



Leading Conversion Technology for Power Resilience

T-1PS - 20 TO 75 KVA

TIER-1 POWER SYSTEM

User Manual V1.1

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



Copyright © 2013. Construction electroniques & telecommunications S.A.
All rights reserved. The contents in document are subject to change without notice.
The products presented are protected by several international patents and trademarks.
Address: CE+T S.a, Rue du Charbonnage 12, B 4020 Wandre, Belgium
www.cet-power.com - info@cet-power.com

 www.cet-power.com

 Belgium, China, India, Luxembourg, Malaysia, Russia, United Kingdom, United States, Australia & Germany

Table of content

| | |
|--|----|
| 1. CE+T at a glance | 5 |
| 2. Abbreviations | 6 |
| 3. Warranty and Safety Conditions | 7 |
| 3.1 Disclaimer | 7 |
| 3.2 Technical care | 7 |
| 3.3 Installation | 8 |
| 3.3.1 Handling..... | 8 |
| 3.3.2 Surge and Transients Protection | 9 |
| 3.3.3 Other..... | 9 |
| 3.4 Maintenance | 9 |
| 3.5 Replacement and Dismantling..... | 9 |
| 4. TSI TECHNOLOGY | 10 |
| 4.1 EPC Mode | 11 |
| 4.2 On-line Mode (REG Mode) | 11 |
| 4.3 Safe Mode..... | 11 |
| 4.4 Mix Mode & Walk-in Mode..... | 11 |
| 5. Building Blocks | 12 |
| 5.1 Inverter | 12 |
| 5.1.1 Specification | 12 |
| 5.2 Sub-rack (Shelf) | 14 |
| 6. Accessories | 15 |
| 6.1 Monitoring - T2S ETH | 15 |
| 6.1.1 Parameters setting | 15 |
| 6.1.2 System diagnostic and troubleshooting | 15 |
| 6.1.3 Monitoring..... | 15 |
| 6.2 Catena GUI Shelf | 16 |
| 6.3 Surge Arresters | 17 |
| 7. T-1PS Design and Description | 18 |
| 7.1 T-1PS 20 to 75 System Design..... | 18 |
| 7.2 T-1PS 20 to 75 kVA System description..... | 19 |
| 7.2.1 T-1PS 25 kVA System - General arrangement..... | 19 |
| 7.2.2 T-1PS 75 kVA System - General arrangement..... | 20 |
| 7.3 Installation considerations..... | 21 |
| 7.3.1 T-1PS Single Phase Configuration - 120 VAC | 21 |
| 7.3.2 T-1PS Single Phase Configuration - 240 VAC | 22 |
| 7.3.3 T-1PS Three Phase Configuration - 208 VAC | 23 |
| 7.3.4 TSI Bravo module - Current ratings..... | 24 |
| 8. System Installation..... | 25 |
| 8.1 Site Preparation..... | 25 |

| | | |
|--------|---|----|
| 8.1.1 | Transformer and Generator Sizing | 26 |
| 8.2 | Unpacking the system | 26 |
| 8.3 | Module packing..... | 26 |
| 8.4 | Anchoring the cabinet to the floor | 27 |
| 8.5 | Cabling..... | 27 |
| 8.5.1 | Cable inlets | 28 |
| 8.5.2 | Grounding | 28 |
| 8.5.3 | AC Input and Output | 29 |
| 8.5.4 | DC Input..... | 30 |
| 8.5.5 | Signaling..... | 36 |
| 8.6 | Switching OFF T-1PS System | 37 |
| 9. | Human-Machine Interface..... | 38 |
| 9.1 | Inverter module..... | 38 |
| 9.2 | T2S ETH..... | 38 |
| 9.3 | T2S Ethernet via Catena..... | 39 |
| 9.3.1 | User GUI Interface Catena..... | 39 |
| 9.3.2 | Toolbar | 45 |
| 10. | Unit - Inserting/removing/replacing | 48 |
| 10.1 | TSI Inverter Module | 48 |
| 10.1.1 | Removal..... | 48 |
| 10.1.2 | Inserting..... | 48 |
| 10.2 | T2S ETH..... | 49 |
| 10.2.1 | Removal..... | 49 |
| 10.2.2 | Inserting..... | 49 |
| 10.3 | Fan replacement | 50 |
| 11. | Final check | 51 |
| 12. | Commissioning | 52 |
| 12.1 | Check list..... | 52 |
| 13. | Trouble shooting | 53 |
| 13.1 | Trouble shooting..... | 53 |
| 13.2 | Defective modules..... | 54 |
| 13.2.1 | Replacing modules..... | 54 |
| 13.2.2 | Return defective T2S interface | 54 |
| 13.2.3 | Return defective shelf | 54 |
| 13.2.4 | Return defective modules..... | 54 |
| 14. | Service | 55 |
| 15. | Maintenance Task..... | 56 |

Release Note:

| Version | Release date (DD/MM/YYYY) | Modified page number | Modifications |
|----------------|--------------------------------------|---------------------------------|------------------------------|
| 1.0 | 01/10/2018 | - | First release of the Manual. |
| 1.1 | 25/05/2020 | - | 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 system performances and related maintenance costs.

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

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

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 |
| TUS | TSI Universal Synchronization |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| USB | Universal Serial Bus |
| PE | Protective Earth (also called Ground Conductor) |
| N | Neutral |
| PCB | Printed Circuit Board |
| TRS | True Redundant Structure |
| MCB | Miniature Circuit Breaker |
| MCCB | Molded Case Circuit Breaker |
| CB | Circuit Breaker |

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 de-rating 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 factory certified 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 electronic 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 product 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 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.
- 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 8.5.3, 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 module or dummy 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 (NEC - NFPA 70).
- 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.

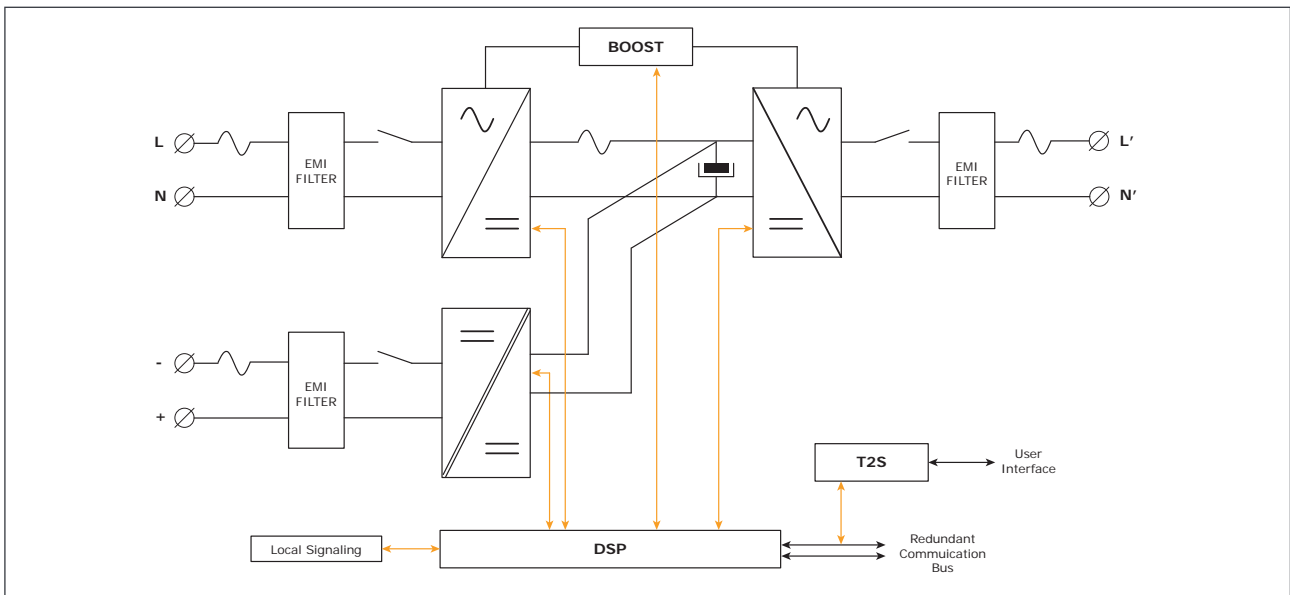
To download the latest:

- Documents - www.cet-power.com
- Softwares - my.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 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 BOOST functionality multiplies the nominal current by 10 for a period of 20 ms (max) in the event of downstream current surge or fault. 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 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.

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.

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 downstream 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. Friendly use on Genset.
 - 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. Building Blocks

5.1 Inverter

BRAVO TSI: -48 VDC / 120 VAC, 60 Hz (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.
- The LED's on the module front plate display the status of converter and output power.
- Inverter modules can be combined to build a single or multi-phase structure.
- The inverter modules are equipped with a 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].



Figure 1. TSI Bravo Module

Note: BRAVO modules for use in a NEBS environment are of different design. Use only BRAVO modules with specific NEBS label and Part Number.

5.1.1 Specification

| GENERAL | 48 Vdc / 120 Vac |
|---|--|
| Part number | T321330271 |
| EMC (immunity) | IEC 1000 - 4 |
| EMC (emission) (class) | FCC part 15 |
| Safety | cUL 1778 Recognized |
| Cooling / Isolation | Forced / Doubled |
| MTBF | 240,000 hrs (MIL-217-F) |
| Efficiency (Typical): Enhanced power conversion / on line | 95 % / 91 % |
| Dielectric strength DC/AC | 4300 Vdc |
| True Redundant Systems – compliance | 3 disconnection levels on AC out and DC in power ports 4 disconnection levels on AC in port |
| RoHS | Compliant |
| Vibration | GR 63 office vibration 0 to 100 Hz-0,1g / transport vibration 5-100 Hz 0,5 g 100 to 500 Hz-1,5 g / Drop test |
| Operating ambience / Ingress Protection | Free from dust and corrosive materials / NEMA 1 (2) |

| | |
|--|--|
| Altitude above sea without de-rating | <1500 m / de-rating >1500 m – 0.8 % per 100 m |
| Ambient / storage temperature / relative humidity | -20 to 50 °C / -40 to 70 °C / 95 %, non-condensing |
| Material (casing) | Coated steel-ALU ZINC |
| AC OUTPUT POWER | |
| Nominal Output power (VA) / (W) | 2500 / 2000 |
| Short time overload capacity | 150 % (15 s) 110 % permanent within T° range. |
| Admissible load power factor | Full power rating from 0 inductive to 0 capacitive |
| Internal temperature management and switch off | 2% / °C de-rating beyond 50° C with cut off at 65° C |
| DC INPUT SPECIFICATIONS | |
| Nominal voltage (DC) | 48 V |
| Voltage range (DC) | 40 - 60 V |
| Nominal current | 56 A (at 40 Vdc and 2000 W output) |
| Maximum input current (for 15 s) / voltage ripple | 84 A / <2 mV Psopho |
| Input voltage boundaries | User selectable with T2S ETH interface |
| AC INPUT SPECIFICATIONS | |
| Nominal voltage (AC) | 120 Vac (120/240 V or 120/208 V with combination of shelves) |
| Voltage range (AC) | 100 - 138 Vac (without de-rating) (can be disabled) |
| Brownout | 80 – 100 Vac use DC source contribution if need be (can be disabled) 2000 VA/1600 W @ 150 VAC |
| Conformity range before transfer to DC | Adjustable |
| Power factor | >99% |
| Frequency range (selectable) / synchronization range | 50 – 60 Hz / range 47 – 53 Hz / 57 – 63 Hz |
| AC OUTPUT SPECIFICATIONS | |
| Nominal voltage (AC) | 120 V |
| Frequency / frequency accuracy | 50 - 60 Hz / 0.03 % |
| Total harmonic distortion (resistive load) | < 1.5 % |
| Load impact recovery time | 0.4 ms |
| Turn on delay | 20 s to 40 s depending on the number of module installed |
| Nominal current. Protected against reverse current | 21 A |
| Crest factor at nominal power | 3 : 1 |
| With short circuit management and protection | |

| | |
|--|--|
| Short circuit clear up capacity* | 10 x In for 20 ms. Available while Mains at AC input port with magnitude control and management. |
| Short circuit current after clear up capacity* | 2.1 In during 15 s and 1.5 In after 15 s |
| IN TRANSFER PERFORMANCE | |
| Max. voltage interruption / total transient voltage duration (max) | 0 s / 0 s |
| SIGNALING & SUPERVISION | |
| Display | Synoptic LED |
| Alarms output / supervision | Dry contacts on shelf / T2S ETH and Catena MTBF for T2S ETH and Catena - 240,000 hrs (MIL at 30 °C) |
| Remote on / off | On rear terminal of the shelf via T2S ETH |

* The counter is based on 50Hz operation. When operating at 60 Hz, there is a coefficient 50/60 to apply, and it corresponds to 50 s. If the module stops due to a short circuit, a manual restart shall be needed. During the short circuit, the current will be a square wave form. So, $\sqrt{2}$ (1.414) should be applied to the nominal current.

5.2 Sub-rack (Shelf)

- The BRAVO shelf shall be integrated into min 600 mm deep cabinets, 19 Inch / ETSI mounting.
- 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.
- The optional rear cover can be provided for enhanced safety in the cabinet.
- 18.9" (D) x 19" (W) x 2U (H). [480 mm (D) x 19" (W) x 2U (H)].
- 13 Lbs [6 Kg] empty.

Note: Sub-Rack (shelf) for use in a NEBS environment are of different design. Use only shelves with specific NEBS label and Part Number.

The shelf is not field replaceable and is not sold separately.



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.

(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 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. (Operation of T2S ETH is described in a separate manual available on request)

6.1.3 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

6.2 Catena GUI Shelf

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

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



Figure 4. Monitoring - Catena

- Measures
 - AC IN (Voltage / Current / Power)
 - DC IN (Voltage / Current / Power)
 - AC OUT (Voltage / Current / Power)
 - Module Temperature
- Alarms
 - Major/Minor
 - System Level
 - Phase Information
 - Module Information
- 7" touchscreen
- Web browser with laptop (ETH)
- Height: 3U
- Power: 15 W

Note: Catena is not intended to be connected to metallic Outside Plant (OSP) cable conductors.

6.3 Surge Arresters

The mains (AC) supply of the modular inverter system shall have suitable Lightning surge suppression and Transient voltage surge suppression installed. The manufacturer's recommendations of installation shall be followed. It is recommended to select a device with an 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.

Lightning surges 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 susceptible to lightning than other areas, whereas the intensity dramatically increases with the altitude.

The selection of the surge arresters, as well as their installation, shall adhere to strict rules. Not adhering to these rules could simply void their actions. The selection of the surge arrester and its physical implementation cannot be covered in this document. The installer must analyze the local conditions and 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 not covered by CE+T product warranty.

Caution:

For continued protection against the risk of fire, replace only with the same type and rating of fuse.

7. T-1PS Design and Description

7.1 T-1PS 20 to 75 System Design

T-1PS 20 to 75 is a cabinetized modular inverter specifically designed for clean and temperature-controlled environments.

- Telecom grade design.
- The system cannot be installed back to a wall. A minimum clearance distance of 36 inches is required.
- The system is intended for Central Offices only.
- Based on BRAVO 48 VDC-120 VAC TSI module.
- Fully modular.
- Support redundant configurations.
- Support EPC Mode.
- Cabinet NEMA 1 (IP 20).
- 84.252" (H) X 23.622" (W) X 27.559" (D). [2140 mm (H) X 600 mm (W) X 700 mm (D)].
- The weight of the 75 kVA system is 1120 lbs (562 Kg) with modules.

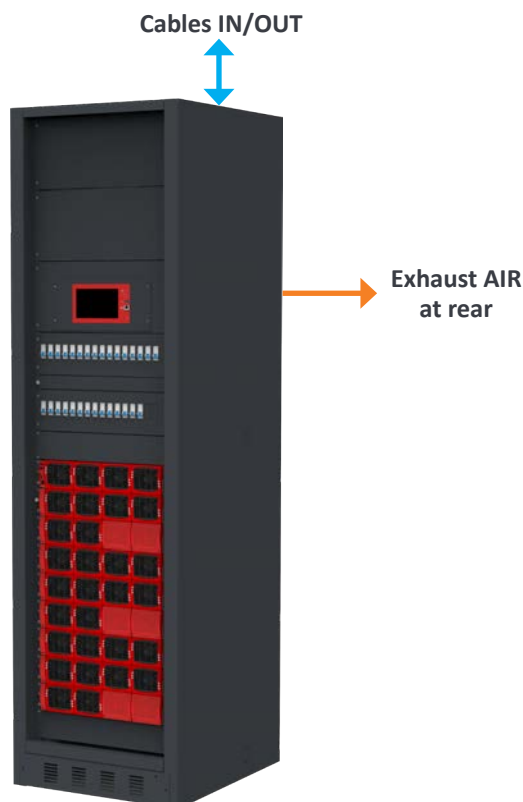


Figure 5. T-1PS 75 kVA Inverter System

7.2 T-1PS 20 to 75 kVA System description

T-1PS 20 to 75 comes fully equipped with

- DC individual protection for modules.
- Catena GUI and remote monitoring capabilities.
- T2S ETH interface.

7.2.1 T-1PS 25 kVA System - General arrangement

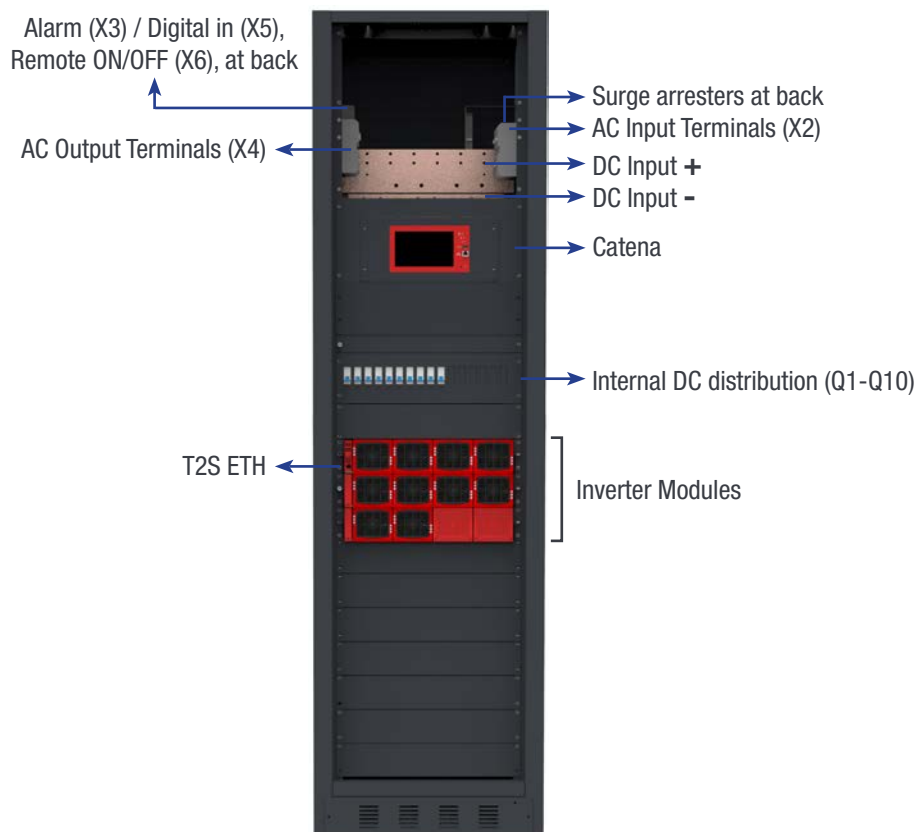


Figure 6. T-1PS 25 kVA System - General Arrangement

7.2.2 T-1PS 75 kVA System - General arrangement

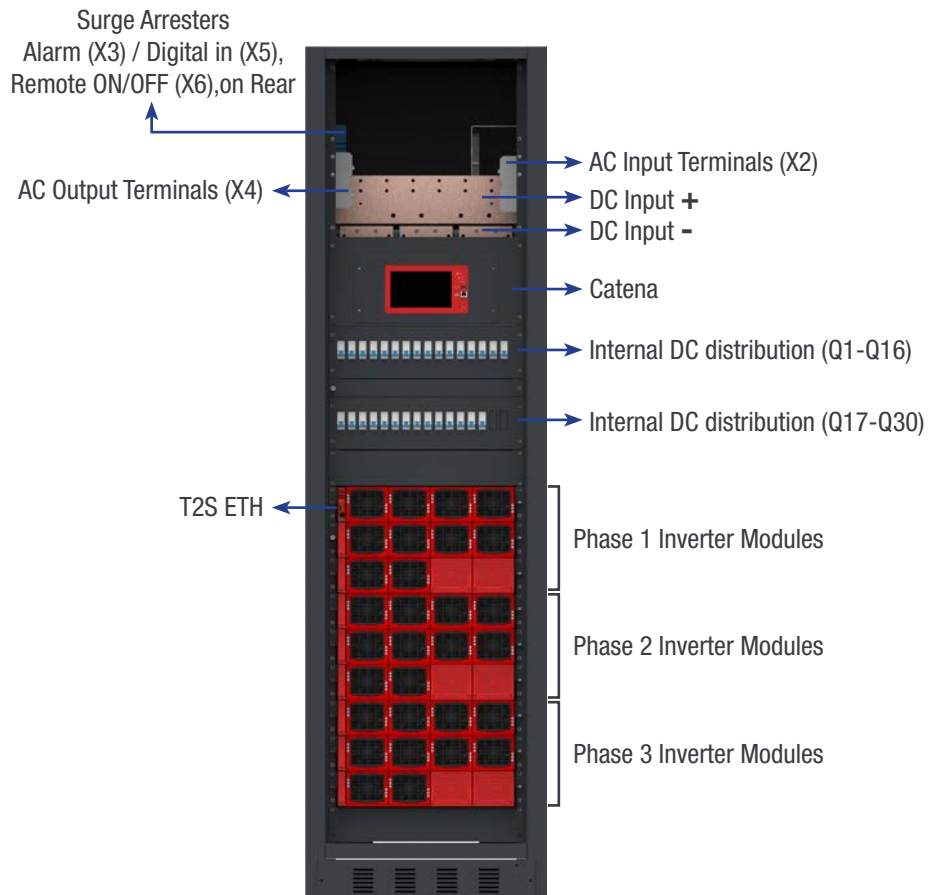


Figure 7. T-1PS 75 kVA System - General Arrangement

7.3 Installation considerations

- All models of T-1 PS are Listed according to UL 1778 - 5th edition (File E323449).
- All models of T-1 PS are FCC compliant according to report L1R90028 issued by SGS Germany on June 19th, 2017.

7.3.1 T-1PS 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 Model | Max Power (kVA) | Max power (KW) | Number of Shelves | Max number of Modules |
|---------------------|-----------------|----------------|-------------------|-----------------------|
| T-1PS-48-1-20-00-08 | 20 | 16 | 2 | 8 |
| T-1PS-48-1-25-00-10 | 25 | 20 | 3 | 10* |

Table 1. Single Phase 120 VAC - System Details

* The remaining two slots are not available for customer use due to UL restrictions.

| System Model | Bulk DC** input | | | 2 DC** input | | |
|---------------------|-----------------|--------------------------------|-------------|-----------------|--------------------------------|----------------------|
| | Fuse or Breaker | Cable Min | Cable Max | Fuse or Breaker | Cable Min (per feed) | Cable Max (per feed) |
| T-1PS-48-1-20-00-08 | 500 A | 2x300 kcmil or 3x3/0 AWG | 9x500 kcmil | 2x250 A | 1x300 kcmil or 2x1/0 AWG | 3x500 kcmil |
| T-1PS-48-1-25-00-10 | 600 A | 2x500 kcmil or 3x4/0 AWG | 9x500 kcmil | 2x300 A | 1x500 kcmil or 2x2/0 AWG | 3x500 kcmil |

Table 2. Single Phase 120 VAC - DC Details

** Refer Section 8.5.4, page 30

| System Model | AC input & AC output | | |
|---------------------|----------------------|-----------|----------------------------------|
| | Branch Protection | | Cable Max based on Terminal Size |
| | Breaker | Cable Min | |
| T-1PS-48-1-20-00-08 | 225 A | 250 kcmil | 300 kcmil |
| T-1PS-48-1-25-00-10 | 250 A | 300 kcmil | 300 kcmil |

Table 3. Single Phase 120 VAC - AC Details

7.3.2 T-1PS 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 Model | Max Power (kVA) | Max power (KW) | Number of Shelves | Max number of Modules |
|---------------------|-----------------|----------------|-------------------|-----------------------|
| T-1PS-48-2-20-00-08 | 20 | 16 | 2 | 8** |
| T-1PS-48-2-40-00-16 | 40 | 32 | 4 | 16** |
| T-1PS-48-2-50-00-20 | 50*** | 40*** | 6 | 20**/*** (24****) |

Table 4. Single Phase 240 VAC - System Details

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

** Number of modules must be even with the 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 Model | Bulk DC**** input | | | 2 DC**** input | | |
|---------------------|-------------------|----------------------------------|-------------|-----------------|--------------------------------|----------------------|
| | Fuse or Breaker | Cable Min | Cable Max | Fuse or Breaker | Cable Min (per feed) | Cable Max (per feed) |
| T-1PS-48-2-20-00-08 | 500 A | 2x300 kcmil or 3x3/0 AWG | 9x500 kcmil | 2x250 A | 1x300 kcmil or 2x1/0 AWG | 3x500 kcmil |
| T-1PS-48-2-40-00-16 | 1000 A | 3x500 kcmil or 4x300 kcmil | 9x500 kcmil | 2x500 A | 2x300 kcmil or 3x3/0 AWG | 3x500 kcmil |
| T-1PS-48-2-50-00-20 | 1200 A | 4x500 kcmil or 6x4/0AWG | 9x500 kcmil | 2x600 A | 2x500 kcmil or 3x4/0 AWG | 3x500 kcmil |

Table 5. Single Phase 240 VAC - DC Details

***** Refer Section 8.5.4, page 30

| System Model | AC input & AC output | | |
|---------------------|----------------------|-----------|----------------------------------|
| | Branch Protection | | Cable Max based on Terminal Size |
| | Breaker | Cable Min | |
| T-1PS-48-2-20-00-08 | 110 A | 1 AWG | 1 AWG |
| T-1PS-48-2-40-00-16 | 225 A | 250 kcmil | 300 kcmil |
| T-1PS-48-2-50-00-20 | 250 A | 300 kcmil | 300 kcmil |

Table 6. Single Phase 240 VAC - AC Details

7.3.3 T-1PS 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 Model | Max Power (kVA) | Max power (KW) | Number of Shelves | Max number of Modules |
|---------------------|-----------------|----------------|-------------------|-----------------------|
| T-1PS-48-3-30-00-12 | 30 | 24 | 3 | 12 * |
| T-1PS-48-3-60-00-24 | 60 | 48 | 6 | 24 * |
| T-1PS-48-3-75-00-30 | 75 | 60 | 9 | 30 * |

Table 7. Three Phase 208 VAC - System Details

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

| System Model | Bulk DC** input | | | 3 DC** input | | |
|---------------------|-----------------|----------------------------------|-------------|-----------------|----------------------------|----------------------|
| | Fuse or Breaker | Cable Min | Cable Max | Fuse or Breaker | Cable Min (per feed) | Cable Max (per feed) |
| T-1PS-48-3-30-00-12 | 700 A | 3x300 kcmil or 4x3/0 AWG | 9x500 kcmil | 3x250 A | 1x300 kcmil or 2x1/0AWG | 2x500 kcmil |
| T-1PS-48-3-60-00-24 | 1600 A | 5x500 kcmil or 7x300 kcmil | 9x500 kcmil | 3x500 A | 2x250 kcmil | 2x500 kcmil |
| T-1PS-48-3-75-00-30 | 2000 A | 6x500 kcmil or 8x300 kcmil | 9x500 kcmil | 3x600 A | 2x500 kcmil | 2x500 kcmil |

Table 8. Three Phase 208 VAC - DC Details

** Refer Section 8.5.4, page 30

| System Model | AC input & AC output | | |
|---------------------|----------------------|-----------|----------------------------------|
| | Branch Protection | | Cable Max Based on Terminal Size |
| | Breaker | Cable Min | |
| T-1PS-48-3-30-00-12 | 110 A | 1 AWG | 1 AWG |
| T-1PS-48-3-60-00-24 | 225 A | 250 kcmil | 300 kcmil |
| T-1PS-48-3-75-00-30 | 250 A | 300 kcmil | 300 kcmil |

Table 9. Three Phase 208 VAC - AC Details

7.3.4 TSI Bravo module - Current ratings

| # Modules | Rated AC Output Current per Phase (Amps) @ 120 Vac | Rated DC Input Current per Polarity (Amps) @ 48 Vdc |
|---|--|---|
| 120 Vac - Single Phase - 2 Wires + PE | | |
| 1 | 20.83 | 48.00 |
| 2 | 41.66 | 96.00 |
| 3 | 62.49 | 144.00 |
| 4 | 83.32 | 192.00 |
| 5 | 104.15 | 240.00 |
| 6 | 124.98 | 288.00 |
| 7 | 145.81 | 336.00 |
| 8 | 166.64 | 384.00 |
| 9 | 187.47 | 432.00 |
| 10 | 208.30 | 480.00 |
| 120/240 Vac - Single Phase - 3 Wires + PE | | |
| 2 | 20.83 | 96.00 |
| 4 | 41.66 | 192.00 |
| 6 | 62.49 | 288.00 |
| 8 | 83.32 | 384.00 |
| 10 | 104.15 | 480.00 |
| 12 | 124.98 | 576.00 |
| 14 | 145.81 | 672.00 |
| 16 | 166.64 | 768.00 |
| 18 | 187.47 | 864.00 |
| 20 | 208.30 | 960.00 |
| 120/208 Vac - Three Phase - 4 Wires + PE | | |
| 3 | 20.83 | 144.00 |
| 6 | 41.66 | 288.00 |
| 9 | 62.49 | 432.00 |
| 12 | 83.32 | 576.00 |
| 15 | 104.15 | 720.00 |
| 18 | 124.98 | 864.00 |
| 21 | 145.81 | 1,008.00 |
| 24 | 166.64 | 1,152.00 |
| 27 | 187.47 | 1,296.00 |
| 30 | 208.30 | 1,440.00 |
| Upstream / downstream protections and field wiring should be based on the maximum number of modules. | | |

Table 10. Module Current Details

8. System Installation

8.1 Site Preparation

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

When installing T-1PS 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 T-1PS.

At Output

An appropriate branch protection should be provided between T-1 PS and the loads.

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

- Refer to Section 7 for sizing protections and connecting cables. All cables must be copper 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.
- 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 the dummy cover.
- T-1PS is designed for temperature controlled (max 40°C / 104°F) and clean environments. The presence of airborne particles such as urban dust, sand and metallic dust is 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.

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 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 lying 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.

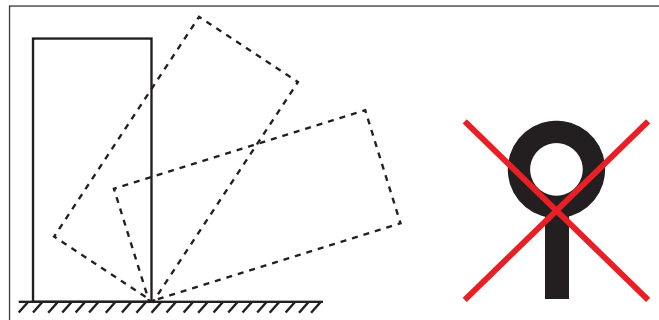


Figure 8. Cabinet Lifting

8.3 Module packing

Modules ordered with the system are packed separately in a carton or a pallet.

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 Anchoring the cabinet to the floor

The cabinet is fixed through the base of the cabinet.

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

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

Must have 36" (900 mm) clearance at the front and back.

The installer has to level and plumb the frames in order to compensate the variations in floor flatness.

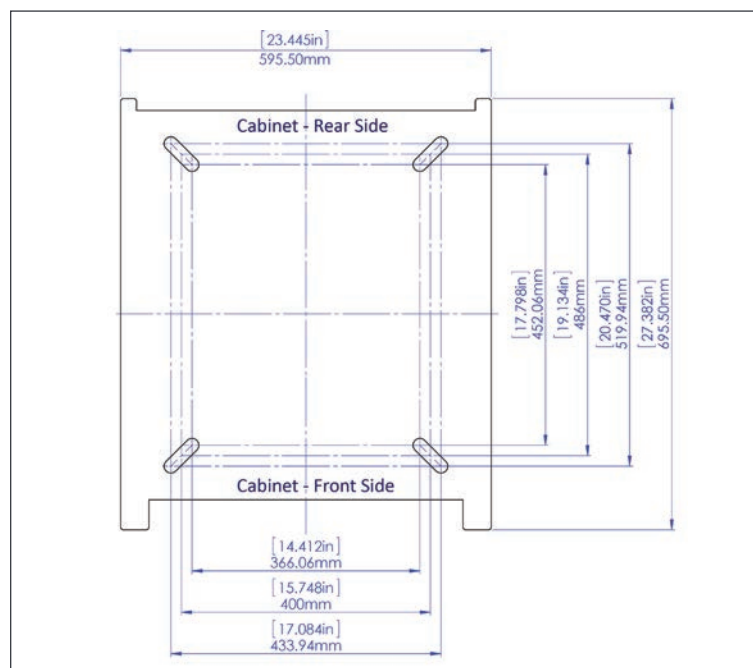


Figure 9. Anchor hole locations

8.5 Cabling

Check section 7, page 18 to identify system configuration and refer to section 7.3, page 21 for cable sizes. Refer also to 8, page 25 for important safety notices.

8.5.1 Cable inlets

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

Cables entrances should be protected by bushings, UL category NZMT2, rated for minimum 50°C.

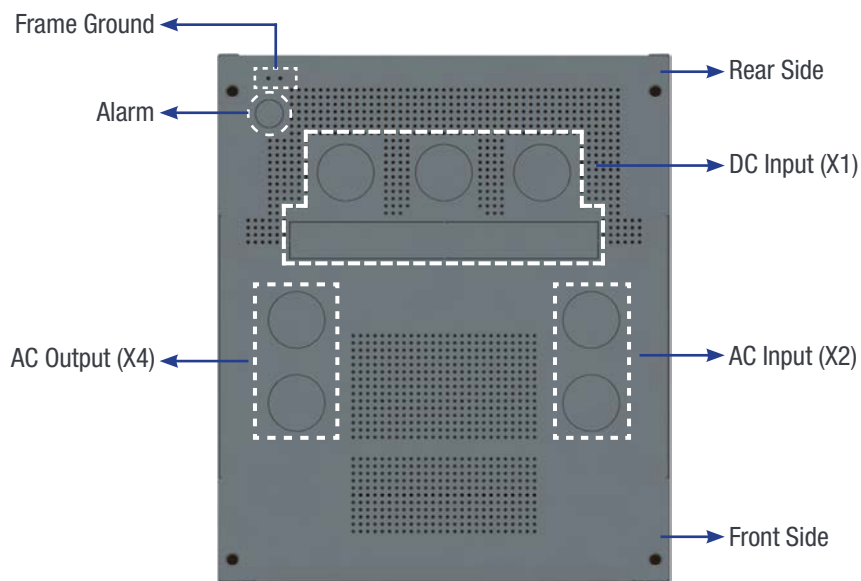


Figure 10. Cable Inlet – Positions

8.5.2 Grounding

The main protective conductor connection is made to the X2 (AC IN) terminal, which is marked with a symbol for identification.



The ground must be terminated even if commercial Mains are not available. Recommended cable cross section is the size equal (min) to Neutral cable cross section. Adhere to local regulations. (See 8.5.3, page 29)

The ground has to be connected in accordance with local code and NEC - NFPA 70.

T-1 PS is only intended for Common Bonding Network (CBN).

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

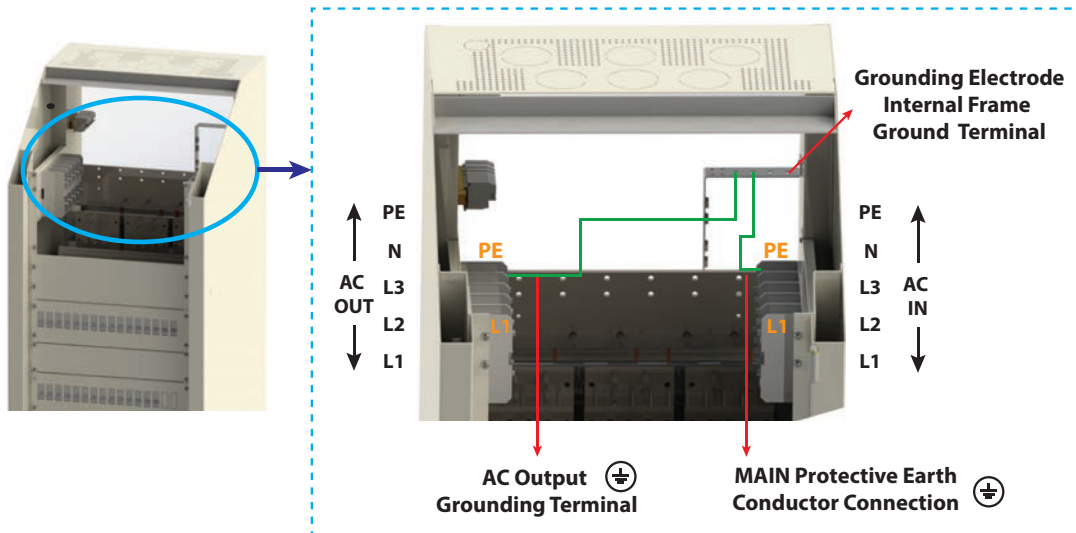


Figure 11. Earthing connections

8.5.3 AC Input and Output

The pictorial representation of the arrangement of the terminal block is as follow.

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

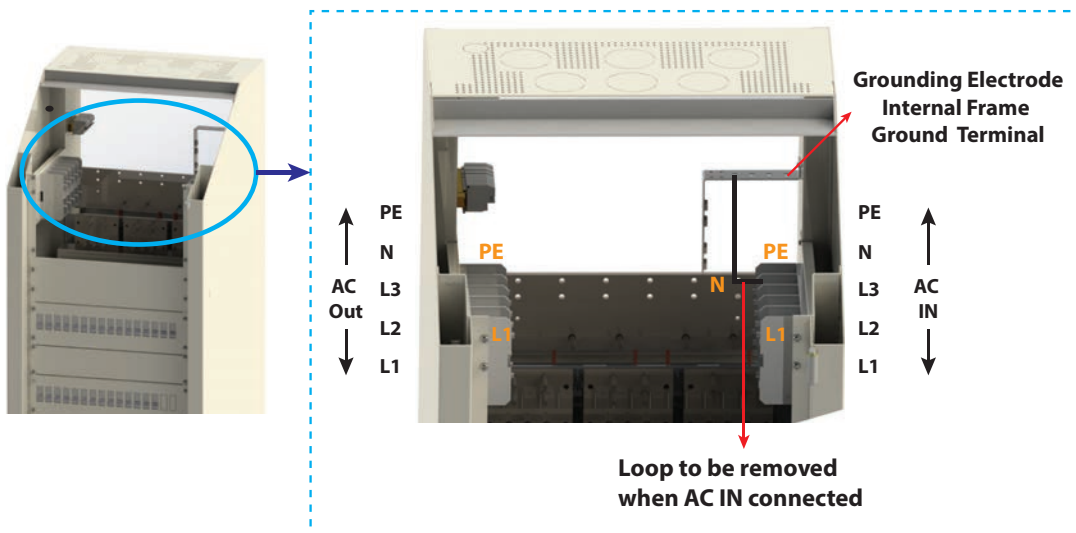


Figure 12. AC IN and Frame ground looping

Note:

When the AC mains is not connected, the output AC circuit is considered to be a separately-derived source. If local codes require grounding of this circuit, use the PE output terminal bonding that circuit to the enclosure and ground the enclosure to a suitable grounding electrode in accordance with local code requirements.

The AC Input (X2) and AC Output (X4) terminals shall be wired as per following indications:

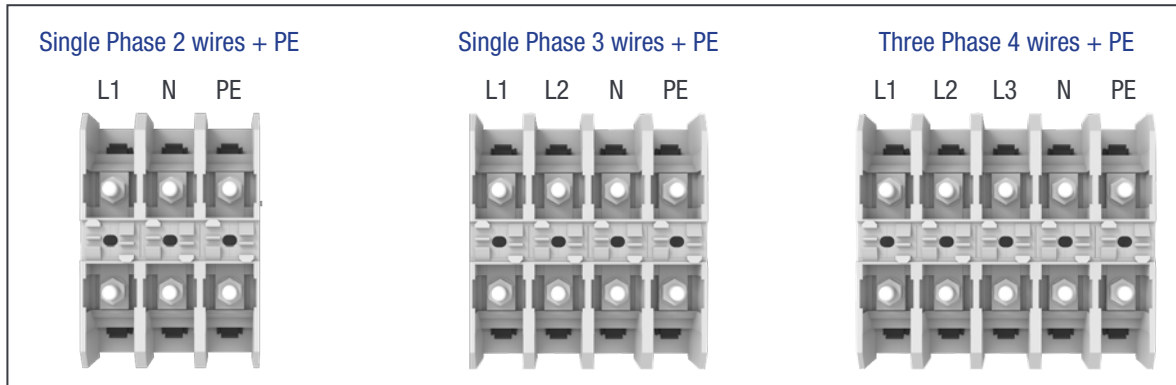


Figure 13. AC Input (X2) and Output (X4) - Terminal blocks

Note: Refer section 8.5.3, page 29 for the L, N and PE connections of AC input and output terminal.

WARNING !!!
Recommendation of IEC 60364 4. 43

431.3 Disconnection and reconnection of the neutral conductor in multi-phase systems

Where disconnection of the neutral conductor is required, disconnection and reconnection shall be such that the neutral conductor shall not be disconnected before the line conductors and shall be reconnected at the same time as or before the line conductors.

8.5.3.1 Torque - AC Input and Output

| System | AC IN & Out Terminal (ENTRELEC) | Torque ft-lb | Metric Equivalent | CE+T Standard Torque ft-lb |
|--------|---------------------------------|---------------|-------------------|----------------------------|
| T-1PS | Terminal 35 MM ² | 2.21 to 4.43 | M5 | 3.69 |
| | Terminal 120 MM ² | 7.38 to 14.75 | M10 | 14.75 |

8.5.4 DC Input

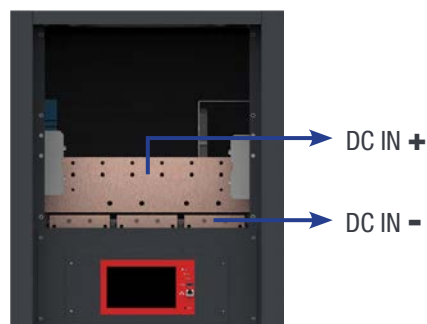


Figure 14. DC Position

8.5.4.1 Torque - DC Input

| System | DC IN | Torque ft-lb | Metric Equivalent | CE+T Standard Torque ft-lb |
|--------|---|-----------------|----------------------|----------------------------------|
| T-1PS | 3/8-24 UNF Bolt connection on copper bar | 17.70 | M10 | 17.70 |

8.5.4.2 Single feed DC Input

- Common DC input per system.
- 2 hole 1/2" (M12) holes with 1-3/4" (44.45 mm) between center or 2 hole 3/8" (M8) holes with 1" (25.4 mm) between center.
- Internal DC distribution with circuit breakers (Q01-Q30) per inverter module.
- Max 9 x 500 kcmil (240 mm²).

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

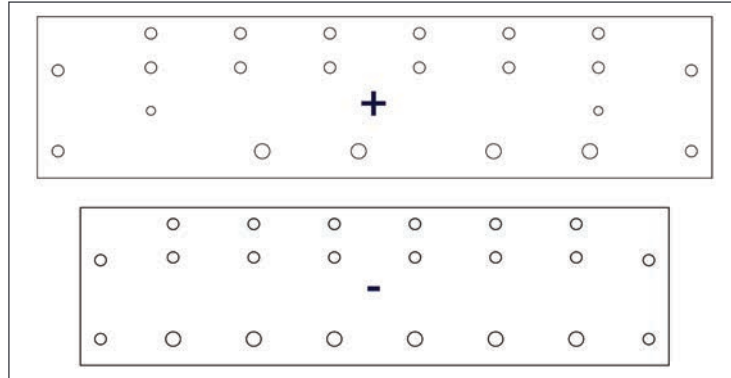


Figure 15. Single Feed DC - Bus Bar arrangements

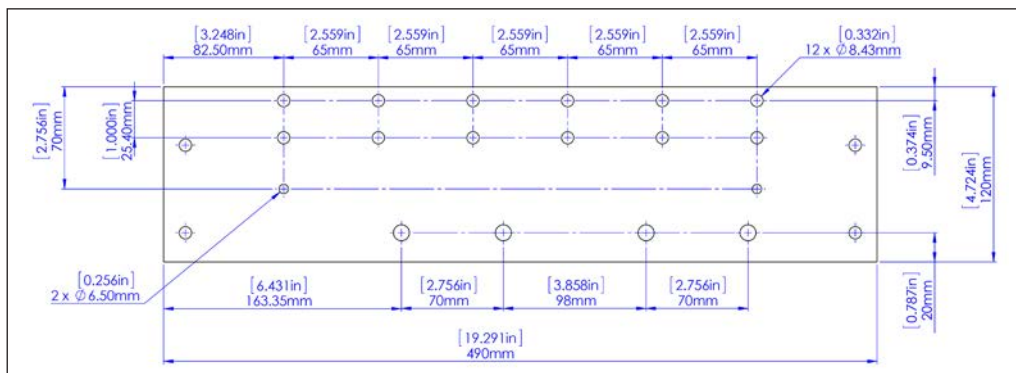


Figure 16. Single Feed DC - Negative bar hole details

8.5.4.3 Dual DC Feed Input

- 2 x DC input per system.
- 2 hole 1/2" (M12) holes with 1-3/4"(44.45 mm) between center or 2 hole 3/8"(M8) holes with 1"(25.4 mm) between center.
- Internal DC distribution with circuit breakers (Q01-Q30) per inverter module.
- Max 3 x 500 kcmil (240 mm²) per pole (group)

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

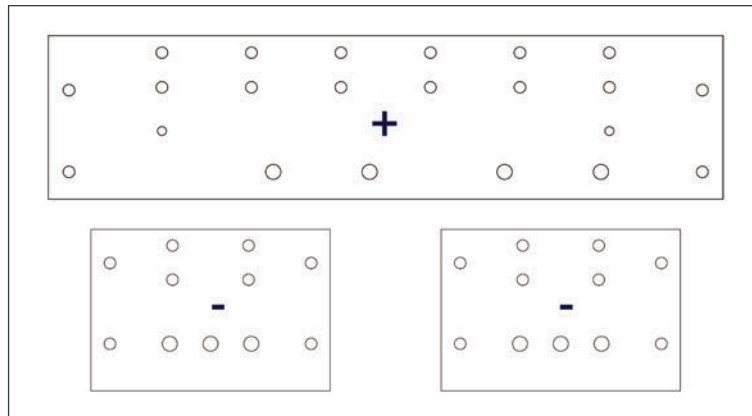


Figure 17. Dual DC Feed - Bus Bar arrangements

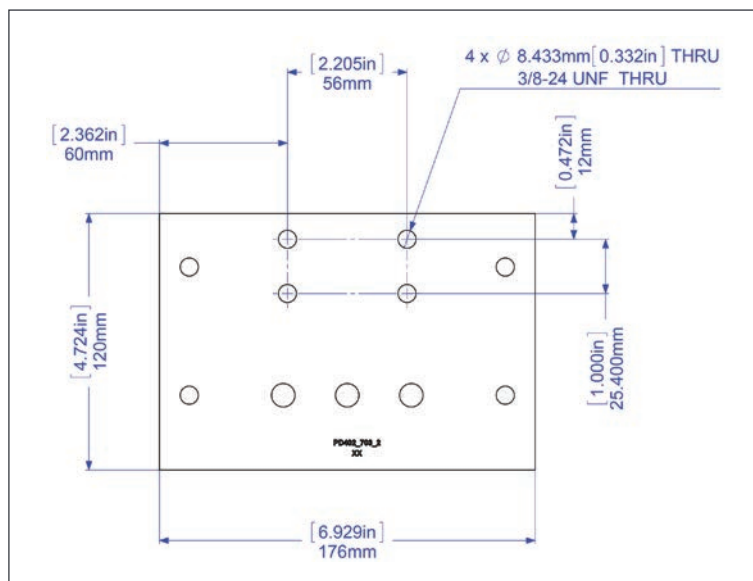


Figure 18. Dual DC Feed - Negative bar hole details

8.5.4.4 Dual DC Feed - Internal Wiring Pattern

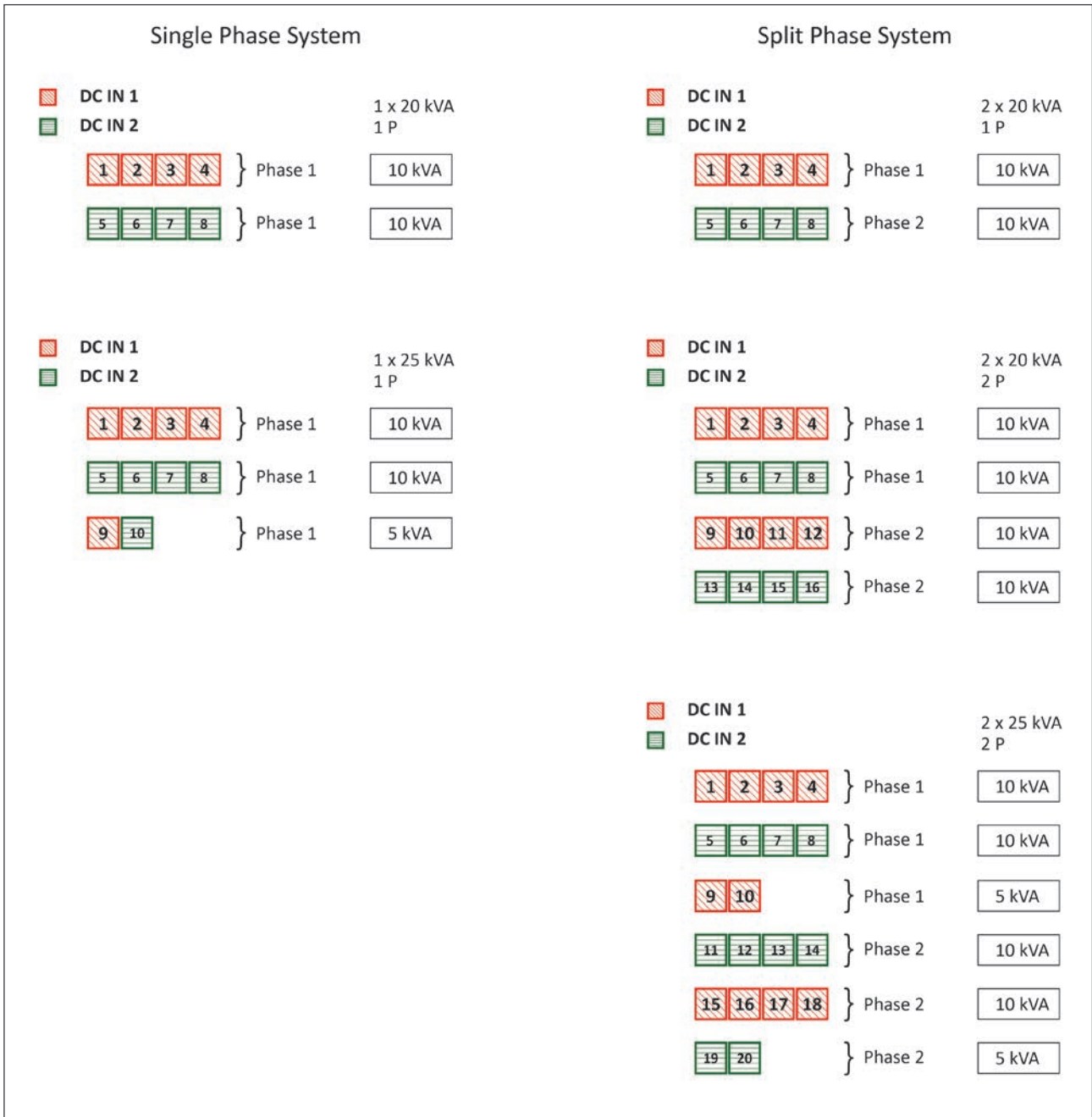


Figure 19. Dual DC - Arrangement

8.5.4.5 Triple DC Feed Input

- 3 x DC input connection per system.
- Two holes of $\frac{3}{8}$ " 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 mm²) 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.

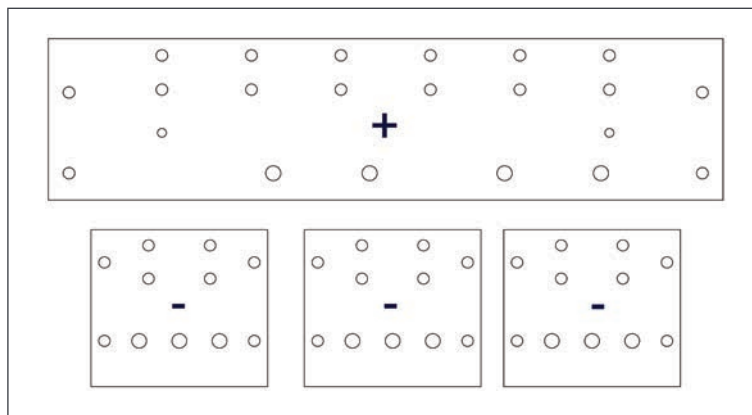


Figure 20. Triple DC Feed - Bus bar arrangements

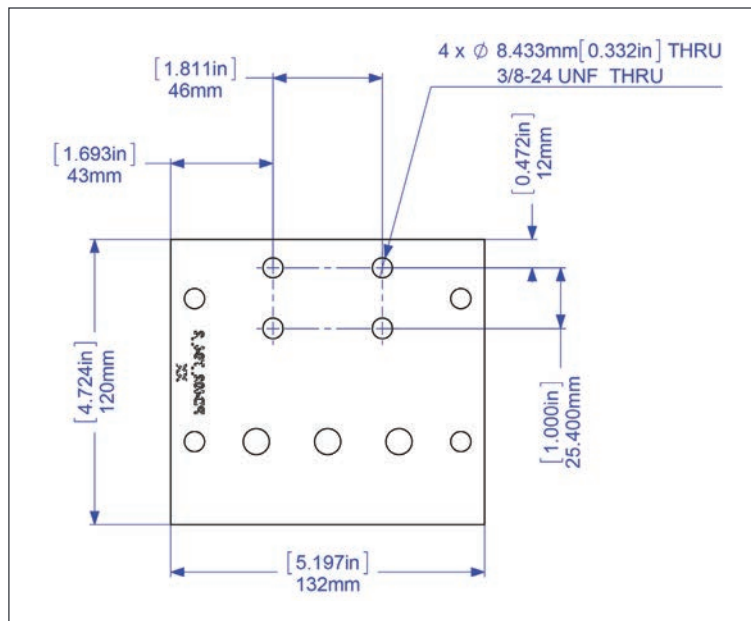


Figure 21. Triple DC Feed - Negative bar hole details

8.5.4.6 Triple DC Feed Input - Internal Wiring Pattern

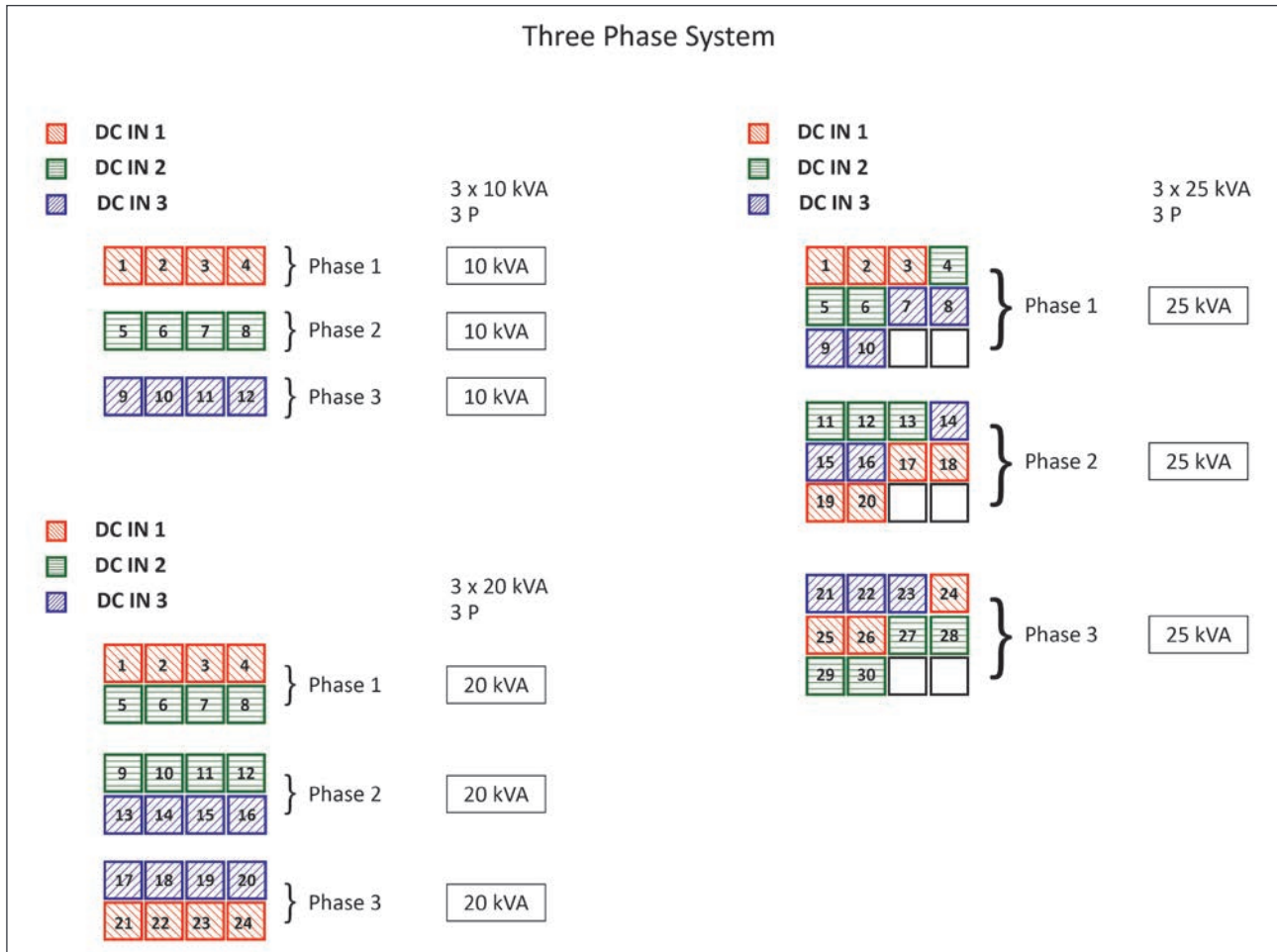


Figure 22. Triple DC - Arrangement

8.5.5 Signaling

All relays are shown in non energized state.

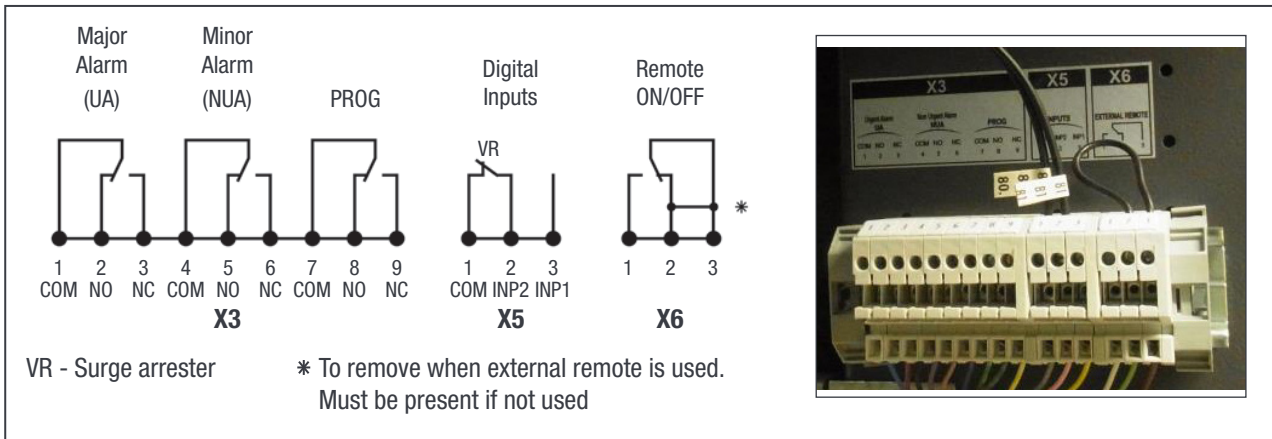


Figure 23. Alarm dry contacts

Note:

The output relays delay time can set from 2 to 60 seconds.

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

8.5.5.1 Alarm (X3)

- Relay characteristics X3 (Major (UA), Minor (NUA), Prog)
 - Switching power 60 W
 - Rating 2 A at 30 VDC / 1 A at 60 VDC
 - Max wire size 16 AWG (1mm²)

Note: In idle condition, the relays are energized, and contacts are released when the event occurs.

8.5.5.2 Digital In (X5)

- Input characteristics X5 (Digital In 1, Digital In 2)
 - Signal voltage +5 VDC (galvanically insulated)
 - Max wire size 16 AWG (1mm²)

Note: To configure alarm severities for the relay such as Major, Minor and Relay 3, go to *Parameters > Inputs/Relays > Relays Mapping*. For more details, refer relay mapping section in T2S ETH user manual.

8.5.5.3 Remote ON/OFF (X6)

The function of remote ON/OFF is used to turn off the module/system output.

By default, a jumper is placed between pin 3 and 2. If remote on/off is used, jumper should be removed from the shelf and connect changeover contactor.

- Input DC is not affected by the remote ON/OFF.
- The remote ON/OFF requires changeover contacts, one input opens as the other in close. If both transitions are not picked up then the status is not changed.
- Digital input characteristics (Remote On/Off)
 - Signal voltage +5 VDC (galvanically insulated)
 - Max wire size 16 AWG (1mm²)

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 (OFF) DC Input (Green) |
| 3 | Open | Closed | Normal operation | All (Green) |
| 4 | Closed | Closed | Normal operation | All (Green) |

Table 11. Remote ON/OFF Operation

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

8.6 Switching OFF T-1PS System

Perform the following steps to Switch OFF the T-1PS System.

Caution: While switching OFF the T-1PS System, the power to load will be disconnected.

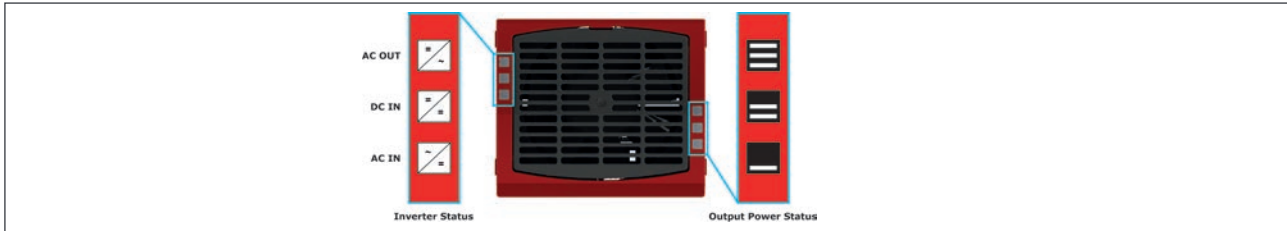
1. Switch OFF AC Output Breakers.
2. Switch OFF AC Input Breakers.
3. Switch OFF DC Input Breakers.
4. Switch OFF the Upstream and Downstream Breakers.

Caution: Risk of electric shock. Capacitors store hazardous energy. Do not remove the system from the cabinet; wait at least five minutes after disconnecting all sources of power.

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 |

| Output Power (redundancy not counted) | | | | | | | Output Power (redundancy not counted) |
|---------------------------------------|-----------|-----------|-----------|------|-----------------|--|---------------------------------------|
| <5% | 5% to 40% | 40 to 70% | 80 to 95% | 100% | 100% = overload | Status output power LED | |
| × | × | × | ≡ | ≡ | ≡ | Behaviour (B - Blinking : P - Permanent) | |
| × | × | = | = | = | = | | |
| — | — | — | × | — | — | | |
| 1B | 1P | 2P | 2P | 3P | 3B | | |

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.

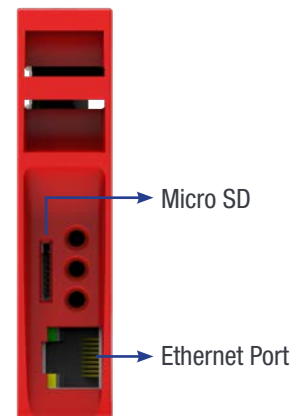


Figure 24. T2S ETH Front Details

9.3 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 display.

9.3.1 User GUI Interface Catena

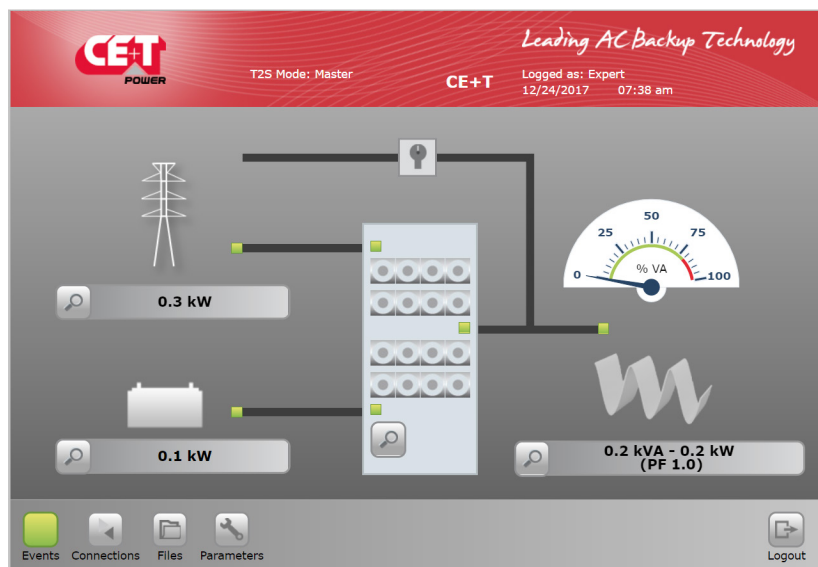


Figure 25. Catena - Home page

Catena provides a quick and efficient user interface to:

- Get and an overview of the system information
- Detail 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.

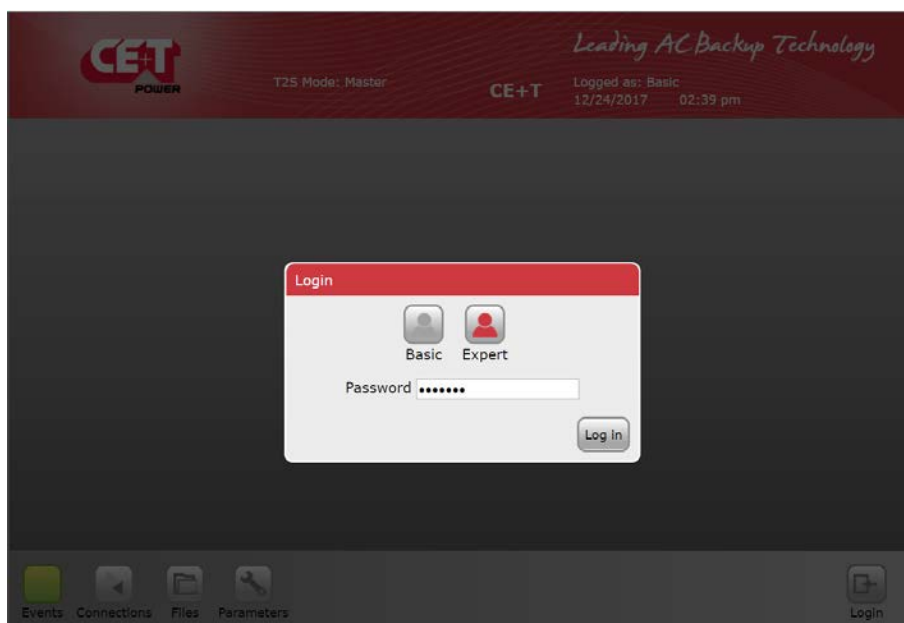


Figure 26. Catena – Login page

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.

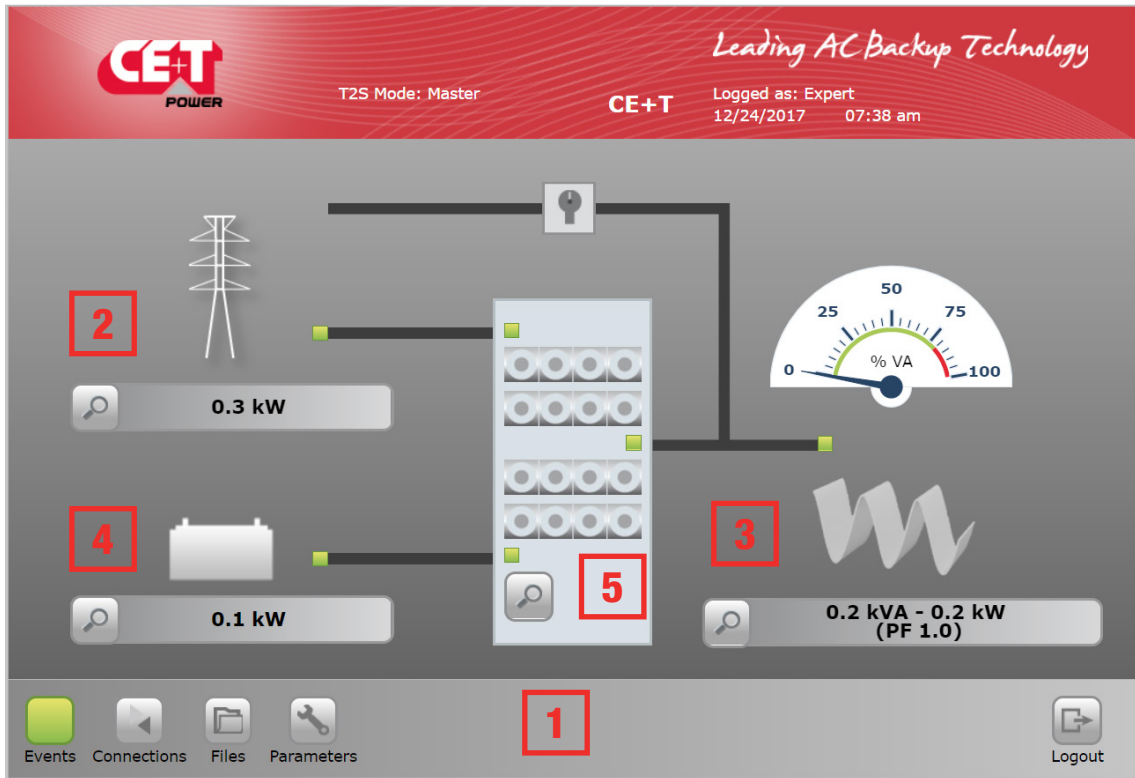


Figure 27. Catena – Home page details

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.

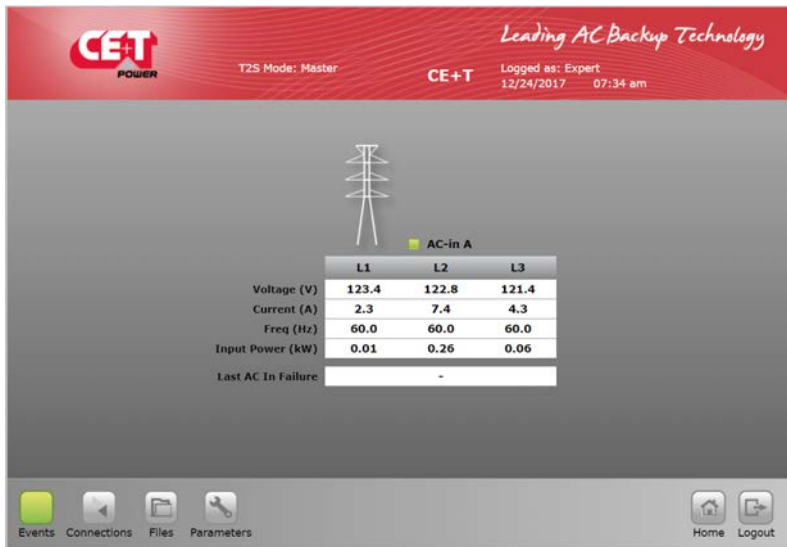
All LED symbols indicate if there are any alarms present in the system.

- 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:



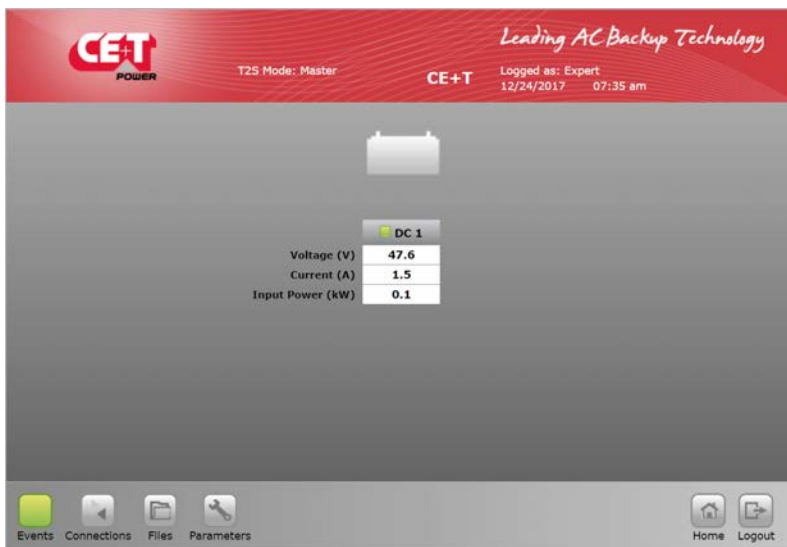
This screen provides the following information:

- 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 28. 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 29. 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

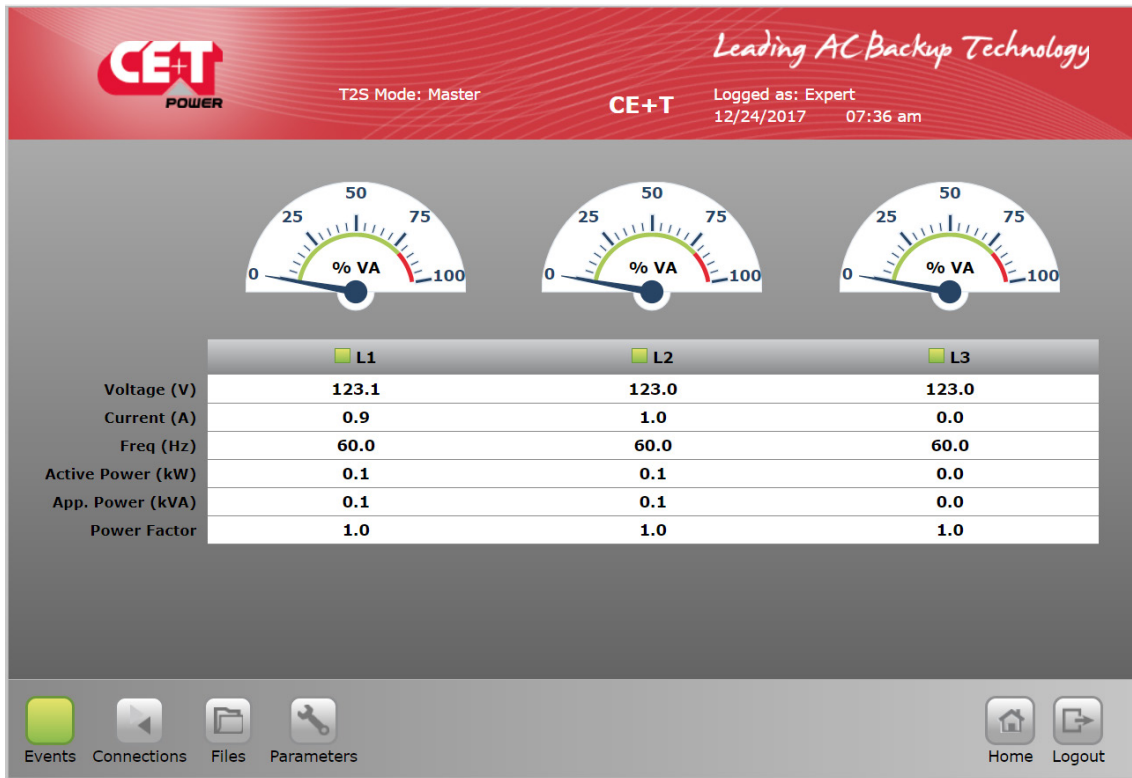




Figure 30. Catena – AC output page

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 31. 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  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

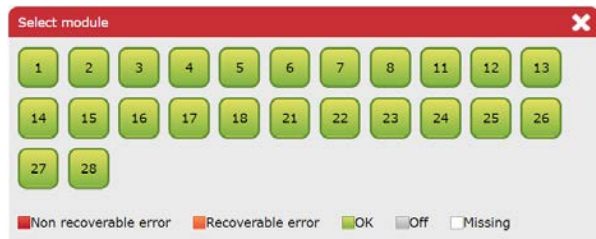


Figure 32. Catena – Module list

For last two, refer to module manual for troubleshooting.

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 33. Catena - Module page

9.3.2 Toolbar




Figure 34. Catena - Toolbar

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.

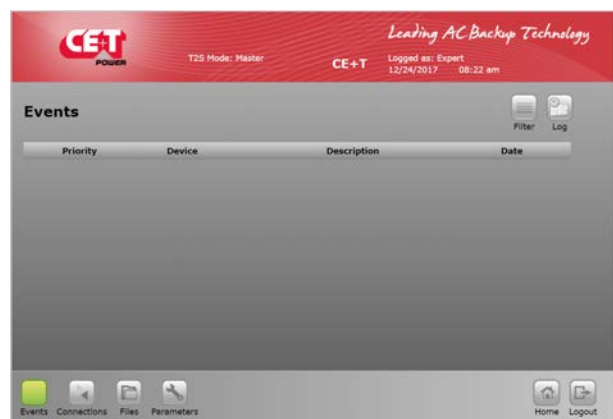



Figure 35. Catena – Events page



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.

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

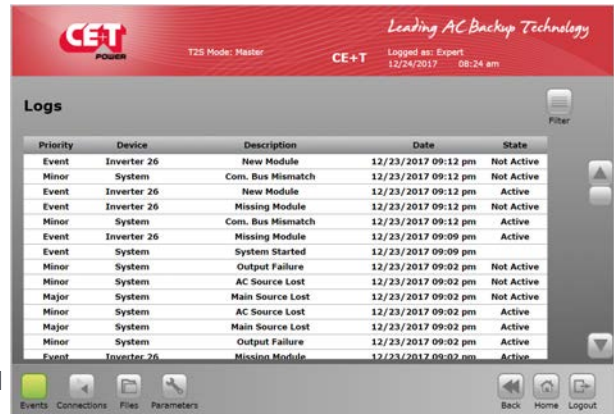


Figure 36. Catena – Logs page

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.

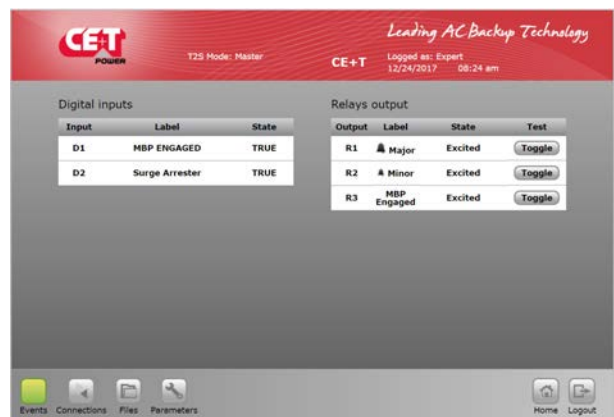


Figure 37. Catena – Connections page

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.

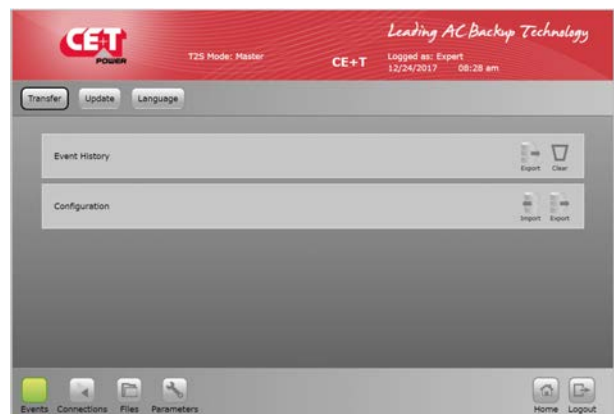


Figure 38. Catena – Files page

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 39. 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.

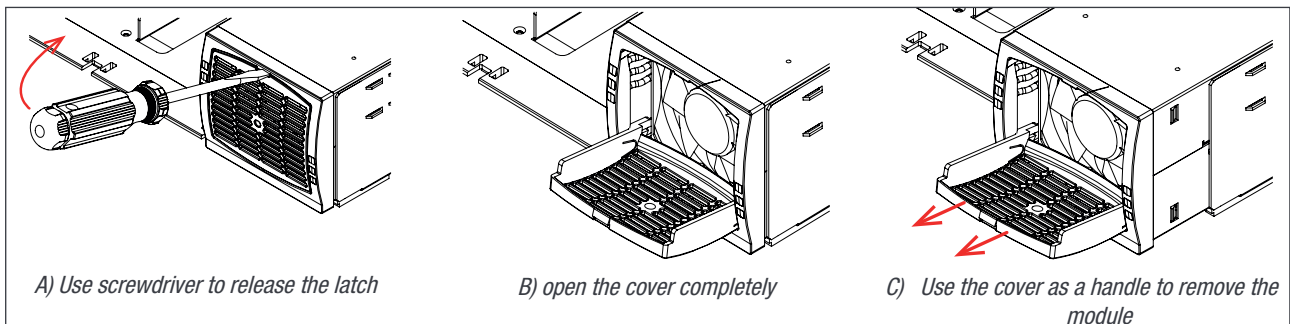


Figure 40. Module Removal

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.

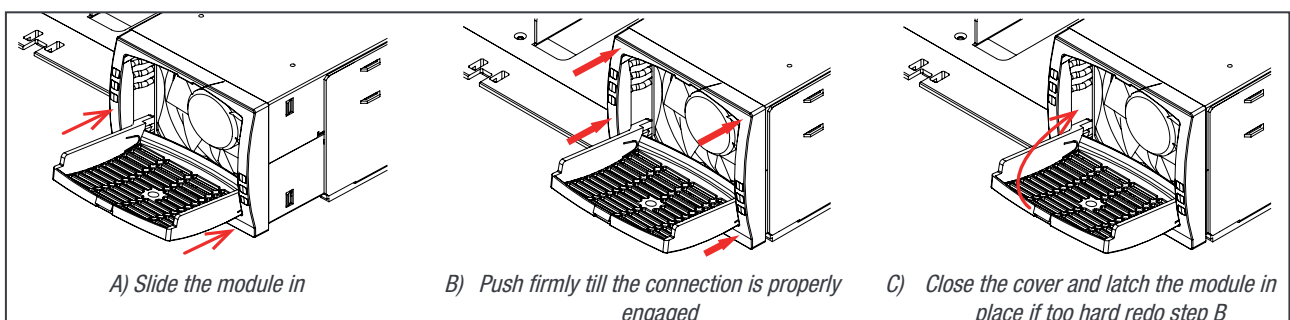


Figure 41. Module Inserting

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 42. 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.

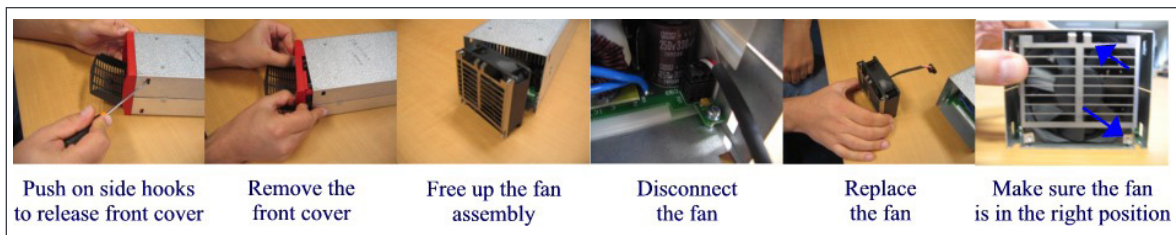


Figure 43. Module Fan Replacement

11. Final check

- Make sure that the sub-rack/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 sized according to recommendations and local regulations.
- Make sure that all cables have strain relieved.
- Make sure that all breakers are sized according to recommendation and local regulations.
- Make sure that DC polarity is according to marking.
- Torque all electrical terminations according to recommendation and local regulations.
- Make sure that no inverter/controller bays are left open.
- Cover empty inverter bays with dummy cover.
- 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.

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

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

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

12.1 Check list

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

13. Trouble shooting

13.1 Trouble shooting

| | |
|------------------------------------|--|
| Inverter module does not power up: | <ul style="list-style-type: none"> 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: | <ul style="list-style-type: none"> 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: | <ul style="list-style-type: none"> 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: | <ul style="list-style-type: none"> Check output breaker |
| All OK but I have alarm: | <ul style="list-style-type: none"> Check configuration file and correct No of modules Download/clear log file |
| No output alarm: | <ul style="list-style-type: none"> Check the default time delay (UA “Major Alarm” - 60s, NUA “Minor Alarm” - 30s) Check configuration file |
| No information on Catena: | <ul style="list-style-type: none"> Check that T2S ETH is present and properly inserted Check that the RJ45 cable is connected between T2S ETH shelf and Catena |

13.2 Defective modules

Unless input power is down, all LED's on each module should be green (see section 9, page 38). 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.

13.2.1 Replacing modules

Refer to section 10, page 48 to remove and re-insert modules.

13.2.2 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 13.2.4, page 54.


13.2.3 Return defective shelf

There are no active devices on the inverter module shelf. Due to this failure of the shelf is uncommon and difficult to validate. If it is determined that the shelf is faulty please dispose as per section 13.2.4, page 54.

13.2.4 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.

| TSI-EPC 48V-120VAC-BRAVO |
|--|
| P/N: T321330271 S/N: 018990 |
| INPUT Vdc in : 48 V (40-60) Idc in : 48A --- Vac in: 120V (83-140) 50/60Hz Iac in: 18A |
| OUTPUT: Vac out:120 V (100-130) 50/60Hz Iac out : 21A Max Power: 2000W/2500VA |
|  |
| BURN IN STAMP 39/18 |
| Designed in Belgium Made in CE+T PSS |

| TSI-EPC 48V-120VAC-BRAVO |
|--|
| P/N: T321330271 S/N: 000158 |
| INPUT Vdc in : 48 V (40-60) Idc in : 48A --- Vac in: 120V (83-140) 50/60Hz Iac in: 18A |
| OUTPUT: Vac out:120 V (100-130) 50/60Hz Iac out : 21A Max Power: 2000W/2500VA |
|  |
| BURN IN STAMP 39/18 |
| Designed in Belgium Made in CE+T PSI |

14. 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.

15. 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.

