Leading Conversion Technology for Power Resilience

TSI MIPS - 120 VAC

MODULAR INVERTER POWER SYSTEM

User Manual V7.5

BEYOND THE INVERTER

THE NEW GENERATION OF POWER CONVERTERS

- DUAL INPUT INVERTER
  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

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Leading Conversion Technology for Power Resilience

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Release Note:

Version	Release date (DD/MM/YYYY)	Modified page number	Modifications
7.0	19/02/2014	-	First release of the Manual
7.1	30/04/2014	16	System description illustration (AC in & AC out representation changed)
		23	Cabinet inlets illustration (AC in & AC out location changed)
		24	Earth grounding and Neutral grounding illustration
		36	MBP section updated with content
7.2	23/03/2015	6, 7, 11, 22, 32, 34, 36, and 39	Added additional information's and updated the illustrations
7.3	20/04/2016	-	Amendment and correction
7.4	07/03/2018	-	Updated images and information
7.5	23/10/2020	-	New layout

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 performance and related maintenance costs.

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

- Maximizes the operator's applications uptime;
- Operates with lowest OPEX;
- Provides the best protection from power 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 days a year.

2. Abbreviations

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

3. Warranty and Safety Conditions*

WARNING:

The electronics in the power supply system are designed for an indoor, clean environment.

When installed in a dusty and/or corrosive environment, indoors, it is important to:

- Install an appropriate filter on the enclosure door, or on the room's air conditioning system. Installation of filters may result in derating of module.
- Keep the enclosure door closed during operation.
- Replace the filters on a regular basis.

Important Safety Instructions, Save These Instructions.

3.1 Disclaimer

- The manufacturer declines all responsibilities if equipment is not installed, used or operated according to the instructions herein by skilled technicians according to local regulations.
- Warranty does not apply if the product is not installed, used or handled according to the instructions in the manual. Manufacturer may waive warranty if the system is not installed and commissioned by factory trained technician.
- This equipment is shipped with a SHOCKWATCH monitor. If the SHOCKWATCH shows that the equipment was exposed to excessive force the warranty will be void.

3.2 Technical care

- This electric equipment can only be repaired or maintained by a "qualified employee" with adequate training. Even personnel who are in charge of simple repairs or maintenance are required to have knowledge or experience related to 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 are trained to recognize and avoid any dangers that might be present when working on or near exposed electrical parts.
- Qualified employees know how to lock out and tag out machines so the machines will not accidentally be turned on and injure employees working on them.
- Qualified employees are trained in OSHA and NFPA safety related work practices, and NFPA 70E Arc Flash Protection and PPE requirements.
- All operators are to be trained to perform the emergency shut-down procedure.
- Never wear metallic objects such as rings, watches, or bracelets during installation, service and maintenance of the product.
- Maximum operating ambient temperature is 40°C (104°F).
- Insulated tools must be used at all times when working with live systems.

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

- When handling the system/units pay attention to sharp edges.
- This product is suitable for use in a computer room.

3.3 Installation

- This product is intended to be installed only in restricted access areas as defined by UL60950 and in accordance with the National Electric Code, ANSI/NFPA 70, or equivalent agencies.
- The 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.
- 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 de-energized when necessary.
- REG systems and EPC systems that have no AC input wired and connected can be seen as independent power sources. To comply with local and international safety standards N (input) and PE shall be bonded. The bonded connection between N (input) and PE must be removed once the AC input is connected. Refer 8.5.4, page 29.
- AC and DC circuits shall be terminated with no voltage / power applied (de-energized).
- The safety standard IEC/EN62040-1-1 requires that, in the event of an output short circuit, the inverter must disconnect in 5 seconds maximum. The parameter can be adjusted on T2S ETH or equivalent device; however, if the parameter is set at a value > 5 seconds, an external protection must be provided so that the short circuit protection operates within 5 seconds. Default setting is 60 seconds.
- The system is designed for installation within an IP20 environment. When installed in a dusty or humid environment, appropriate measures (air filtering …) must be taken. Installation of filters may result in de-rating of module.
- Environment Conditions:
  - Storage Conditions: -40 to 70°C
  - Relative Humidity: 95%, non-condensing
  - Altitude above sea without de-rating: Less than 1500 m
Greater than 1500 m – de-rating at 0.8% per 100 m

3.3.1 Handling

- The cabinet shall not be lifted using lifting eyes.
- Remove weight from the cabinet by removing the inverter modules. Mark inverter modules clearly with shelf and position for correct rebuild. This is especially important in dual or three phase configurations.
- Empty module positions must not be left open. Replace with blank module or cover.
- This equipment is shipped with a SHOCKWATCH monitor. SHOCKWATCH monitor should be inspected upon receipt of shipment. If the SHOCKWATCH shows that the equipment was exposed to excessive force the warranty will be void.

3.3.2 Surge and Transients Protection

The mains (AC) supply of the modular inverter system shall be equipped with Lightning surge suppression and Transient voltage surge suppression suitable for the application. Follow manufacturer's recommendation for installation. Selecting a device with an alarm relay for function failure is advised.

All sites are considered to have a working lightning surge suppression device in service and installed close enough to ensure effective protection in accordance with best industry practice.

- Indoor sites Min Class II.
- Outdoor sites Min Class I + Class II or combined Class I+II. The modular inverter system/rack can reach hazardous leakage currents. Grounding must be carried out prior to energizing the system. Grounding shall be made according to local regulations.

3.3.3 Other

- Insulation test (Hi-Pot) must not be performed without instructions from the manufacturer. Irreparable damage may occur.

3.4 Maintenance

- The modular inverter system/rack can reach hazardous leakage currents. Grounding must be carried out prior to energizing the system. Grounding shall be made according to local regulations.
- Prior to any work conducted on a system/unit make sure that AC input voltage and DC input voltage are disconnected.
- Inverter modules and shelves contain capacitors for filtering and energy storage. Prior to accessing the system/modules after power down, wait at least 5 minutes to allow capacitors to discharge.
- Some components and terminals carry high voltage during operation. Contact may result in fatal injury.

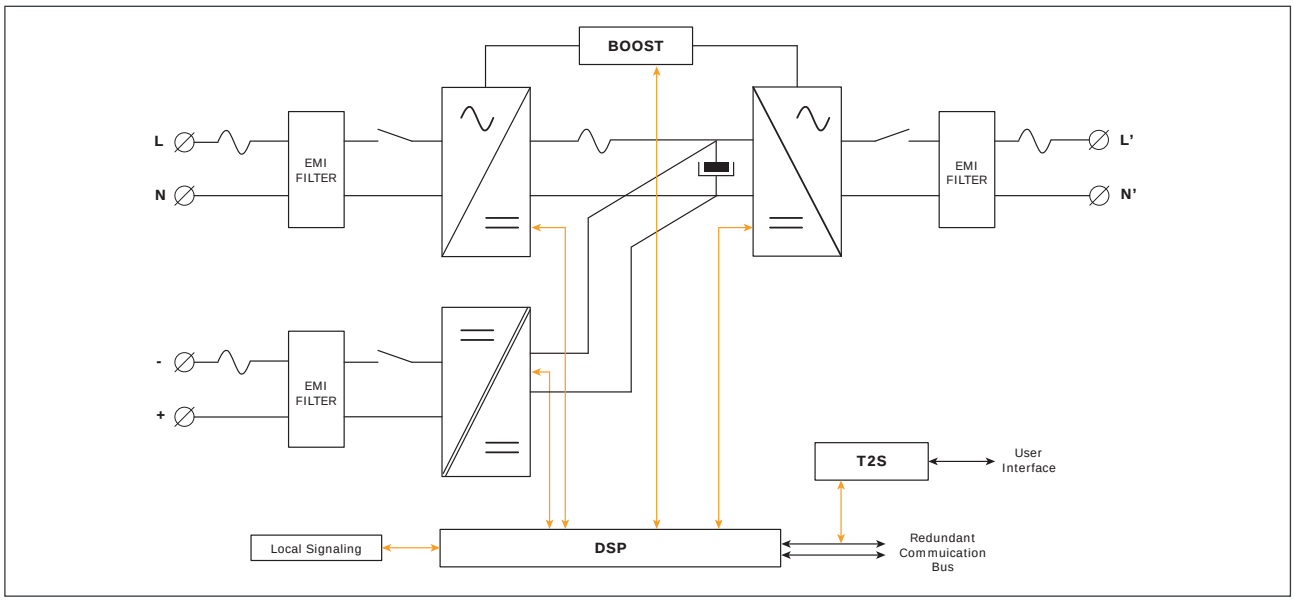
3.5 Replacement and Dismantling

- 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 of the materials which are potentially harmful to the environment, in accordance with the local regulations in force in the country of installation.
- If the equipment is dismantled, to dispose of its component products, you must comply with the local regulations in force in the country of destination and in any case avoid causing any kind of pollution.

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 AC output is converted from the AC main source and/or the DC source.

The block diagram 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. The output sine wave is constant and disturbance free regardless of the active source due to internal energy buffering,

The function of the BOOST is for circuit protection in the event of a circuit fault condition on the output of the system. When a circuit fault is detected, the system will multiply the output current by approximately 10x to activate the load circuit protection device (breaker/fuse). The duration of the boost is limited to 20 ms. The power for the boost function comes primarily from the AC input through a diode bridge. This has been designed in such a way so that it will not trip the input AC/DC protection devices. This functionality is intended for circuit and equipment protection only. It is not for personnel safety.

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 TRS functionality is included in every inverter module. Running them in parallel provides a modular system with no single point of failure, 100% pure sinusoidal output, high system efficiency, and 0 ms source transfer time.

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.

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

- In EPC Mode, the AC Main source is the primary source while the DC source is secondary.
- The TSI is designed to operate on the AC main source on a permanent basis and to deliver output AC voltage with low THD.
- There is no physical difference on the output sine wave whether the source is AC (or) DC. If the AC main source is out of tolerance or drops below acceptable level, the converter seamlessly switches to DC and the converter operates in “Back-up Mode” (Transfer time is 0 ms).
- As soon as the AC main source returns to its normal operating 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 sine wave output.
- To set EPC Mode in T2S ETH, go to Parameters > Power > General > Source power ratio DC vs AC (%) and enter the value **“0”**.

4.2 On-line Mode (REG Mode)

- In On-line Mode, the DC source is the primary source of supply while the AC main source 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 AC power to the load.
- In case of short circuit at the load side, the boost is automatically energized for a specific duration to trip downstream protective devices.
- To set On-line Mode in T2S ETH, go to Parameters > Power > General > Source power ratio DC vs AC (%) and enter the value **“100”**.

4.3 Safe Mode

- Safe Mode uses the DC source as primary source of supply while the AC main source is in secondary standby.
- The AC main source is normally disconnected through an internal relay and is only connected when down stream fault clearance is required (boost) or if the DC source is unavailable.
- The transfer time between DC and AC results in a typical transfer time of 10 ms.
- Safe Mode is used in extremely harsh environments such as railways. Under harsh conditions it provides extra isolation against disturbances carried by the AC main source.
- To set Safe Mode in T2S ETH, go to Parameters > Power > AC In > Mode On Line (Safe) and select **“Enable”** from drop down list.

4.4 Mix Mode & Walk-in Mode

- Walk-in Mode allows the inverter to come back progressively on the AC priority source after an outage. This is to avoid block loading a generator.
  - To set Walk-in Mode in T2S ETH, go to Parameters > Power > Other > Walk In Mode Time (x10 s) and select **“Enable”** from drop down list.
- In Mix Mode, the total output load of the module will be shared by both DC and AC input sources.
  - To set Mix Mode in T2S ETH, go to Parameters > Power > General > Source power ratio DC vs AC (%) and enter the value between **“0-100”**. (0 - only AC, 100 - only DC)

5. Inverter Components

5.1 Inverter module

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

125 VDC / 120 VAC, 60 Hz (50 Hz)

380 VDC / 120 VAC, 60 Hz (50 Hz)

Figure 1. *TSI Bravo Module*

- The TSI Bravo is a 2500 VA / 2000 W converter based on the TSI technology (see section 4, page 11).
- 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). [435 mm (D) x 102 mm (W) x 88 mm (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 10 kVA 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.
- Each bravo shelf is designed for single phase input and 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.

Figure 2. *Bravo shelf with modules*

6. Accessories

6.1 Monitoring - T2S ETH

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 supports IPv4 network and featured with an 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.

6.1.2 System diagnostic and troubleshooting

The T2S ETH is featured with a built-in user interface to allow on-line diagnostic through the laptop.

Installers and maintenance technicians should always carry a proper laptop to access/reconfigure the system on-site.

6.1.3 Section 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 through T2S ETH
- SNMP v2c and v3 through Catena (If T2S ETH is connected to Catena)
- Power: 2 W

Figure 3. *Monitoring - T2S ETH*

Note:

Operation of T2S-ETH is described in a separate manual available upon request.

Some systems may be ordered with a T2S-USB. Manual available upon request.

6.2 CATENA

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

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

Figure 4. *Monitoring - CATENA*

- Measures
  - Power / Power Factor
  - AC IN
  - DC IN
  - AC OUT
  - Module Temperature.
- Alarms
  - Major/Minor
  - System Level
  - Phase Information
  - Module Information
- 7” touchscreen
- Web browser with laptop (ETH)
- Height: 3U
- SNMP v1, v2c, v3, and MODBUS.

Figure 5. *CATENA - Front Details*

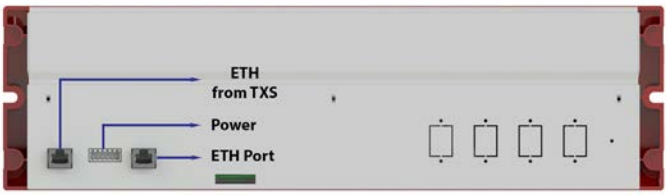


Figure 6. *CATENA - Rear Details*

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

6.3 CANDIS

6.3.1 CANDIS shelf

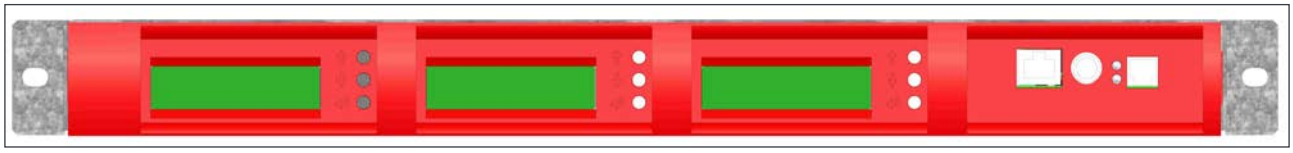


Figure 7. *Monitoring - CANDIS*

The CANDIS shelf has slots for up to 3 display units and 1 TCP/IP agent.

6.3.2 Display

Backlit 2 line dot matrix.

The display shows two values simultaneously.

6.3.3 TCP/IP Agent

The TCP/IP interface board is mounted on the CanDis shelf and is powered from within the system.

- Supports SNMP v1, v2c, v3.

Figure 8. *CS 121 SNMP AGENT*

Remark:

TCP/IP interface also exists as stand alone unit with protective enclosure. Features are identical. It can be mounted independently from the CANDIS shelf, fixed on a support or snapped-on to DIN rail.

6.3.4 CATENA with T2S-ETH

Figure 9. *Monitoring - T2S ETH*

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

6.4 Manual Bypass

Figure 10. *MBP Switch*

The Manual Bypass operates via manually operated switches to create a connection from the AC main input directly to the output AC distribution. Standard Manual Bypass are “Make before Break”. When engaged or disengaged, no disturbance is transmitted to the load.

When MBP is engaged, inverter modules are switched off and can be removed without impacting the load. The DC source is not physically disconnected. After disconnecting the DC source (By opening the DC Breakers), the shelf section is safe for maintenance.

When in **NORMAL mode**, power is supplied to the TSI Inverter modules’ AC input. Clean, stable AC out is supplied to the critical load.

When in **BYPASS mode**, the Mains AC input is passed directly to the critical load. The critical load is subject to any AC mains disturbances. Prior to engaging BYPASS mode, appropriate precautions should be taken to ensure continuity of power to the critical load.

The INTERIM position is to allow the modules to restart when returning from BYPASS. When transferring the load to BYPASS, the operator does not need to stop in the INTERIM position. When returning from BYPASS, the switch shall be left in the INTERIM position until the top-left LED on each module has turned green.

See section “11. Manual Bypass Operation”, page 50 for more information.

NOTE:

When the system is in Bypass the load is subjected to AC main disturbances.

An internal MBP must be present if connection is made via a non-CE+T external MBP.

6.4.1 EMBS

“See EMBS User Manual” for more information.

6.5 Surge Arresters

The mains (AC) supply of the modular inverter system shall be fitted with suitable Lightning surge suppression and Transient voltage surge suppression. Manufacturers installation guidelines shall be followed. It is advised to select a device with an alarm relay contact for notification.

All 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.

Surges from induced lightning and power switching operations are smaller but are more numerous and can result in equipment misoperation, lockup or damage.

Inverter damage caused by improper surge protection are not covered by CE+T product warranty.

7. MIPS Design and Description

7.1 System Design

MIPS is a cabinetized modular inverter specifically designed for clean and temperature controlled environments.

- Telecom grade design.
- Based on TSI BRAVO – 120 VAC Inverter Module.
- Fully modular.
- Supports redundant configurations.
- Supports EPC mode.
- Cabinet NEMA 1 (IP 20)
- The cabinet requires air flow out the rear of the modules and is not designed to be installed back against a wall. Maintain 36” space of air flow and maintenance access per NEC.

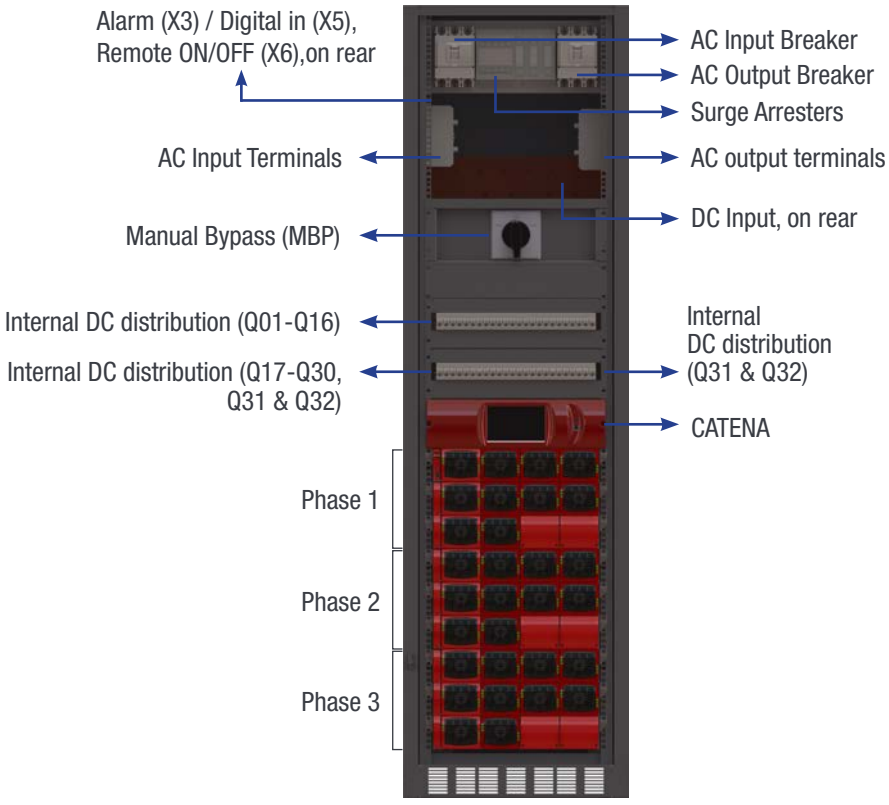
Picture is given for illustration only. Some accessories shown may be optional.

Figure 11. *MIPS 75 KVA Inverter System*

7.2 System Description

MIPS comes fully equipped with

- Individual DC protection for modules.
- MBP included by default (can be removed on request).
- EMBS available upon request.
- CATENA or CANDIS shelf and display (one display per phase configured).
- TCP-IP interface (included by default).
- T2S interface.
- AC input breaker (bulk)-supplementary type (can be removed on request).
- AC output breaker (bulk)-branch circuit protection (can be removed or replaced by supplementary type on request).



When connecting AC input and output cables, you must remove the washer from the terminal block prior to landing the cable lug.

Reinstall the washer between the cable lug and the nut.

Figure 12. *MIPS 75 kVA System - General Arrangement*

Options

- Surge Arrestors (Installed by default)
- Door
- DC Disconnect
- External Manual Bypass Switch (EMBS)

7.3 MIPS Single phase configuration - 120 VAC

A single phase system is 120 VAC from L to N. Input and output are the same, consisting of 2 wires + (PE) Ground.

System Designation	Max Power (kVA)	Max power (KW)	Number of Shelves	Max number of Modules
MIPS-1-20-xx-08	20	16	2	8
MIPS-1-25-xx-10	25*	20*	3	10 (12**)

* : This configuration doesn't use all available slots. ** : Up to 2 modules can be allocated to redundancy.

System Designation	Bulk DC*** input			2 DC*** input		
	Fuse or Breaker	Cable Min	Cable Max	Fuse or Breaker	Cable Min (per feed)	Cable Max (per feed)
MIPS-1-20-xx-08 48 Vdc	500 A	2 x 300 MCM or 3 x 3/0 AWG	9 x 500 MCM	2 x 250 A	1x 300 MCM or 2 x 1/0 AWG	3 x 500 MCM
MIPS-1-20-xx-08 125 Vdc	200 A†	3/0 AWG	300 MCM	2 x 100 A†	#3 AWG	300 MCM
MIPS-1-20-xx-08 380 Vdc	75 A†	#4 AWG	300 MCM	2 x 40 A†	#8 AWG	300 MCM
MIPS-1-25-xx-10 48 Vdc	600 A	2 x 500 MCM or 3 x 4/0 AWG	9 x 500 MCM	2 x 300 A	1 x 500 MCM or 2 x 2/0 AWG	3 x 500 MCM
MIPS-1-25-xx-10 125 Vdc	250 A†	250 MCM or 3 x #4 AWG	300 MCM	2 x 125 A†	#1 AWG	300 MCM
MIPS-1-25-xx-10 380 Vdc	100 A†	#3 AWG or 2 x #8 AWG	300 MCM	2 x 50 A†	#8 AWG	300 MCM

† Use double-pole breakers for both positive (+) and negative (-) when DC voltage is greater than 75 Vdc.

*** : Refer Section 8.5.5, page 30.

System Designation	AC input & AC output				
	Branch Protection		Supplementary Protection		Cable Max Based on Terminal Size
	Breaker	Cable Min	Breaker	Cable Min	
MIPS-1-20-xx-08	225 A	250 kcmil	200 A	4/0 AWG	300 kcmil
MIPS-1-25-xx-10	250 A	300 kcmil	225 A	250 kcmil	300 kcmil

Note:

By default input and output breakers are installed in the cabinet with above mentioned rating.

Input breaker is "Supplementary", an additional branch protection, supplied by customer, should be installed in main switch gear. Output breaker is "Branch" and can be directly connected to downstream distribution panel.

7.4 MIPS Single Phase Configuration - 240 VAC

A split phase system is 120 VAC from L to N and 240 VAC from L1 to L2 and L1 and L2 are phase shifted by 180 degrees. (For 208 VAC systems, the phase shift can be set to 120 degrees). Input and output are made upon 3 wires + Ground, cabling and phase shift must match.

System Designation	Max Power (kVA)	Max power (KW)	Number of Shelves	Max number of Modules
MIPS-2-20-xx-08	20	16	2	8**
MIPS-2-40-xx-16	40	32	4	16**
MIPS-2-50-xx-20	50***	40***	6	20**/*** (24****)

* : Also known as “Single Phase 240VAC” (including UL). Number of wires is always meaningful to distinguish from other single phase.

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

*** : This configuration doesn’t have all slots in use.

**** :Up to 2 x 2 modules can be allocated to redundancy.

System Designation	Bulk DC*** input			2 DC*** input		
	Fuse or Breaker	Cable Min	Cable Max	Fuse or Breaker	Cable Min (per feed)	Cable Max (per feed)
MIPS-2-20-xx-08 48 Vdc	500 A	2 x 300 MCM or 3 x 3/0 AWG	9 x 500 MCM	2 x 250 A	1 x 300 MCM or 2 x 1/0 AWG	3 x 500 MCM
MIPS-2-20-xx-08 125 Vdc	200 A†	3/0 AWG	300 MCM	2 x 100 A†	#3 AWG	300 MCM
MIPS-2-20-xx-08 380 Vdc	75 A†	#4 AWG	300 MCM	2 x 40 A†	#8 AWG	300 MCM
MIPS-2-40-xx-16 48 Vdc	1000 A	3 x 500 MCM or 4 x 300 MCM	9 x 500 MCM	2 x 500 A	2 x 300 MCM or 3 x 3/0 AWG	3 x 500 MCM
MIPS-2-40-xx-16 125 Vdc	400 A†	600 MCM or 3 x 1/0 AWG	2 x 500 MCM	2 x 200 A†	3/0 AWG	2 x 500 MCM
MIPS-2-40-xx-16 380 Vdc	150 A†	1/0 AWG	300 MCM	2 x 75 A†	#4 AWG	300 MCM
MIPS-2-50-xx-20 48 Vdc	1200 A	4 x 500 MCM or 6 x 4/0 AWG	9 x 500 MCM	2 x 600 A	2 x 500 MCM or 3 x 4/0 AWG	3 x 500 MCM
MIPS-2-50-xx-20 125 Vdc	500 A†	2 x 250 MCM	2 x 500 MCM	2 x 250 A†	250 MCM	2 x 500 MCM
MIPS-2-50-xx-20 380 Vdc	200 A†	3/0 AWG	2 x 500 MCM	2 x 100 A†	#3 AWG	2 x 500 MCM

† Use double-pole breakers for both positive (+) and negative (-) when DC voltage is greater than 75 Vdc.

***** : Refer Section 8.5.5, page 30

System Designation	AC input & AC output				
	Branch Protection		Supplementary Protection		Cable Max Based on Terminal Size
	Breaker	Cable Min	Breaker	Cable Min	
MIPS-2-20-xx-08	110 A	1 AWG	100 A	2 AWG	1 AWG
MIPS-2-40-xx-16	225 A	250 kcmil	200 A	4/0 AWG	300 kcmil
MIPS-2-50-xx-20	250 A	300 kcmil	225 A	250 kcmil	300 kcmil

Note:

By default input and output breakers are installed in the cabinet with above mentioned rating.
Input breaker is "Supplementary", an additional branch protection, supplied by customer, should be installed in main switch gear. Output breaker is "Branch" and can be directly connected to downstream distribution panel.

Neutral must be landed on both input and output terminals.

7.5 MIPS Three Phase Configuration - 208 VAC

Three phase systems are 120 VAC L to N and 208 VAC from L1 to L2, L1 to L3, L2 to L3.
Input and output are made upon 4 wires + (PE) Ground, "Y" or "Star" connection.
All phases are phase shifted by 120 degrees one to the other.

System Designation	Max Power (kVA)	Max power (KW)	Number of Shelves	Max number of Modules
MIPS-3-30-xx-12	30	24	3	12 *
MIPS-3-60-xx-24	60	48	6	24 *
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			2 DC*** input		
	Fuse or Breaker	Cable Min	Cable Max	Fuse or Breaker	Cable Min (per feed)	Cable Max (per feed)
MIPS-3-30-xx-12 48 Vdc	700 A	3 x 300 MCM or 4 x 3/0 AWG	9 x 500 MCM	3 x 250 A	1 x 300 MCM or 2 x 1/0 AWG	2 x 500 MCM
MIPS-3-30-xx-12 125 Vdc	300 A†	350 MCM	3 x 500 MCM	3 x 100 A†	#3 AWG	2 x 500 MCM
MIPS-3-30-xx-12 380 Vdc	100 A†	#3 AWG	3 x 500 MCM	3 x 40 A†	#8 AWG	2 x 500 MCM
MIPS-3-60-xx-24 48 Vdc	1600 A	5 x 500 MCM or 7 x 300 MCM	9 x 500 MCM	3 x 500 A	2 x 250 MCM	2 x 500 MCM
MIPS-3-60-xx-24 125 Vdc	600 A†	2 x 350 MCM or 4 x 1/0 AWG	3 x 500 MCM	3 x 200 A†	3/0 AWG	2 x 500 MCM
MIPS-3-60-xx-24 380 Vdc	200 A†	3/0 AWG	3 x 500 MCM	3 x 75 A†	#4 AWG	2 x 500 MCM

System Designation	Bulk DC*** input			2 DC*** input		
	Fuse or Breaker	Cable Min	Cable Max	Fuse or Breaker	Cable Min (per feed)	Cable Max (per feed)
MIPS-3-75-xx-30 48 Vdc	2000 A	6 x 500 MCM or 8 x 300 MCM	9 x 500 MCM	3 x 600 A	2 x 500 MCM	2 x 500 MCM
MIPS-3-75-xx-30 125 Vdc	800 A†	3 x 300 MCM or 6 x 1/0 AWG	3 x 500 MCM	3 x 250 A†	1 x 300 MCM or 2 x 1/0 AWG	2 x 500 MCM
MIPS-3-75-xx-30 380 Vdc	250 A†	250 MCM	3 x 500 MCM	3 x 100 A†	#3 AWG	2 x 500 MCM

† Use double-pole breakers for both positive (+) and negative (-) when DC voltage is greater than 75 Vdc.

*** : Refer Section 8.5.5, page 30

System Designation	AC input & AC output				
	Branch Protection		Supplementary Protection		Cable Max Based on Terminal Size
	Breaker	Cable Min	Breaker	Cable Min	
MIPS-3-30-xx-12	110 A	1 AWG	100 A	2 AWG	1 AWG
MIPS-3-60-xx-24	225 A	250kcmil	200 A	4/0 AWG	300kcmil
MIPS-3-75-xx-30	250 A	300kcmil	225 A	250kcmil	300kcmil

Note:

Sometimes three phase systems with 2 legs instead of three can be requested. They can be called split phase or dual phase. Effectively they are based upon same hardware than split phase (see section 7.4, page 21) with 3 wires (L1-L2-N) . Since phases are shifted by 120 degree the L1 - L2 output voltage is 208VAC.

Three phase configuration can be connected to 240VAC L-L(138VAC L-N) sources. Refer to supplier for specific recommendations and approval. By default input and output breakers are installed in the cabinet with above mentioned rating.

Input breaker is “Supplementary”, an additional branch protection, supplied by customer, should be installed in main switch gear. Output breaker is “Branch” and can be directly connected to downstream distribution panel.

Neutral must be landed on both input and output terminals.

7.6 MIPS Module Based Current Ratings

# Modules	Rated AC Input / Output Current per Phase (Amps)	Rated DC (48V) Input Current per Polarity (Amps)	Rated DC (125V) Input Current per Polarity (Amps)	Rated DC (380V) Input Current per Polarity (Amps)
120 Vac – Single Phase – 2 Wires + PE (L-N+G)				
1	20.83	48.00	18.43	6.06
2	41.66	96.00	36.86	12.13
3	62.49	144.00	55.30	18.19
4	83.32	192.00	73.73	24.25
5	104.15	240.00	92.16	30.32
6	124.98	288.00	110.59	36.38
7	145.81	336.00	129.02	42.44
8	166.64	384.00	147.46	48.51
9	187.47	432.00	165.89	54.57
10	208.30	480.00	184.32	60.63
120/240 Vac – Single Phase – 3 Wires + PE (L-L-N+G)				
2	20.83	96.00	36.86	12.13
4	41.66	192.00	73.73	24.25
6	62.49	288.00	110.59	36.38
8	83.32	384.00	147.46	48.51
10	104.15	480.00	184.32	60.63
12	124.98	576.00	221.18	72.76
14	145.81	672.00	258.05	84.88
16	166.64	768.00	294.91	97.01
18	187.47	864.00	331.78	109.14
20	208.30	960.00	368.64	121.26
120/208 Vac – Three Phase – 4 Wires + PE (L-L-L-N+G)				
3	20.83	144.00	55.30	18.19
6	41.66	288.00	110.59	36.38
9	62.49	432.00	165.89	54.57
12	83.32	576.00	221.18	72.76
15	104.15	720.00	276.48	90.95
18	124.98	864.00	331.78	109.14
21	145.81	1008.00	387.07	127.33
24	166.64	1152.00	442.37	145.52
27	187.47	1296.00	497.66	163.71
30	208.30	1440.00	552.96	181.89
Upstream / downstream protections and field wiring should be based on the maximum number of modules for the system.				

8. System Installation

8.1 Site Preparation

- Input and output protection.

When installing MIPS inverter systems, UL489 listed AC upstream (input) and downstream (output) circuit breakers are required. Refer Section 7.3, page 20, 7.4, page 21, and 7.5, page 22 for breaker sizes.

At MIPS 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 MIPS Output

Whenever the MIPS is supplied with supplementary output breaker or without any protective device at all (see option listed in 7.2, page 19), appropriate protection should be provided on site according to following table:

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

- Refer to Section 7, page 18 for sizing over current protection and cables. All cables should be copper wire and must be rated for min 90°C (194°F).
- All cables must be C-UL-US or CSA Listed cables.
- All cables lugs must be C-UL-US or CSA listed. They must be sized according to the rated current of the inverter system and to the customer terminal connection.
- Wire all positions for future expansion.
- All AC input, AC output, DC input, and signal cables shall be kept separated.
- Cable crossings shall be arranged at 90 degree angles.
- Empty inverter positions shall be covered with blank module covers
- System cooling – The System should not be installed with the rear of the unit at, near, or up against a wall
  - **A minimum of 12 inch clearance is required on the rear of the cabinet**.
  - **A minimum of 6 inch clearance is required on top of the cabinet**.
- The System is designed to operate in a temperature controlled (maximum operating ambient 40°C/104°F) and clean environment. The presence of airborne particles such as dust, sand and metallic debris are forbidden. Appropriate filters shall be installed.
- Heat Load Calculation - The system heat loss can be calculated by taking the system size in KW and multiplying by 375.2 BTU/hr.

Warning:

Filters mounted to the air inlets reduce the air pressure and may cause inverters to 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.

8.1.1 Transformer and Generator Sizing

The inverter is capable of operating at 150% of rated capacity for 15 seconds. The boost function allows up to 10 times the rated inverter capacity for 20 ms to clear downstream faults.

- Transformers supplying AC to the inverter should be sized at a minimum of 1.5 times the kVA rating of the inverter to meet this requirement.
- Generators supplying emergency AC to the building and to the inverter should be sized at a minimum of 2 times the kVA rating of the inverter.

8.2 Packaging Information

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.

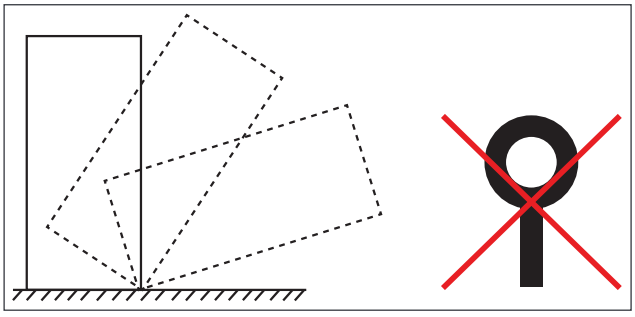


Figure 13. *Cabinet Lifting*

8.3 Module packing

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

If the modules have been ordered separately they are packed in carton on pallet. Refer to installation procedure to address modules.

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.

Figure 14. *Module Description*

8.4 Anchoring the cabinet to the floor

The cabinet is anchored through the base of the cabinet.

Remove lowest front cover to get access to the anchoring locations.

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

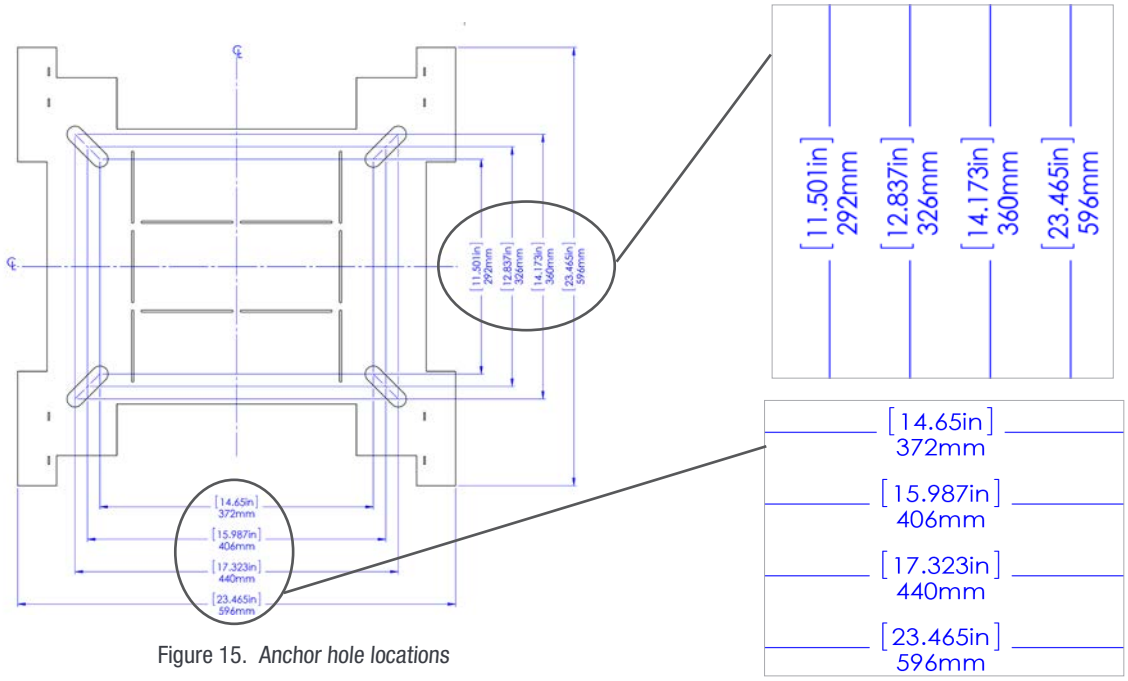


Figure 15. *Anchor hole locations*

8.5 Cabling

Check section 7, page 18 to identify system configuration and refer to section 7.3, page 20, 7.4, page 21 and 7.5, page 22 for cable sizes. Refer also to 8.1, page 25 for important safety notices.

8.5.1 Tightening Torque

Torque recommendation for cable termination are:

8.5.1.1 AC Connections (per Mfg)

Terminal Block	Tightening Torque Nm
MIPS (Small TB*)	10
MIPS (Large TB**)	20

Figure 16. *Torque Table - AC Connections*

* For MIPS, small terminal block is for MIPS-1-10, MIPS-1-20, MIPS-2-20, MIPS-3-30

** For MIPS, large terminal block is for MIPS-1-25, MIPS-2-40, MIPS-2-50, MIPS-3-60, MIPS-3-75

8.5.1.2 DC Connections (per NEC)

Size of wire [AWG/kcmil]	Tightening Torque Nm
2 - 1	16.9
1/0 - 2/0	20.3
3/0 - 4/0	28.2
250 - 350	36.7
500	42.4
600	
750	

8.5.2 Cable Inlets

Use appropriate conduit fitting to attach the conduits to the top of the cabinet. Use existing knock outs and do not block the airflow through the top of the cabinet. The top panel can be removed to facilitate wiring.

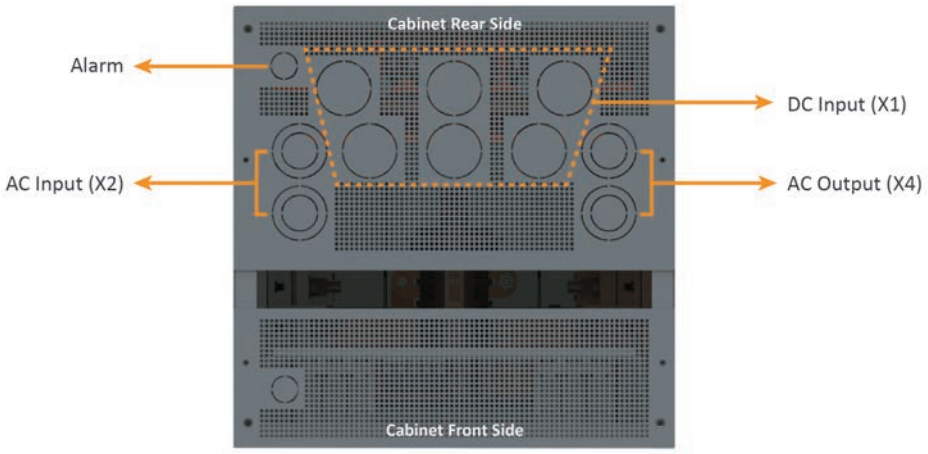


Figure 17. *Cable Inlet - Positions*

8.5.3 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 8.5.4, page 29)

Ground has to be connected in accordance with local code.

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

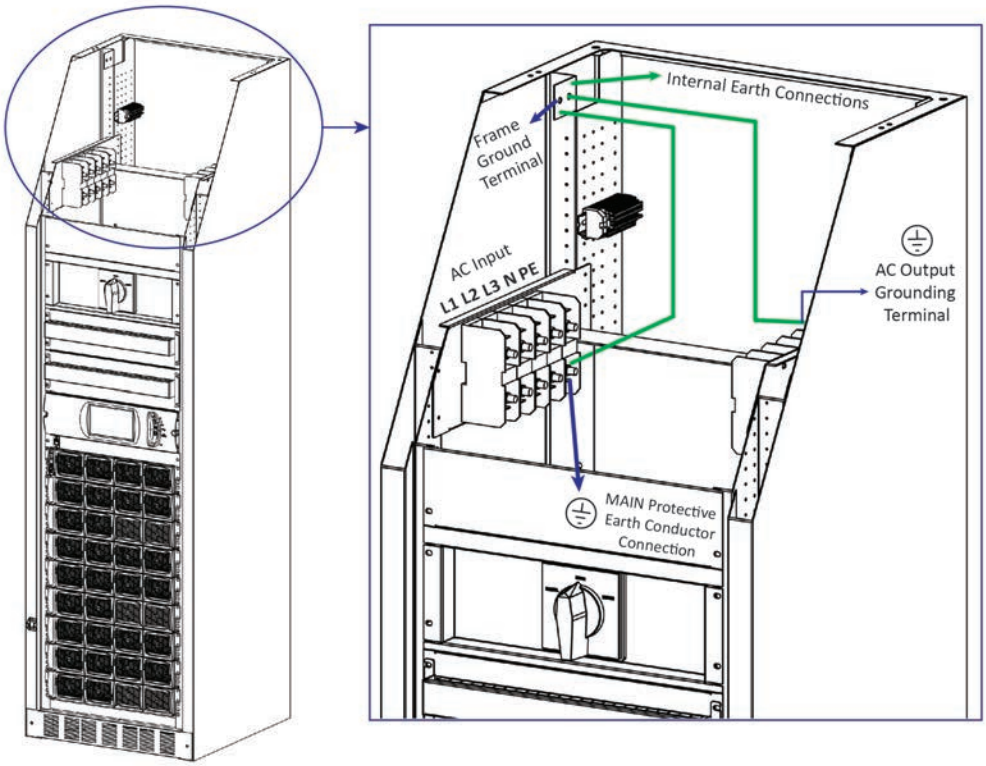
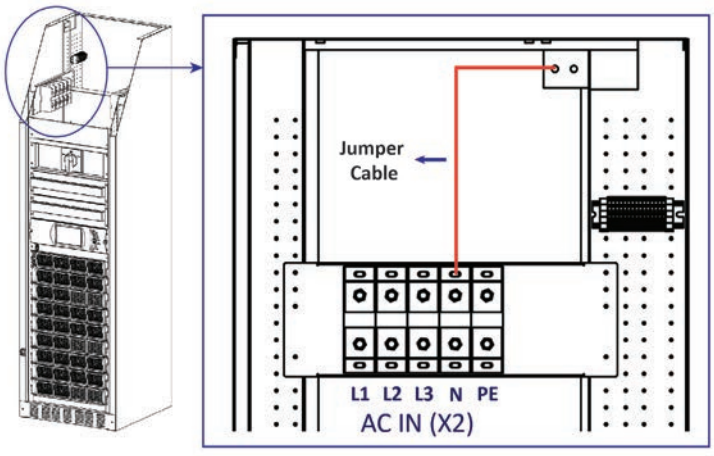


Figure 18. *Earthing connections*

8.5.4 AC Input and Output

The pictorial representation of terminal blocks arrangement is as follows.

Note: If AC IN is connected, remove the Neutral bonding jumper cable between X2 (AC IN) and frame ground.

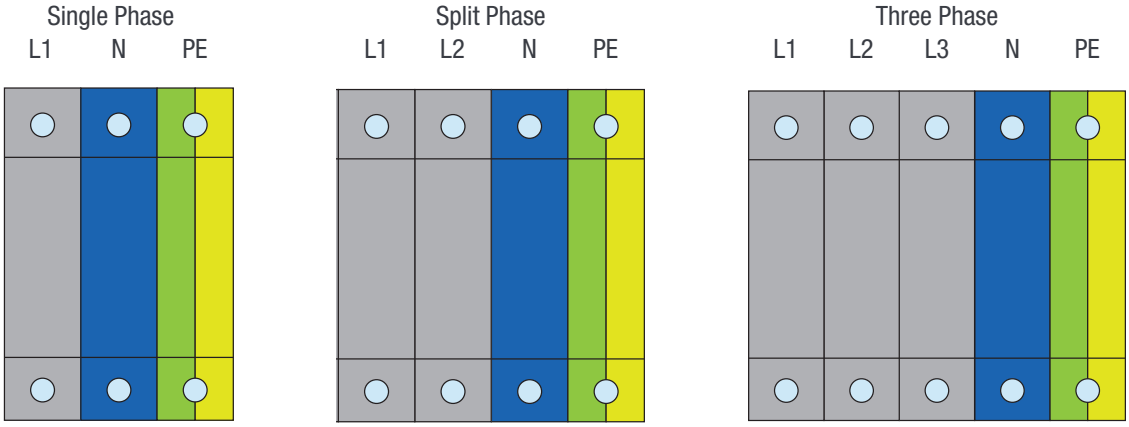


When connecting AC input and output cables, you must remove the washer from the terminal block prior to landing the cable lug.

Reinstall the washer between the cable lug and the nut.

Figure 19. *Neutral bonding jumper*

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



When connecting AC input and output cables, you must remove the washer from the terminal block prior to landing the cable lug.

Reinstall the washer between the cable lug and the nut.

8.5.5 DC Input

8.5.5.1 Single feed DC Input

- One (1) common DC connection.
- Two holes of $^{3}/_{8}$" threaded hole with 1"(25.4 mm) between center.
- Internal DC distribution with circuit breakers (Q01-Q30) to each inverte
- Max 9 x 500 kcmil (240 mm^2) cables.
- Can be single or double lug (refer to site requirement).

Note: Screws, nuts and cable shoes are not included in the delivery.

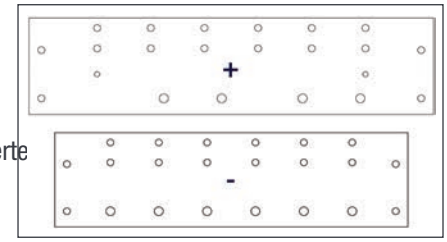


Figure 20. *Single Feed DC - Bus Bar*

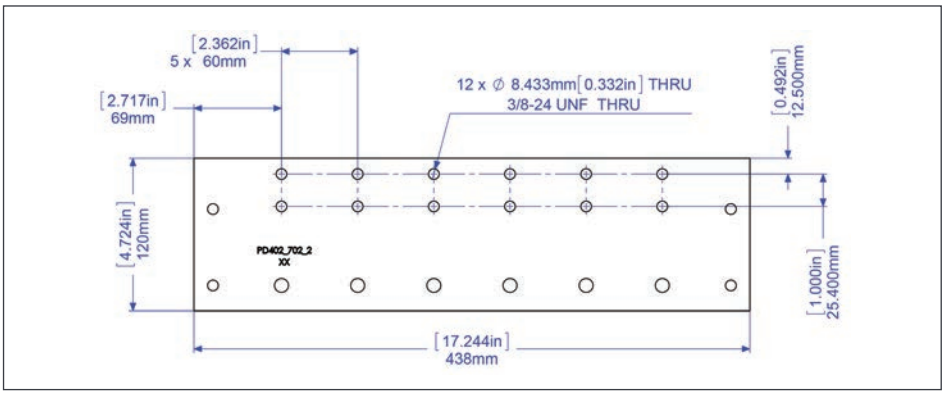


Figure 21. *Single Feed DC - Negative bar hole details*

8.5.5.2 Dual DC Feed Input

- 2 x DC input connection per system.
- Two holes of $^{3}/_{8}$" threaded hole with 1"(25.4 mm) between center.
- Internal DC distribution with circuit breakers (Q01-Q30) to each inverter module.
- Max 3 x 500 kcmil (240 mm^2) per pole (group).
- Can be single or double lug (refer to site requirement).

Note: Screws, nuts and cable shoes are not included in the delivery.

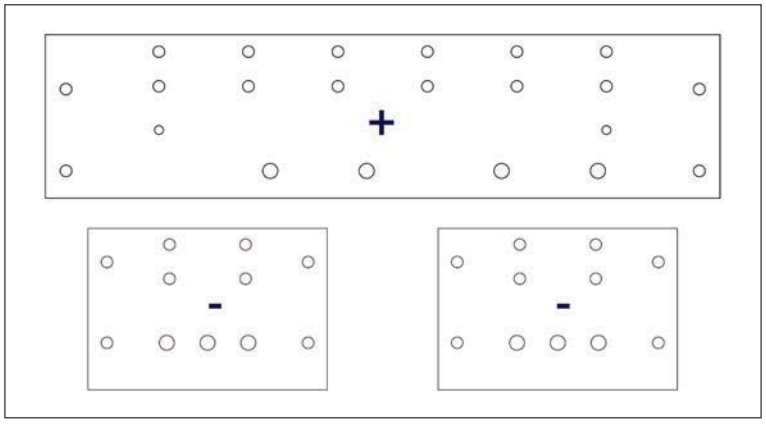


Figure 22. *Dual DC Feed - Bus Bar*

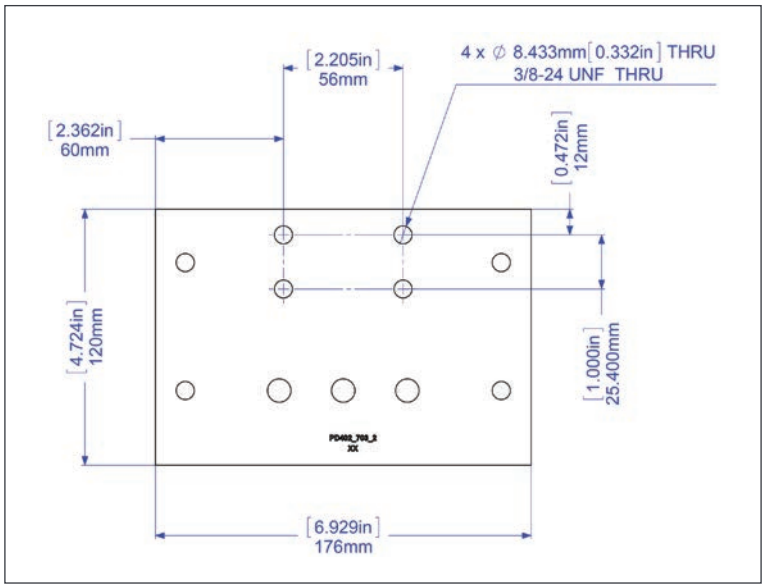
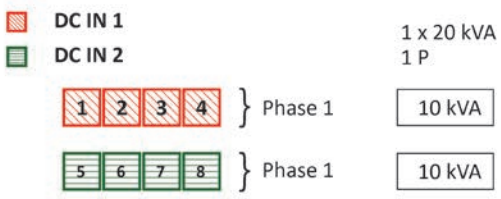
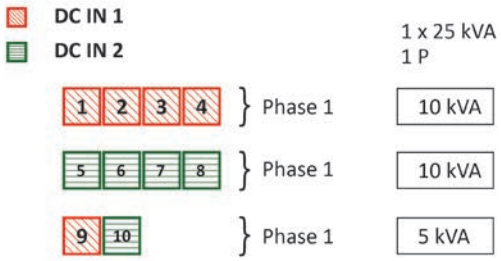


Figure 23. *Dual DC Feed - Negative bar hole details*

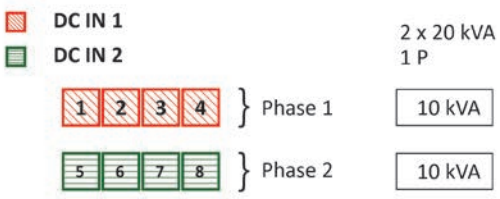
8.5.5.3 Dual DC Feed - Internal Wiring Pattern

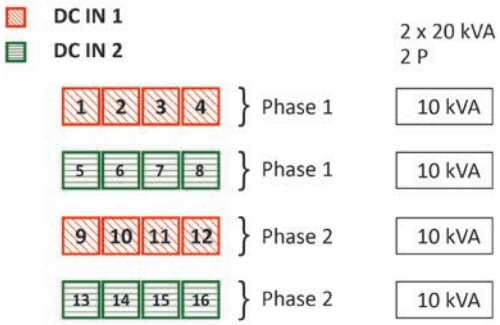
Single Phase System

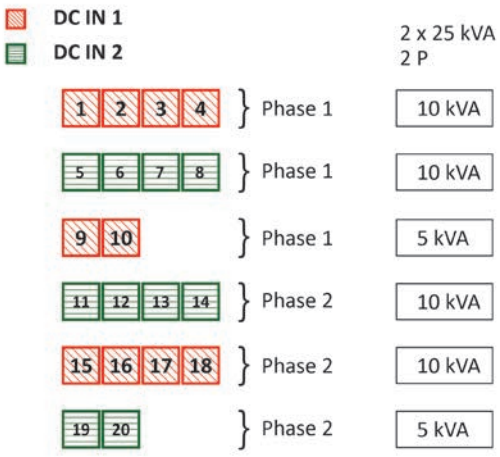




Split Phase System







8.5.5.4 Triple DC Feed Input

- 3 x DC input connection per system.
- Two holes of $^{3}/_{8}$" threaded hole with 1"(25.4 mm) between center.
- Internal DC distribution with circuit breakers (Q01-Q32) to each inverter module.
- Max 2 x 500 kcmil (240 mm^2) per pole(group).
- Can be single or double lug (refer to site requirement).

Note: Screws, nuts and cable shoes are not included in the delivery.

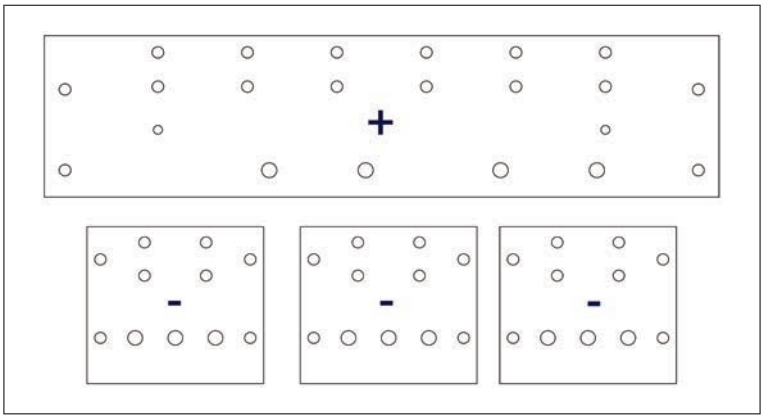


Figure 24. *Triple DC Feed - Bus bar positions*

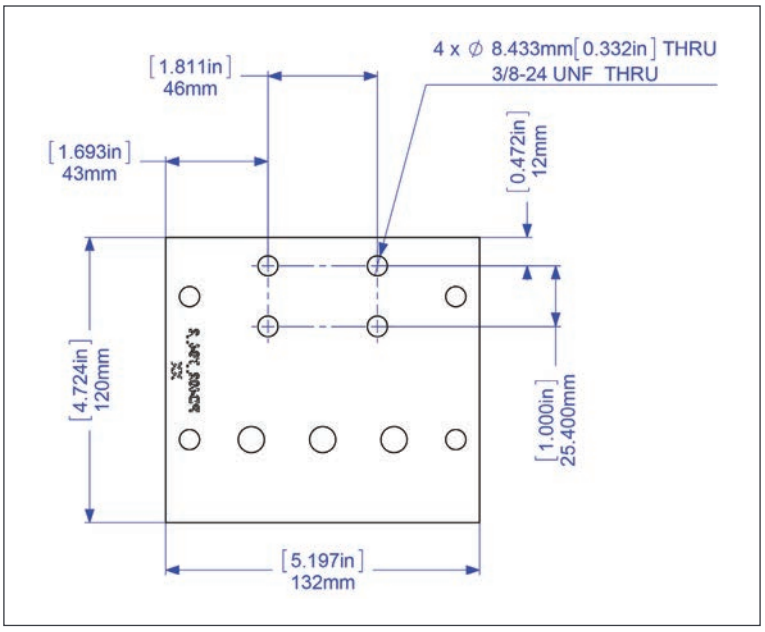
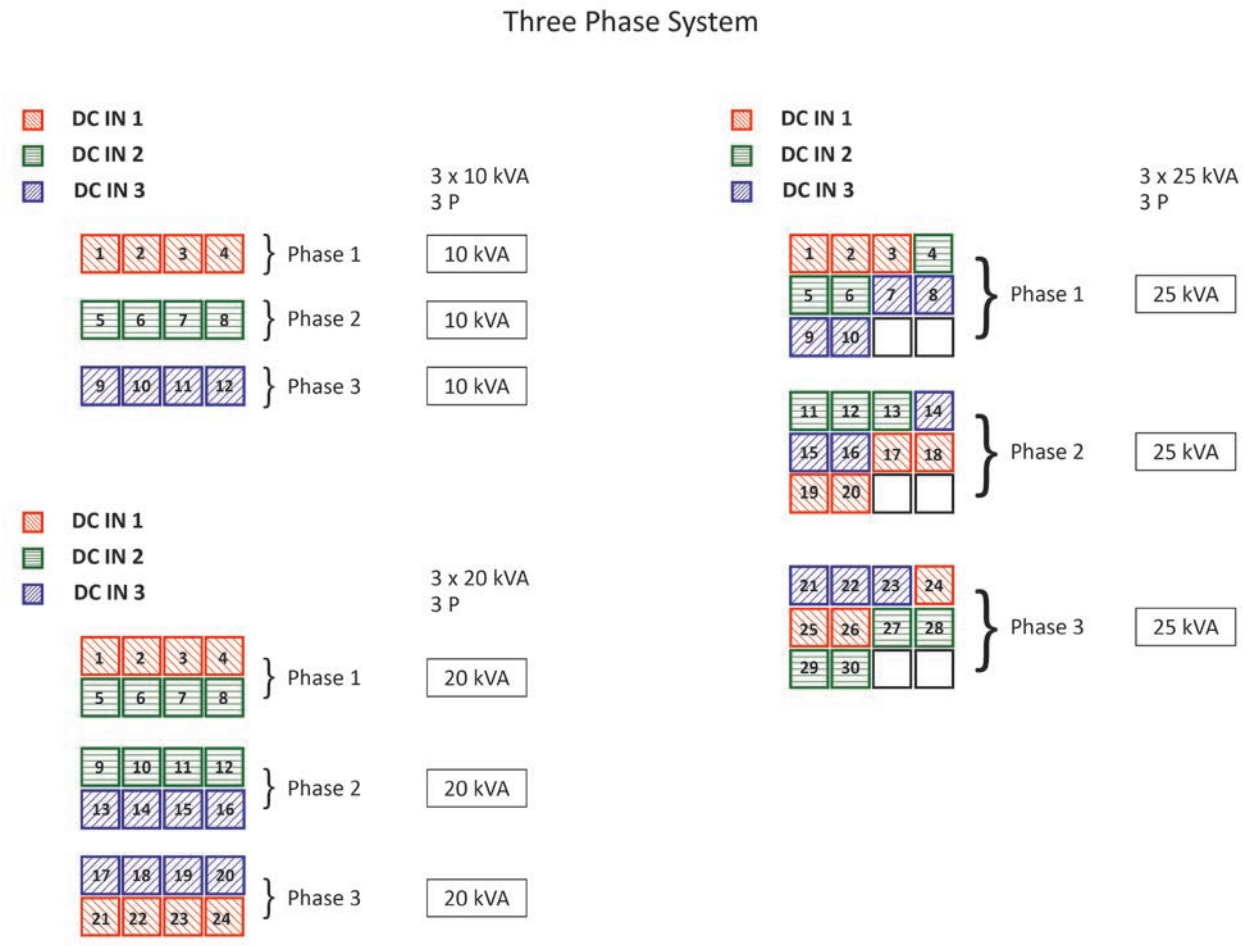


Figure 25. *Triple DC Feed - Negative bar hole details*

8.5.5.5 Triple DC Feed Input - Internal Wiring Pattern



8.5.6 Signaling

All relays are shown in non energized state.

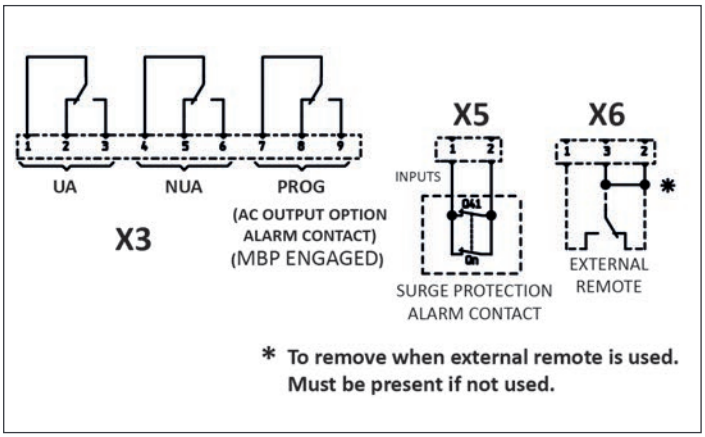


Figure 26. *Alarm dry contacts*

Note:

Output relays are time delayed factory default set to 30 seconds, User settable from 2 to 30 seconds.

To connect "Inverter in Bypass" status signal from inverter to External Manual Bypass (MBP) Switch, connect external MBP to X3 terminals 7 and 9.

8.5.6.1 Alarm (X3)

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

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

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

8.5.6.2 Digital In (X5)

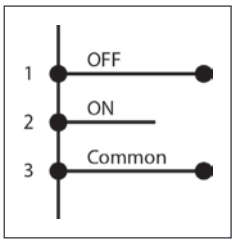
- Input characteristics X5 (Digital In 1, Digital In 2)

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

Note: Not available if internal MBP is installed.

8.5.6.3 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 turns the AC output 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 closes. If both transitions are not picked up the status is not changed.
- Digital input characteristics (Remote ON/OFF)
  - Signal voltage +5 VDC (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!

8.6 Switching OFF MIPS System

Perform the following steps to Switch OFF the MIPS System.

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

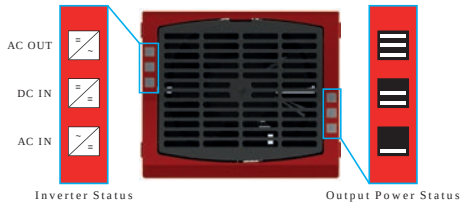
1. Switch OFF AC Output Breakers.
2. Switch OFF AC Input Breakers.
3. Switch OFF DC Input Breakers.
4. Switch OFF the Upstream and Downstream and Bypass Breakers. (As applicable)

CAUTION - Risk of electric shock. Capacitors store hazardous energy. Do not remove any modules from the cabinet for at least 5 minutes after disconnecting all sources of AC or DC supply.

Caution - Risk of electric shock. This inverter receives power from more than one source. Disconnection of AC source and DC source is required to de-energize this unit before servicing.

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

Table 1. *Module Inverter LED's - Indications*

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)

Table 2. *Module Power LED's - Indications*

9.2 T2S ETH

- Alarm indication on Catena (Urgent / Non Urgent / Configurable)
  - Green: No alarm
  - Red: Alarm
  - Flashing Exchanging information with inverters (only Configurable alarm)
- Outgoing alarm relay delay time
  - Major and Minor Adjustable from 2 to 60 seconds
- Parameter setting via Laptop.
- Factory default according to list of set values.

Note: To know more details, refer to T2S ETH user manual.

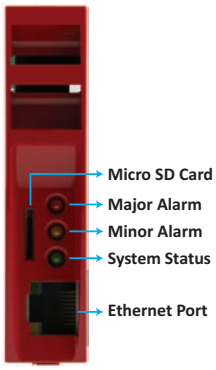


Figure 27. *T2S ETH Front details*

9.3 T2S Ethernet via Catena

Once system is powered ON, the Catena is up and ready for operation.

Configuration and other parameters can be changed using the Catena display.

9.3.1 User GUI Interface Catena

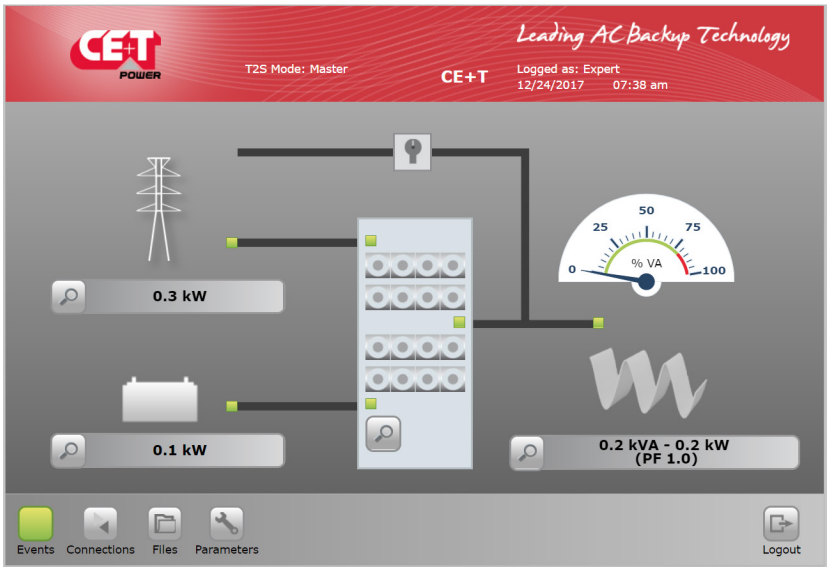


Figure 28. *Catena - Home page*

Catena provides a quick and efficient user interface to:

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

9.3.1.1 Catena Start up

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.

Since Catena software v4.4.0, units equipped with a front RJ45 port; set computer to "obtain IP automatically" and direct web-browser to http://catena.local (don't forget the dot).

Customer network connects (with static IP) is on rear of the unit.

Use the touch screen or connect the laptop to the Ethernet port and start your web browser.

1. In the web browser, enter the default IP address 192.168.0.2.
2. Choose a user (Basic or Expert) and click "Log in".
    - No password is required for Basic
    - Expert is protected with default password "**pass456**"

Note: In Catena display, the default keyboard entry setting is with "CAPS LOCK ON", the password must be entered in lower case, change keyboard to lower case setting before entering the password.

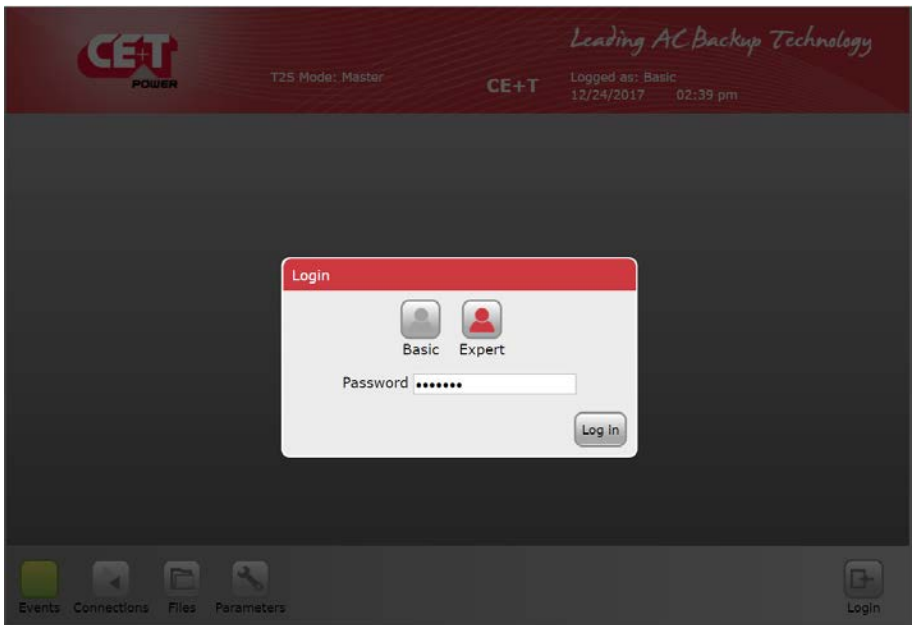


Figure 29. *Catena – Login page*

The Catena is a monitoring device that gets information from the T2S ETH controller. So the pages in Catena display and web interface are same. Refer **T2S ETH user manual**, for viewing system information, accessing the parameters, and configuration settings.

9.3.1.2 The Home page

After connecting at the basic or expert level, the catena will display the home page as below.

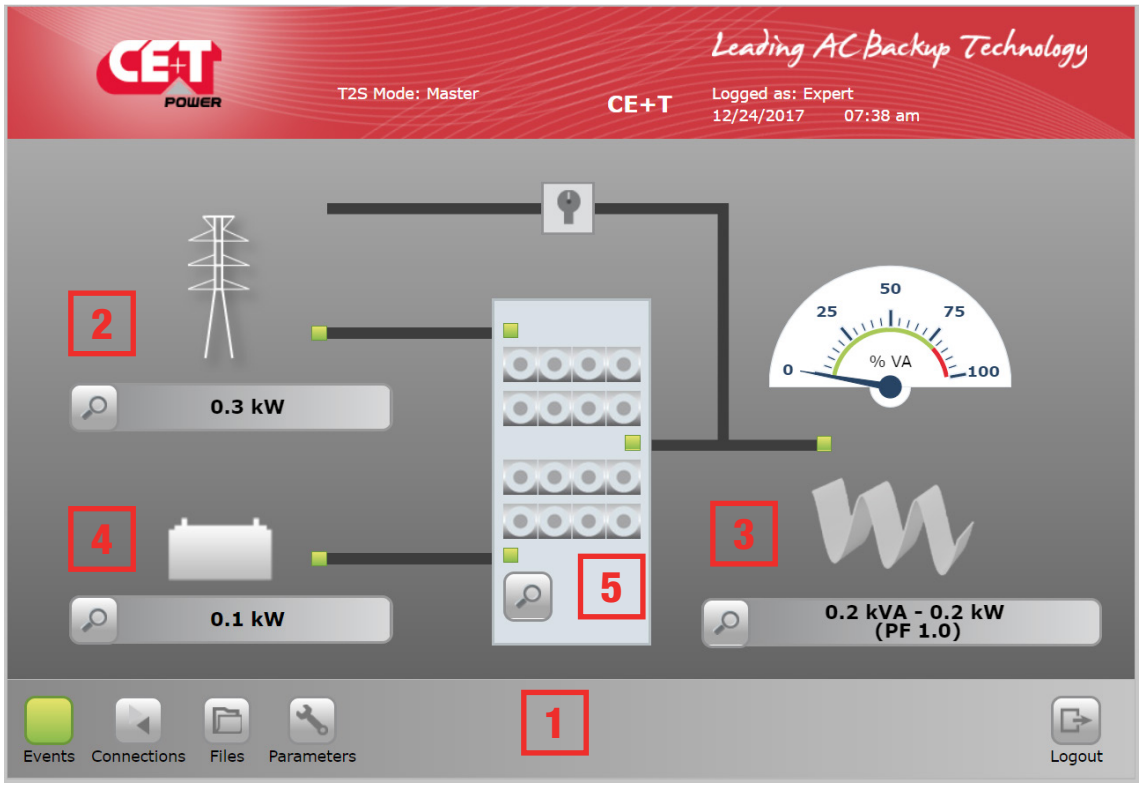


Figure 30. *Catena – Home page details*

1. Toolbar provides access to events, connections, files, and parameters
2. AC input menu display AC input power in kW
3. AC output menu display the level of AC output power in kW/kVA
4. DC input menu
5. System menu and further module menu

If a MBP is configured in the system, it will be depicted on top of system, from AC IN to AC OUT.

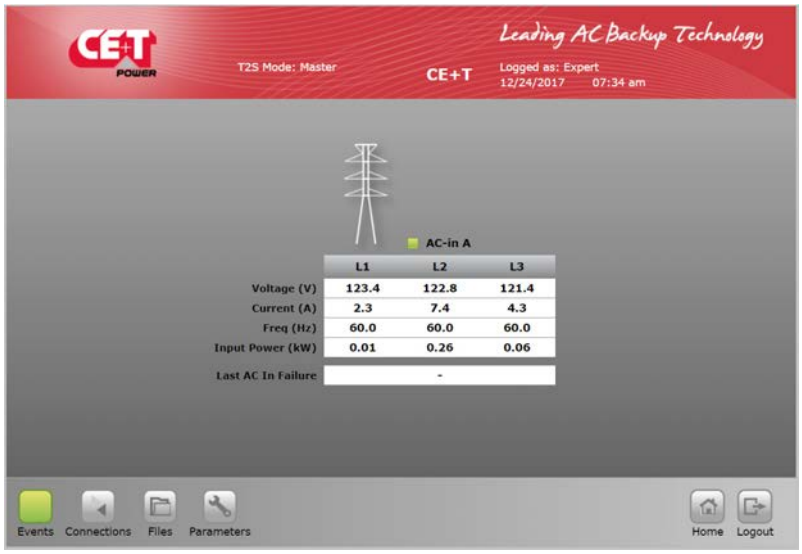
All LED symbols indicate if there are any alarms present in the system.

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

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

9.3.1.3 The AC input page

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



This screen provides the following information:

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

Figure 31. *Catena – AC input page*

9.3.1.4 The DC input page

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

This screen provides the following information:

- DC input voltage VDC
- DC input current

Figure 32. *Catena – DC input page*

9.3.1.5 The AC output page

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

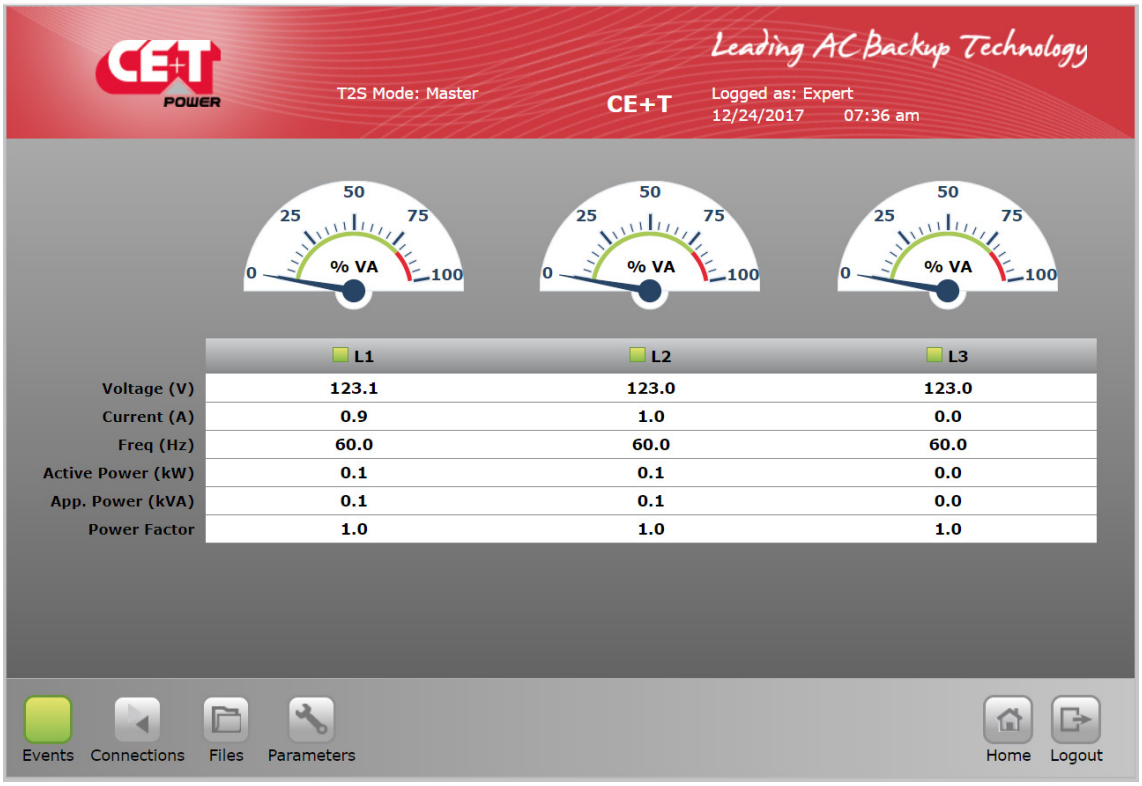


Figure 33. *Catena – AC output page*

This screen provides the following information:

- Graph indicating the power per phase of N (Not N+1), system capacity calculation does not include redundant modules.
- 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)

9.3.1.6 The System page

Click the **Search** button at the cabinet in the home page will bring you to the system page where following information can be found:

System level:

- **Installed power** - It is the total power of the configured modules, including redundancy. For example: The system is configured for a maximum of 25 kVA.
- **Available power** - It is the total power of active modules present in the system.

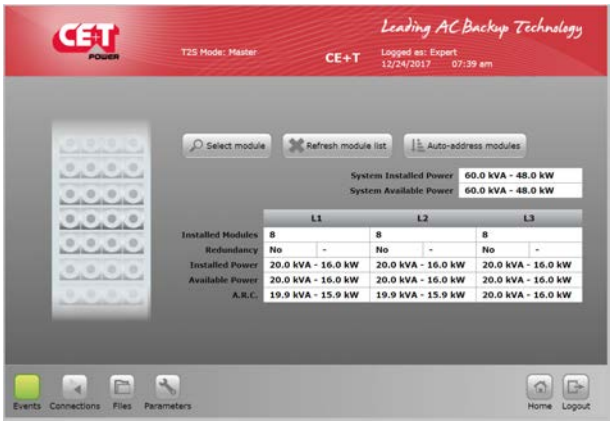


Figure 34. *Catena – System page*

Phase level:

For each output phase, following information is given:

- Number of installed modules
- Redundancy: defined or not, satisfied or not
- Installed and available power following the same logic as per system level
- A.R.C. (Available Redundant Capacity) is the remaining available power before reach the redundancy level.

Clicking the select module button will launch the module selection pop-up.

Each module information can be accessed by clicking the corresponding button.

A legend is always present to recall the color scheme:

- White: no module in slot
- Grey: module manually off
- Green: module OK
- Orange: module in recoverable error
- Red: module with unrecoverable error

For last two, refer to module manual for troubleshooting.

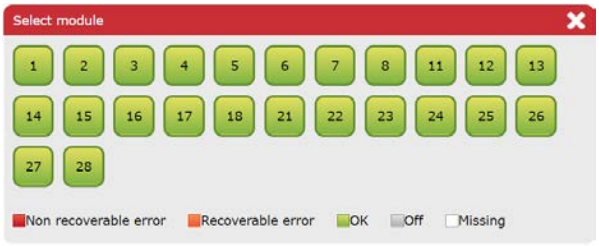


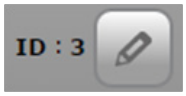
Figure 35. *Catena – Module list*

Module Page

This page gives the module by module measurement.

T2S ETH is the monitoring solution for inverters, which are all single phase module.

Many controls are available from this page to manage the module:



The T° probe is the average T° of the inverter module heat sink

Figure 36. *Catena - Module page*

9.3.2 Toolbar

Figure 37. *Catena - Tool bar*

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

9.3.2.1 Events

The circled number on the icon indicates the number of active alarms.

Click the **Events** button  , Events page opens and lists all events currently ongoing in the system. These are sorted by appearing time, newer on top of the list.

“Device” column provides the source of the alarm, which can be down to inverter of a given module (example: module 4 AC IN) to System or monitoring level.

Events appear with a color corresponding to their alarm level
(grey – event, orange – minor, red – major).

A filter as shown below is available to display only a subset of these events.

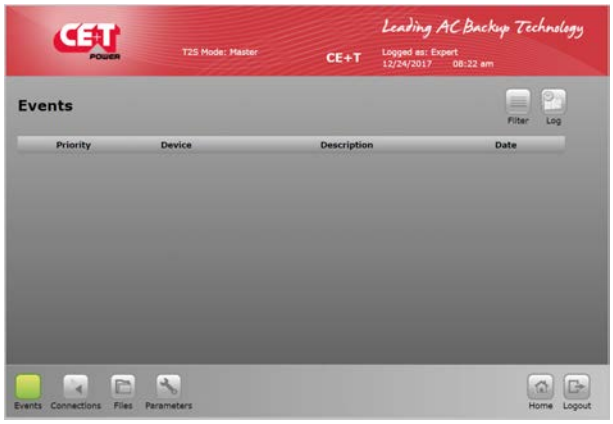


Figure 38. *Catena – Events page*

9.3.2.2 Log

Click the **Log** button  to access the log file. It displays the list of last 2000 events with date and time stamps.

Compared to the event page, an extra column is displayed if the event has appeared or disappeared.

For each event, there are two log lines: one with the timestamp of the event appearing and the second one with the timestamp of the event disappearing.

Users can filter the log like the event page.

The user is able to see the difference between event and log page: no color for alarm level is used in log page, a column states it.

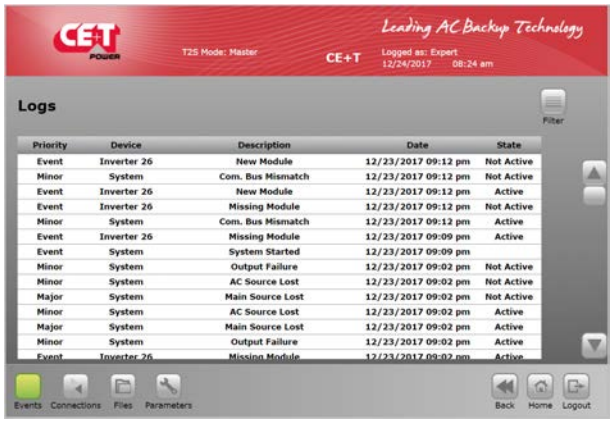


Figure 39. *Catena – Logs page*

Log download and clear functions are available in “Files” menu.

9.3.2.3 Connections

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

T2S ETH has two digital inputs and three alarm relays.

State of each of these connections can be read through the “connections” page.

An extra button “toggle” allows the user to test each relay manually, toggling it for a few seconds with the aim of detecting a mechanically failing device over time.

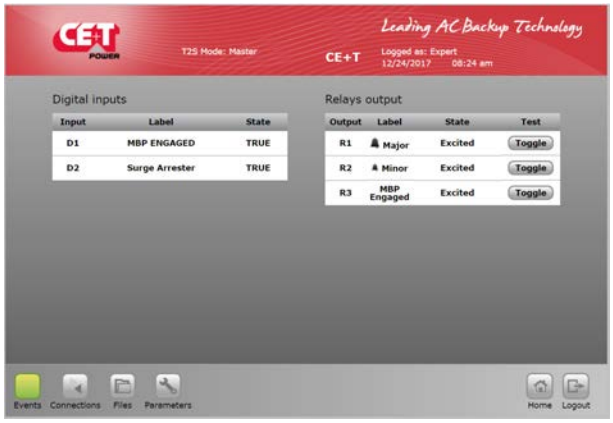


Figure 40. *Catena – Connections page*

9.3.2.4 Files

Click on Files to:

- Export the log file
- Clear the log file (only possible in expert mode)
- Upgrade the software of the T2S ETH unit.
- Upload a language file.

Figure 41. *Catena – Files page*

9.3.2.5 Parameters

The Parameters page is divided into tabs which are a compound of sub menus:

- Monitoring
- Input/Relays
- SNMP
- Modbus
- Power
- Info

(Note: To know more details about parameters section, refer T2S ETH user manual.)

Figure 42. *Catena – Parameters page*

10. Unit - Inserting/removing/replacing

10.1 TSI Inverter Module

- When a new module is inserted in a system, it is automatically assigned the configuration file from the existing modules or from the T2S-ETH.
- When a new module is inserted in a system, it is automatically assigned to the next available address.

10.1.1 Removal

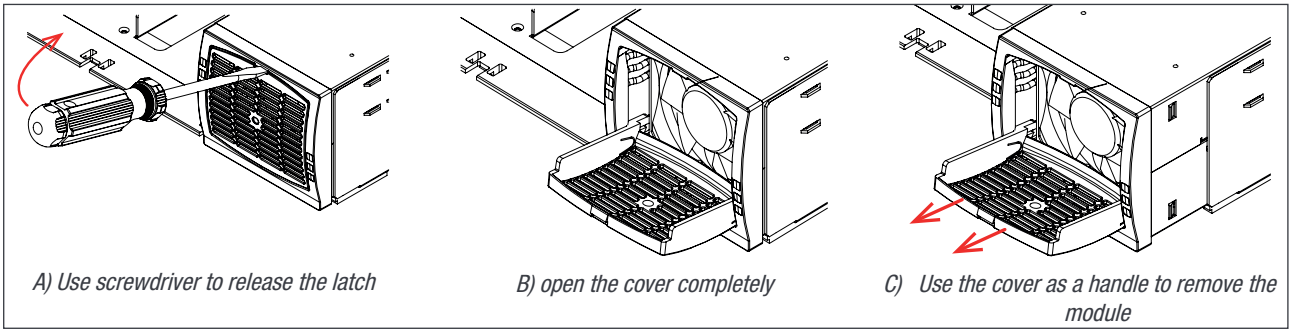
Note: When one or several inverter modules is/are removed, live parts become accessible. Replace module with dummy cover without delay.

Warning: Inverter module is not switched off while opening the handle. The handle only hooks the module to the shelf.

Step 1. Use a screwdriver to release the latch of the handle.

Step 2. Open the handle and pull the module out.

Step 3. Replace with a new module or dummy cover.



A) Use screwdriver to release the latch

B) open the cover completely

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

Figure 43. *Module Removal*

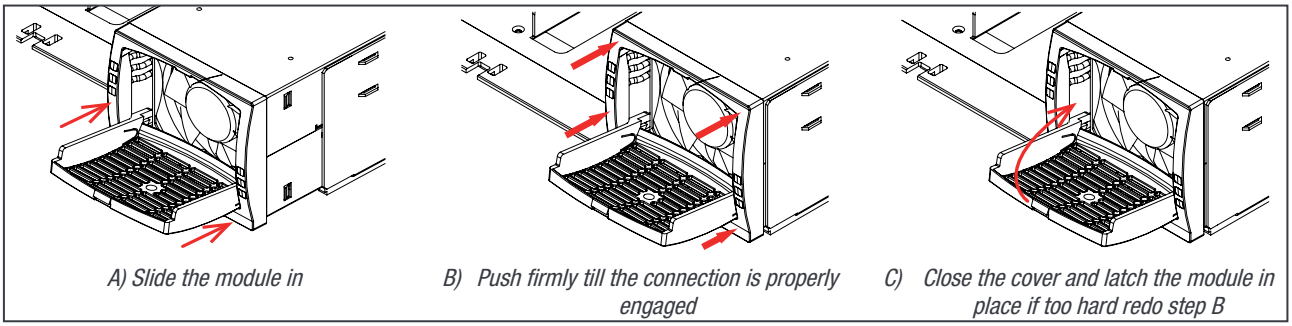
10.1.2 Inserting

Step 1. Check module compatibility (DC Voltage!).

Step 2. Use a screwdriver to release the latch of the handle.

Step 3. Open the handle and Push firmly until the unit is properly connected.

Step 4. 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

Figure 44. *Module Inserting*

10.2 T2S ETH

T2S ETH is hot-swappable. It can be removed or replaced without affecting the operation of the system. If a new T2S ETH is inserted in the live system, the modules will automatically configure the system parameters within the T2S ETH.

10.2.1 Removal

1. Use a small screwdriver to release the latch keeping the T2S in position.
2. Pull the T2S ETH out.

Figure 45. *T2S Removal*

10.2.2 Inserting

1. Push the T2S firmly in place until the latch snaps in position.
2. In Catena, Green LED (OK) will flash for a few seconds and wait until it becomes solid green. Once the LED turns green, the connection is established and the home page appears in Catena screen.
3. If Catena screen displays any warning message as “Limited or no connectivity”:
   - Check the ETH cable connection between Catena and T2S ETH.
   - Reset Catena, by pressing the RESET button at front side of the Catena or
   - Reinsert the T2S ETH in the shelf.

10.3 Fan replacement

The fan's life is approximately 60,000 (Sixty thousand) hours. The inverter modules have fan runtime meters and fan failure alarm. Fan failure can result from the failing fan or driver circuit.

- Let the module rest at least five minutes before initiating work.
- The inverter front cover must be removed. Use a flat screwdriver, release all the four latches on side of the module and remove the front cover.
- Disconnect the fan supply cord and remove the fan.
- Replace with a new fan and connect the supply cord.
- Fix the front cover and make sure all the four latches are locked.
- Insert the module in corresponding slot in the shelf.
- Check the fan for operation.
- Access T2S ETH and reset the fan run time alarm.

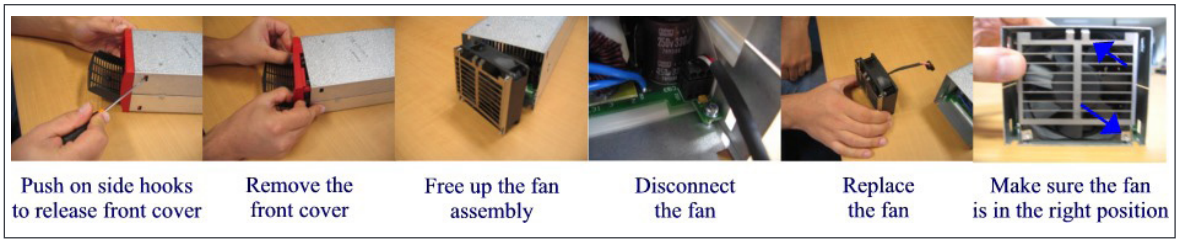


Figure 46. *Module Fan Replacement*

11. Manual Bypass Operation

- Manual Bypass has to be operated by trained personnel only.
- When system is in Manual Bypass the load is connected to AC main voltage without filtering.
- An MBP Engaged output alarm will occur when the system is in Manual Bypass.
- The Manual Bypass is not possible to operate remotely.
- MBP switch is optional.
- An internal MBP switch must be present to cancel the output phase shift prior to operating a non-CE+T wraparound MBP.

11.1 Pre-requisites

Before engaging the MBP, the following conditions have to be fulfilled and actively checked. Failure to follow this procedure could result in loss of power to Critical Load.

1. The AC Input breaker must be closed.
2. Inverter must be synchronized with commercial power.
   - Use Voltmeter to measure voltage between L1- commercial and L1 - inverter output.
   - Do same measurement with L2 – L2 and L3 – L3.
   - In all cases, voltage must be less than 20 V.
3. The upstream AC & DC breaker must be correctly sized to accept possible overload, The inverter might be overloaded during MBP procedure, depending on voltage network and output inverter voltage setting and if the AC is supplied by a Gen-set, the minimal required power will be twice nominal power of the inverter.

11.2 Manual Bypass Operation

The Manual Bypass operates via individual switch that creates a bypass from mains input via output AC distribution. Inverter modules are bypassed and possible to disconnect without impacting the load.

Operation is “Make before Break”.

11.2.1 Normal to Bypass, Engage MBP

1. Turn the switch from **Normal** to **Bypass** (Do not stop at **INTERIM** Position)
2. Turn OFF **DC Input**

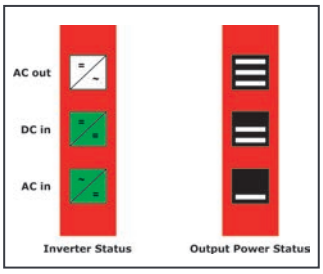
Figure 47. *MBP Switch*

Manual Bypass puts the module in OFF state but doesn’t disconnect the DC.
Make sure DC is disconnected before any intervention inside the system.

Warning: Risk of electric shock. Power will be available at AC Input terminal, AC Output terminal, DC Input terminal, and Surge Arresters.

Warning: Always engage MBP on inverter before operating wraparound external bypass.

11.2.2 Bypass to Normal, Disengage MBP



1. Turn switch to **INTERIM** (mid position).
2. PAUSE: Wait until the inverter modules have come to full operation and have synchronized (30-60seconds). The Top-Left LED on each module should be Green prior to proceding.
3. Rotate the switch to the **NORMAL** position.
4. Turn on DC input.

Note: When systems are operated as DC primary, failure to follow this procedure may result in DC Plant and/or genset overloads.

WARNING

IF ATS (automatic transfer switch) IS INSTALLED UPSTREAM TO SELECT AC SOURCE. MAKE SURE THAT THE ATS SWITCH DOES NOT ALLOW TRANSFER BETWEEN AC SOURCE OUT OF SYNC. THE MAXIMUM ALLOWED PHASE SHIFT IS 10°.

12. EMBS

"See EMBS User Manual" for more information.

13. Final Check

- Make sure that the sub-rack and cabinet is properly anchored 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 all cables are sized and installed according to NEC guidelines and the local authority having jurisdiction.
- Make sure all cables have proper strain relief installed.
- Make sure that all breakers are sized according to the NEC guidelines and the local authority having jurisdiction.
- Make sure that the DC cable polarity is verified and installed according to the DC terminal designations.
- 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.

14. Commissioning

The inverter module DC input breaker acts as a protective device. When the modules are inserted into a system the DC breaker can then be turned ON to activate the DC input of the module.

Installation must be performed by competent qualified employees.

Commissioning and startup must be performed by any personnel who have been duly trained and possess a valid (non-expired) trainee ID certification number.

Contact your CE+T sales representative for more information on training classes. Classes are available for vendors, installers, and service providers.

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

Equipment is not covered by warranty if procedures are not followed.

14.1 Check list

Refer the document “Commissioning Procedure” and available on request.

15. Trouble shooting

15.1 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 ETH 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:	Check the default time delay (UA “Major Alarm” - 60s, NUA “Minor Alarm” - 30s)
	Check configuration file
No information on Catena:	Check that T2S ETH is present and properly inserted
	Check that the RJ45 cable is connected between T2S ETH shelf and Catena

15.2 Defective modules

Unless input power is down, all LED's on each module should be green (see section 9, page 37). No light, orange light, red or flashing light are abnormal conditions. Collect and record the module information. If no fix can be found, replace the module.

15.2.1 Replacing modules

Refer to section 10, page 47 to remove and re-insert modules.

15.2.2 Return defective T2S interface

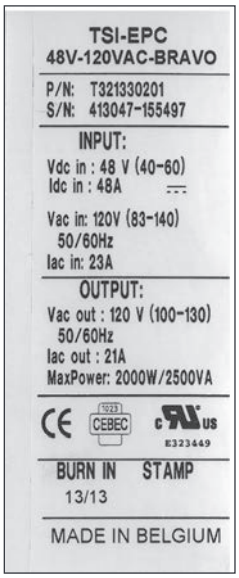
A T2S totally dark (indication area) or that cannot interface with your laptop are evidence of failure. Proceed as per section 15.2.4, page 55.

15.2.3 Return defective shelf

There are no active components on the TSI shelf. Due to this, failure of the shelf is uncommon. Field replacement of a shelf is complicated and requires a CE+T factory technician to be dispatched to the site. Refer to section 16, page 56 for more information.

15.2.4 Return defective modules

- A repair request should follow the regular logistics chain:
  End-user => Distributor or Value Added Reseller => CE+T Power.
- Before returning a defective product, a RMA number must be requested through the http://my.cet-power.com. Repair registering guidelines may be requested by email at repair@cet-power.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!
- While returning the defective module, should mention all the details in the RMA document.



16. 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 customer.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.

17. Maintenance Task

As maintenance can be performed on live system, all tasks should be performed only by trained personnel with sufficient knowledge on TSI products.

Tasks :

- Identify the site, customer, rack number, product type.
- Download and save the configuration file for back up.
- Check configuration file to be in accordance with operational site conditions.
- Read and save log files for back up.
- Check and analyze log file and if alarm is present.
- Replace dust filter if present. The filter is mandatory in the dusty environment.
- Check module temperature and log value. If the internal temperature is higher than the previous year, determine if this is due to increased load, accumulated dust or reduced airflow. It is common to have a delta of 15°C by 30% of the load between the ambient and the internal temperature. If temperature increases due to internal dust built up, clean the TSI with the vacuum cleaner.
- 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 waveform, power factor, crest factor, THD I from power analyzer.
- Take system picture
- Keep track of reports and provide the end-user with a copy.
- Perform an MBP procedure. This task is not really recommended*, but could be demanded by the site manager.

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