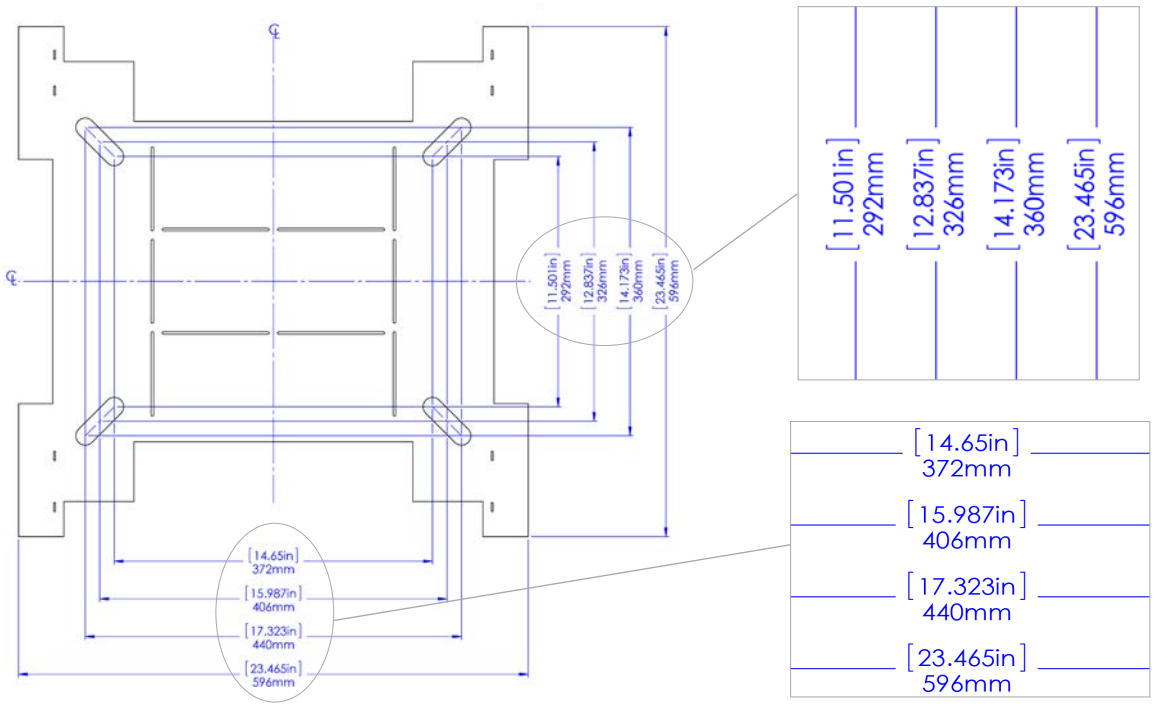


8.5 Fixing the cabinet to the floor

Each cabinet is fixed through the base of the cabinet.

Remove lowest front cover to get access to the fixing holes.

Max screw diameter is 0.8" (22mm). See Hole pattern, foot print. For foot print measurements.



8.6 Cabling

Check section 7 to identify system configuration and refer to section 7.3, page 22 for cable sizes. Refer also to 8.1 for important safety notices.

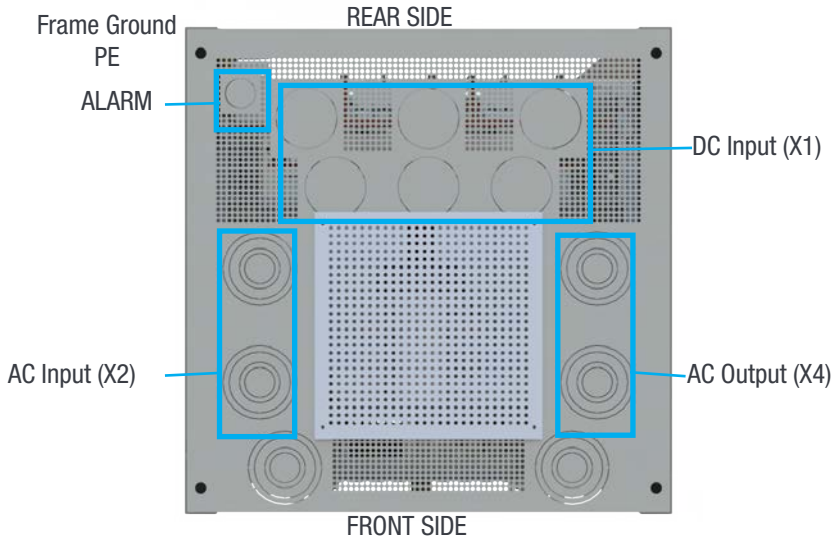
8.6.1 Tightening Torque

Torque recommendation for cable termination are

Size of wire for connection [AWG/kcmil]	Tightening Torque [pound-inches (N-m)]
2 -1	150 (16.9)
1/0 - 2/0	180 (20.3)
3/0 - 4/0	250 (28.2)
250 - 350	325 (36.7)
500	375 (42.4)

8.6.2 Cable inlets

Use appropriate collar to fix the conduits to the cabinet ceiling. Use existing punch out to not block the airflow through the top of the cabinet. The ceiling can be split to facilitate the cabling.



8.6.3 Grounding

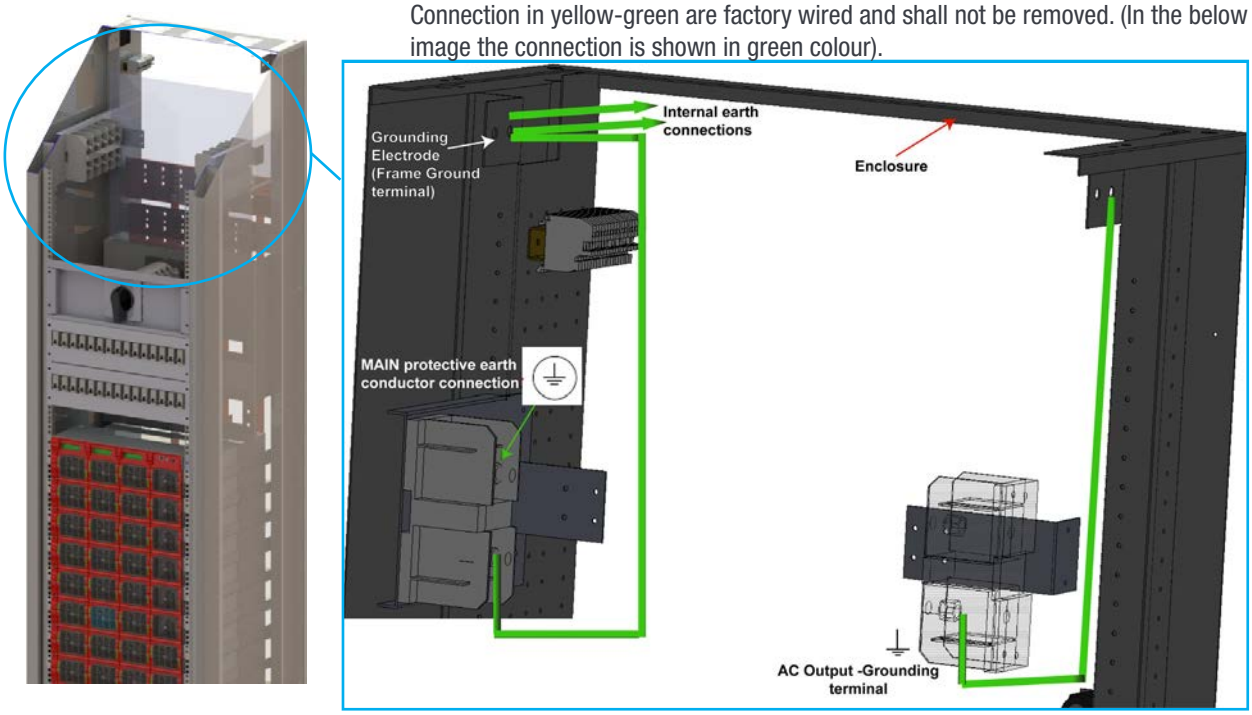
Main protective conductor(PE) connection is made to the X2(AC IN) terminal block marked with symbol for identification.

PE must be terminated even if commercial Mains is not available and shall be connected to building or main panel ground.

Recommended Cable cross section is the size equal(min) to Neutral cable cross section. Adhere to local regulations.
(see section 8.6.4, page 28)

Ground has to be connected in accordance with local code.

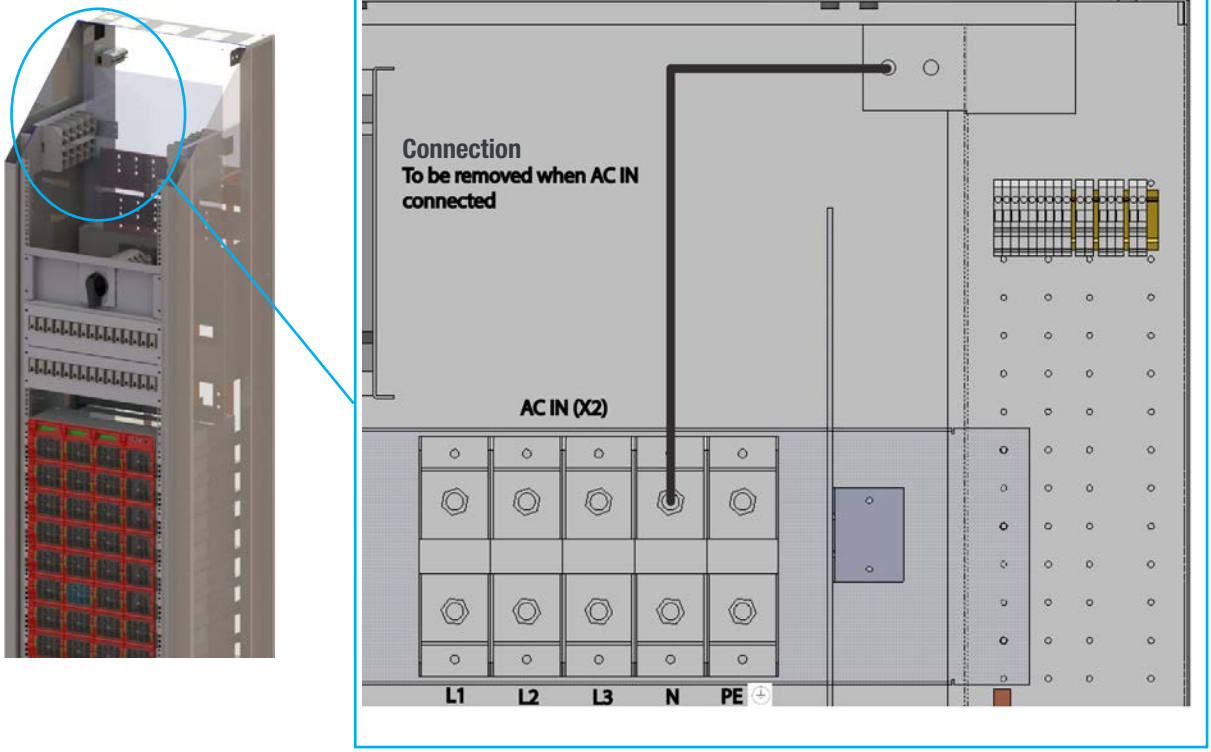
Connection in yellow-green are factory wired and shall not be removed. (In the below image the connection is shown in green colour).



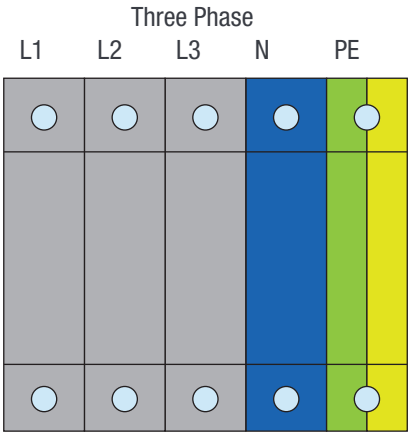
8.6.4 AC input and output

The pictorial representation of terminal blocks arrangement is as follows.

If AC IN is connected, remove the bonding neutral jumper, remove cable between X2(AC IN) and frame Ground.



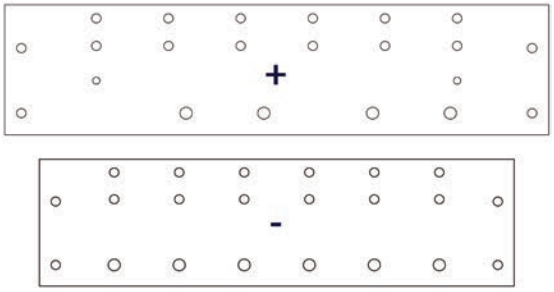
AC input and AC output shall be wired to connecting terminal blocks as per following indications:

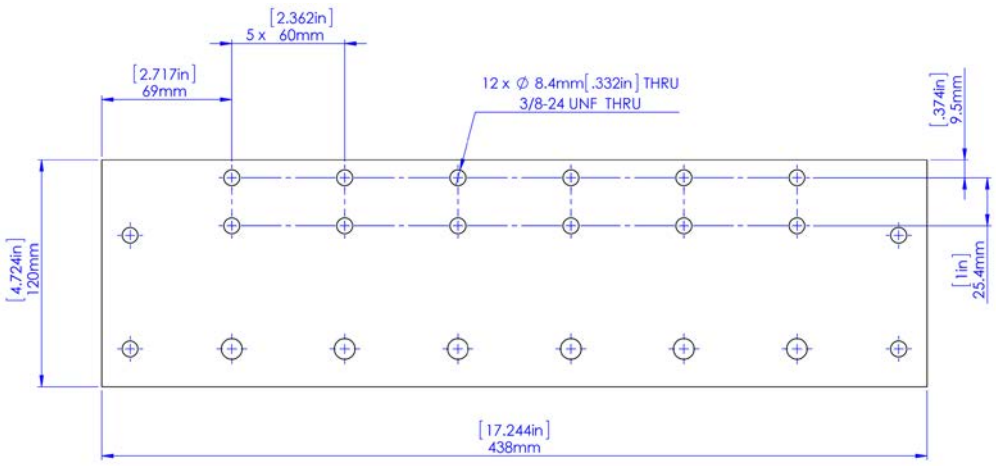


8.6.5 DC Input

8.6.5.1 Single feed DC Input

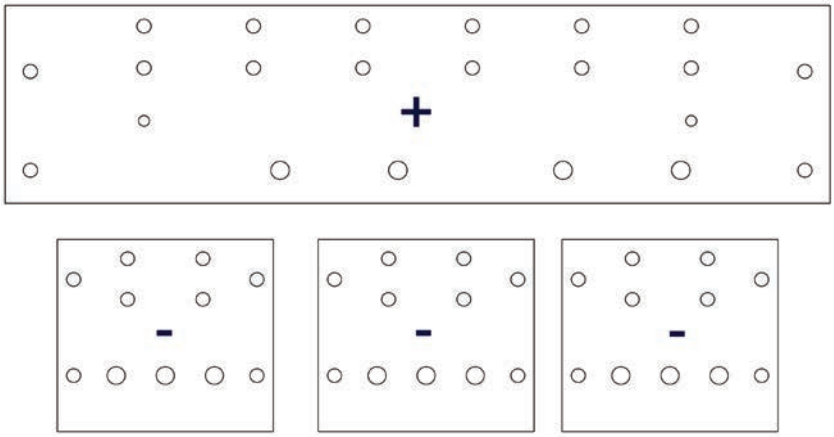
- One (1) common DC connection.
- Note: Screws, nuts and cable shoes are not included in the delivery.
- Two holes of $^{3}/_{8}$" threaded hole with 1"(25.4mm) between center.
- Internal DC distribution with circuit breakers (Q01-Q30) to each inverter module.
- Max 9x500 kcmil (240mm^2)
- Can be single or double lug (refer to site requirement for right type).

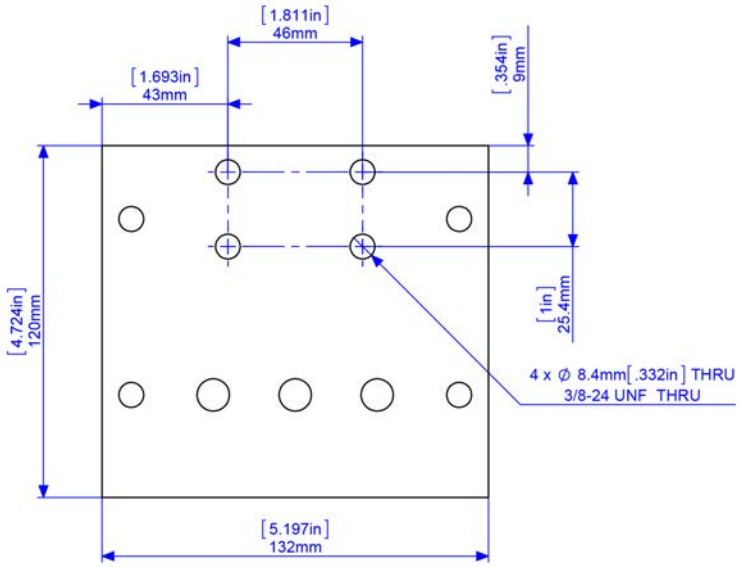


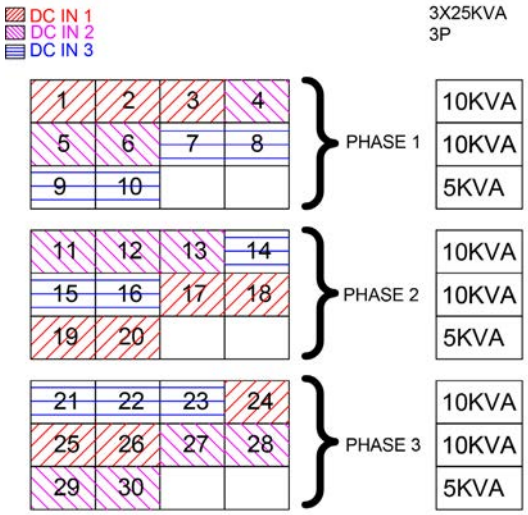


8.6.5.2 3 DC feed Input

- 3x DC input connection per system.
- Note: Screws, nuts and cable shoes are not included in the delivery.
- Two holes of $^{3}/_{8}$" threaded hole with 1"(25.4mm) between center.
- Internal DC distribution with circuit breakers (Q01-Q32) to each inverter module.
- Max 2x500 kcmil (240mm^2) per pole(group).
- Can be single or double lug (refer to site requirement for right type).

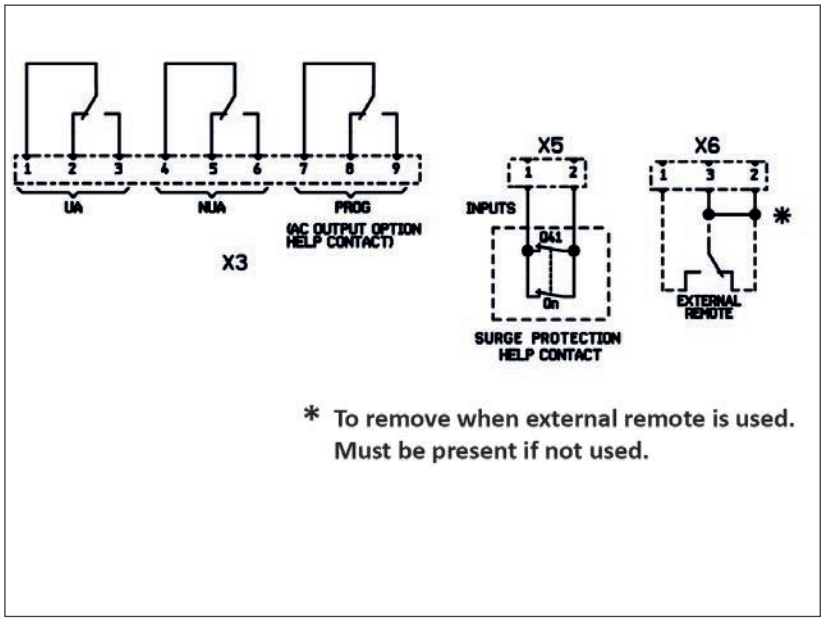






8.6.6 Alarms and Signals

- All relays are shown in non energized state.
- There only one terminal block in Cabinet A with all remote alarms for T2S from Phase 1, Phase 2 and Phase 3.
- TUS has a seperate alarm terminal block in Cabinet A.
  - See section 7 for more details.



8.6.6.1 Alarm (X3)

- Relay characteristics X3 (Major (UA), Minor(NUA), Prog)

  - Switching power 60W
  - Rating 2A at 30VDC / 1A at 60VDC
  - Max wire size 17 AWG (1mm^2)

Relays are energized when idle and contacts are released when event occurs.

8.6.6.2 Digital In (X5)

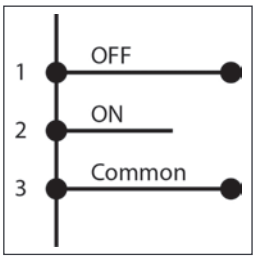
- Input characteristics X5 (Digital In 1, Digital In 2)

  - Signal voltage +5 VDC (galvanically insulated)
  - Max wire size 17 AWG (1mm^2)

8.6.6.3 Remote ON/OFF (X6)

Note: The system is by default equipped with a connection between pin 3 and 2. If remote ON/OFF is not used the strap shall remain. Should the remote ON/OFF be used the strap must be replaced with a changeover contact or emergency button.

- The remote ON/OFF switch the output AC OFF.
- Input AC and input DC is not affected by the remote ON/OFF.
- The remote ON/OFF requires changeover contacts, one input opens as the other close. If both transitions are not picked up the status is not changed.
- Digital input characteristics (Remote On/Off)
  - Signal voltage +5VDC (galvanically insulated)
  - Max wire size 17 AWG (1mm^2)



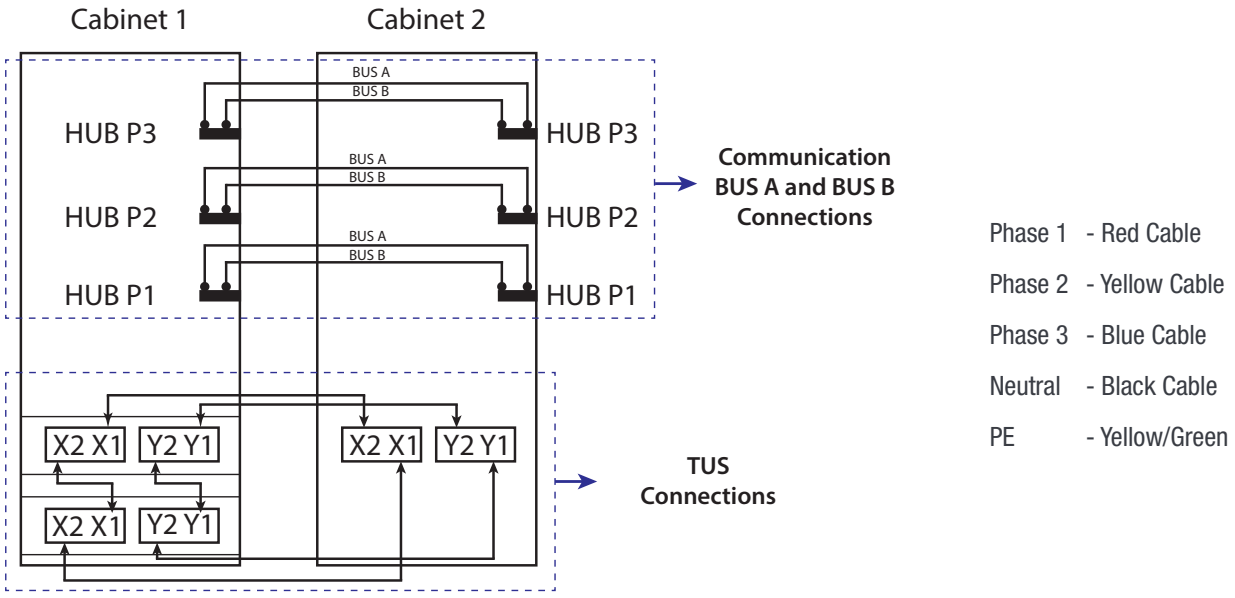
Functional table for remote ON/OFF function

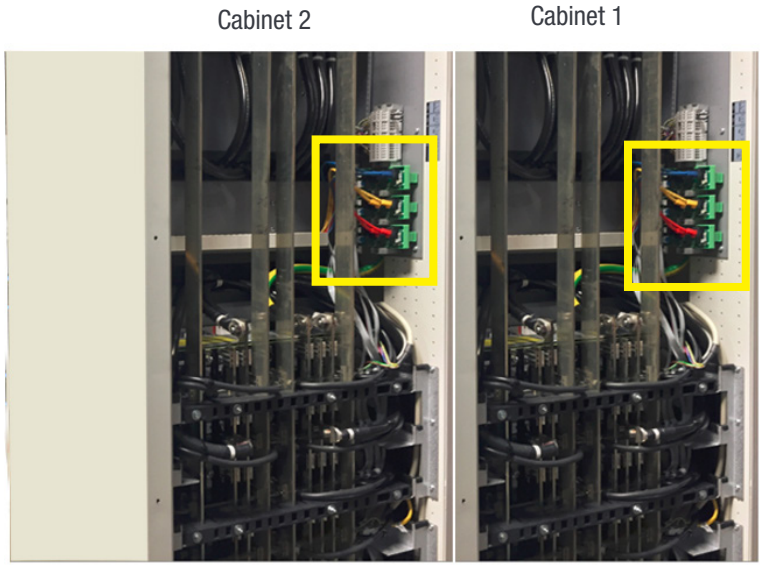
#	Pin 1-3	Pin 2-3	Status	Indication
1	Open	Open	Normal operation	All (Green)
2	Closed	Open	OFF	AC output (OFF) AC Input (Green) DC Input (Green)
3	Open	Closed	Normal operation	All (Green)
4	Closed	Closed	Normal operation	All (Green)

Warning: If remote ON/OFF not used, pin 2 and 3 MUST be bridged together!

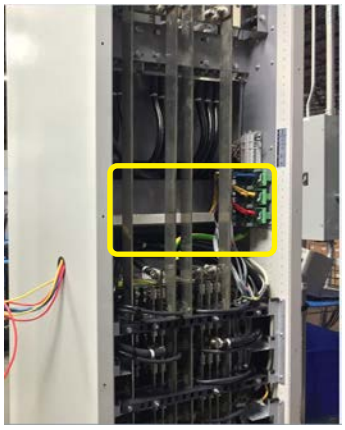
8.7 TUS Inter-connections

- TUS connections are pre-wired, however since cabinets are shipped separately, wires have to be reconnected.
- The following diagram shows the connections for the TUS shelves and TUS communication buses.
  See appendix 17.4, page 57 for more details.

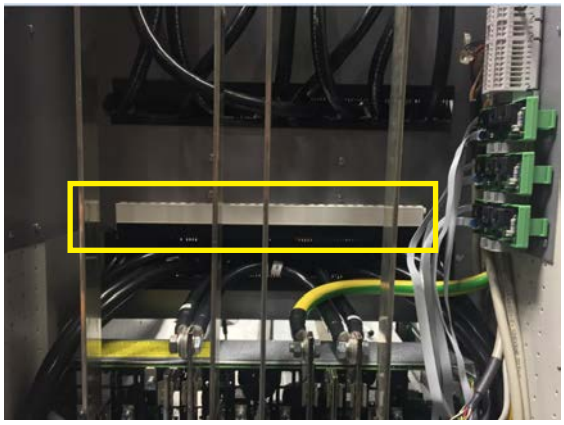




System Rear Side



Cabinet-1 with Raceway installed (Actual)



Raceway on the Cabinet-1 Circled in Yellow before the Cabling

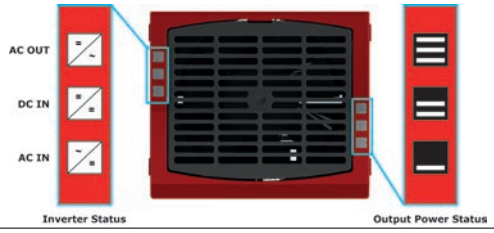
Knockouts on sides of the Cabinet-1 right from the front and Cabinet-2 left from the front

Knockouts with Insulating Bushing (installed on all the four knockouts)

Note: The Knockouts shall be made only the cabinets where the TUS is Installed. The standard cabinet will not have any knockouts.

9. Human-Machine Interface

9.1 Inverter module

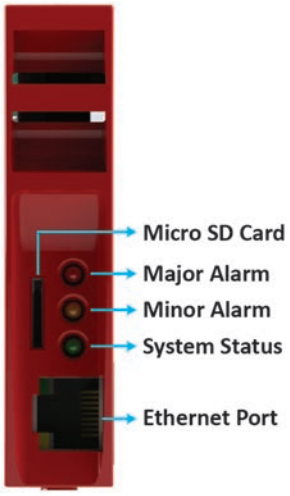


Inverter Status LED	Description	Remedial action
OFF	No input power or forced stop	Check environment
Permanent green	Operation	
Blinking green	Converter OK but working conditions are not fulfilled to operate properly	
Blinking green/orange alternatively	Recovery mode after boost (10 In short circuit condition)	
Permanent orange	Starting mode	
Blinking orange	Modules cannot start	Check T2S
Blinking red	Recoverable fault	
Permanent red	Non recoverable fault	Send module back for repair

Output Power (redundancy not counted)						
<5%	5% to 40%	40 to 70%	80 to 95%	100%	100% = overload	Output Power (redundancy not counted)
×	×	×	≡	≡	≡	Status output power LED
×	×	=	=	=	=	
—	—	—	×	—	—	
1B	1P	2P	2P	3P	3B	Behaviour (B = blinking – P permanent)

9.2 T2S

- Alarm indication on T2S (Urgent / Non Urgent / Configurable)
  - Green: No alarm
  - Red: Alarm
  - Flashing Exchanging information with inverters (only Configurable alarm)
- Outgoing alarm relay delay
  - Urgent 60 seconds delay
  - Non urgent 30 second delay
- Parameter setting via Laptop.
- Factory default according to list of set values.



9.3 Catena

Refer to Catena user manual for detailed operating with Catena.

10.System Operation

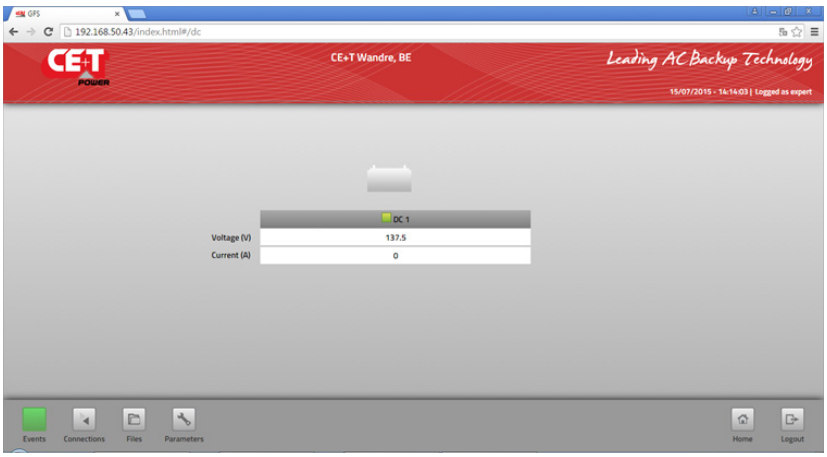
MIPS System is delivered with default set of parameters referred as factory settings.

Upon various site operating conditions or Site Manager requirements some parameters might have to be adjusted.

10.1 T2S Ethernet via Catena

Once system is powered upon, the Catena is up and ready for operation.
Configuration and other parameters can be changed using the Catena interface.

10.1.1 User GUI Interface Catena



CATENA provides a quick and efficient user interface to:

- Get and overview of the system information
- Detail information on
  - AC input power at system level
  - AC output power at system level
  - DC information at system level
  - Inverters information module level

10.1.1.1 CATENA Start up

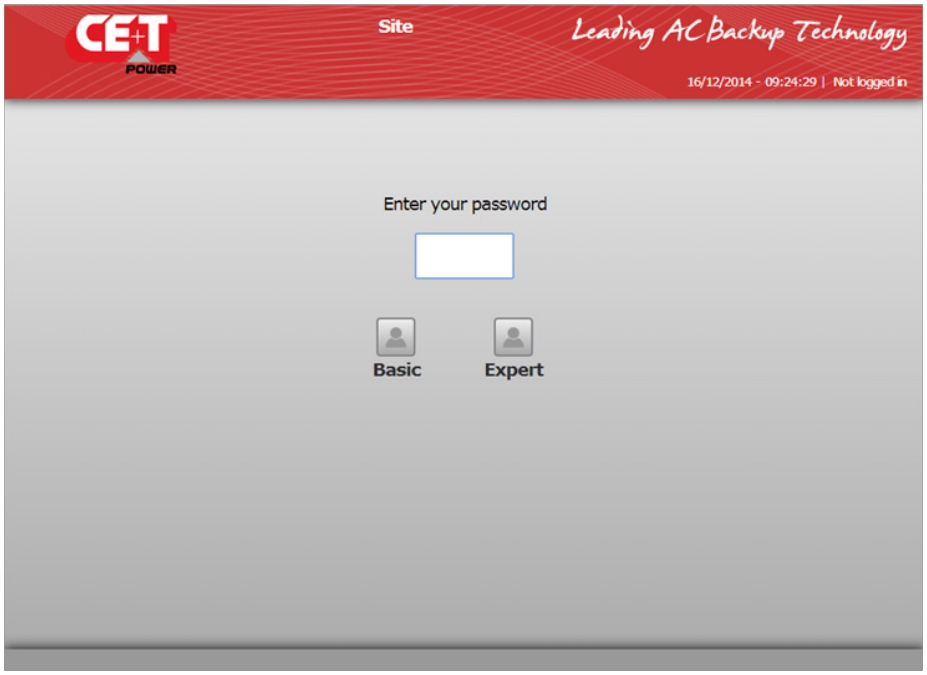
Applying start-up power – web interface

Initiate the start-up routine by applying power to the CATENA

NOTE: The controller will perform a short self-test as it boots up. Alarm alerts are normal.

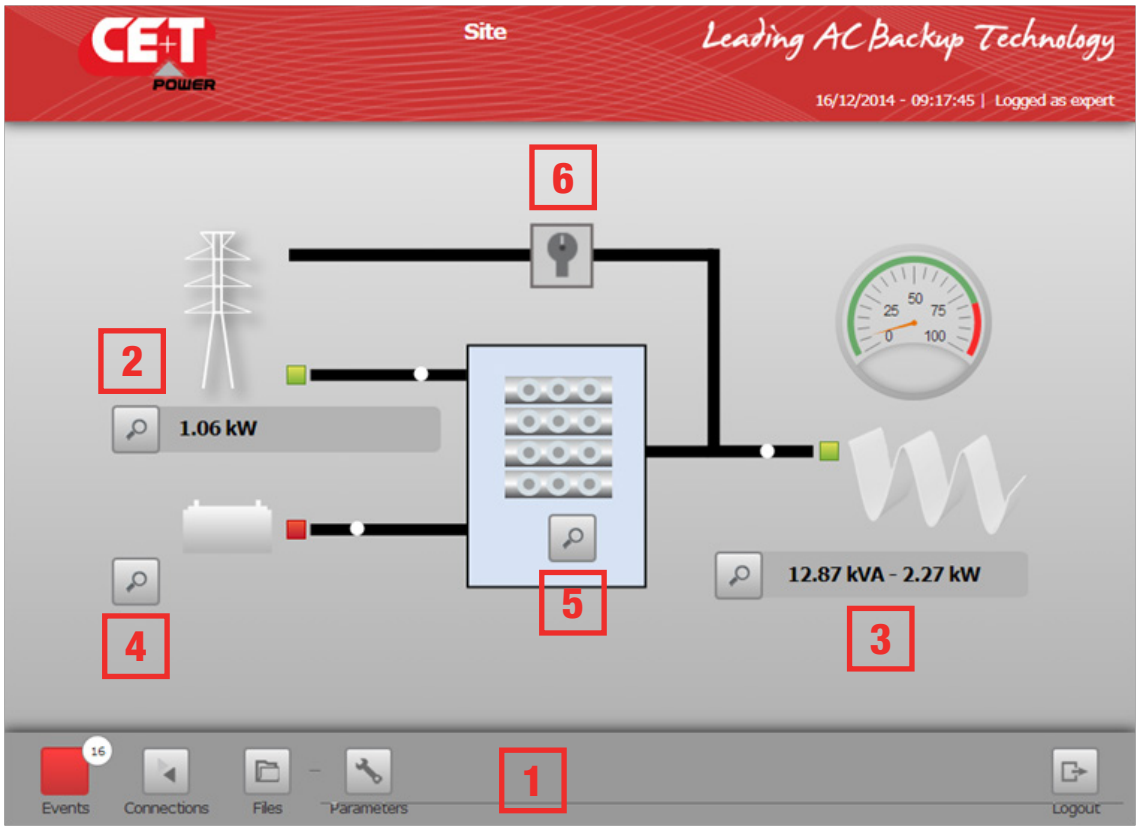
Use the touchscreen or connect the computer to the ETHERNET port and start your web browser.

1. Point your browser to 192.168.0.2 (default address).
2. Choose a user type (Basic or expert) and enter your password. Default password is “pass123” for basic, “pass456” for expert.



10.1.1.2 The Home page

After connecting in basic or expert level the catena will display the home page below



1. Tool bar to access to event, connections, files or parameters
2. AC input menu display AC input power in kW
3. AC output menu display level of AC output power in kW/kVA
4. DC input menu
5. System menu and further module menu
6. Manual by pass status engaged / not engaged (if present)

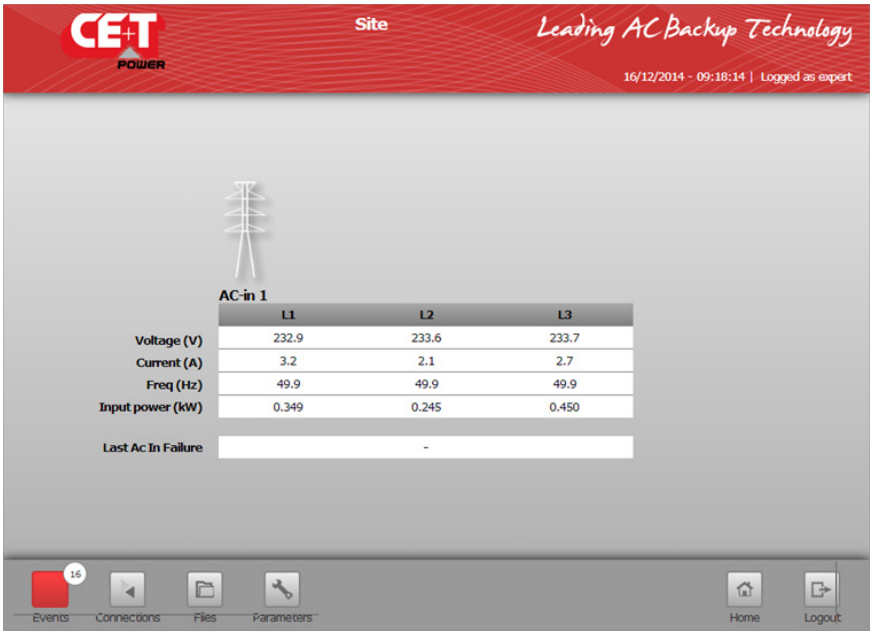
All LED symbol indicate if there any alarm present in the system

- Green No alarm present normal operation
- Alarm present minor (orange) , major (Red)

Click the **Search** button to obtain more details.

10.1.1.3 The AC input page

Click the **Search** button  at AC input to obtain detail AC input information of the 3 phase

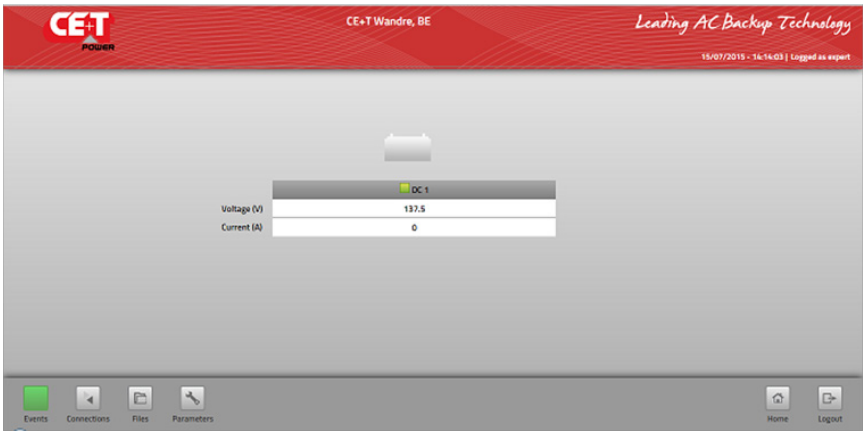


Provide

- AC input voltage for each phase
- AC input current per phase
- Frequency
- Input power going to the BRAVO inverter
- Record the last AC input failure date and time

10.1.1.4 The DC input page

Click the **Search** button  at DC input to obtain detail DC input information

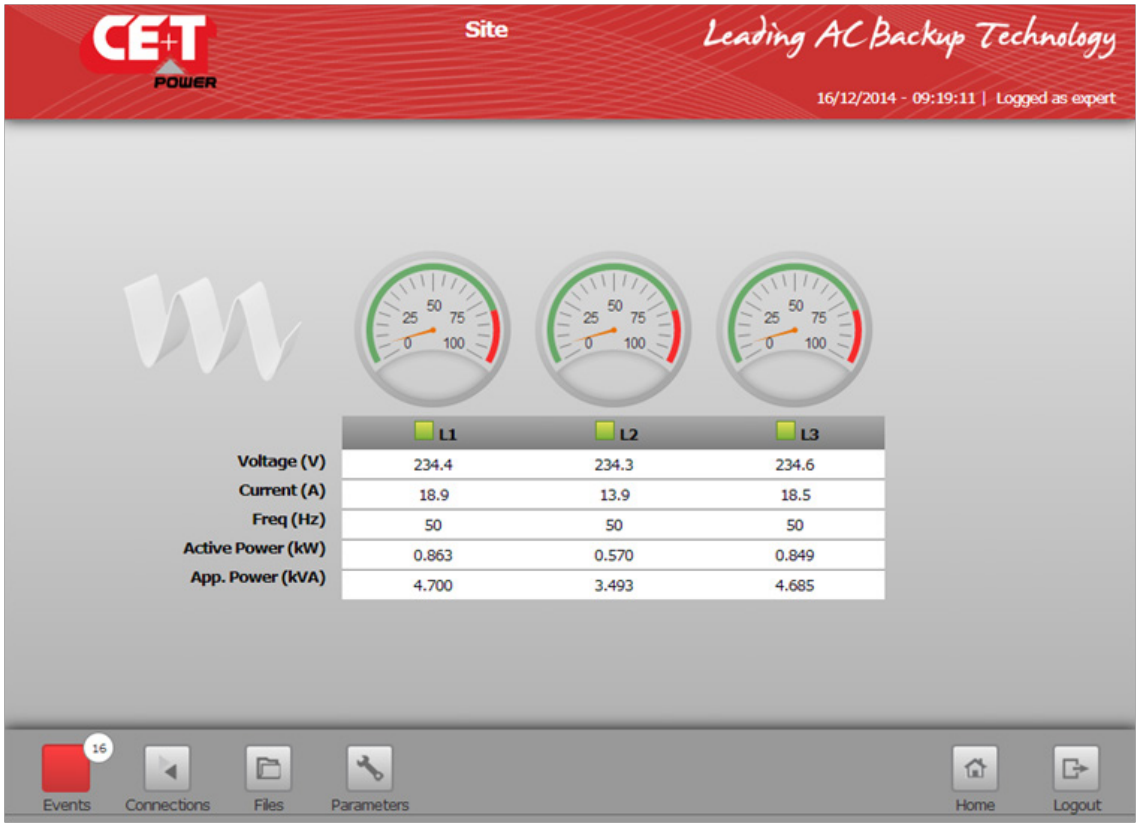


Provide

- DC input voltage VDC
- DC input current

10.1.1.5 The AC output page

Click the **Search** button  at AC output to obtain detail AC output information



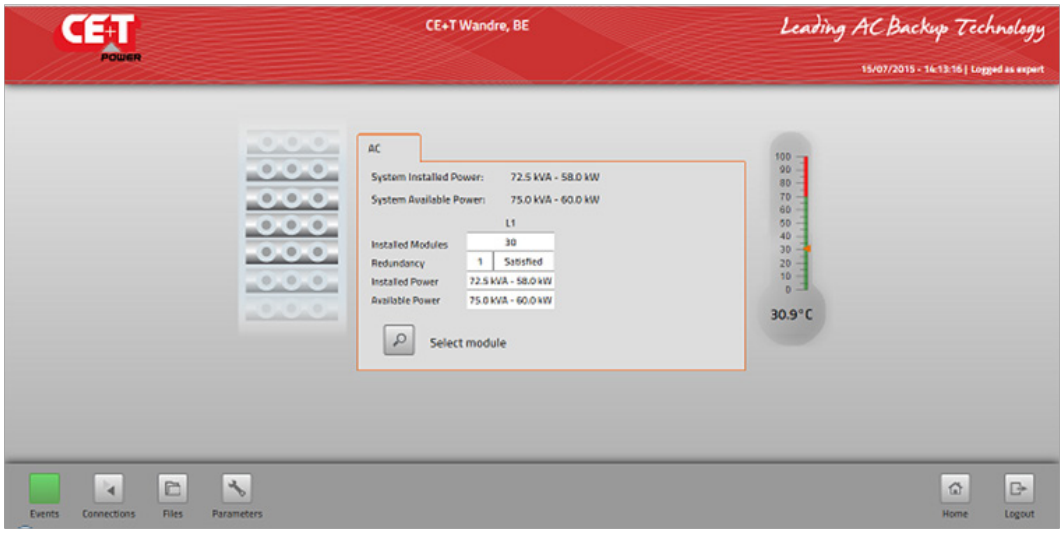
Provide

- Graph indicating the level of power per phase
- AC output voltage for each phase
- AC output current per phase
- Frequency
- AC output power (kW)
- Apparent power (kVA)

LEDs indicate any alarm and on which phase (Green no alarm) Red (Alarm)

10.1.1.6 The System page

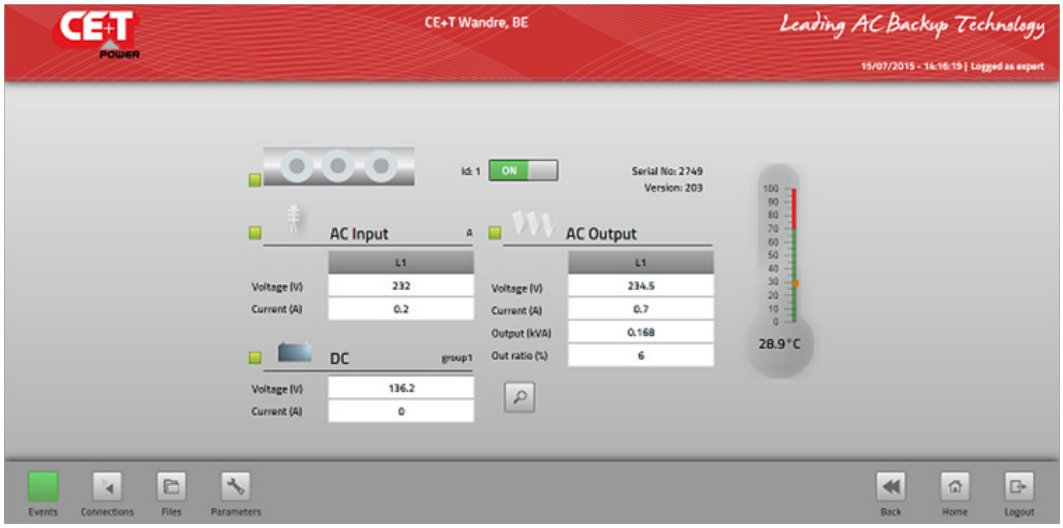
Click the **Search** button  at the cabinet in the home page will bring you to the system page



- AC folder is related to the inverter module with detail per phase
  - Number of module installed per phase
  - Redundancy 0 (No redundancy 1 one module redundant)
  - Installed power per phase
  - Available power per phase

If you want to browser each module separately, click again on “Select module” 

A popup will display and allow you to browse the module you want. The module page will then display as follow:



- The T° probe is the average T° of the inverter module heatsink

10.1.2 The TOOLBAR

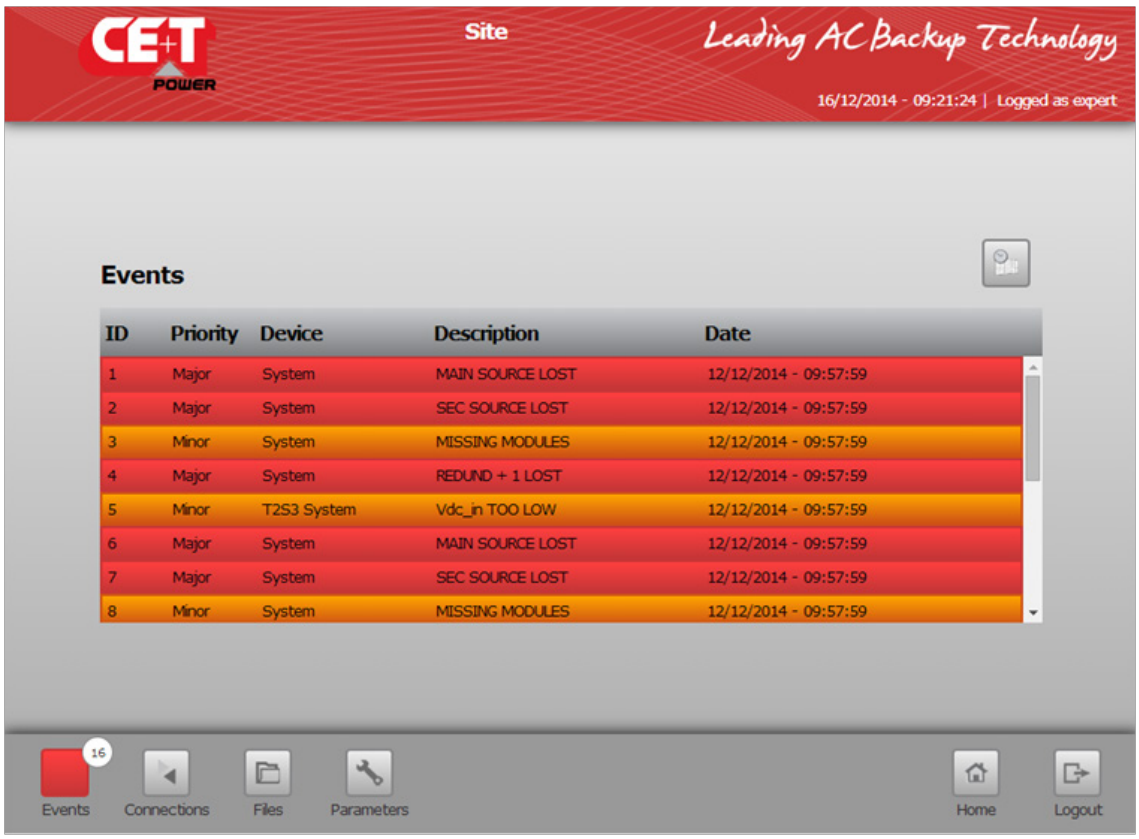
10.1.2.1 Event

At the bottom of the screen a permanent “Tool bar” populated with different button:

Events present in the system the circled number indicate how many “active event” are present.

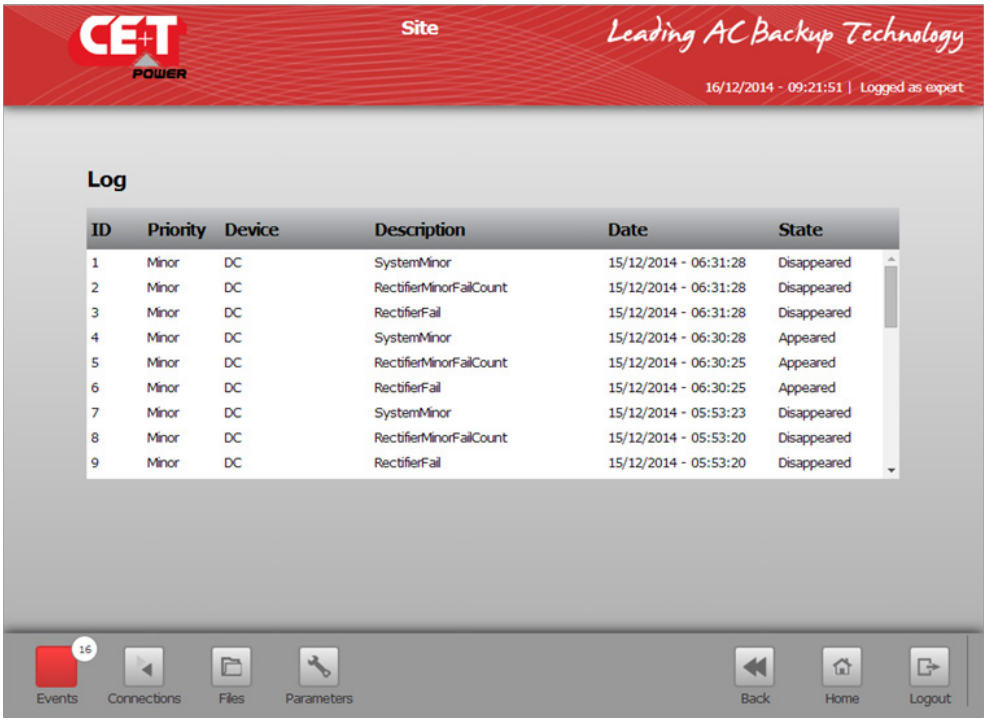
The color indicate the severity of the event. Green is OK, Orange is Minor and Red is Major.

Figure below gives list of active event /alarm Red is Major, Orange is Minor



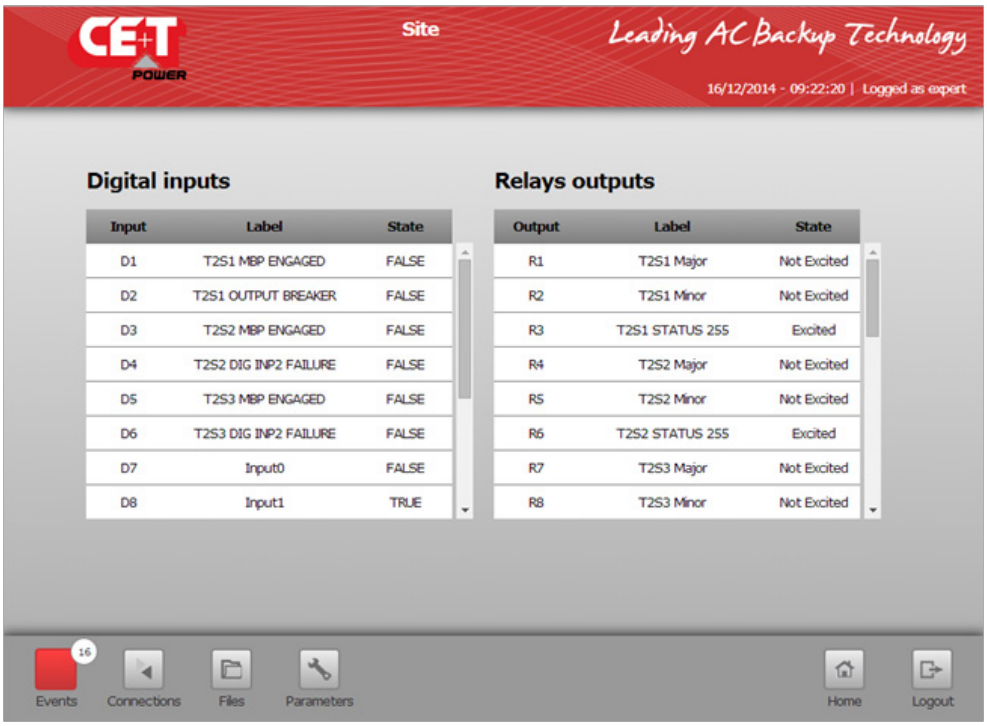
Click the **Log** button  to access the log file which is a record of last 2000 event with date and time the occurred in the system.

Figure below show a screen of the log file.



10.1.2.2 Connections

Click on **Connections** button to access the mapping of the digital inputs and relays output



10.1.2.3 Files

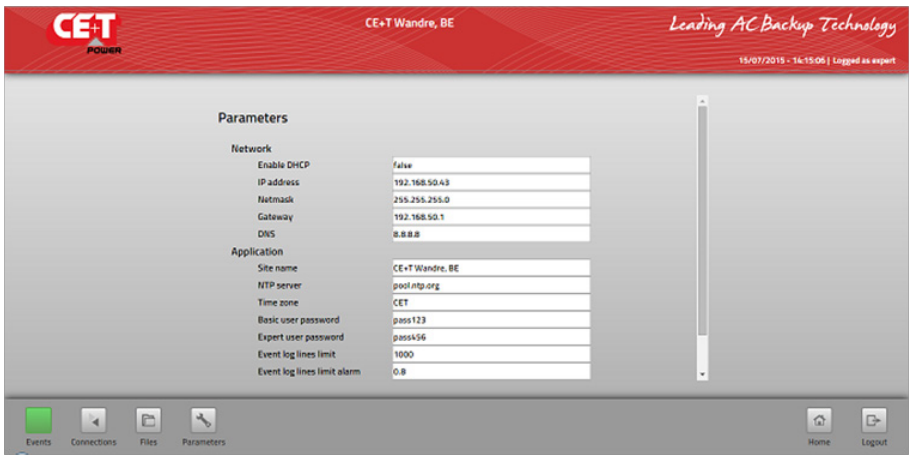
Click on Files to:

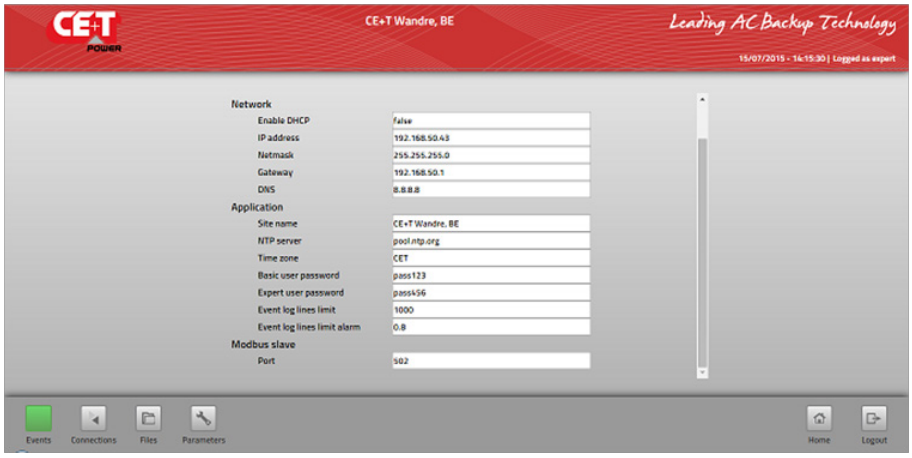
- Export the log file
- Clear the log file (only possible in expert mode)
- Upgrade the software of the CATENA supervisor

10.1.2.4 Parameters

To define and setup all communication parameter listed below

Please do not change setting below unless necessary.





10.2 Switching OFF MIPS System

Perform the following steps to Switch OFF the MIPS System.

Caution: While switching OFF the MIPS System, the power to load will be disconnected.

1. Switch OFF AC Output Breakers.
2. Switch OFF AC Input Breakers.
3. Switch OFF DC Input Breakers.
4. Switch OFF the Upstream and Downstream Breakers.

Caution – Risk of electric shock. Capacitors store hazardous energy. Do not remove the system from the cabinet atleast five minutes after disconnecting all sources of supply.

11.Inserting/removing/replacing modules

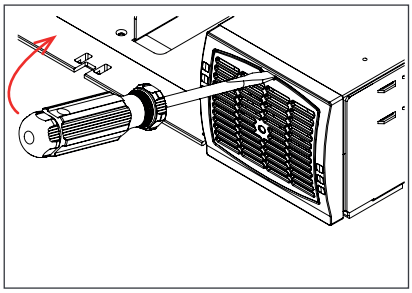
11.1 TSI Inverter

- The TSI inverter module is hot swappable.
- When a new module is inserted in a live system it automatically takes the working set of parameters.
- When a new module is inserted in a live system it is automatically assigned to the next available address.

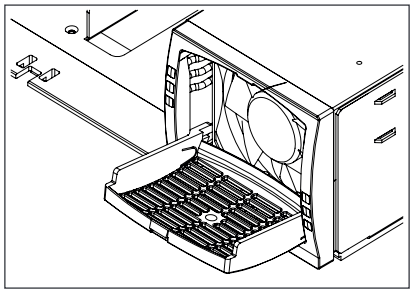
11.1.1 Removal

Notice: When one or several inverter modules is/are removed, live parts become accessible. Replace module with blinds without delay.

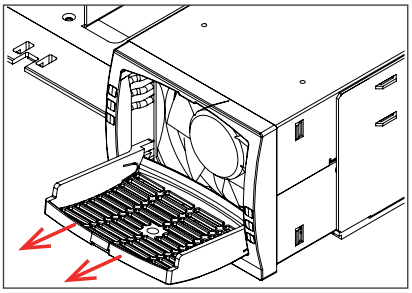
- Inverter module is not switched off when opening the handle. The handle only hooks the module to the shelf.
- Use a screw driver to release the latch of the handle
- Open the handle
- Pull the module out
- Replace with new module or blind unit



A) Use screwdriver to release the latch



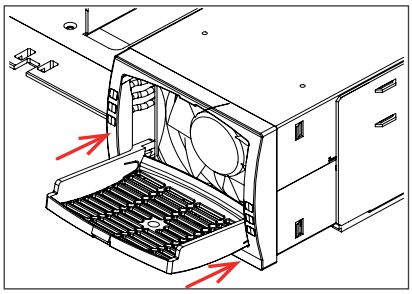
B) open the cover completely



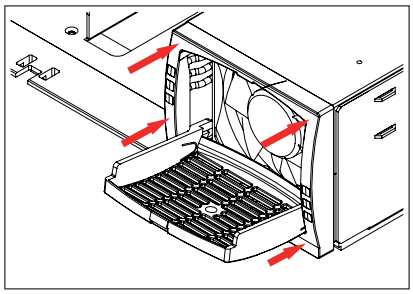
C) Use the cover as a handle to remove the module

11.1.2 Inserting

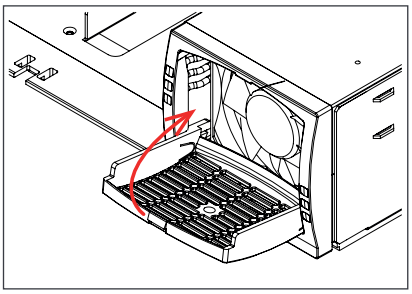
- Check module compatibility (DC Voltage!).
- Use a screw driver to release the latch of the handle.
- Open the handle and Push firmly until the unit is properly connected.
- Close the cover and latch in position.



A) Slide the module in



B) Push firmly till the connection is properly engaged

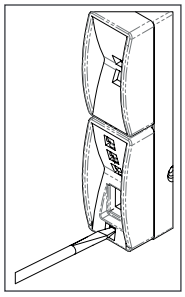


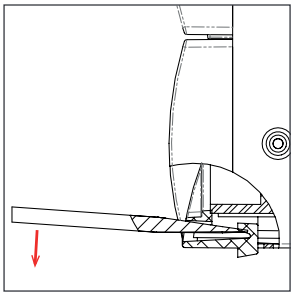
C) Close the cover and latch the module in place if too hard redo step B

11.2 T2S

11.2.1 Removal

- Use a small screw driver to release the latch keeping the T2S in position.
- Pull the T2S out.





11.2.2 Inserting

- Push the T2S firmly in place until the latch snaps in position.

11.3 Fan replacement

The FAN life is approx 45.000hours. The inverter modules have fan runtime meters and fan failure alarm. Fan failure can result from failing fan or driver circuit.

- Let the module rest at least 5 minutes prior to initiating work.
- The inverter front must be removed. Use a blunt tool to depress the latches on the module side fixing the front to the module.
- Remove the fan and unplug the supply cord.
- Replace with new fan and connect supply cord.
- Replace front, make sure that the front latch properly.
- Plug in.
- Check fan for operation.
- Access T2S and reset the fan run time alarm from within the action menu.

Push on side hooks to release front cover | Remove the front cover | Free up the fan assembly | Disconnect the fan | Replace the fan | Make sure the fan is in the right position

12. System Start-up and Shut down

12.1 Final Check

- Make sure that the sub-rack and slidings/cabinet is properly fixed to the cabinet/floor.
- Make sure that the sub-rack/cabinet is connected to Ground.
- Make sure that all DC and AC input breakers are switched OFF.
- Make sure that all cables are according to recommendations and local regulations.
- Make sure that all cables are strained relived.
- Make sure that all breakers are according to recommendation and local regulations.
- Make sure that DC polarity is according to marking.
- Re tighten all electrical terminations.
- Make sure that no inverter/controller positions are left open.
- Cover empty inverter positions with blanks.
- Make sure that the Remote ON/OFF is appropriately wired according to local regulations.
- Make sure that the point of AC supply meets local regulations.

Due to the complexity of the system, startup and commissioning must be performed by CE+T service personnel.

13.Commissioning

The DC breaker is a protection device. Modules are plugged in a system and DC breaker is then engaged. Please make sure the corresponding DC breaker is engaged in the ON position. Failure to observe this rules will result not to have all module operating when running on DC and have module failure when AC input recover from fault condition.

Installation and commissioning must be done and conducted by trained people fully authorized to act on installation.

It is prohibited to perform any isolation test without instruction from manufacturer.

Equipments are not covered by warranty if procedures are not respected.

14.Trouble shooting and defective situations fixing

14.1 Trouble shooting

Inverter module does not power up:	Check AC input present and in range (AC breakers)
	Check DC input present and in range (DC breakers)
	Check that the inverter is properly inserted
	Remove inverter to verify that slot is not damaged, check connectors
	Check that module(s) is (are) in OFF state
	Check for loose terminations
Inverter system does not start:	Check that T2S is present and properly inserted
	Check remote ON/OFF terminal
	Check the configuration and setting
	Check threshold level
Inverter only run on AC or DC:	Check AC input present and in range (AC breakers)
	Check DC input present and in range (DC breakers)
	Check the configuration and setting
	Check threshold level(s)
No output power:	Check output breaker
All OK but I have alarm:	Check configuration file and correct No of modules
	Download/clear log file
No output alarm:	Mind the default time delay (UA: 60s, NUA: 30s)
	Check configuration file
No information on CanDis:	Check that T2S is present and properly inserted
	Check that the RJ45 cable is connected between T2S shelf and CanDis shelf
No value on TCP/IP:	Check that the RJ45 cable is connected between T2S shelf and CanDis shelf
	Wait approx 2 minutes to allow the system to collect serial data.

14.2 Defective modules

Unless input power is down all LEDs on each module should be green (see section 9, page 35). No light, orange light , red or flashing light are abnormal conditions. Collect and record module information. If no fix can be found, replace module.

14.2.1 Replacing modules

Refer to section 11, page 46 to remove and re-insert modules.

14.2.2 Return defective T2S interface

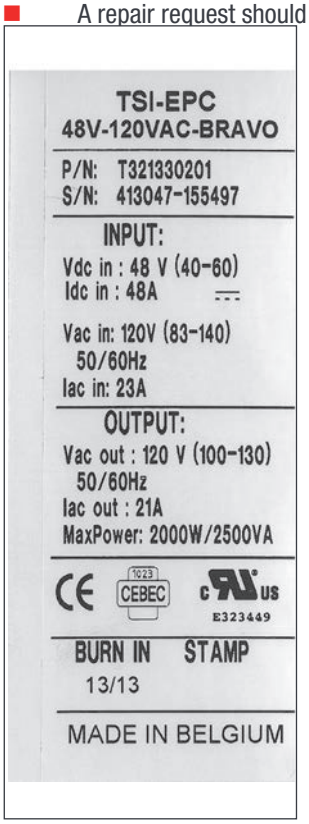
A T2S totally dark (indication area) or that cannot interface with your laptop are evidence of failure. Proceed as per section 14.2.4, page 51.

14.2.3 Return defective shelf

The shelf is passive. Failure is unlikely to happen. In turn defective situation are barely always visible. After depose proceed as per section 14.2.4, page 51.

14.2.4 Return defective modules

- A repair request should follow the regular logistics chain:
  End-user => Distributor => CE+T Power.



- Before returning a defective product, a RMA number must be requested by email at tech.support@cetamerica.com.
- The RMA number should be mentioned on all shipping documents related to the repair.
- Be aware that products shipped back to CE+T Power without being registered first will not be treated with high priority!
- Information on failure occurrence as well as module status given through Menu 2-1 shall be attached to defective unit return package or recorded in RMA.

15.Service

For Service

- Check Service Level Agreement (SLA) of your vendor. Most of the time they provide assistance on call with integrated service. If such SLA is in place, you must call their assistance first.
- If your vendor doesn't provide such assistance (*) you may call CE+T directly. Toll free Number **1(855) 669 - 4627**(**)

Service is available from 8:00 A.M. to 10:00 P.M. EST, Monday through Friday, except closing periods for holidays or inclement weather.

Major Incidents and Emergency conditions can be invoked for immediate handling of same number or by dropping a mail on tech.support@cetamerica.com (***)

(*) CE+T will redirect your call to your vendor if he has such SLA in place.

(**) Valid in USA and Canada only.

(***) Messages that are not Major Incident or Emergency will be served at the next scheduled working day.

16.Maintenance Task

As maintenance will be performed on live system, all tasks should be performed only by trained personnel with sufficient acknowledge on TSI product.

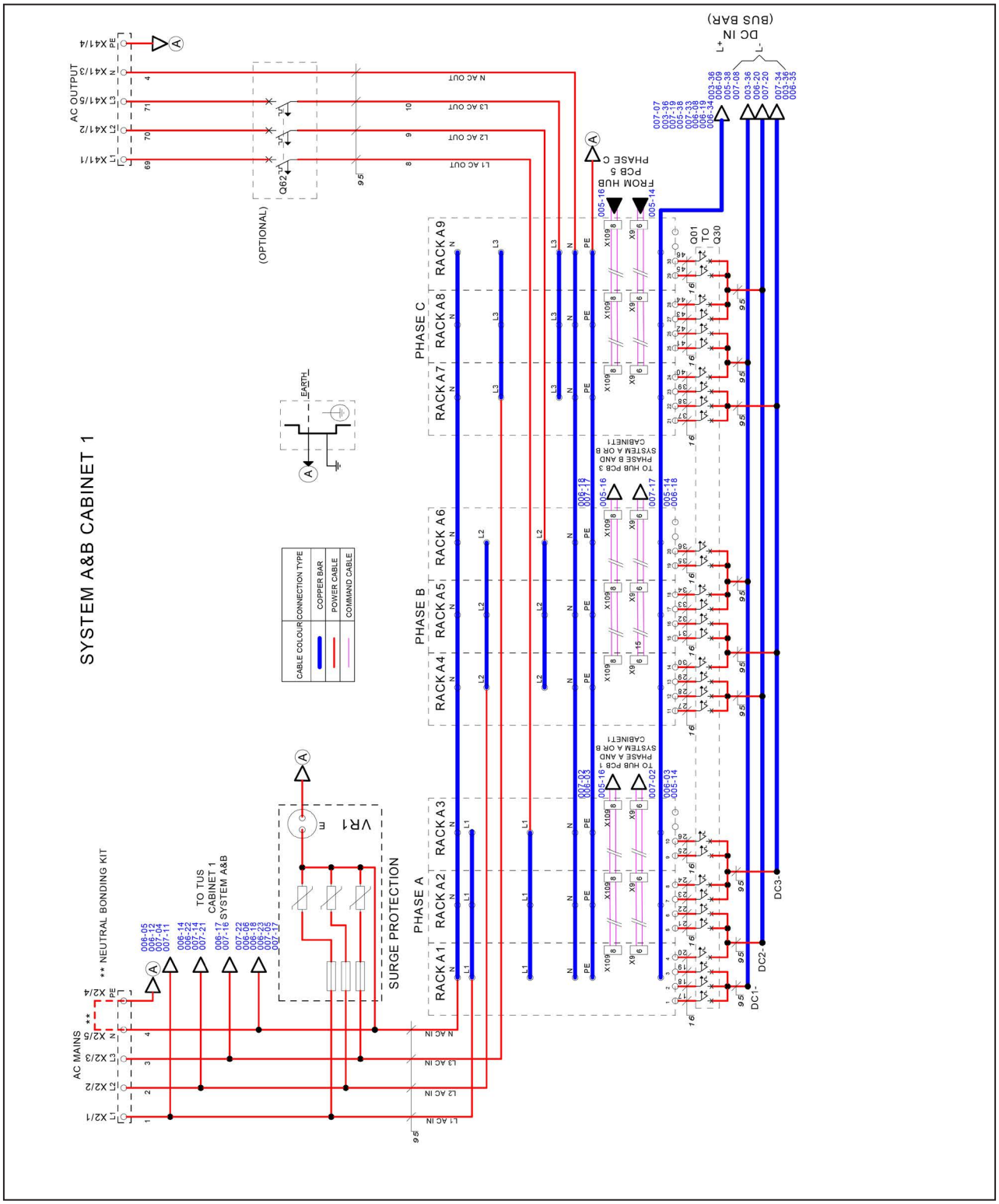
Tasks :

- Identify the site, customer, rack number, product type.
- Download and save configuration file for back up.
- Check configuration file to be in accordance with operational site conditions.
- Read and save log file for back up.
- Check and analyze log file, and if alarm are present.
- Replace dust filter if present. Filter is mandatory in dusty environment.
- Check module temperature and log value. If internal temperature is higher then previous year, it should be interesting analyze if it is due an increasing load or dust effect. It is common to have a delta of 15°C by 30% of load between the ambient and the internal temperature. If temperature increase due internal dust built up clean the TSI with vacuum cleaner and/or soft compressed air.
- Clean system (vacuum cleaner or dry cloth)
- Control the inverter mapping (AC Group, DC Group, Address)
- Check load level and record the rate value (print in word document the 4 screen modules information for the 32 modules, the 3 screen for the phases value and the 2 screens for the group AC and DC value)
- Change the configuration file for AC and DC mix mode to check that all TSI work on both power supply
- Check alarm operation (e.g., redundancy lost, mains failure, DC failure) on dry contact and through SNMP system or web interface.
- Switch OFF AC IN and check alarms.
- Check temperature terminal and temperature wiring. If possible use an infrared camera.
- Read and record value as wave form, power factor, Crest factor, THD I from power analyzer.
- Take system picture
- Keep track of report and provide end user with a copy.
- Perform a MBP procedure. This task is not really recommended*, but could be demanded by site manager.

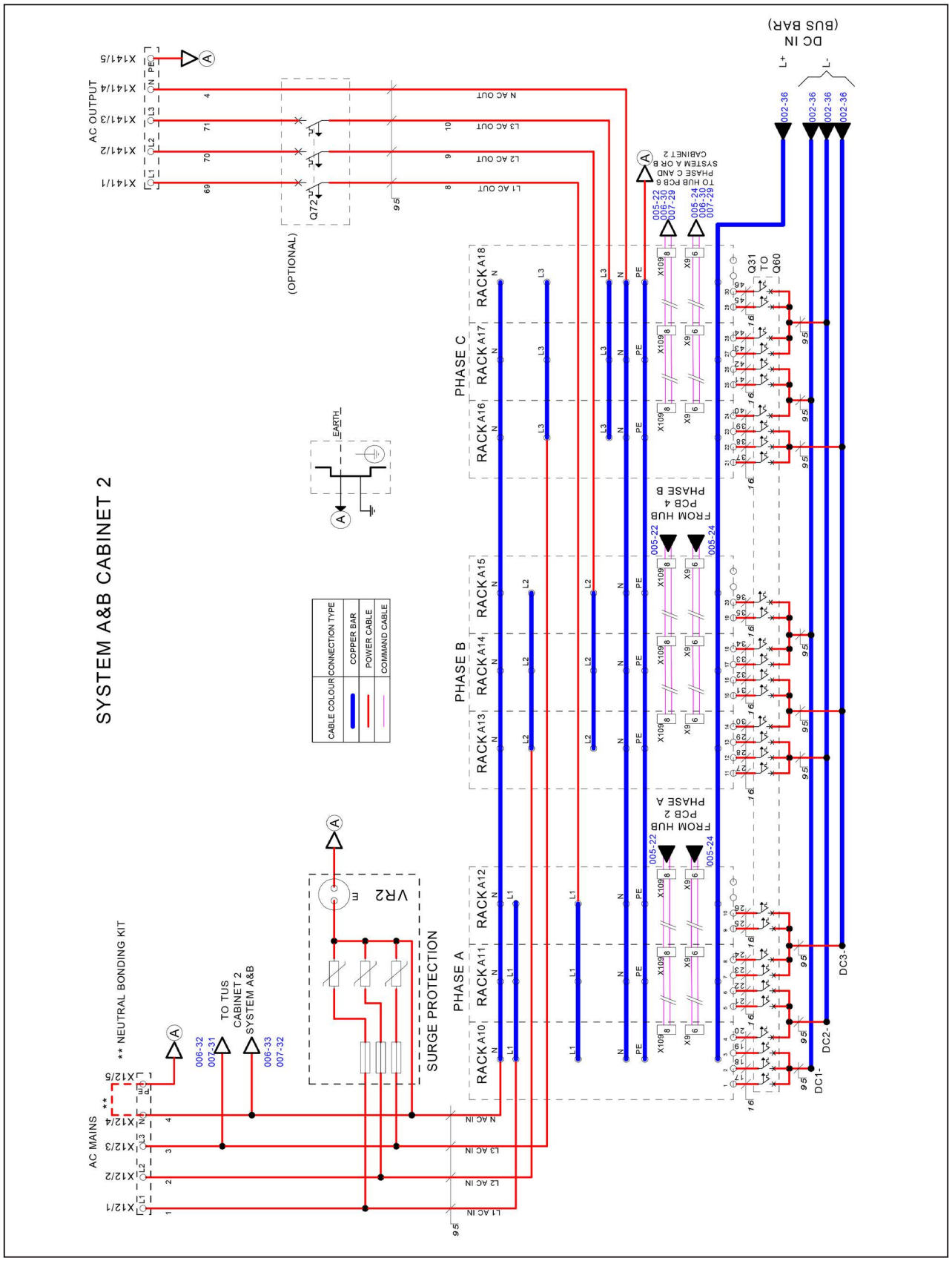
* It is not recommended because when you perform a By-pass procedure, generally there is no back up on AC input line, and the load shutdown if mains disappear.

17. Appendix

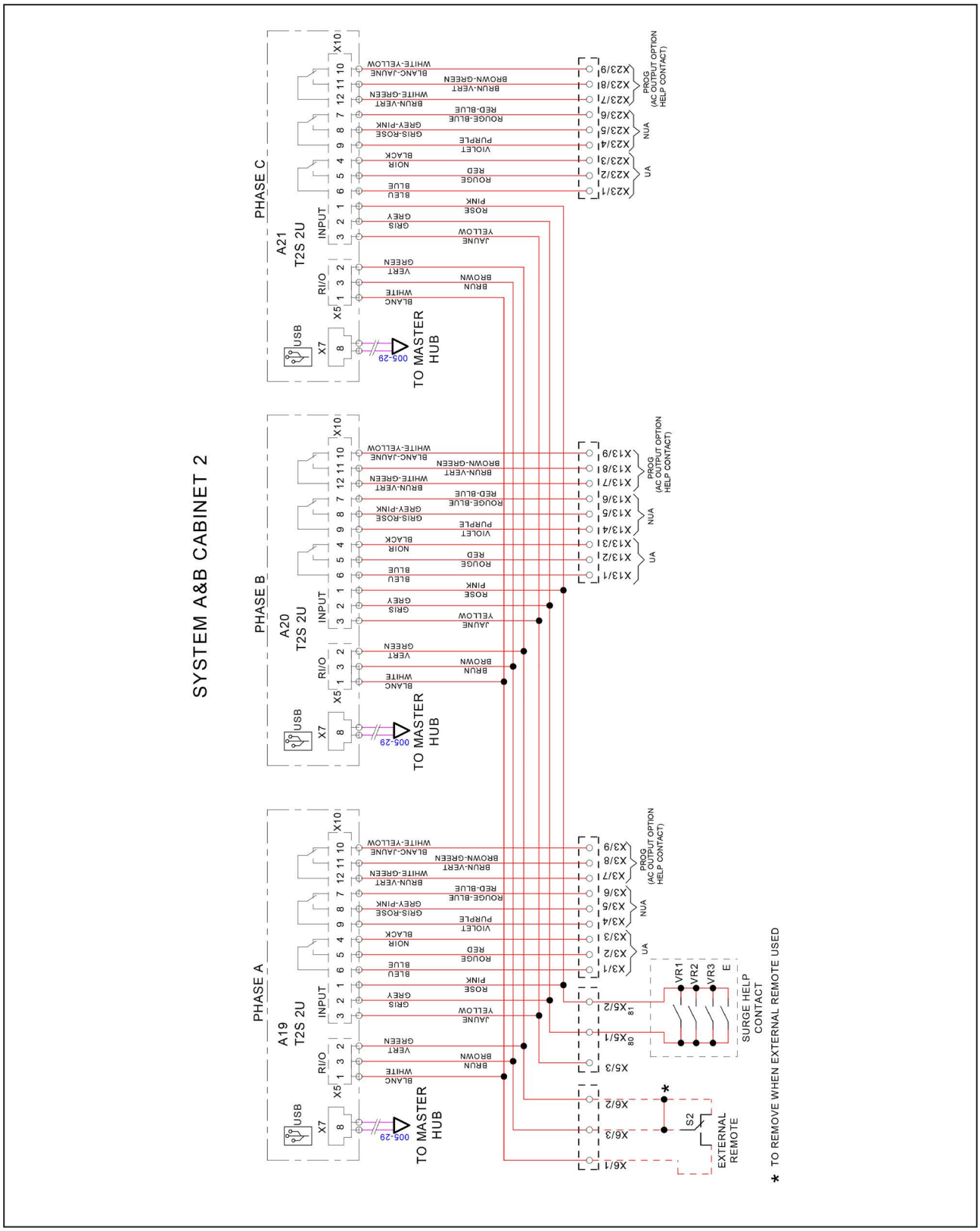
17.1 Single Line Diagram 1



17.2 Single Line Diagram 2



17.3 TUS Alarm



17.4 TUS Connections