ABB solar inverters

Product manual
TRIO-20.0/27.6-TL-US
(20.0 to 27.6 kW)

Power and productivity
for a better world™

List of related manuals

TRIO manuals and guides	Code (English)
TRIO-20.0_27.6-TL-OUTD-US (-A) Quick Installation Guide	BCM.00202.1

T001CV

IMPORTANT SAFETY INSTRUCTIONS

This manual contains important safety instructions that must be followed during installation and maintenance of the rapid shutdown system.

SAVE THESE INSTRUCTIONS!

Keep this document in a safe place near the inverter for easy access during installation and maintenance.

THE INSTALLER MUST READ THIS DOCUMENT IN ITS ENTIRETY BEFORE INSTALLING THIS EQUIPMENT.

The purpose of this document is to support the qualified technician, who has received training and/or has demonstrated skills and knowledge in construction, to install and maintain this inverter. This manual covers only the details concerning the rapid shutdown components and how it is installed in the allowable ABB string inverters. Information concerning the equipment connected to this product is available from the respective manufacturers.

Warranty conditions can be found on the Rapid Shutdown product page of the website. NOTE: Any changes or modifications not approved by the manufacturer could void the warranty of this product.

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FCC REMARKS

The equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

Product Manual

TRIO-20.0/27.6 string inverters

TRIO-20.0-276-TL-OUTD-US(-A) Product manual
BCG.00627.2_AB NA

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Introduction and safety

1

Warnings in this document

This is a list of special safety symbols used in this manual that highlight potential safety risks and/or useful information. The symbol usage is described below:

	**CAUTION** The reader should stop, use caution and fully understand the operations explained before proceeding.
	**DANGEROUS VOLTAGE** The product works with high voltages. All work on the TRIO must follow the described documentation and must comply with all prevailing codes and regulations associated with high voltages.
	**HOT TEMPERATURE** Some surfaces may become hot; wear appropriate personal protective equipment (PPE) when working with this product.
	UL1741 Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources. CSA-C22.2 No. 107.1-01 - General Use Power Supplies.

Equipment safety warnings

In addition to the safety and hazard symbols, the following symbols are also used in this installation guide

	Equipment Ground, protective earth		
	Alternating current (AC)		Phase
	Direct current (DC)		Grounding (earth)

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General installation warnings

The TRIO transformerless inverter is designed and tested according to international safety requirements (UL1741/IEEE1547); however, certain safety precautions must be observed when installing and operating this inverter. Read and follow all instructions, cautions and warnings in this installation manual.

All operations regarding transport, installation start-up, and maintenance must be carried out by qualified, trained personnel and in compliance with all prevailing local codes and regulations.

Assembly warnings

Prior to installation, inspect the unit to ensure absence of any transport or handling damage, which could affect insulation integrity or safety clearances. The failure to do so could result in safety hazards.

Assemble the inverter per the instructions in this manual. Use care when choosing the installation location and adhere to specified cooling requirements.

Unauthorized removal of necessary protection features, improper use, incorrect installation or operation may lead to serious safety and shock hazards and/or equipment damage.

Electrical connection warnings

This grid-tied inverter system operates only when properly connected to the AC utility grid. Before connecting the TRIO grid-tied inverter to the AC utility grid, contact the local power distribution company to receive the appropriate approvals. The inverter-to-AC utility grid connection must be made only by qualified technical personnel.

Wiring methods used should be in accordance with the National Electric Code, ANSI/NFPA 70 and/or any prevailing local codes and regulations.

Output circuits must be isolated from the enclosure. System grounding, required by Sections 690.41 - 690.43 of the National Electric Code, ANSI/NFPA 70, is the responsibility of the installer.

The inverter should be connected only to a dedicated branch circuit. Models that include AC output overcurrent protection (-S1B) are intended for equipment disconnection and protection, not system disconnection. It is the responsibility of the end user to provide PV system disconnection and protection for the AC output circuit.

Connect only to a circuit provided with the maximum branch OCPD in accordance with the CSA document available at www.abb.com/solarinverters and listed in the technical data sheet of the appendix, section 7.

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Safety instructions

These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions. Be sure all flammable materials including construction items are away from the unit. Do not install the inverter in or near potentially explosive areas.

The TRIO is not provided with an isolation transformer and is intended to be installed per NFPA 70, 690.35 with an ungrounded PV array. These models have no grounded input conductors. Install the TRIO inverter in accordance with the electrical standards prescribed by the applicable National Electric Code (NEC), and/or by other local codes and regulations.

General information

The equipment has been manufactured in accordance with the strictest accident-prevention regulations and supplied with safety devices suitable for the protection of components and operators. Inform ABB about non-standard installation conditions.

It is essential to provide operators with correct information. They must read and comply with the technical information given in the manual and any other attached documentation. The instructions given in the manual do not replace the information and warnings on the safety labels mounted on the product. They do not replace the safety regulations enforced in the country of installation.

Maintenance operations must be carried out according to the maintenance section 6 of this manual. Do not use the equipment if any operating anomalies are found. Liabilities arising from commercial components are delegated to their respective manufacturers.

Thermal and voltage hazard

Depending upon ambient temperatures during operation and immediately following shutdown, surface temperatures on the cooling fins (heat sink) and some areas of the chassis may be extremely hot to the touch.

Prior to touching any part of the inverter, use care to ensure surfaces and equipment are at touch-safe temperatures and voltages before proceeding.

The customer and/or installer must appropriately instruct all personnel who may come near the equipment, and highlight, if necessary with notices or other means, the hazardous areas or operations (magnetic fields, hazardous voltages, high temperatures, possibility of discharges, generic hazard, etc.).

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Anytime the inverter has been disconnected from the AC utility grid, use extreme caution, as some components can retain charge sufficient to create a shock hazard and may need time to dissipate the charge. To minimize occurrence of such conditions, comply with all corresponding safety symbols and markings present on the unit and in this manual.

Clothing and protective devices

Appropriate Personal Protective Equipment (PPE) must be worn at all times when servicing this equipment under any conditions which may subject personnel to hazardous voltages or temperatures that are not touch-safe.

All operations on the equipment should be performed with properly electrically-insulated instruments.

Location of safety notices and labels

Note the location of safety notices on the inverter for notification and protection. Labels must not be hidden with external objects or parts such as rags, boxes, or other such equipment. They should be cleaned periodically and always maintained in view.

Appropriate usage

The TRIO inverter is a photovoltaic inverter that converts direct current of a connected PV array into alternating current and feeds that power into the AC utility grid. This inverter is designed for outdoor use, but can be used indoors if installed to specified environmental and mounting parameters stated in this manual, and adherence to codes enforced by the jurisdiction, such as the National Electric Code. (See environmental conditions below and environmental checks in Installation location, section 2.)

If installed indoors, the inverter must be inaccessible to unqualified persons.

Conditions of Use

WARNING! This inverter utilizes a transformerless design and requires connected array(s) to be floating with respect to ground; it can be used only with photovoltaic modules that do not require one of the terminals to be grounded.

- The DC and AC operating currents MUST NOT exceed the limits documented in the technical specifications in the Appendix, section 7.
- The inverter is certified for use only with photovoltaic arrays connected to its input channel(s). Do not connect batteries or other types of power sources.
- The inverter can only be used if all the technical requirements in this manual are observed and applied.

Environmental Conditions

Adverse environmental conditions can lead to a reduction in performance. The equipment should be installed outdoors, but only in environmental conditions indicated in this manual. Care must be taken to provide adequate ventilation if installed indoors.

Improper or Prohibited Use

The following actions are dangerous and not consistent with acceptable practice under the terms of the warranty:

- Installing the equipment in environments with flammable conditions.
- Using the equipment with safety devices not working or disabled.
- Using the equipment or parts of the equipment by connecting it to other machines or equipment, unless otherwise expressed.
- Modifying areas that are operator-restricted and/or altering parts of the equipment in order to vary the performance or change its protection.
- Cleaning with corrosive products that may corrode parts of the equipment or with products that might generate electrostatic charges.
- Using or installing the equipment or parts of it without having read and correctly interpreted the contents of this manual.
- Blocking airflow to the cooling fins (e.g., warming or drying rags) on the unit or accessory parts is dangerous and could compromise the inverter operation.

Arc fault detection (AFD)

The 2011 National Electric Code (NEC) and 2013 Canadian Electric Code (CEC) includes the requirement that a photovoltaic system with a DC voltage greater than 80V, and which is on a building or whose DC conductors enter a building, be equipped with a listed device which can detect a series DC arc fault and interrupt the circuit. This functionality is commonly referred to as a DC Arc Fault Circuit Interruption. The 2014 NEC Arc Fault requirements are not limited to systems on or in buildings and apply to all PV systems with a DC voltage greater than 80V. See 690.11 of the National Electric Code for more information.

The DC arc fault detection (AFD) solution is based on Digital Signal Processor (DSP) technology. The AFD module has two independent channels, designed to accommodate the two independent MPPT channels associated with all ABB string inverters, and has two current sensors and associated circuitry to identify the presence of a series DC arc fault at the input of either inverter MPPT channel.

The DC AFD module performs a self-test every time the system is started and the inverter display shows the result, which can only be pass or fail. If the inverter fails, an error code will be displayed and the inverter will not connect to the grid. If it passes, the inverter connects and works normally.

If a DC arc fault is detected during normal operations, the inverter disconnects from the AC grid. The DC arc fault error is indicated on the inverter display screen, and lock out of inverter operation is initiated until the fault is manually reset.

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NOTE: Refer to Arc Fault Detection Self-Test Errors (-A Models Only) in the Troubleshooting, section 5, for display error messages and instructions to reset fault conditions or manually start the self-test procedure.

Available versions

The inverters can be divided into two groups according to their rated output power of 20.0 kW or 27.6 kW. For inverters of equal output power, the differences between models are the configurations of the wiring box. A description of the wiring box configurations available can be found below.

20.0 kW MODELS	
TRIO-20.0-TL-OUTD-S-US-480 TRIO-20.0-TL-OUTD-S-US-480-A TRIO-20.0-TL-OUTD-S1-US-480 TRIO-20.0-TL-OUTD-S1-US-480-A TRIO-20.0-TL-OUTD-S1A-US-480 TRIO-20.0-TL-OUTD-S1A-US-480-A TRIO-20.0-TL-OUTD-S1B-US-480 TRIO-20.0-TL-OUTD-S1B-US-480-A	Dimensions (HxWxD): 41.7 x 27.6 x 11.5 in 1061 x 702 x 292 mm Weight: 157 lbs./71kg

27.6 kW MODELS	
TRIO-27.6-TL-OUTD-S-US-480 TRIO-27.6-TL-OUTD-S-US-480-A TRIO-27.6-TL-OUTD-S1-US-480 TRIO-27.6-TL-OUTD-S1-US-480-A TRIO-27.6-TL-OUTD-S1A-US-480 TRIO-27.6-TL-OUTD-S1A-US-480-A TRIO-27.6-TL-OUTD-S1B-US-480 TRIO-27.6-TL-OUTD-S1B-US-480-A	Dimensions (HxWxD): 41.7 x 27.6 x 11.5 in 1061 x 702 x 292 mm Weight: 168 lbs/76kg

Wiring box configurations available	
TRIO-20/27.6-TL-OUTD-S-US-480	DC Disconnect Switch
TRIO-20/27.6-TL-OUTD-S-US-480-A	DC Disconnect Switch Integrated PV AFCI Type 1 device for arc fault detection (AFD)
TRIO-20/27.6-TL-OUTD-S1-US-480	DC Disconnect Switch 8 string DC Input Fuses Class II DC Surge Protection
TRIO-20/27.6-TL-OUTD-S1-US-480-A	DC Disconnect Switch 8 string DC Input Fuses Class II DC Surge Protection Integrated PV AFCI Type 1 device for arc fault detection (AFD)

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Wiring box configurations available	
TRIO-20/27.6-TL-OUTD-S1A-US-480	DC Disconnect Switch 8 string DC Input Fuses Class II DC Surge Protection Class II AC Surge Protection
TRIO-20/27.6-TL-OUTD-S1A-US-480-A	DC Disconnect Switch 8 string DC Input Fuses Class II DC Surge Protection Class II AC Surge Protection Integrated PV AFCI Type 1 device for arc fault detection (AFD)
TRIO-20/27.6-TL-OUTD-S1B-US-480	DC Disconnect Switch 8 string DC Input Fuses Class II DC Surge Protection AC Fused Disconnect Switch
TRIO-20/27.6-TL-OUTD-S1B-US-480-A	DC Disconnect Switch 8 string DC Input Fuses Class II DC Surge Protection AC Fused Disconnect Switch Integrated PV AFCI Type 1 device for arc fault detection (AFD)

Regulatory label

Technical data in this manual does not supersede the data on the labels affixed to the equipment. The nameplate shown is affixed to the inverter and provides the following information:

1. Certification
2. Product origin
3. Model name
4. DC input data
5. AC output data

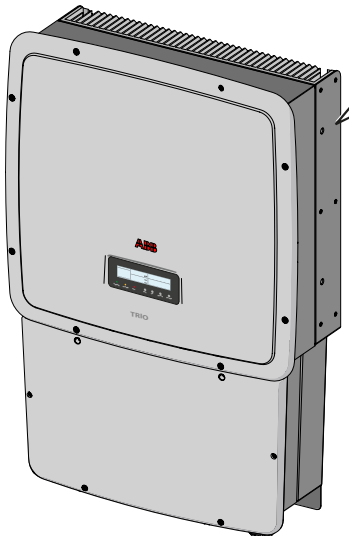

ABB ① C SA US UL 1741 CSA-C22.2 No. 107.1-01

www.abb.com/solar ② Made in Italy

SOLAR GRID TIED INVERTER
UTILITY INTERACTIVE - TRANSFORMERLESS INVERTER
MODEL: TRIO-20.0-TL-OUTD-S-US-480-A ③

DC RATING ④	
Nominal Input Operating Voltage	700 V⎓
Max. Input Voltage	1000 V⎓ (1)
Range of Input Operating Voltage	200 - 950 V⎓ (1)
Range of Input Voltage @Full Power	450 - 800 V⎓ (1)
Max. Input Current	25 A (1)(2)
Max. Input Short Circuit Current (P.V. Panels	30 A (1)(2)

AC RATING ⑤	
Nominal Output Voltage	480 V~ 3Ø
Operating Voltage Range	422-528 V~
Nominal Output Frequency	60 Hz (factory preset)
Operating Frequency Range	59.3 (3) - 60.5 Hz (4)
Output Power Factor	>0.995
Max. Output Current	27 A (rms)
Max. Continuous Output Power	20000 W @ 45°C amb.
Max. Output Overcurrent Protection	40 A (rms)

Operating Ambient Temperature: -25 to +60 °C (-13 to +140 °F), with Output Power Derating
Type of Enclosure: NEMA 4X
Photovoltaic Arc-Fault Circuit Protection - Type 1
(1): For More Details Refer to the Instructions Manual
(2): For each of the two input channels
(3): Adjustable from 57.0 Hz to 59.8 Hz
(4): Adjustable from 60.2 Hz to 63.0 Hz

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesidered operation.

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Installation location

2

Transportation and handling

Transportation of the equipment, especially by road, must be carried out by suitable ways and means for protecting the components (in particular, the electronic components) from violent shocks, humidity, vibration, etc. During handling, do not make any sudden or fast movements that can create dangerous swinging.

NOTE: During transportation the crated TRIO inverters should only be stacked three high.
For storage purposes, units in their original unopened packaging can be stacked five high on a flat dry surface capable of withstanding the weight.
DO NOT stack with equipment or products other than those indicated or store in damaging, corrosive environments.

Lifting

ABB packages and protects individual components using suitable means to make their transport and subsequent handling easier. Due to the weight and complexity of this equipment, ABB recommends the process of loading and unloading of this equipment be done by an experienced or specialized staff knowledgeable in material handling.

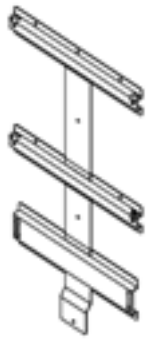
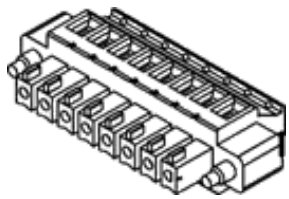
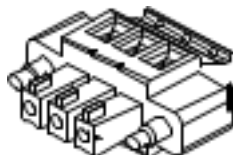
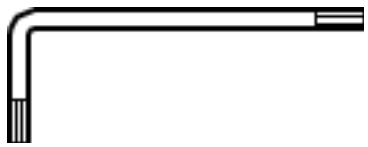
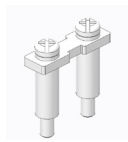
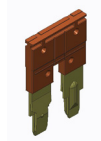
Where indicated or where there is a provision, eyebolts or handles can be inserted and used as lifting points. Do not lift several units or parts of the equipment at the same time, unless otherwise indicated.

Incoming inspection

It is the customer's responsibility to examine the condition of the unit. Upon receipt of the inverter, please check the following:

- Inspect the shipping container for any external damage.
- Inventory the contents against the table below and verify receipt of all items.
- Use care not to discard any equipment, parts, or manuals.
- Call the delivering carrier if damage or shortage is detected.

If inspection reveals damage to the inverter, contact the supplier or authorized distributor for a repair/return determination and instructions regarding the process.

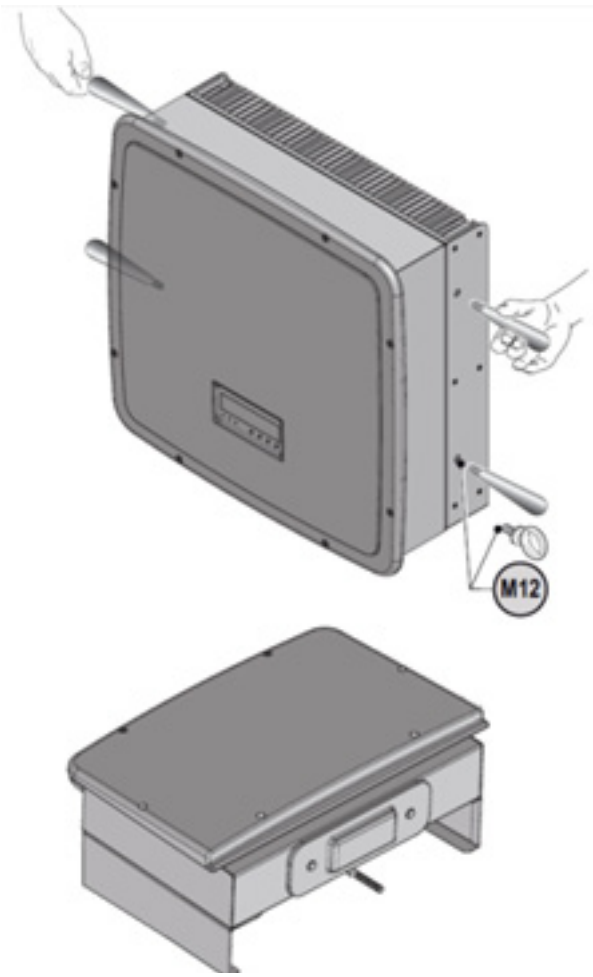
COMPONENTS FOR ALL MODELS		QTY/PART NO.
	(1) Mounting bracket, (10 each) wall anchor, screw, washer, (1) locking screw for securing wiring box to mounting bracket	Bracket XAK.V0L03.0 OR Mounting kit XAK.V0L01.0
	8 pin connector	4 82000005908-G
	3 pin connector	2 82000005907-G
	Torx wrench; 90°; T20; 64x23mm,	1 81510000077
COMPONENTS FOR NON-AFD MODELS ONLY		QTY/PART NO
 	Jumpers for configuration of parallel input channels	2 each Reliance RAQ2-16, ABB JB12-2
OPTIONAL COMPONENT		QTY/PART NO
 	Optional lifting kit includes handles and eyebolts for lifting the inverter	1 kit M12 3M2200HNDK0

Handling the TRIO

The TRIO inverter and wiring box are shipped as separate components within a common container. They are designed to be installed individually allowing an easier installation process.

The inverter unit weighs 143 pounds or less, depending on the version, and should always be lifted by two persons.

An optional lifting kit, with handles and eyebolts for lifting the inverter, is available and can be used to assist in hanging the inverter on the mounting bracket.



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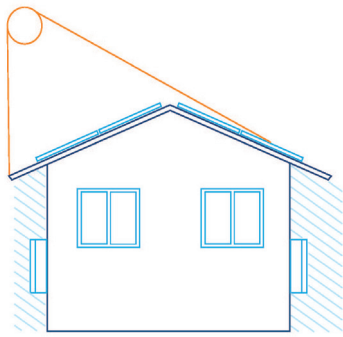
Select the installation location

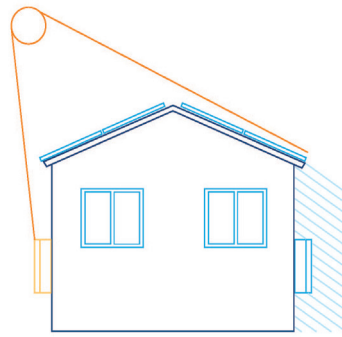
WARNING! The TRIO inverter must be installed by qualified installers and/or licensed electricians according to the applicable local code regulations (NEC, CEC, and other).
Once physically mounted, the wiring must be carried out with the equipment disconnected from the grid (power disconnect switch open) and the photovoltaic modules shaded or isolated.

Environmental check

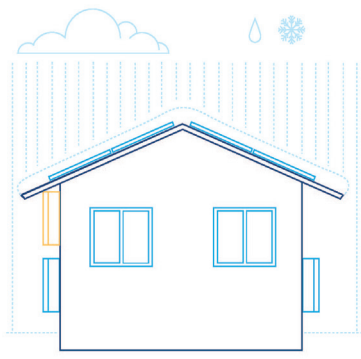
- See technical data in the Appendix, section 7, to check the environmental parameters to be observed (degree of protection, temperature, humidity, altitude, etc.).
- The maximum operational ambient air temperature MUST be considered when choosing the inverter installation location.
- Installing the inverter where operating temperatures exceed the specifications will result in power derating. It is recommended the inverter be installed within the specified temperature range.
- Do not install in direct sunlight. If the preferred mounting location is in direct sunlight, install the ABB Sun Shield on the inverter in order to provide the necessary shade.
- Do not install in small closed spaces where air cannot circulate freely.
- Due to acoustical noise (about 50dBA at 1 m) from the inverter, do not install in rooms where people live or where the prolonged presence of people or animals is expected.
- To avoid overheating, always make sure the flow of air around the inverter is not blocked.
- Do not install in places where gases or flammable substances may be present.



Properly installed



Direct sun on left inverter- use ABB Sun Shade



Air restricted for top left inverter - not properly installed

Air restricted by snow for both inverters - not properly installed

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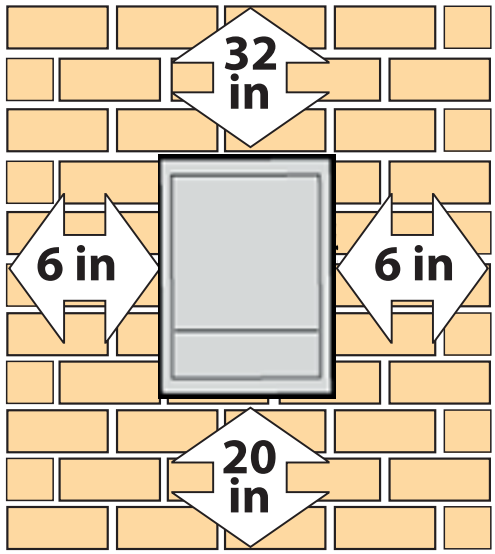
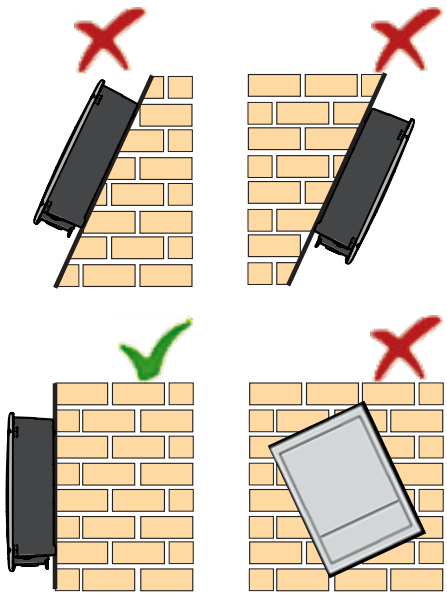
Installation position

When choosing the installation location and position, comply with the following conditions:

- Install on a wall or strong structure capable of bearing the weight.
- Install vertically with a maximum incline of +/- 5°. If the mounted inverter is tilted to an angle greater than the maximum noted, heat dissipation can be inhibited, and may result in less than expected output power.
- Install in a safe place where all switch handles and controls remain easy to reach and meet height requirements of the applicable electrical code. Install at eye level so the display and status LEDs can be easily seen.
- Ensure sufficient working area in front of the inverter to allow easy access and compliance with the minimum clearance requirements of NEC 110.34(A).
- When planning the installation, maintain clearance distances shown to allow normal control functions and easy maintenance operations.





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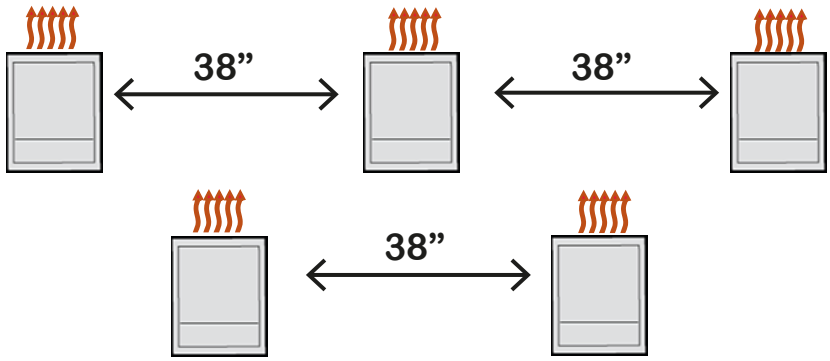
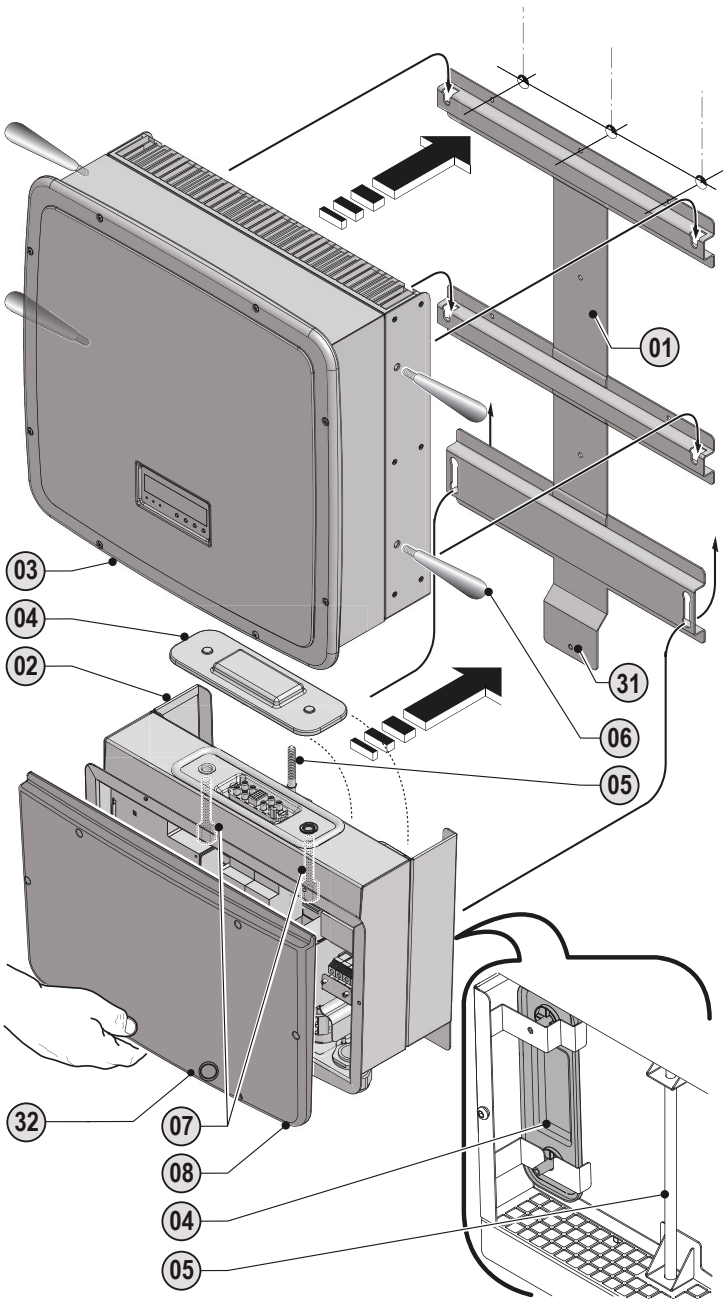
For multiple-inverter installations, position the inverters side-by-side, maintaining minimum clearances. If the space available does not allow the side-by-side arrangement, multiple inverters can be placed in the staggered arrangement shown; this minimizes heat dissipation from lower inverters affecting operation of other inverters.

Minimum clearances illustrated include width of inverter plus additional allowances for inverters arranged above or below.



Labeled illustration of TRIO

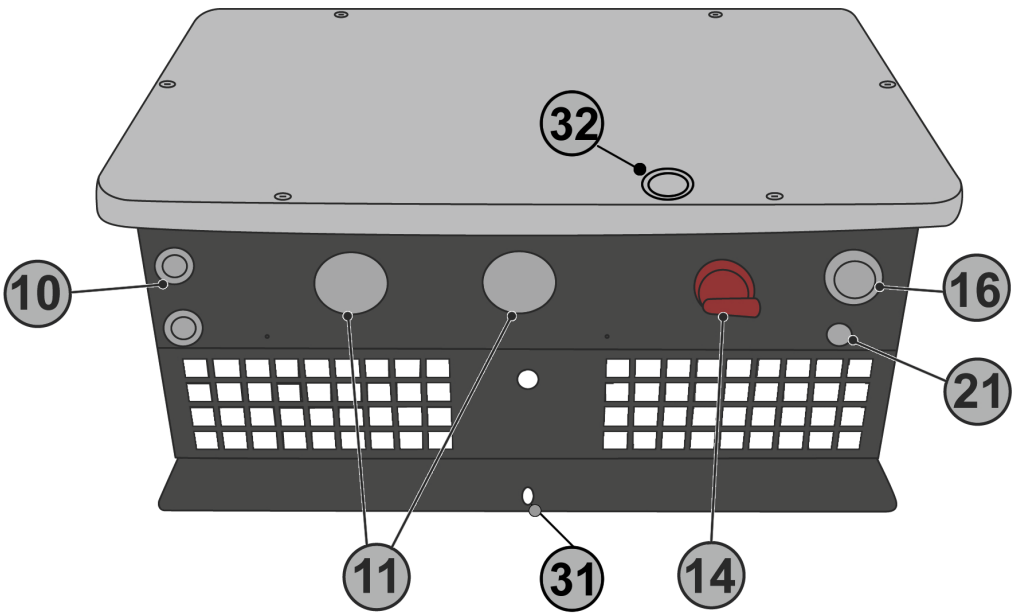
01	mounting bracket
02	wiring box
03	inverter
04	coupling connector cover
05	clamp screw
06	optional handles
07	connector screws
08	wiring box cover
31	bottom locking tab for securing mounting bracket to wiring box and inverter, can also be used as exterior grounding electrode, if required
32	hole on wiring box cover and wiring box chassis used to insert a padlock, if required



Conduit entries for all versions are located on the bottom of the wiring box along with the DC disconnect switch handle **14**. Conduit entries are illustrated below. The appropriate conduit connector must be used in order to maintain required spacing between wiring groups and preserve the integrity of the NEMA 4X environmental rating.

- A silkscreen printed label on the wiring box front cover **08** illustrates the ON/OFF positioning of the disconnect switch handle.
- In the OFF position (open and locked), the DC disconnect switch handle will be turned counter-clockwise in a position parallel to the inverter mounting surface as illustrated below.
- In the ON position, the DC disconnect switch handle must be pushed in and turned clockwise to a position perpendicular to the inverter mounting surface.
- The cover is only removable with the DC disconnect switch handle set to the OFF position.
- A padlock can be inserted in the slot on the switch handle when in the OFF position to prevent the disconnect from being turned to the ON position.

WARNING! The DC switch (14) disconnects the photovoltaic array current from the inverter when the switch is in OFF position. It DOES NOT disconnect the AC from the grid.

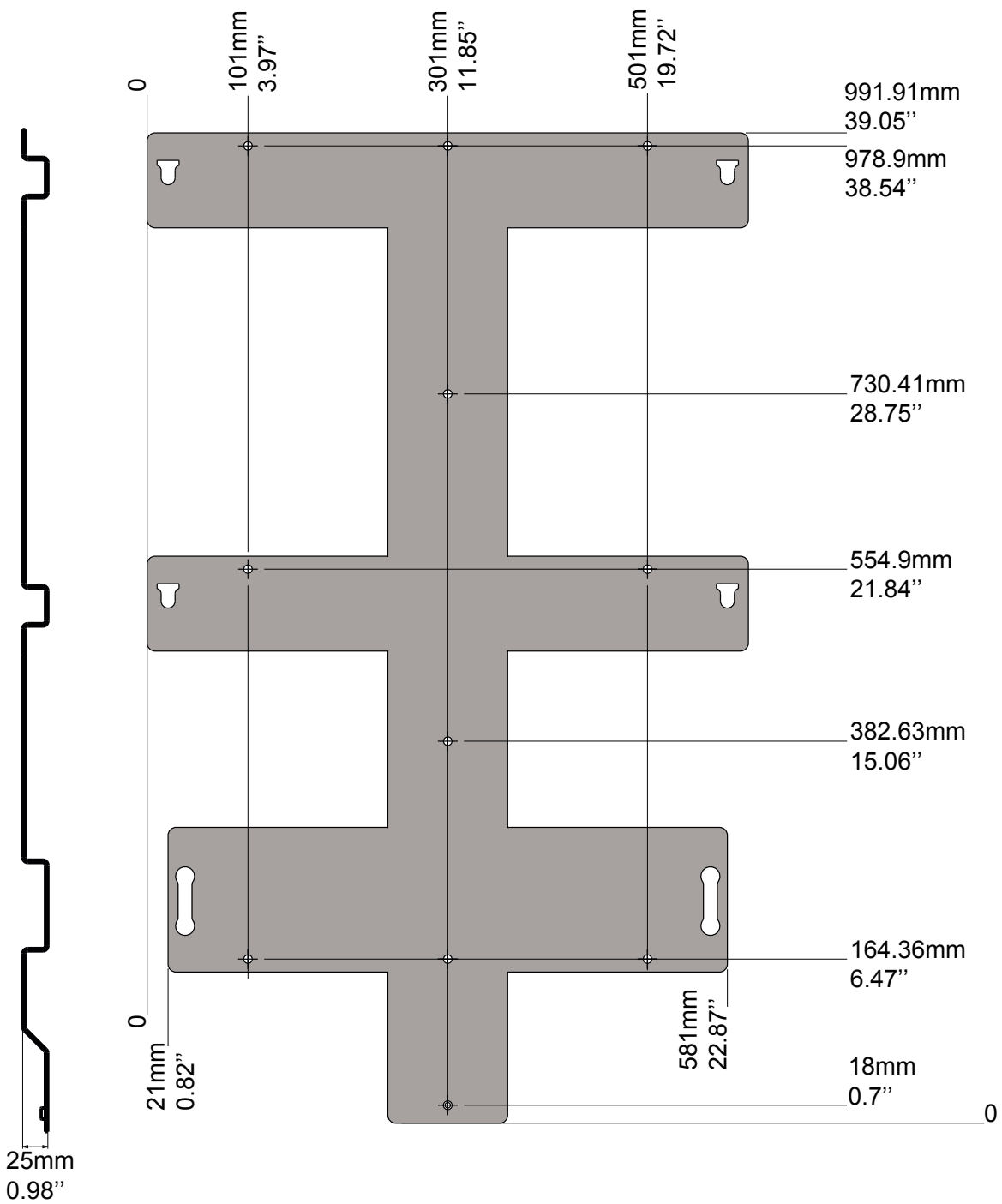


10	Service and communications cable opening with plastic threaded plug, Trade size 1/2“	21	Anti-condensation valve (eliminates condensation buildup) DO NOT REMOVE!
11	DC cable openings with plastic threaded plug, Trade size 1”, 1 ½”	31	Bottom locking tab for securing mounting bracket to inverter and wiring box, can also be used as exterior grounding electrode terminal if required.
14	DC disconnect switch handle.	32	Hole on wiring box cover and wiring box chassis used to insert a padlock,if required.
16	AC cable opening with plastic threaded plug, Trade size 1”		

Wall mounting

When mounting the TRIO, first secure the mounting bracket to the desired location and then install the wiring box followed by the inverter unit.

Included in the shipping package is a mounting kit with stainless steel screws and wall anchors for mounting the powder coated, stainless steel bracket to a wall or structure The overall dimensions of the mounting bracket are expressed in millimeters and inches.



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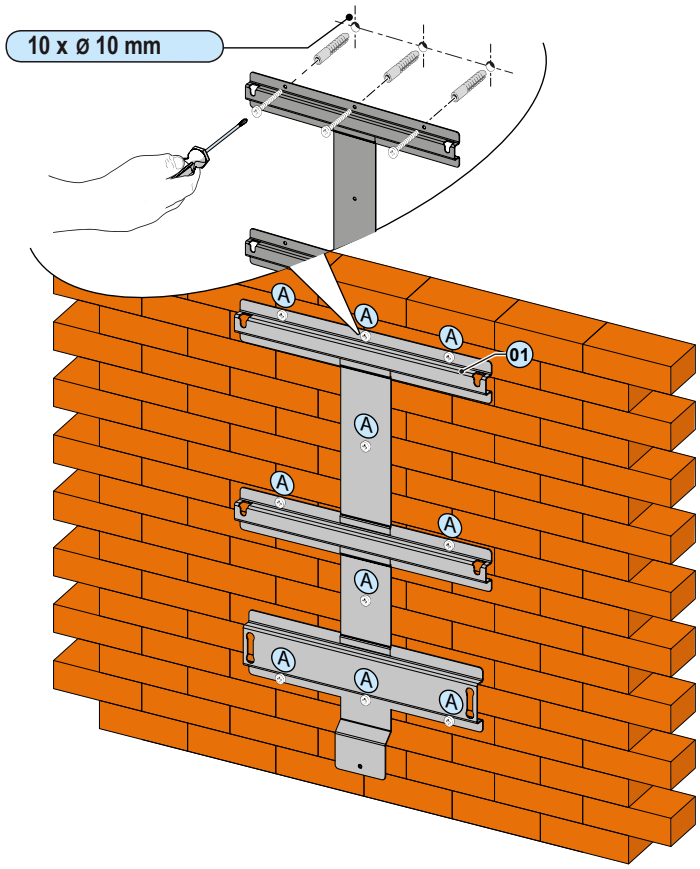
The process of joining the inverter and wiring box together should be completed before the conduit is secured. When completely tightened the wiring box will move up to meet the inverter. It is recommended to employ flexible conduit methods to allow for easy removal of the inverter, if ever required.

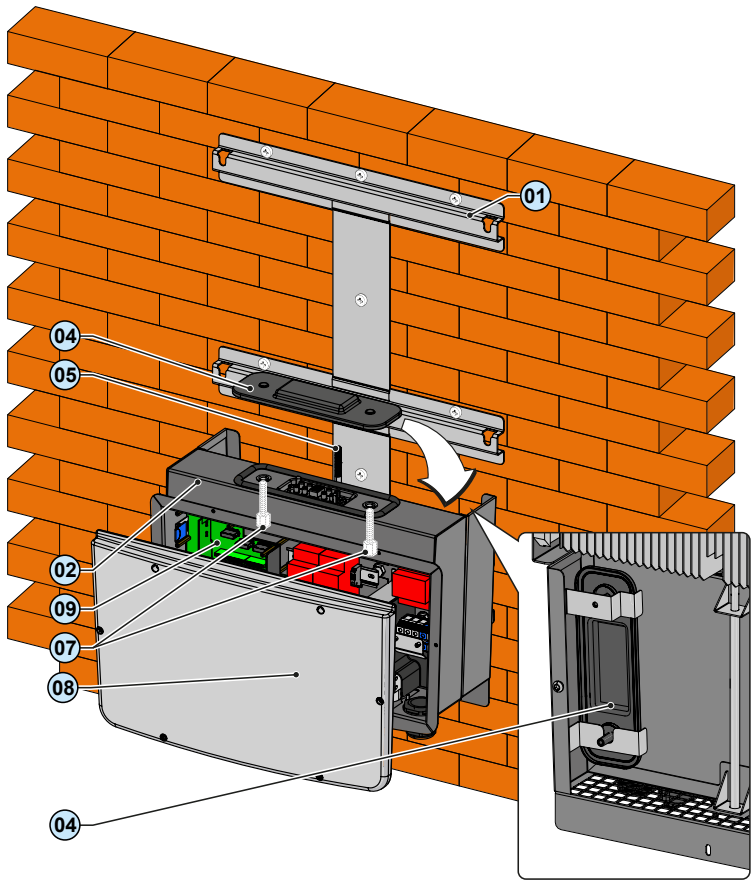
Installation method with flexible conduit

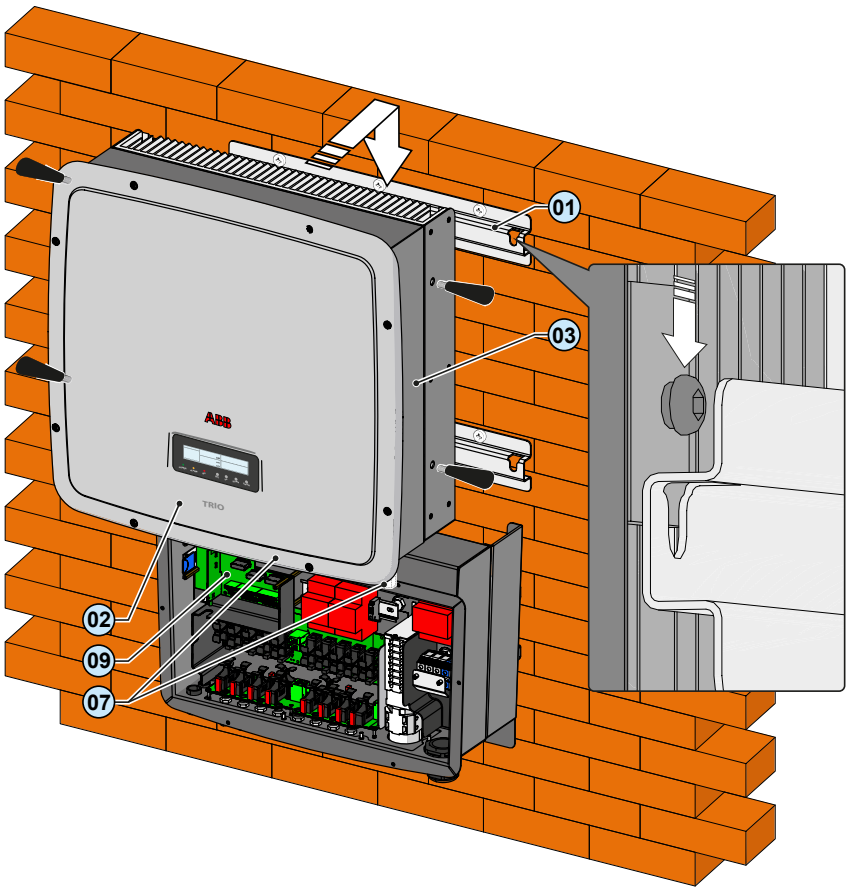
When installing flexible conduit with the TRIO, provide enough conduit to allow for approximately 1-1½" of vertical movement between the inverter and wiring box. Prior to making the conductor connections in the wiring box, provide enough conductor to allow for the movement of the wiring box in the final stages.

- Using a level, position the bracket **01** level on the wall, using it as a drilling template.
- Using a 10mm drill bit, drill the required 10 holes **A** 70mm deep.
- Using the 10 (ten) 10mm diameter wall anchors, screw the bracket to the wall.
- When installing in seismic Zone 3 or higher, the five center wall anchors must be fixed into a wood/steel wall stud or concrete/ masonry wall.



- Remove the front cover **08** from the wiring box.
- Install the wiring box **02** onto the bracket by inserting the heads of the rear screws into the slots in the bracket.
  Note: it is not necessary to install the inverter **03** at this time.
- Unscrew the connector screws **07** and remove the wiring box-to-inverter cover **04** so that the connector can be reached between the wiring box and the inverter.
- Put the wiring box-to-inverter cover in the special pocket provided at the back of the wiring box.





- Locate the four bolts protruding from the rear of the inverter chassis; these are used as mounting studs and are inserted into the four associated slots on the mounting bracket.
- Lift the inverter using two people and orient it to the bracket so the four studs are just above their associated slots.
- Once aligned, lower the inverter unit into position, ensuring all four studs are seated in their respective bracket slots.
- For ease of lifting, the optional lifting kit is recommended (part # 3M2200HNDK0). The kit includes both handles and eye bolts which screw into the inverter heatsink.

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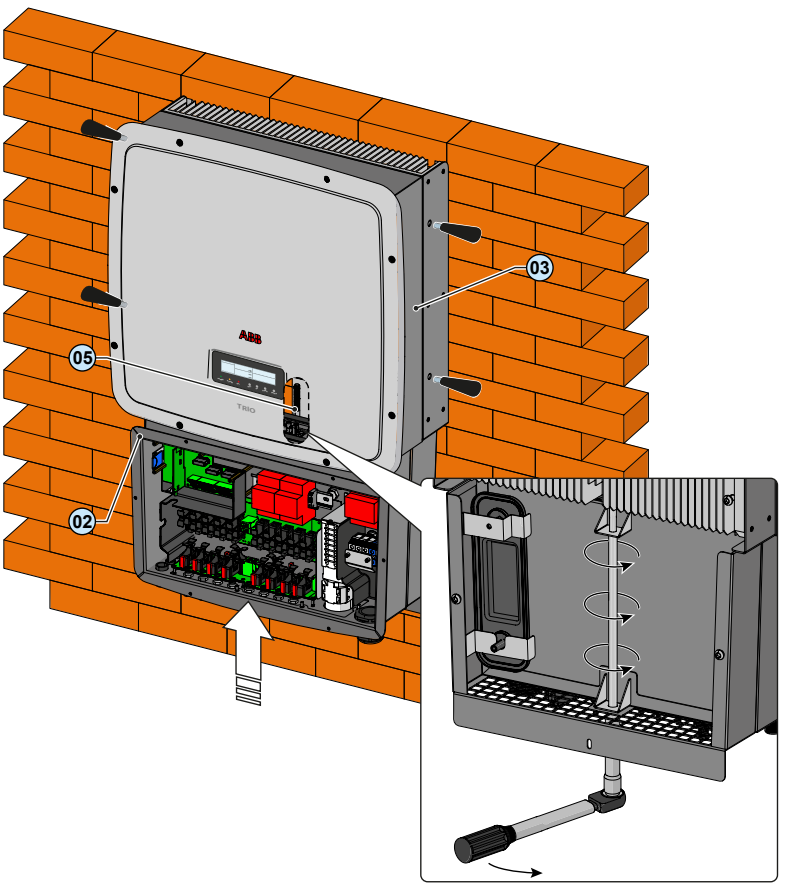
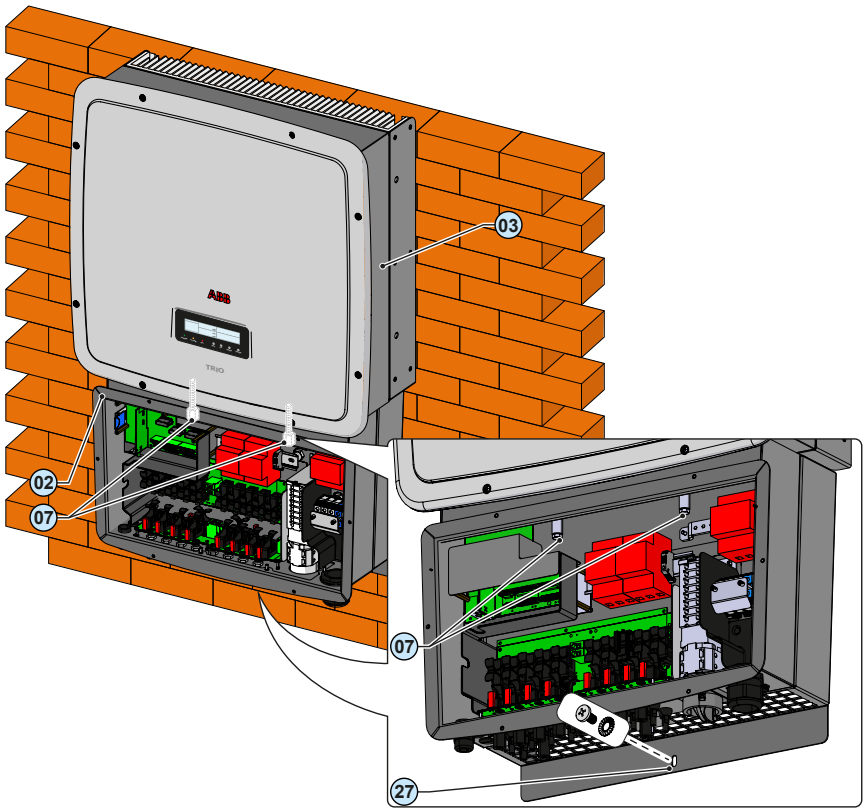
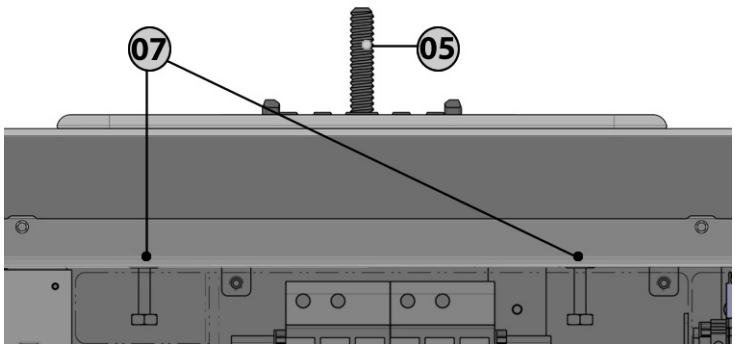
- Join together the wiring box and inverter by tightening the coupling screw **05**, working from the underside of the wiring box.
- Using a 20mm socket, tighten the clamp screw **05** to lift the inverter wiring box toward the inverter until mating connectors of the wiring box and inverter chassis seat fully. **Do not completely tighten at this time.**



- Once the wiring box and inverter are connected, screw in the two connector screws **07** located inside the wiring box to fully lock and seal the connection.
- Using a 13mm socket wrench, finish tightening each of the two connector screws **07** to at least 13.3-14.75 ft-lbs (18-20Nm) torque.
- After tightening the connector screws **07**, finish tightening the clamp screw **05** at the bottom of the wiring box to 13.3 ft-lbs (18Nm) of torque.
- Anchor the connected wiring box and inverter to the lower end of the bracket by tightening the locking screw **27** located underneath the wiring box.
- Upon completion, replace the front cover of the wiring box **08** and torque screws to at least 21 in-lbs (2Nm) to ensure proper waterproof sealing.





Installation method with rigid conduit

If installing rigid conduit with the TRIO, mount the inverter as instructed above before making the rigid conduit connections. The inverter wiring box moves up in the installation procedure and the connection of rigid conduit would prevent this necessary movement if installed prior to mounting the inverter.

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Wiring details

WARNING: If installing a PV system using TRIO in North America, verify that the selected PV module is listed for use in 1000Vdc systems in accordance with local electrical codes.
It is the responsibility of the installer to provide external disconnect switches and Overcurrent Protection Devices (OCPD) as required by National Electric Codes and other prevailing regulations.

- An automatic overcurrent device (e.g., circuit breaker) must be installed between the TRIO inverter and the AC utility grid.
- The –S1B version includes an integrated fused AC disconnect switch in the wiring box; however, because this switch is behind the front cover it is intended as an equipment disconnecting means and may not be accepted by the authority having jurisdiction (AHJ) in lieu of an external disconnect. It is made available as an additional disconnect for cases where the AHJ may require disconnects at both ends of the inverter AC line. Before purchasing this inverter option, consider discussing its intended usage with the AHJ in question.
- The TRIO is designed without an isolation transformer and is intended to be installed per NFPA 70, 690.35 with an ungrounded PV array.

AC overcurrent protection

To protect the AC connection line of the inverter, ABB recommends the following characteristics when installing a device for protection against overcurrent:

	TRIO-20.0-TL US	TRIO-27.6-TL US
Type	Typical installations use a 3-pole/600V rated bi-directional thermal-magnetic circuit breaker, UL489 or equivalent.	
Maximum Current/ Voltage	40A/600V	50A/600V

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Wiring box components

There are four models of the wiring box available for either the 20.0 kW or 27.6 kW versions. Each model is available with or without arc fault detection (AFD). The major differences between the wiring box layouts are illustrated after the descriptions in the table below.

Ref.	Description
01	Mounting bracket
02	Wiring box
03	Inverter
04	Coupling connector cover
05	Clamp screw
06	Optional lifting handles
07	Connector screws
08	Wiring box front cover
09	Communication board
10	Service cable and communications opening with plastic threaded plug, Trade size 1/2“
11	DC cable openings with plastic threaded plug *, Trade size 1”, 1 ½”
12	Solid copper jumper for paralleling inputs
13	DC terminal block (-S version)
14	DC disconnect switch handle
15	Class II DC surge protection (-S1, -S1A, -S1B versions)
16	AC cable opening with plastic threaded plug, Trade size 1”
17	AC terminal block
18	AC board (located behind 19 in –S1A and behind 20 in –S1B)
19	Class II AC surge protection (-S1A version)
20	Fused AC disconnect switch (-S1B version)
21	Anti-condensation valve (eliminates condensation buildup) DO NOT REMOVE!
22	DC fuse holders (-S1, -S1A, -S1B versions)
23	Display
24	LED panel
25	Keypad
26	Heatsink
27	Equipment ground conductor (EGC) busbar (DC equipment grounding bar is common with the AC side; NO interconnecting jumpers are required)
28	AC ground terminal
29	Arc fault detection (AFD) board
30	Positive input paralleling terminal blocks (use with non-AFCI versions only)
31	Negative input paralleling terminal blocks (use with non-AFCI versions only)
32	Bottom locking tab for securing mounting bracket to wall; can also be used as exterior grounding electrode conductor (GEC) connection
33	Hole on wiring box cover and wiring box chassis used to insert a padlock

* If a 2” conduit is needed for DC cable, the DC cable entries can be punched to accommodate these using a knockout hole punch in location of existing knockouts.

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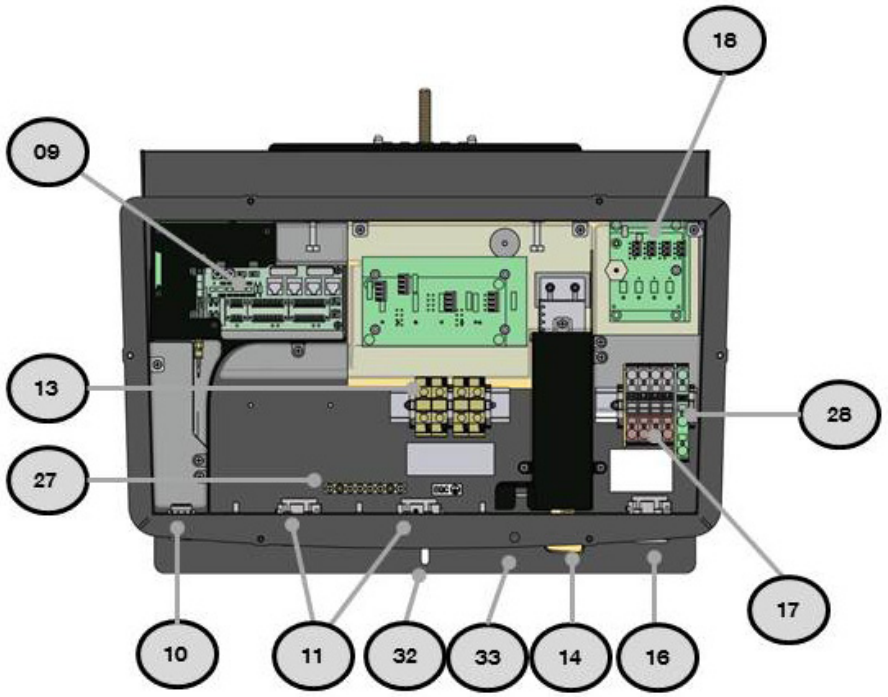
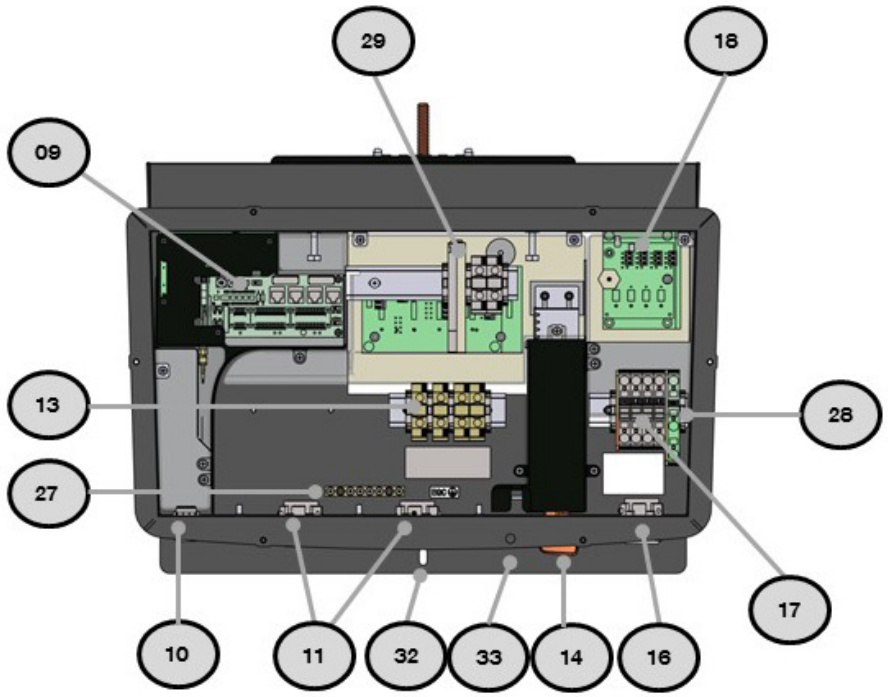
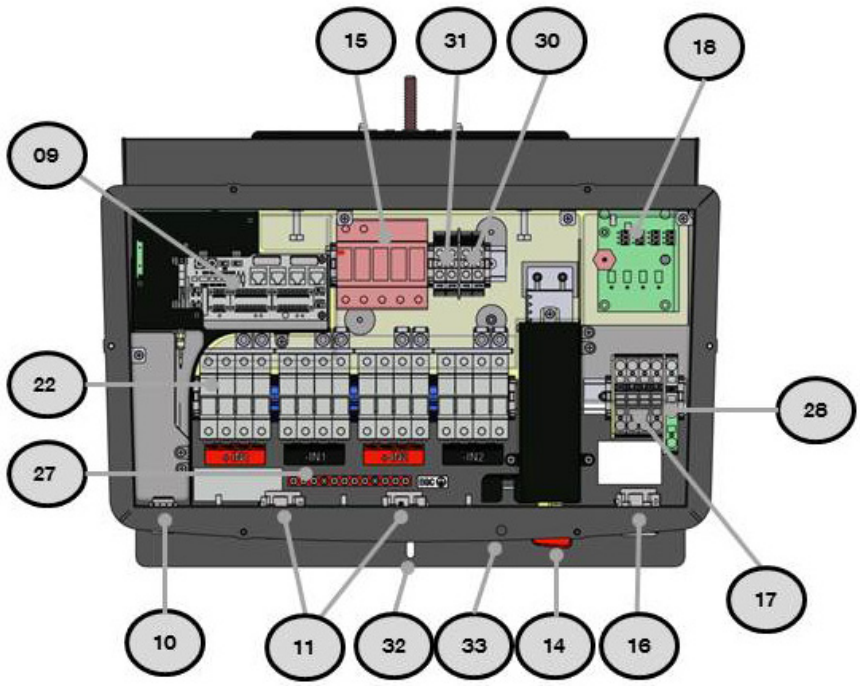
TRIO-XX.X-TL-OUTD-S-US-480



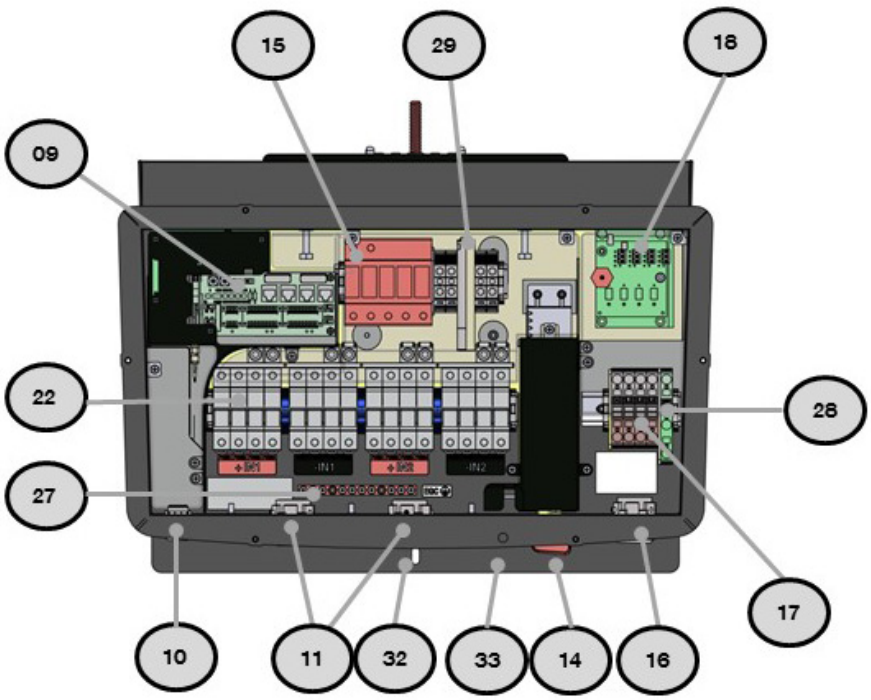
TRIO-XX.X-TL-OUTD-S-US-480-A



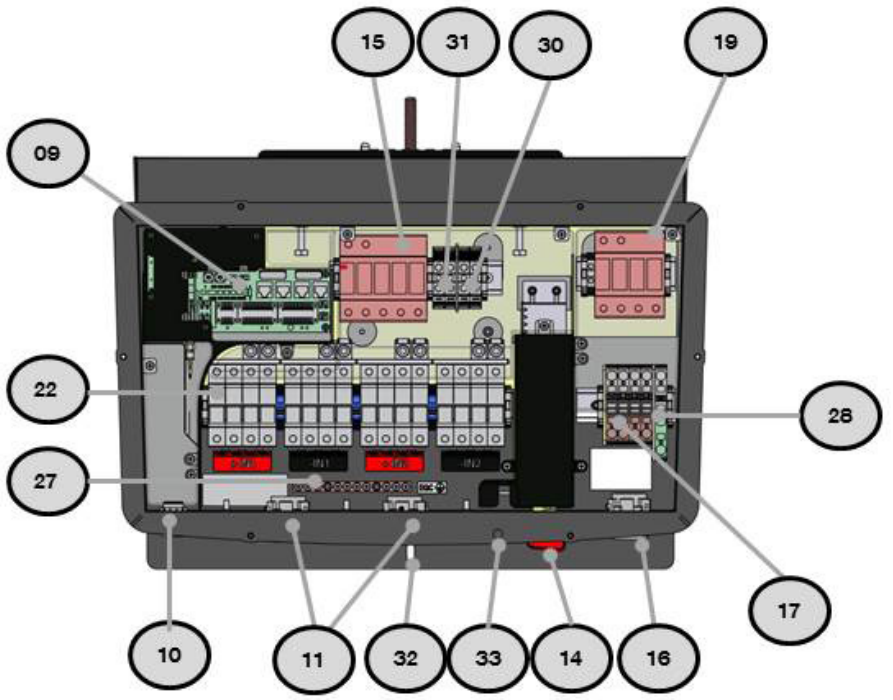
TRIO-XX.X-TL-OUTD-S1-US-480



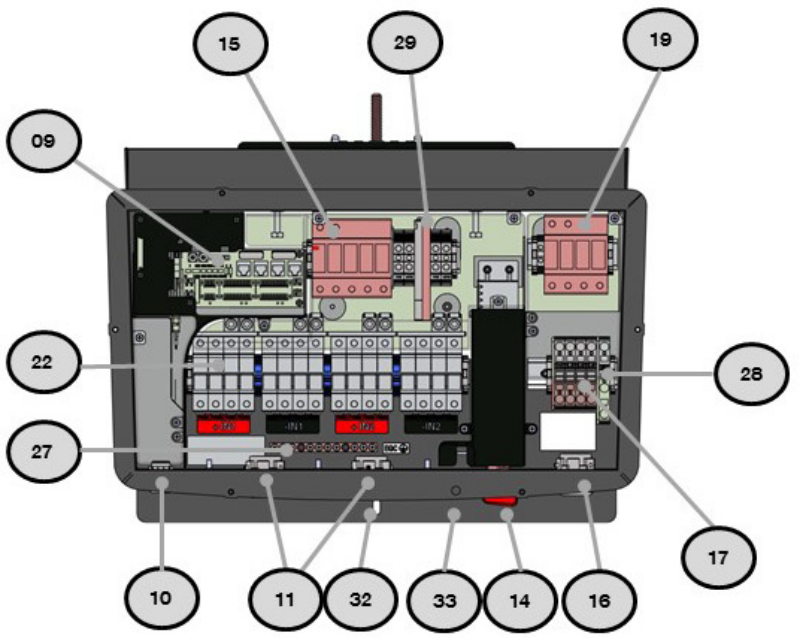
TRIO-XX.X-TL-OUTD-S1-US-480-A



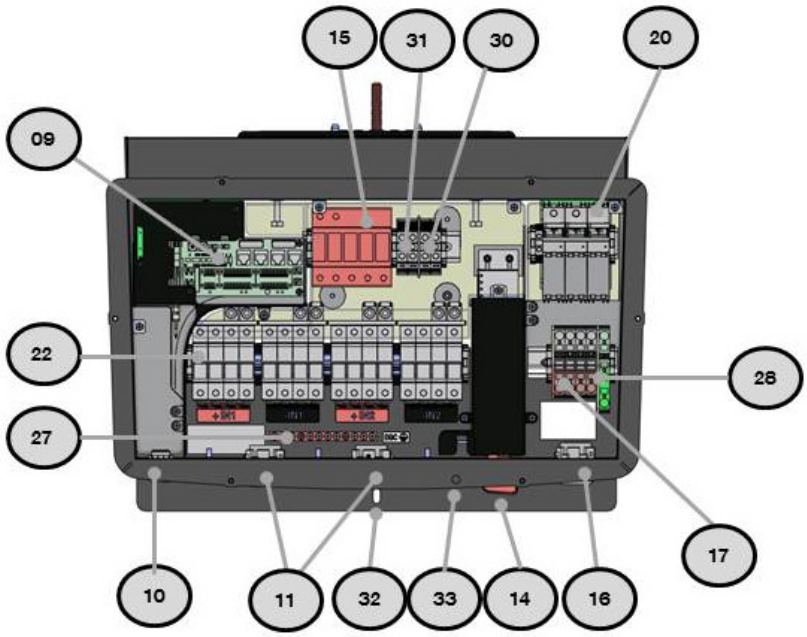
TRIO-XX.X-TL-OUTD-S1A-US-480



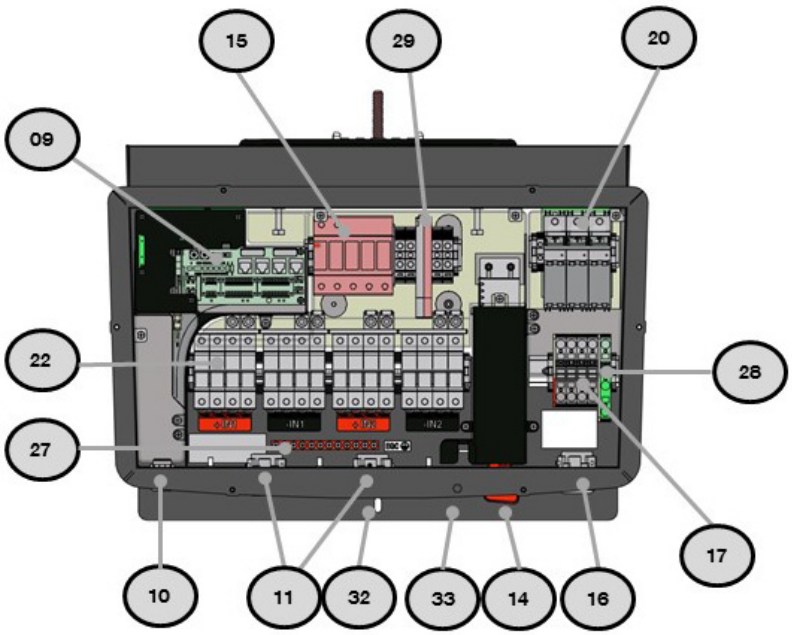
TRIO-XX.X-TL-OUTD-S1A-US-480-A



TRIO-XX.X-TL-OUTD-S1B-US-480



TRIO-XX.X-TL-OUTD-S1B-US-480-A



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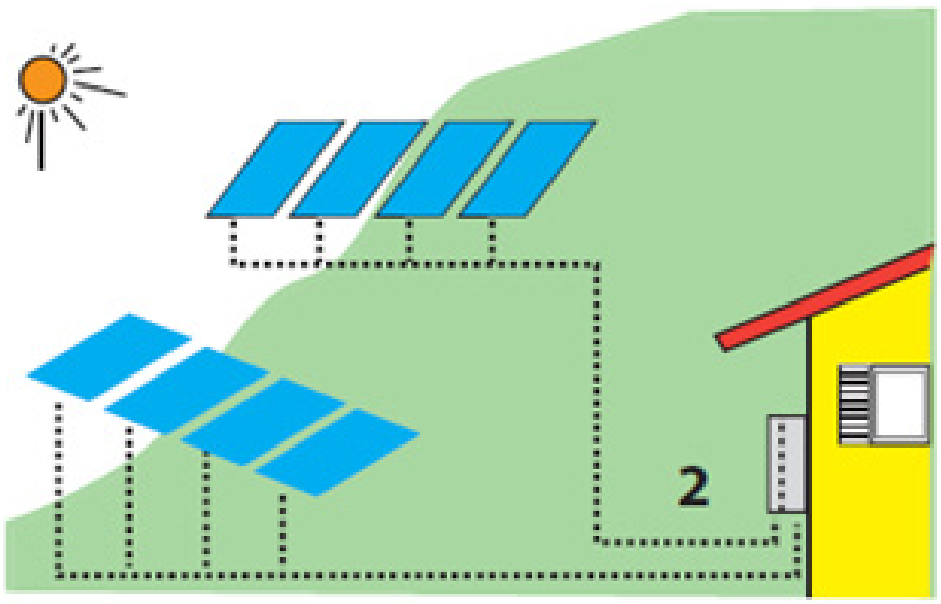
Independent or parallel configuration of inputs

The TRIO Inverters have dual inputs with independent maximum power point tracking (MPPT) control. When operated in the dual input mode, the inverter can optimize two independent arrays. Each of the inputs is dedicated to a separate array with independent maximum power point tracking (MPPT) control. This means that the two arrays can be installed with different positions and orientation. Each array is controlled by an independent MPPT control circuit.

The two trackers of the non-AFD models can also be configured in parallel to handle power and/or current levels higher than those a single tracker can handle.

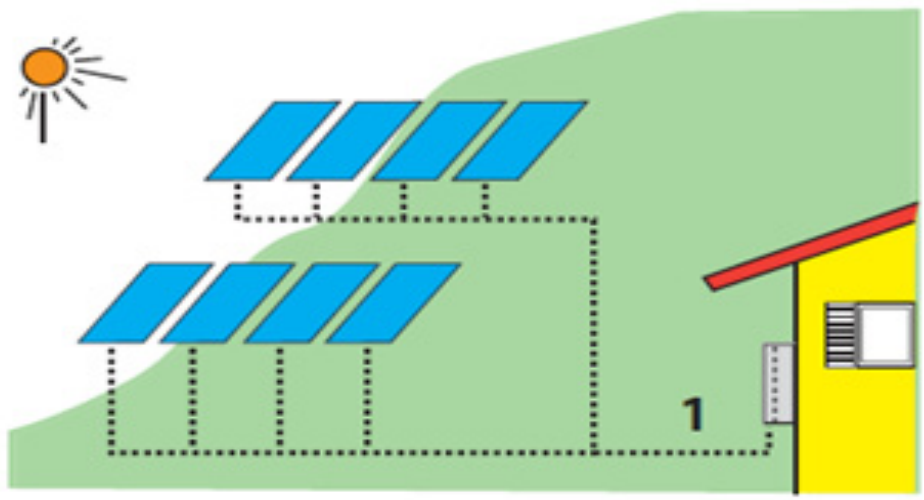
Dual MPPT configuration – independent mode

The dual MPPT structure allows the management of two photovoltaic arrays that are independent of each other (one for each input channel). In the independent mode, the arrays can differ from each other in installation conditions, type and number of photovoltaic modules connected in series.



Single MPPT configuration – parallel mode (non-AFD models)

In the PARallel mode, the two channels are connected in parallel and strings of photovoltaic modules having the same type and number of modules in series can be connected in parallel to the single channel. All strings must be identical and oriented to the same sun azimuth.



Refer to MPPT configuration examples in the Appendix, section 7, for guidelines regarding the choice of Parallel or Independent configurations. The TRIO Inverter is set in independent mode at the factory by default. The following sections describe how to connect the inverter in parallel mode.

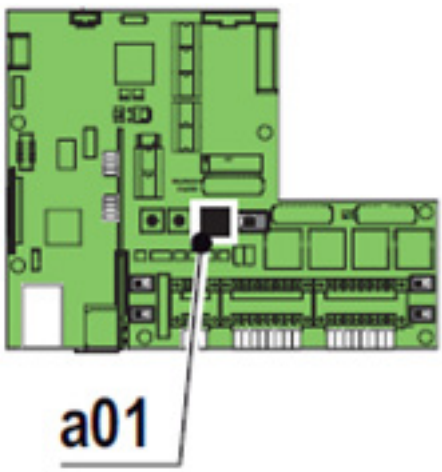
In order to operate in the PARallel mode from a common array, it is necessary to electrically connect the input channels in parallel using the jumpers provided with this inverter. PARallel mode is only available on non-AFD models.
In addition, the input mode switch **a01** located on the communication card 09 must also be set to the parallel mode as described below.

Setting the input mode switch a01

The input mode switch **a01** located on the communication card **09** is used to select the input configuration.

The TRIO is shipped from the factory with the input mode switch in the IND (independent) configuration by default. The **a01** switch will be in the right most position.

To change the inverter input mode to the parallel configuration, move switch **a01** to the left-most position to select PAR (parallel) mode.
Use the instructions on the next page to electrically connect the input channels in parallel.



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Parallel mode versions without AFD

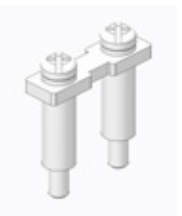
Ensure switch **a01** situated on the communication card **09** is set to the PAR position.

Included in the TRIO packaging are two copper jumpers to be use for paralleling of input channels.

- Use the first jumper to connect the two terminal blocks labelled as –TB1 –TB2 (negative polarity of MPPT1 and MPPT2).
- Use the second jumper to connect the two terminal blocks labelled as +TB1 +TB2 (positive polarity of MPPT1 and MPPT2)

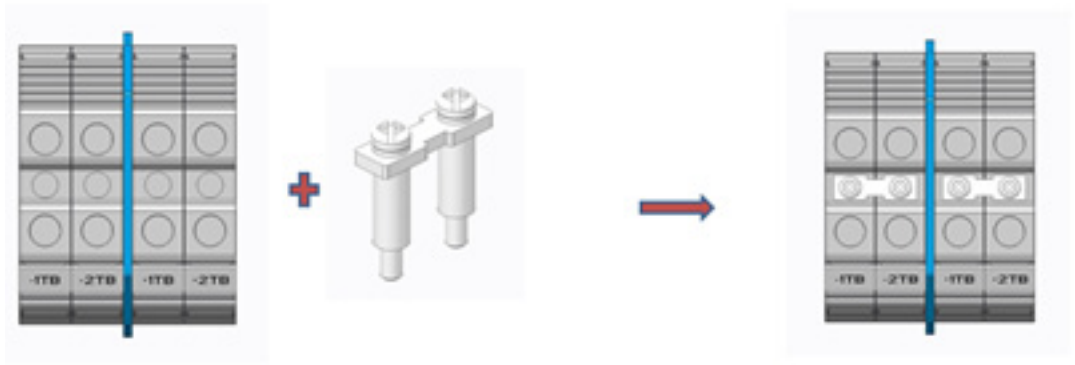
NOTE! A removable transparent cover prevents access to live parts on the upper DC side of the wiring box. In order to connect the wires, remove the four screws in place and remove the cover.

Depending on the brand of the terminal block (Chengdu Reliance or ABB) mounted inside the string combiner box, two different type of jumpers are provided in the product's accessory bag.

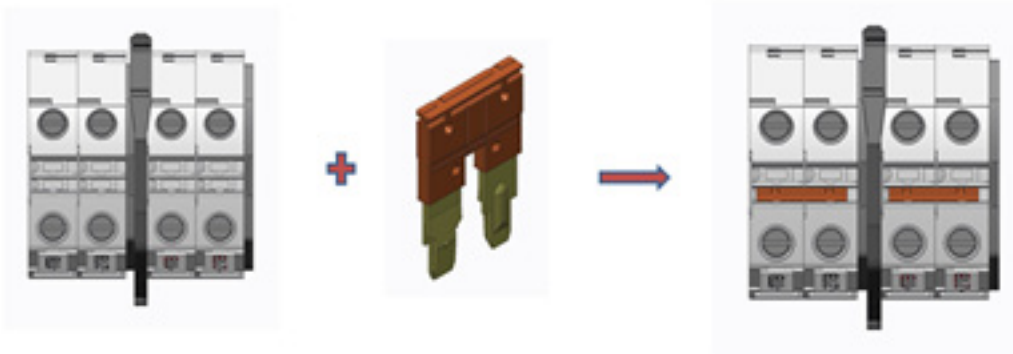
Type A (Chengdu Reliance)	Type B (ABB)
	

1) Remove the removable transparent cover screws, lift it off, and put it aside.

2) A screwdriver is required to tighten the screws incorporated in the copper jumper type A. Tighten the screws to at least 53 in.-lbs (6 Nm) of torque to ensure a low resistance connection. Both jumpers need to be mounted for proper operation.



Type A installation



Type B installation

3) Put the transparent cover back on and firmly tighten the cover screws.

AFD models are <u>not</u> to be used in parallel mode.

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Connection to the PV field (DC side)

WARNING! The DC disconnect switch (**14**) disconnects ONLY the DC current from the photovoltaic modules when the switch is open in the OFF position. It DOES NOT disconnect the AC connection to the grid. To disconnect the inverter from the AC grid, an external, customer supplied AC switch must be used.

To prevent electrocution hazards, all the connection operations must be carried out with the DC disconnect switch (**14**) turned to the OFF position and locked out.

When connecting the DC conductors verify polarity prior to terminating. Confirm maximum system voltage will never exceed 1000V per NEC requirements. Failure to perform these checks may cause arcing and potential fire.

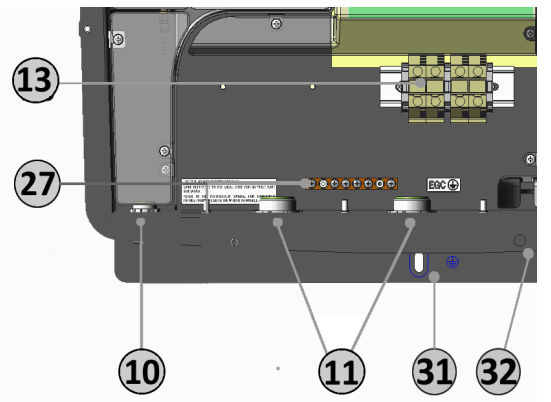
- The electrical installation of the TRIO inverter must be performed in accordance with the electrical standards prescribed by the local regulations and by the National Electric Code.
- For suitable wire size (AWG), refer to NFPA National Electrical Code, Table 310.15(B) (formerly Table 310.16) for US.
- Use only Copper (Cu) wire rated for 75°C or 90°C (167°F or 194°F), solid or with type B or type C stranding (19 strands maximum). For conductors with finer stranding, a suitable UL listed wire ferrule must be used.
- All wiring connections are made inside the wiring box **02**.
- If the inverter is to be mounted at a later time, ensure the coupling connector cover **04** is in place to protect the connector on the wiring box until the inverter is to be mounted.

Connection of DC inputs -S model

Remove the threaded plastic plug and nut from the DC cable opening **11** and insert the appropriate conduit fitting. Tighten to the chassis to ensure NEMA 4X compliance.

Make appropriate conduit runs from array and pull the array conductors through the raceway to the inverter.

The acceptable conductor cross-section ranges from 12 AWG to 2 AWG, copper conductors only. Tighten with at least 22 in-lbs (6Nm) torque.



Connect the conductors to the correct terminals on the DC terminal block **13**. Using a voltmeter (rated 2000V min.) test each string for polarity and voltage.

Verify that the DC voltage in the wiring box has the correct polarity and is within the operational range.

After confirming correct polarity and voltage on all strings, connect any Equipment Grounding conductors in the raceway to the EGC busbar **27**. The DC equipment grounding bar is common with the AC side and no other interconnecting jumpers or the like are required.

Connection of DC inputs -S1, –S1A, and -S1B models

Remove the threaded plastic plug and nut from the DC cable opening **11** and insert the appropriate conduit fitting. Tighten to the chassis to ensure NEMA 4X compliance.

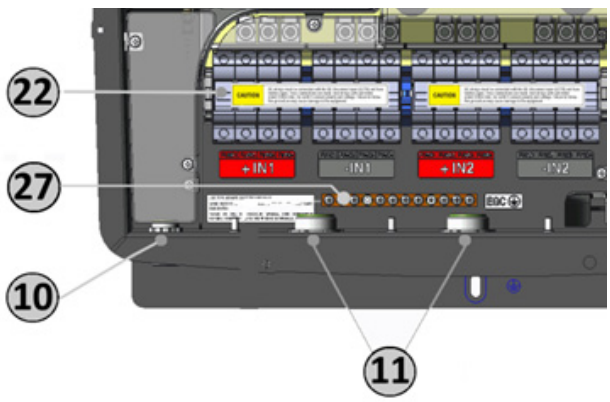
After reading the two CAUTION labels in place on the DC fuse blocks **22**, remove them and then open all fuse holders before connecting the PV strings.

Connect conductors to the correct input channel (if using the parallel configuration, either input channel is acceptable).

The acceptable wire size range is from 12 AWG to 6 AWG, copper conductors only; refer to local code for appropriate wire size. Fuse holders have screw terminals and the torque depends on wire size. For wire sizes 10 AWG and larger, tighten to 30 in-lbs (3.4 Nm) torque.

Test each string for polarity and voltage using a voltmeter (rated 2000V min.). After confirming correct polarity and voltage on all strings, close all fuse holders.

Connect any Equipment Grounding conductors in the raceway to the EGC busbar **27**. The DC equipment grounding bar is common with the AC side and no other interconnecting jumpers or the like are required.



String protection -S1, -S1A, and –S1B models

The -S1, -S1A and -S1B versions of the TRIO wiring box are provisioned with 30A rated UL Listed/CSA certified fuse holders, supplied with 15A, 1000V DC rated fuses.

To determine the correct fuse value to use with a specific PV array, refer to the PV module documentation and the National Electrical Code 690.8 and 690.9 or your local electrical code.

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Grid output connection (AC side)

- For suitable wire size (AWG), refer to NFPA National Electrical Code, Table 310.15(B)(16) (formerly Table 310.16) for US.
- Use only Copper (Cu) wire rated for 75°C or 90°C (167°F or 194°F), solid or with type B or type C stranding (19 strands maximum). For conductors with finer stranding, a suitable UL listed wire ferrule must be used.
- Phase conductors must be sized based on ampacity requirements of the NEC or other applicable prevailing code, but no smaller than 8 AWG Cu.
- The (Cu) neutral conductor is used only for voltage sensing within the inverter and may be sized equal to or greater than the EGC conductor per NEC705.95(B).
- To prevent electrocution hazards, all the connection operations must be carried out with the external AC disconnect switch downstream of the inverter (grid side) open and locked out.
- Before connecting the inverter to the grid, the grid standard for the country of installation must be properly set. Refer to instructions on page 49 to configure this setting.

Characteristics and sizing of the AC output conductors

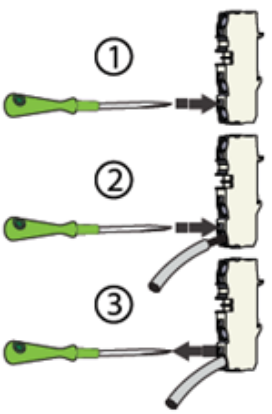
The AC output conductors must be sized properly to meet applicable code requirements and to minimize effects of line voltage drops that can:

- Affect the overall system efficiency, as this harvested power is lost directly to heat.
- Cause nuisance tripping (disconnection) of the inverter.

Wiring impedance that is too high can cause an increase in the AC voltage seen at the inverter terminals, and in compliance with UL1741 and IEEE1547, could cause the inverter to disconnect from the grid under otherwise normal grid operating conditions. IEEE1547 default settings mandate the inverter operate normally if its terminal voltage is in the range of [+10%/-12%] of the VNOM setting of the inverter.

To limit these issues the system designer must consider the worst case grid voltage conditions and length of wiring runs between the inverter to the point of common connection, and size wiring appropriately. For North America, based on ANSI B values, the worst case voltage range is +/- 6% of VNOM and line voltage drop in this case should be limited to less than 3% of VNOM. If range is expected to be greater, then voltage drop must be decreased accordingly.

Wire installation

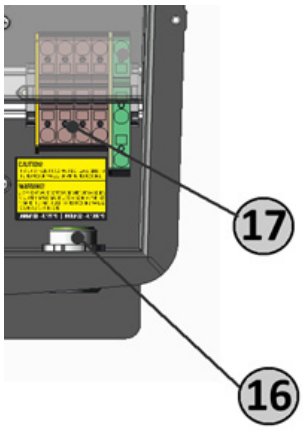


The TRIO Inverter has pressure type terminal blocks for connection of the AC conductors. To connect wiring to these blocks use the following procedure:
Strip ½" of insulation from the end of the conductor to be terminated. Use a small (~1/4"wide) flat blade screwdriver to open the pressure contact:

- Insert the screwdriver in the rectangular tool slot.

- Lightly press the screwdriver tip toward the wire slot until the clamp opens; hold the clamp open with the screwdriver.
- Insert the conductor into the socket until seated.
- Release the pressure on the screwdriver and remove it from the slot.
- Check the integrity of the connection by tugging on the wire.

Connection to the AC terminal block

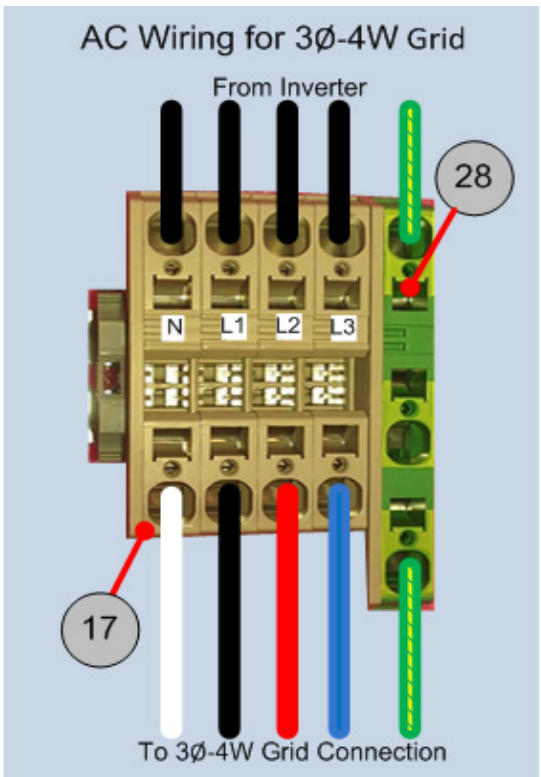


For all models, connection to the AC terminal block **17** is made by pulling conductors through a raceway connected to the AC conduit knockout **16**.

Remove the threaded plastic plug from the AC conduit knockout **16** and replace with a conduit hub sized to fit the required wiring and raceway. Pull the circuit conductors through the conduit opening and connect the necessary conductors.

Terminal blocks are rated for operation to 90°C and accept wire size in the range of 8 AWG - 4 AWG solid or with type B or type C standing (19 strands maximum). For conductors with finer stranding, a suitable UL listed wire ferrule must be used.

The TRIO is intended to be connected to a four wire WYE grid; connect Neutral, L1, L2, L3, and EGC conductors.



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Auxiliary grounding electrode conductor (GEC)

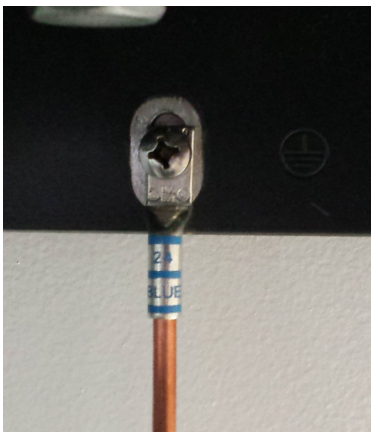
Transformerless inverters do not required a grounding electrode conductor (GEC). A GEC is required only when a DC bonding jumper is present. Because transformerless inverters operate from floating arrays, neither side (POS or NEG) of the array is bonded to ground; hence, no internal bonding jumper exists.

Section 690.47(D) of the 2014 NEC allows for auxiliary electrodes to be installed. Should an auxiliary electrode be desired, the following directions are to be used to make the connection.

When the grounding electrode conductor is to be run inside the same conduit as the AC output conductors, the GEC should be connected inside the inverter at either one of the two open sockets marked for grounding on the AC terminal block.

If the grounding electrode conductor is to be run outside of a conduit, this conductor should be connected to the grounding point **31** outside of the inverter.

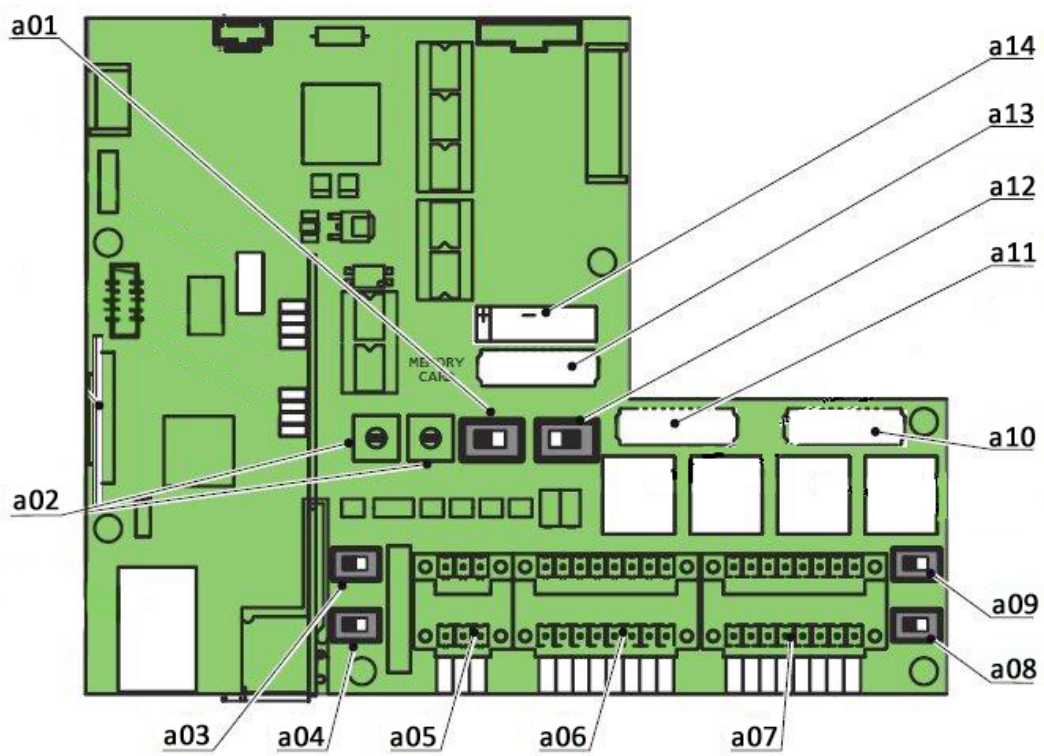
- Using proper tooling, crimp a compression type grounding lug, rated for at least 1000V on the end of the grounding electrode conductor.
- Connect the compression lug to the bottom of the wiring box at the marked grounding location by passing the locking screw through the lug to connect the wiring box and bracket as shown below.



Caution! It is very important not to drill a hole in the wiring box to pass the grounding electrode through. Furthermore, the anti-condensation valve **21** should not be removed to pass the grounding electrode through. Either of these actions affects the environmental rating of the inverter and could void the warranty!

Labeled illustration of communication card 09

A removable plastic cover prevents access to the section of the wiring box where the communication card resides. In order to access this area, remove the four screws in place and remove the cover.



Ref.	Description
a01	Input mode switch for setting PARallel or INDdependent input modes
a02	Rotary switches for setting the country and the language of the display
a03	Switch for setting analog sensor 1 to Volts or mA
a04	Switch for setting analog sensor 2 to Volts or mA
a05	Connection to the multi-function relay
a06	Connection of environmental sensors: AN1, AN2, PT100, PT1000 and auxiliary 24V service output
a07	Connection for the RS-485 PC line (SERVICE), RS-485 PMU line (MODBUS), auxiliary 5V output and remote ON/OFF
a08	Switch for setting the termination resistance of the RS-485 PMU line (MODBUS)
a09	Switch for setting the termination resistance of the RS-485 PC line (SERVICE)
a10	RS-485 PC communication card housing (SERVICE)
a11	RS-485 PMU communication card housing (MODBUS)
a12	Switch not activated; for factory use only (default = left most position)
a13	Inverter data memory card housing
a14	CR2032 battery housing

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Connections to the communication card

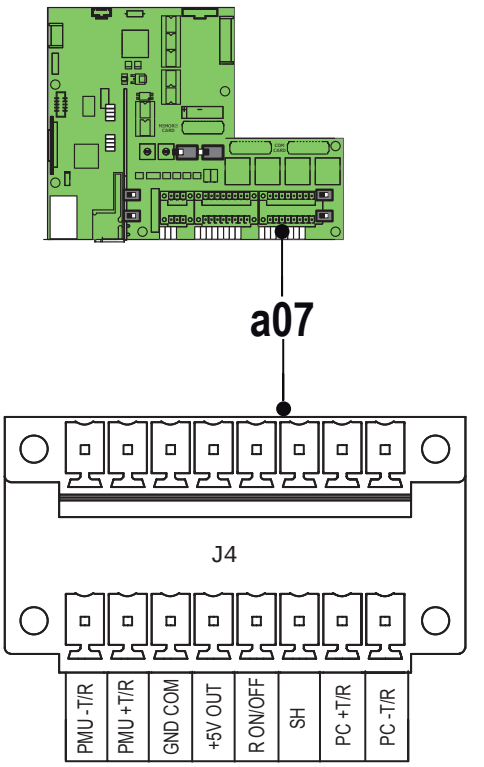
Remove the threaded plastic plugs from the service cable opening **10** and replace with the appropriate conduit connector as noted below. Whether these cables need to be protected by conduit depends on the applicable wiring code.

If no conduit is used, the cables should be brought into the wiring box via a 1/2" box connector with rubber cable glands to maintain NEMA 4X rating.

If conduit is used, run the appropriate raceway and terminate it to the wiring box chassis using a conduit connector that matches the raceway. The conduit must be terminated at one of the two ½" openings **10**. The sensor cables are connected on the communication card **09** using the mating connectors supplied in the hardware bag shipped with the inverter.

Serial communication a07 (RS-485)

There are two RS-485 communication lines on the inverter. Each are accessed from terminal block **a07**. Connect either communication port using terminal block **a07** (+T/R, -T/R and GND).



1) SERVICE/PC - dedicated line using AURORA Protocol for the connection of ABB monitoring and service equipment. PC port works only on AURORA Protocol. Baud rate is fixed at 19200 bit/s.

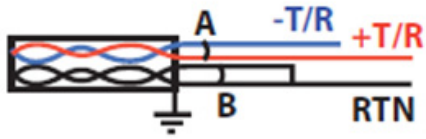
2) MODBUS/PMU - dedicated line for MODBUS RTU communications. PMU port works on both MODBUS and AURORA Protocol; MODBUS is the default. In order to use AURORA Protocol on this port, it must be set manually from the inverter display, unit by unit.

Baud rate can be chosen among the following list of values: 2400 4800 9600 19200 38400 57600 115200. Default value is 9600 bit/s. In order to change the default value, it must be set manually from the display, unit by unit.

If AURORA Protocol is set on this port it will work with a fixed baud rate of 19200 bit/s. See the Display Settings Menu in Operations, section 4, for instructions to change the PMU RS-485 protocol and/or baud rate.

The PC port is used by ABB service personnel for firmware upgrade, troubleshooting and maintenance. When service interventions are required, user SCADA systems will need to be temporarily disconnected.
It is highly recommended that the Service/PC bus be interconnected between the inverters and brought to a terminal strip at the data logger location. In this way, future firmware upgrades can be applied to all inverters on the bus without having to access the wiring box terminals of each one individually.
The PMU port can be used for SCADA systems and is the only choice for plant control systems working on MODBUS protocol.

Use a cable designed for use with RS-485 communications such as Belden 3106A, which is a data cable wire with one twisted pair for the +/-T/R signals, one ground conductor, and a shield with drain wire (equivalent). The table below shows connections for a dual twisted pair shielded cable.



Signal	Symbol	Pair	Cable
Positive data	+T/R	A	1
Negative data	-T/R	A	2
Reference	RTN	B	1+2

Continuity of the shield in the RS-485 cable is important for low noise on the line; this is particularly so for large plants with multiple inverters. For best results the shield must be tied to ground at only one point on the line, typically at one end or the other.

The shield wiring must be continuous as it passes from one inverter to the next on a daisy chain, but must not be tied to ground at these junctions.

The SH terminal is provided as a floating tie point for this purpose. It allows shields (drain wires) from incoming and out-going daisy chain cables to be secured together but not grounded.

Daisy Chain units for connection to a monitoring system

The RS-485 terminal block connectors can be used to connect a single inverter or implement a multi-unit wiring configuration called daisy chain. Note terminal block **a07** has two rows of contacts. The upper and lower rows are internally paralleled to allow daisy chain connections.

Using the appropriate cable designed for use with RS-485 communications, connect all the units RS-485 lines in series according to the daisy chain cabling method ENTER-EXIT.

On the last inverter in a daisy chain, or on a single inverter, activate the termination resistance of the communication line by moving switch **a08** or **a09** to ON position, being careful to set the termination resistance switch of the serial line used (SERVICE/PC or MODBUS/PMU).

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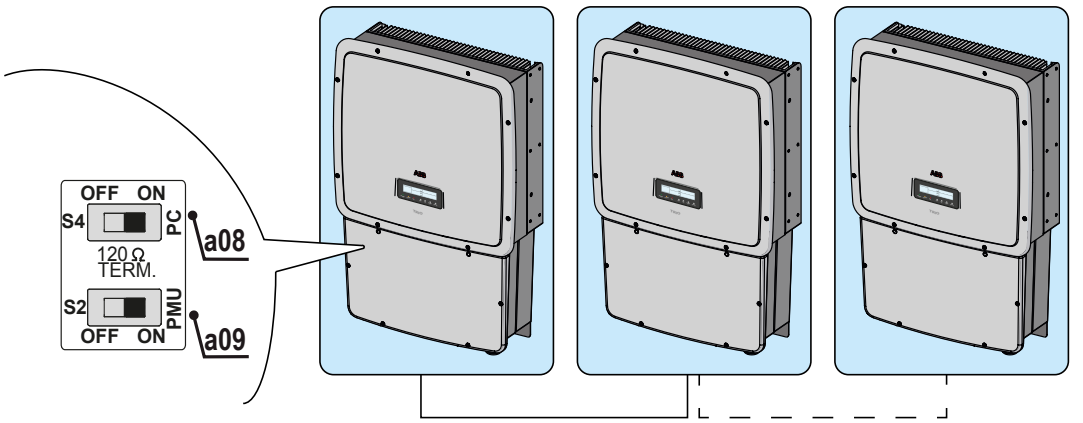


The opposite end of the daisy-chained bus must be connected to a suitable data logger with appropriate RS485 protocol or an RS485-USB communication adapter such as the AURORA PVI-USB-RS-485_232, to allow the bus to be interfaced to a computer or other (e.g., SCADA) system.

Adaptors equivalent to the AURORA PVI-USB-RS-485_232 which may also be used for this purpose can be found on the market; however, they have not been specifically tested and ABB cannot guarantee correct operation of the connection. These devices may also require external termination impedance, whereas this is not necessary with the AURORA PVI-USB-RS-485_232.

Remote on/off a07

The connection and disconnection of the inverter to and from the grid can be controlled externally. The function must be enabled in the menu on the inverter display (see Operations, section 4, of this manual).

If the remote control function is disabled, the inverter automatically switches on and off in response to applicable conditions. If the remote control function is enabled from the menu, the switching on of the inverter also depends on the state of the R_ON/OFF terminal compared to the GND terminal present on the connector **a07** of the communication card **09**.

When the R_ON/OFF signal is brought to the same potential as the GND signal (i.e. by making a short circuit between the two terminals of the connector), the inverter disconnects from the grid. This arrangement can be used to control the inverter from an external source via hardware connection to the R_ON/OFF terminal. The system can also be used to facilitate a software ON/OFF by placing a short across the R_ON/OFF terminal as noted above and then using the ON/OFF function enable bit to control inverter operation. This signal would need to be obtained by an external source using the RS485 port.

The remote control OFF condition is shown on the display. The connections of this control are made between the R_ON/OFF input and GND. Since this is a digital input, there are no requirements regarding wire size (it only needs room to pass cables through the cable openings and the terminal connector).

The devices to be connected to the output must comply with the following requirements:
Direct current: Maximum Reverse Voltage: 10 V, Maximum Current: 8 mA.

Auxiliary +5 V output a07

Included on connector **a07** is an auxiliary 5 V output. The maximum allowed absorption by this auxiliary supply voltage is 100 mA.

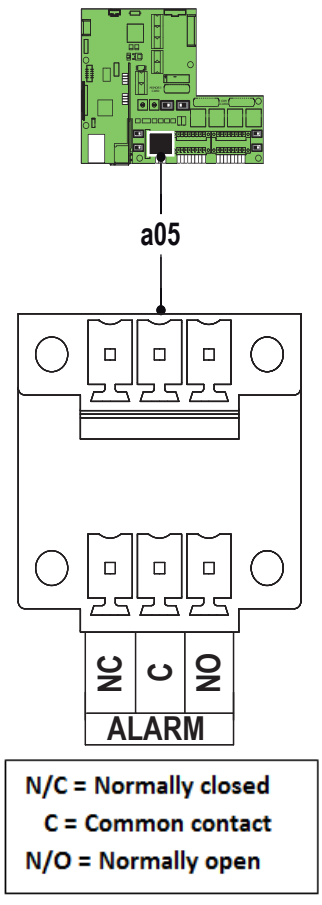
Configurable relay a05

The inverter has a multi-function relay **a05**, whose switching can be configured, for example, to activate a visual and/or audible alarm or be utilized by another control such as a building control system. The relay can be wired by the user as either normally open contact – N/O – or normally closed contact – N/C.

The devices to be connected to the relay can be of different types (light, sound, etc.) but must comply with the following requirements:

Alternating current:	Maximum Voltage: 240 Vac, OV Category II Maximum Current: 1 A
Direct current:	Maximum Voltage: 30 Vdc, Maximum Current: 0.8 A
Cable requirements:	Conductor size: from 24 AWG - 16 AWG

This contact can be used in four different operating modes which are set via the programming menu of the inverter display in Operations, section 4, of this manual. The four operating modes and switch configurations are described below.



Production - the relay switches whenever a connection to the grid occurs.
If the N/O (or N/C) contact is chosen, the contact will stay open (or closed) until the inverter is connected to the grid. Once the inverter connects to the grid and starts to export power, the relay switches state and closes (or opens).

When the inverter disconnects from the grid, the relay contact returns to its position of rest, namely open (or closed).

Alarm - the relay switches whenever there is an alarm (Error) on the inverter.
No switching occurs when there is a Warning.

If the N/O (or N/C) contact is chosen, the contact will stay open (or closed) until the inverter reports an error; once the inverter reports an error, the relay switches state and closes (or opens).

The contact remains switched from its rest condition until normal operation is restored.

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Alarm (configurable): the relay switches whenever there is an alarm (Error) or a Warning, which has been previously selected by the user through the dedicated menu.

If the N/O (or N/C) contact is chosen, the contact will stay open (or closed) until the inverter reports an error or a warning out of those selected from the menu. Once the inverter displays an error or a warning out of those selected, the relay switches state and closes (or opens) the contact. The relay remains switched from its rest condition until the alarm or warning has disappeared.

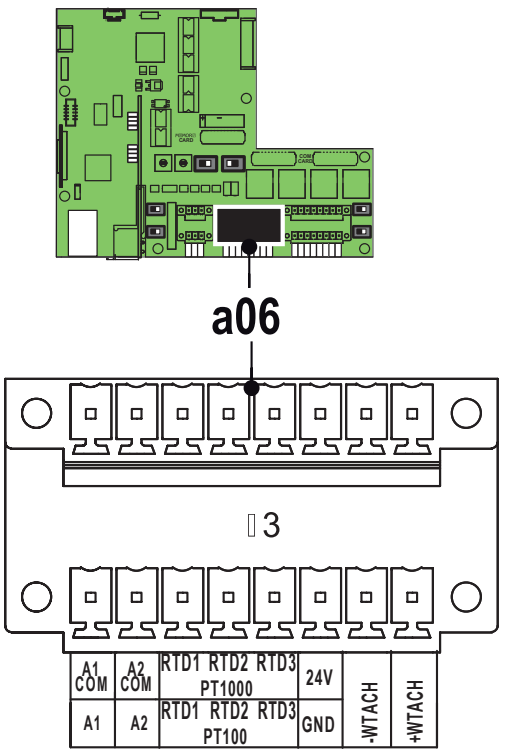
Crepuscular (twilight): the relay switches when the voltage from the photovoltaic array exceeds/ falls below the threshold set for grid connection.

If the N/O (or N/C) contact is chosen, the contact will stay open (or closed) until the inverter has an input voltage higher than the one selected for grid connection. The contact remains switched from its rest condition for as long as the inverter is switched on (even if not connected to the grid).

This mode is can be used to disconnect large output transformers that could have unnecessary consumption during the night.

Environmental sensors a06

Up to two temperature sensors and two general analog sensors for monitoring environmental systems can be connected to TRIO via terminals at location **a06** on the communication board.

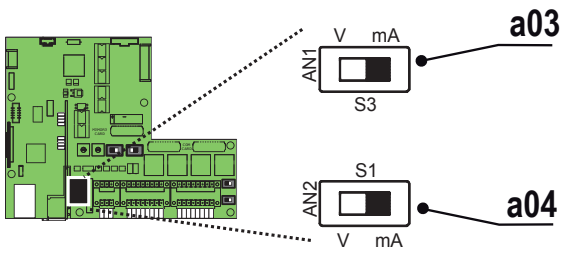


Terminal groups RTDxPT100 and RTDxPT1000 are dedicated analog inputs for temperature sensors:
PT100 - Connection of a PT100 temperature sensor
PT1000 - Connection of a PT1000 temperature sensor

Terminal pairs A1 and A2 allow connection of two 2-wire external analog sensors:
A1+A1COM - Analog sensor 1 connection,
A2+A2COM - Analog sensor 2 connection

Proper orientation of the analog sensors connected to these inputs requires specific calibration parameters to be set into the inverter memory. The required parameters necessary for any 2-wire sensor are: GAIN, OFFSET, AND UNIT of MEASURE.

The actual value of these parameters for marketed sensors are shown in the appendix, section 7, and must have values associated with the specific sensor loaded by accessing the relevant menu. See Operations, section 4, for setup of the analog inputs.



For each analog sensor, AN1 and AN2, it is also necessary to set the switch, **a03** or **a04**, to select whether the reading is in Volts or mA.

Connection diagrams for the main sensors marketed by ABB can be found in the Appendix, section 7.

Each sensor model has precise configuration values that must be set accurately. The power supply to the sensors must be installed outside the inverter, according to the manufacturer's specifications.

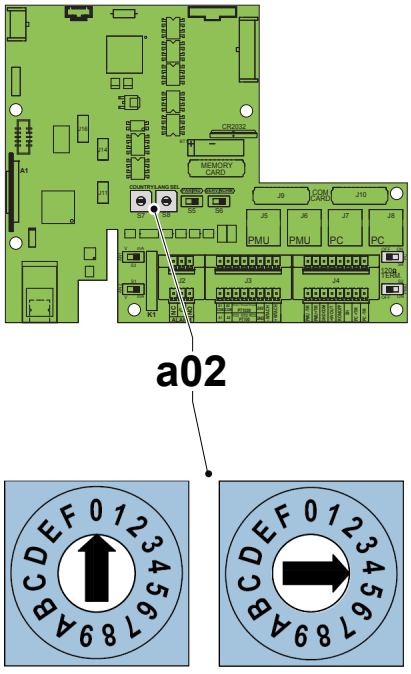
Auxiliary +24 V service output a06

Included on connector **a06,** illustrated above, is a +24VDC service output. The maximum allowed absorption by this auxiliary supply voltage is 300 mA.

Setting the country standard and language

The various grid parameters settings are dependent upon the country where the inverter is installed. These settings are determined by the position of switch **a02** on the communication board. The language of the display menus will be also be defined by the grid standard chosen.

Before turning the rotary switches, make sure the inverter is switched off.



The TRIO is shipped with the predefined settings for the North American market, positions 0/4.

If it is necessary to reduce the maximum output power settings, the inverter can be configured to **position 1/A** using the two rotary dials **a02**. See output settings below. This setting utilizes the inverter active power management function, and does not change the inverter power factor setting.

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To change the settings, use a small flat head screwdriver and move the dial of the left-most switch to line up with position 1 on the rotary dial **a02**, and the second switch (right-most) to line up with position A on the dial. (If a switch position not assigned to a grid standard is selected, “Invalid Selection” will appear on the LCD.)

Country Settings	TRIO-20.0-TL US	TRIO-27.6-TL US
Default Maximum Output Power (0/4)	22000	30000
Maximum Output Power (1/A)	20000	27600

Saving the country standard and language

The settings of switch **a02** become permanent after 24 hours of operation of the inverter (it does not need to be connected to the grid, but only needs DC power). The time remaining before the settings become fixed can be seen in the dedicated menu, and a notice appears if the time has expired. If it is necessary to change the standard of the country after the settings have been fixed (after 24 hours of operation) please contact technical support with the part number and serial number of the inverter.

4

Monitoring and data transmission

One of the first rules for preventing damage to the equipment and injury to the operator is to have a thorough knowledge of the user interface operations.
ABB cannot be held responsible for damage to the equipment or the operator if caused by incompetence, insufficient qualifications or lack of training.

Normally, the inverter operates automatically and does not require manual intervention. When there is not enough sunlight to supply power for export to the grid, (e.g., during the night) it disconnects automatically and goes into stand-by mode.

The operating cycle is automatically restored when there is sufficient sunlight. At this point, the lights on the LED panel will indicate this state.

Types of data available

The inverter provides two types of data which are accessed through the appropriate interface software and/or the LCD.

Real-time operating data
Real-time operating data can be transmitted on request through the communication lines and are not recorded in the inverter. For data transmission to a computer, download the free Aurora Manager Lite software from www.abb.com/solarinverters.

Internally stored data
The inverter internally stores a set of data that is necessary for processing statistical data which includes an error log with time stamps.

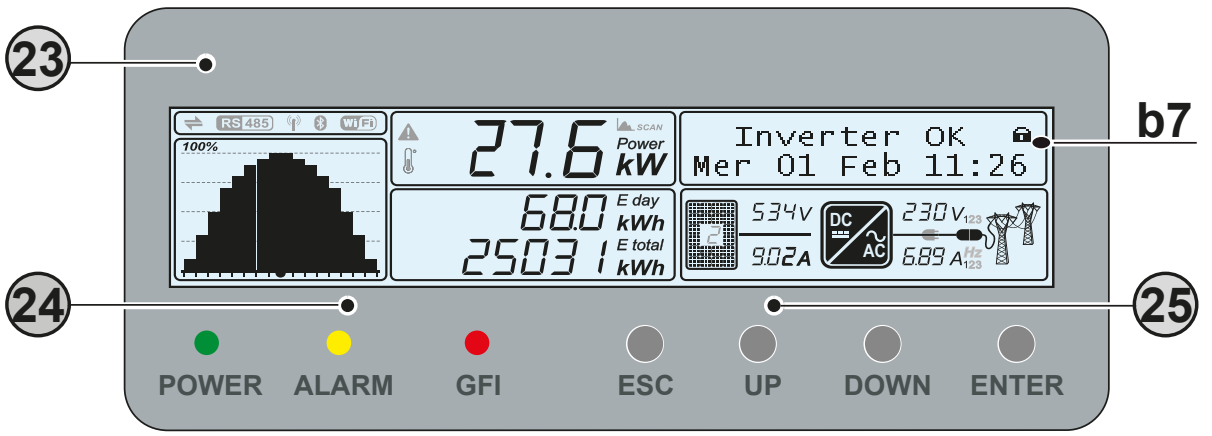
User interface

The inverter is able to provide operation information through the following:

- Warning lights (LEDs).
- Liquid Crystal Display (LCD) for displaying operating data.
- Data transmission on dedicated RS-485 serial line. The data can be collected by a PC (using the signal converter PVI-USB-RS485_232) or a data logger equipped with an RS-485 port (PVI-DESKTOP). Contact ABB technical support with any questions regarding the compatibility of the devices.

Display and keypad

There are three indicators on the LED panel and four buttons on the keypad. LEDs indicate the operating state of the inverter. The keypad is used to review data on the cyclical display area **b10** and access the data logged internally on the TRIO, using the menus described in this section.



LED	Description
Green POWER LED	Indicates that the inverter is working correctly. This LED flashes while the grid is being checked during start up. If a valid grid voltage is measured, the LED stays on continuously, provided there is sufficient sunlight to activate the unit. If not, the LED continues to flash until there is sufficient sunlight for activation. During this phase, the LCD shows the “Waiting for Sun” message.
Yellow ALARM LED	Indicates that the inverter has detected an anomaly; the type of problem is shown on the display area **b7.**
Red GFI LED	The GFI (ground fault indicator) LED indicates that the inverter has detected a ground fault on the DC side of the PV array. When this fault is detected, the inverter immediately disconnects from the grid and the relevant error warning appears in the display area **b7**.

Keypad button	Description
ESC button	Use the ESC button to access the main menus, exit a mode or go back.
UP button	Use the UP button to read the data on the display by scrolling upwards, or to increase the set value during data entry.
DOWN button	Use the DOWN button to read the data on the display by scrolling downwards, or to decrease the set value during data entry.
ENTER button	Press ENTER to confirm the operation or to enter the set data item.

During operation, the display cycles through available data points, updating every five seconds. Screens may be scrolled manually by pressing the UP and DOWN buttons on the keypad. Activation of cyclical scrolling will be indicated by two arrows in the top left corner of the two-line display. Scrolling can be blocked by pressing the ENTER key until a padlock symbol appears.

Some parameters (e.g., current, voltage, power, partial energy, lifetime energy etc.) are available only after grid connection.

T010CC4

LED indicators

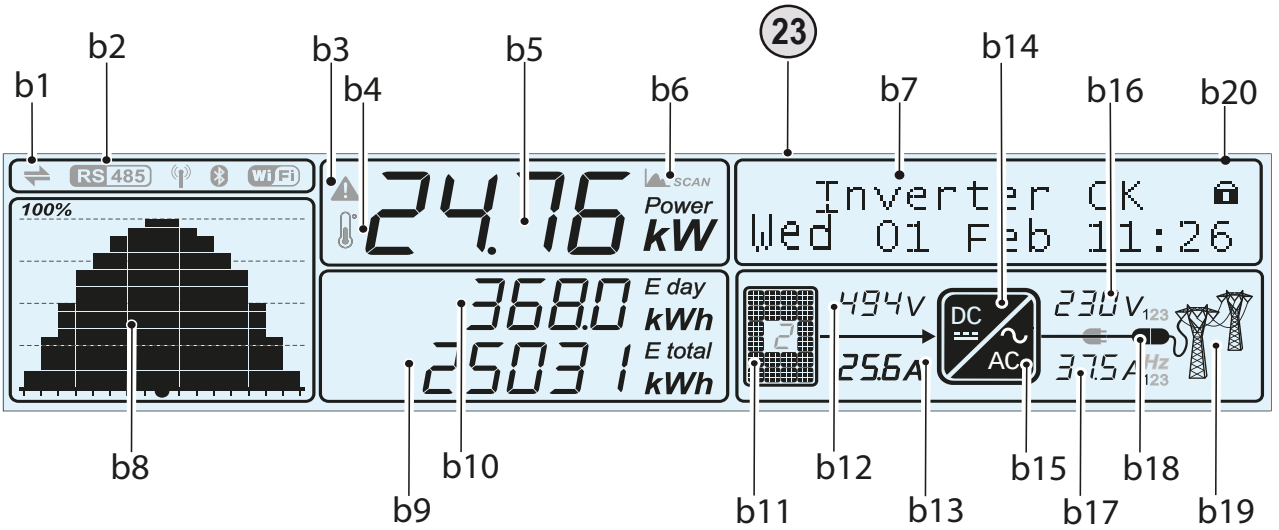
In their various combinations, the LEDs can indicate conditions that are different from the single one. The table below shows the possible combinations of activation of the LEDs in relation to the operating state of the inverter.

Warning and Error messages referenced below are described in Troubleshooting, section 5.

LED BEHAVIOR			
LED off **LED on** **LED flashing** **any condition**			
	LEDs Status	Operational Status	Remarks
1	green: yellow: red:	Inverter is not operating	Input voltage less than 50Vdc at the input
2	green: yellow: red:	Inverter is initializing, loading settings and performing grid check	Transition status while operating conditions are checked
3	green: yellow: red:	Inverter is powering the grid	Normal operation
4	green: yellow: red:	Inverter is shut down because of a GFI fault	Ground fault has been detected
5	green: yellow: red:	Inverter detected a fault	The fault can be inside or outside the inverter. See the alarm code appearing on the LCD
6	green: yellow: red:	Installation phase: inverter is disconnected from grid	During installation it refers to setup of the address for RS-485 communication
7	green: yellow: red:	Inverter is disconnected from grid	Indicates a missing grid connection

Descriptions of symbols and display fields

The operating parameters of the equipment can be viewed on the display **23** and include warnings, alarms, channels, voltages, etc. During operation, the display cycles through the various operating parameters described below.



b1	RS-485 data transmission	b8	Power graph	b15	DC/AC circuit
b2	RS-485 line present	b9	Total energy	b16	AC voltage
b3	Warning	b10	Daily energy produced	b17	AC current
b4	Temperature derating	b11	MPPT channel (1 or 2)	b18	Connection to grid
b5	Instantaneous power	b12	DC voltage	b19	Grid status
b6	MPP scan running	b13	DC current	b20	Cyclic view on/off
b7	Inverter information display	b14	DC/DC circuit		

Cyclical display of general information

The information display area **b7** consists of 2 lines with 16 characters per line. When moving through the menu using the buttons of the keypad, area **b7** is used to:

- display the operating state of the inverter and the statistical data
- display the service messages for the operator
- display the alarm and fault messages for the operator
- navigate the menus

Pressing the ESC button allows access to the three main menus, STATISTICS, SETTINGS and INFORMATION. ESC is also used to cancel an entry or return to the previous menus.

The UP and DOWN buttons of the keypad are used to move through a menu and change menu settings by increasing or decreasing the settable values.

The ENTER button is used to open the menu choices, make a selection and confirm a change in adjustable values.

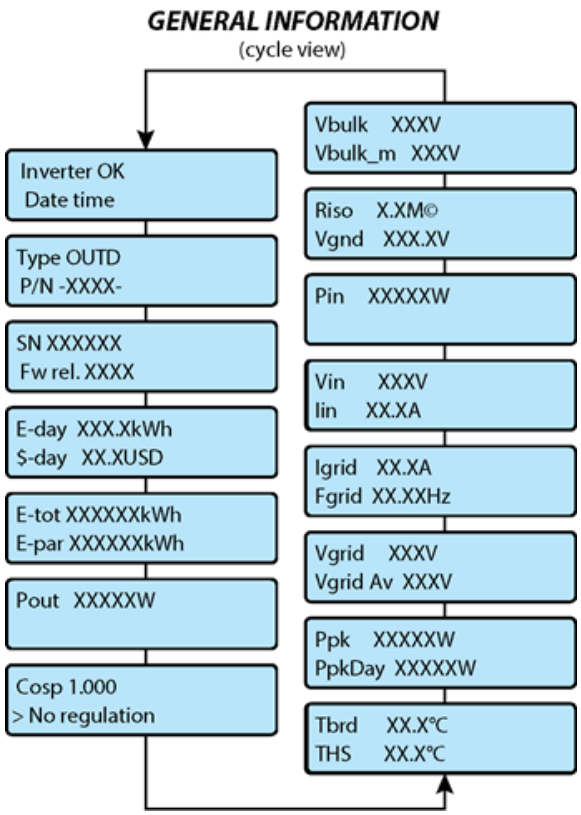
T010CC4

During regular operation, the display will cycle through general information shown in the diagram on the right.

To lock the display on any of the information screens, press and hold the ENTER button until the padlock symbol appears (see **b20** in the table on page 56) In the data cycling mode, the icon at location **b20** changes from a padlock to a two-arrow icon.

When locked, the current information displayed will remain on screen.

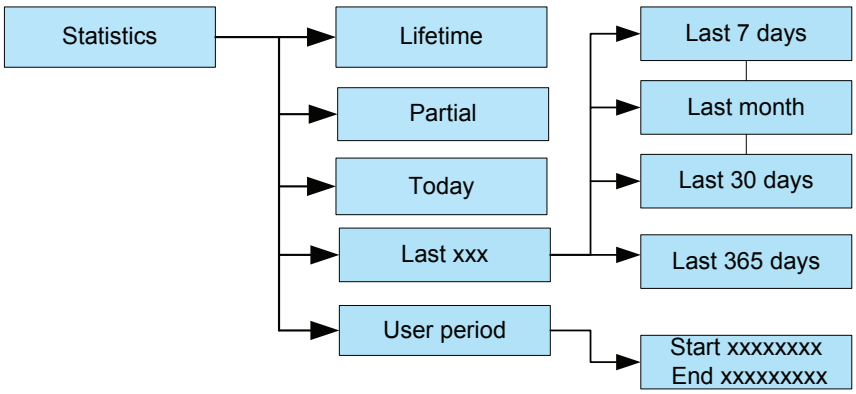
Press and hold the ENTER button until the two-arrow icon is displayed to unlock and cycle through the display.



The three main menus that enable monitoring of the inverter's operations are outlined and described on the following pages. Press the ESC button to access the menus from the general information screens. Use the UP and DOWN keys to scroll through the three menus and press ENTER to make a selection.

Statistics menu

The Statistics menu is a view only display of internally logged inverter data.



Lifetime - Displays the total statistics for lifetime operation:

- Time: Total operating time.
- E-tot: Total energy produced.
- Val. : Total production value, calculated with the currency and conversion coefficient set in the relevant section of the SETTINGS menu.
- CO2: Amount of CO2 saved.

Partial - Displays partial statistics using a counter that can be reset*.
- Time: Partial operating time since the counter was activated.
- E-par: Partial energy produced since the counter was activated.
- PPeak: Peak power value measured since the partial counter was activated.
- Val.: Partial production value calculated with the currency and conversion coefficient set in the relevant section of the SETTINGS menu.
- CO2: Amount of CO2 saved daily since the counter was activated.

* To reset all the counters of this submenu, press the ENTER button and hold for 3 seconds until a beep is heard.

Today - Displays the daily statistics:
- E-day: Daily energy produced.
- PPeak: Daily peak power value.
- Val.: Daily production value calculated with the currency and conversion coefficient set in the relevant section of the SETTINGS.
- CO2: Amount of CO2 saved today

Last 7 days - **Last month** - **Last 30 days** - **Last 365 days** -
Select any one of the above time periods to view the following information:
- E-##: Energy produced over the period selected.
- Val.: Economic gain over the period selected.
- CO2: Amount of CO2 saved for the period selected.

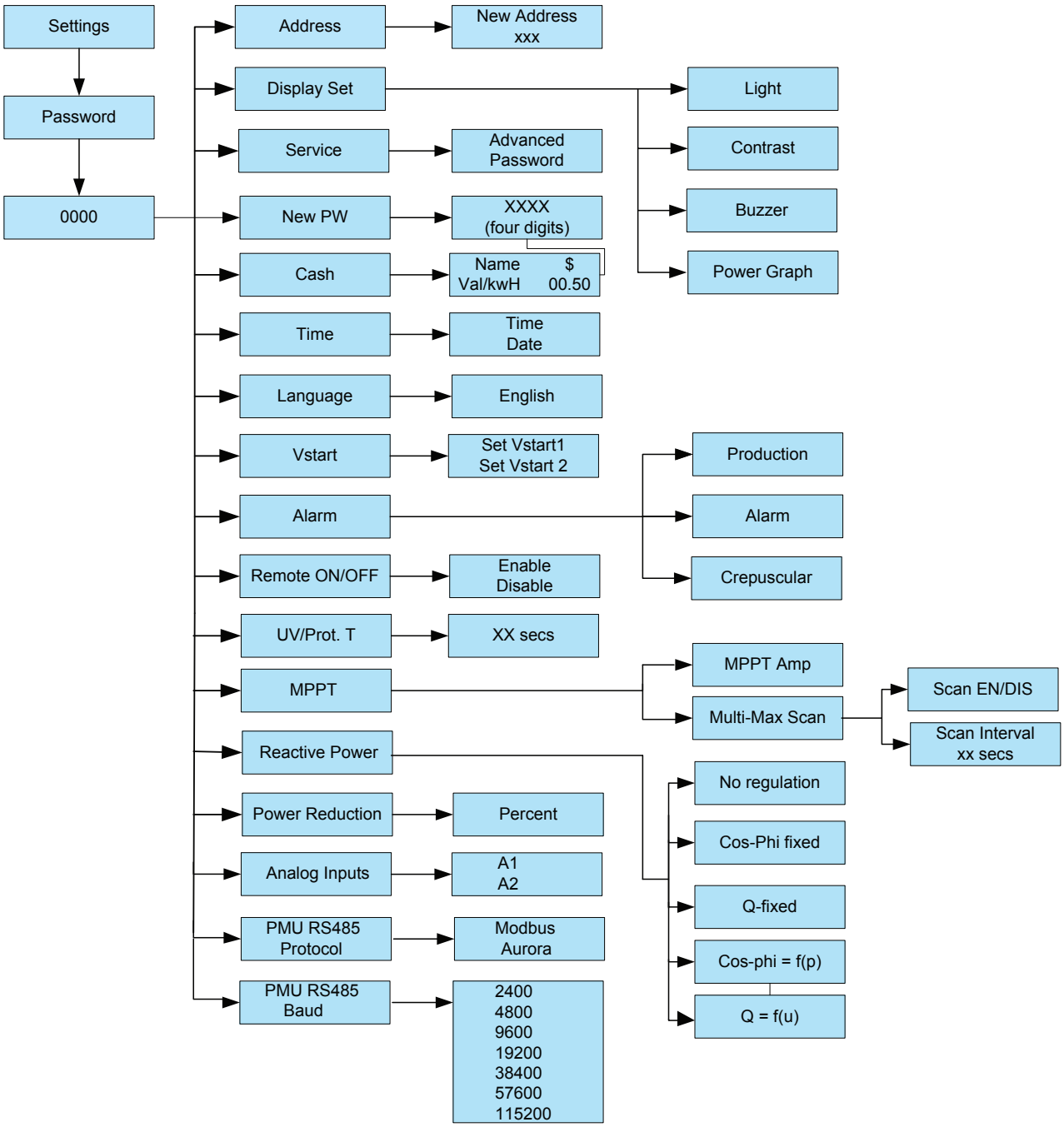
User period - Displays the statistics for a period selected by the user. Use the display keys to set the start and end date of the period as follows:
Scroll to User Period and press ENTER to open the Start/End date screen.
- Use ENTER to move from one field to the next (from left to right).
- Use ESC to go back to the previous field (from right to left).
- Press ESC repeatedly to go back to the previous menus.

To set the day: Press DOWN to scroll numbers from 31 to 1, UP to scroll from 1 to 31.
To set the month: Press DOWN to scroll months from December to January; UP to reverse.
Once the start and end dates for the user periods have been selected, the following data is available:
- E-use: Energy produced during the selected period.
- Val.: Value of production for the selected period calculated with the currency and conversion coefficient set in the relevant section of the SETTINGS menu.
- CO2: Amount of CO2 saved during the selected period.

Settings menu

The Settings menu requires a password which allows access to configuration and modification of the basic inverter settings.

- Press ESC to open the main menus.
- Scroll DOWN to *Settings* and press ENTER.
- The password screen is populated in the display.
- The default password is 0000; pressing ENTER four times loads four zeroes into the display and opens the submenus outlined below.



Address - Used to set the address for the serial communication of inverters connected to the RS-485 line. The addresses that can be assigned are 2 to 63. Use the UP and DOWN buttons to scroll the numerical scale. “Auto” address is equivalent to address=1 and can be used on only one of the inverters in a daisy chain connection

NOTE! No more than 63 inverters can be connected to a single RS-485 link. The number may be less depending on the data logger used.

Display Settings - Used to set the characteristics of the display.

1. Light: setting of the mode and adjustment of the brightness of the display
- Mode:
  ON: Light always on.
  OFF: Light always off.
- Auto: Automatic light control. The light comes on whenever a button is pressed and stays on for 30 sec, after which it gradually goes out.
- Intensity: adjustment of display brightness (scale from 0 to 9).

2. Contrast: adjustment of display contrast (scale from 0 to 9).
3. Buzzer: button sound setting
   ON: the sound of the buttons is activated.
   OFF: the sound of the buttons is deactivated.
3. Power Graph: Time range: 8 H, 16 H, 24 H

Service - This section of the menu is reserved for installers and it is necessary to have a dedicated password. See Troubleshooting, section 5, for instructions to obtain the service level password.

The Service menu can be used to adjust the Voltage and Frequency Trip Limit and Trip Time Parameters according to the grid requirements of the installation locale. This inverter has been factory programmed to automatically disconnect from the utility distribution system in compliance with UL 1741 and IEEE1547 specifications. Default voltage and frequency trip limit and trip time settings to comply with these standards are shown in the table below.

The table lists the default and adjustable parameters available in the Service submenu. Using the UP and DOWN keys on the inverter display panel, scroll to select the values for modification.

WARNING! ABB cannot be held responsible for any negative effects resulting from modifications of inverter set points. The set points in the table below should only be changed with the written permission of the local utility.
Changes to the voltage and frequency trip limit and trip time parameters MUST be done by a qualified contractor or authorized personnel. Improper values entered could cause bodily harm and cause the inverter to shut down.

Parameter	Definition	Default Value	Adjustable Ranges
SET U>>	Indicates the value of the absolute over voltage set point beyond which the inverter disconnects from the grid [115% of Nominal V_{L-N}]	115% of Nominal V_{L-N}	Fixed
SET U<<	Indicates the value of the absolute under voltage set point below which the inverter disconnects from the grid [50% of Nominal V_{L-N}]	50% of Nominal V_{L-N}	Fixed
SET F>>	Indicates the value of the absolute over frequency set point beyond which the inverter disconnects from the grid	63.0 Hz	60.2 Hz to 65.0 Hz

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Parameter	Definition	Default Value	Adjustable Ranges
SET F<<	Indicates the value of the absolute under frequency set point below which the inverter disconnects from the grid	57.0 Hz	59.8 Hz to 55.0 Hz
SET U>	Indicates the value of the intermediate over voltage set point beyond which the inverter disconnects from grid [110% of Nominal V_{L-N}]	110% of Nominal V_{L-N}	(110% x V_{L-N}) to (115% x V_{L-N})
SET U> (10 min)	Inverter disconnects from grid after 10 minutes in case the average grid voltage overcomes threshold value (110% x V_{L-N})	110% of Nominal V_{L-N}	(110% x V_{L-N}) to (115% x V_{L-N})
SET U<	Indicates the value of the intermediate under voltage set point below which the inverter disconnects from grid [88% of Nominal V_{L-N}]	88% of Nominal V_{L-N}	(50% x V_{L-N}) to (88% x V_{L-N})
SET F>	Indicates the value of the intermediate over frequency set point beyond which the inverter disconnects from grid	60.5 Hz	60.2 Hz to 65.0 Hz
SET F<	Indicates the value of the intermediate under frequency set point below which the inverter disconnects from grid	59.3 Hz	59.8 Hz to 55 Hz
SET U Conn>	Indicates the value of the intermediate over voltage (line to neutral) set point to allow the inverter to connect to the grid for the first time	110% of Nominal V_{L-N}	(110% x V_{L-N}) to (115% x V_{L-N})
SET U Conn<	Indicates the value of the intermediate under voltage (line to neutral) set point to allow the inverter to connect to the grid for the first time	88% of Nominal V_{L-N}	(50% x V_{L-N}) to (88% x V_{L-N})
SET F Conn>	Indicates the value of the intermediate over frequency set point to allow the inverter to connect to grid first time	60.5 Hz	60.2 Hz to 63.0 Hz
SET F Conn<	Indicates the value of the intermediate under frequency set point to allow inverter to connect to the grid first time	59.3 Hz	59.8 Hz to 57 Hz
SET TIME U>>	Indicates the value of the countdown timer associated with the absolute over voltage setpoint U>>	0.16 sec	160 msec to 65.5 sec
SET TIME U<<	Indicates the value of the countdown timer associated with the absolute under voltage setpoint U<<	0.16 sec	160 msec to 65.5 sec
SET TIME F>>	Indicates the value of the countdown timer associated with the absolute over frequency setpoint F>>	0.16 sec	160 msec to 327.67 sec
SET TIME F<<	Indicates the value of the countdown timer associated with the absolute under frequency setpoint F<<	0.16 sec	160 msec to 327.67 sec
SET TIME U>	Indicates the value of the countdown timer associated with the intermediate over voltage setpoint U>	1 sec	160 msec to 65.5 sec
SET TIME U<	Indicates the value of the countdown timer associated with the intermediate under voltage setpoint U<	2 sec	160 msec to 65.5 sec
SET TIME F>	Indicates the value of the countdown timer associated with the intermediate over frequency setpoint F>	0.16 sec	160 msec to 327.67 sec
SET TIME F<	Indicates the value of the countdown timer associated with the intermediate under frequency setpoint F<	0.16 sec	160 msec to 327.67 sec

Parameter	Definition	Default Value	Adjustable Ranges
SET TIME Conn 1	Indicates the time the inverter takes to connect to the grid for the first time (not after grid fault).	30 sec	2 sec to 300 sec
SET TIME Conn 2	Indicates the time the inverter takes to connect to the grid after a grid fault.	300 sec	2 sec to 300 sec
DISABLE U>>	Provides ability to enable/disable the absolute over voltage set point U>>	Enable	Disable or Enable
DISABLE U<<	Provides ability to enable/disable the absolute under voltage set point U<<	Enable	Disable or Enable
DISABLE F>>	Provides ability to enable/disable the absolute over frequency set point F>>	Enable	Disable or Enable
DISABLE F<<	Provides ability to enable/disable the absolute under frequency set point F<<	Enable	Disable or Enable
DISABLE U>	Provides ability to enable/disable the intermediate over voltage set point U>	Enable	Disable or Enable
DISABLE U> (10 min)	Provides ability to enable/disable the parameter Set U> (10 min)	Disable	Disable or Enable
DISABLE U<	Provides ability to enable/disable the intermediate under voltage set point U<	Enable	Disable or Enable
DISABLE F>	Provides ability to enable/disable the intermediate over frequency set point F>	Enable	Disable or Enable
DISABLE F<	Provides ability to enable/disable the intermediate under frequency set point F<	Enable	Disable or Enable
U>(10 min) Der.	Provides ability to limit the power for 10 minutes due to the high average voltage value set by the parameter Set U>(10 min)	Disable	Disable or Enable
Slow ramp	Enable/disable the gradual feeding of power after the grid connection	Enable	Disable or Enable
OF Derating	Enable/disable the power derating mode in the event of grid over-frequency	Enable	Disable or Enable
OF Der. Rest. T	Set time of restart for power derating in the event of grid over frequency	Enable	Disable or Enable
Reset country S	Resetting the “grid standard” selection time.	Enable	Disable or Enable

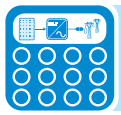
New PW - Used to change the password for accessing the SETTINGS menu. The default password is 0000 and can be changed using the display keyboard.

- Use ENTER to scroll the digits (from left to right)
- Use ESC to return to the previous digit (from right to left)
- Press ESC several times to return to the previous menus
- Use DOWN to progressively scroll the numerical scale downwards (from 9 to 0)

Be careful to memorize the new password. For security purposes there is no reset function. If the password is misplaced it will not be possible to access the inverter.

Cash - Used to set the name of the currency and the value given to 1 kWh of energy produced. The correct setting of these parameters displays the actual earning/saving given by the system.

- Name: the chosen value is set (default is $, USD).
- Val/KWh: indicates the cost/incentive of 1 KWh expressed in the chosen currency (default is 0.16).



Time – Used to set the current date and time (daylight saving time not included).

Language – Used to set the menu language.

Vstart – Used to set the Vstart voltage (separately for both channels if they are configured in independent mode). Change the activation voltage only if necessary. A configuration program that can help to correctly size the photovoltaic system is available on at http://www.stringsizer.abb.com

Alarm - This section of the menu allows programming of the alarm relay function (available as a normally open contact – N/O, and also as a normally closed contact – N/C). This contact can be used, for example, to activate a siren or a visual alarm, control the disconnect device of an external transformer, or control an external device. Maximum ratings of the alarm contact: 240Vac/1A and 30Vdc/0.8A.

The switching of the relay can be set in four different modes:

- PRODUCTION: the relay switches when the inverter connects to the grid.
- ALARM: the relay switches when there is an alarm (code E).
- ALARM (configurable): the relay switches if there are alarms (code E) or warnings (code W) chosen by the user from a list (the list may also show choices that are not available for the specific model).
- CREPUSCULAR: the relay switches only when the input voltage exceeds the input voltage set for connection to the grid.

The operating modes are described in further detail below:
Production: the relay switches when a connection to (or disconnection from) the grid occurs. When N/O (or N/C) contact is chosen, it will stay open (or closed) until the inverter is connected to the grid. Once the inverter starts to export power, the relay changes state and closes (or opens). When the inverter disconnects from the grid, the relay contact returns to its position of rest, open (or closed).

Alarm: the relay switches when there is an alarm (Error) on the inverter. No switching occurs when there is a Warning. When N/O (or N/C) contact is chosen, it will stay open (or closed) until the inverter reports an error; once an error is reported, the relay switches state and closes (or opens). The contact remains switched from its rest condition until normal operation is restored.

Alarm (configurable): the relay switches when there is an alarm (Error or Warning), which has been selected by the user through the programming menu. If N/O (or N/C) contact is chosen, it will stay open (or closed) until the inverter reports an error or a warning out of those selected from the menu. At that point the relay switches state and closes (or opens) the contact. The relay remains switched from its rest condition until the alarm or warning has disappeared.

Crepuscular: (meaning - twilight) the relay switches when the voltage from the PV array exceeds/ falls below the threshold set for grid connection. If N/O (or N/C) contact is chosen, it will stay open (or closed) until the inverter has an input voltage higher than the one selected for grid connection. The contact remains switched from its rest condition for as long as the inverter is switched ON (even if it is not connected to the grid).

Remote ON/OFF - Selecting this function accesses the remote ON/OFF function used to disable the inverter operation by an external switch or an external controller. Set as follows:

- Disable: disables the ON/OFF function, so that inverter operation will operate normally, depending only on grid access and external solar radiation (default).
- Enable: Activates the ON/OFF function, requiring an external contact closure to activate the inverter.

Hardware access to the ON/OFF function is via terminals R_ON/OFF and GND COM, described in Mounting and wiring, section 3, of this manual. When the function is active,
- Turn OFF the inverter terminals by shorting terminals R_ON/OFF and GND COM.
- Turn ON the inverter by removing the short between terminals R_ON/OFF and GND COM.
- With the function enabled, the ON/OFF input status is indicated on the inverter display

UV Prot. T - This section of the menu allows programming of a time interval for which the inverter stays connected to the grid in a situation where the input voltage has dropped below the undervoltage limit (set at 70% of Vstart).
The default time is set at 60 sec. The user can set it from 1 to 3600 sec. Example: with the UV Prot. time set at 60 seconds, if the V_{IN} drops below 70% of Vstart at 9:00, the inverter stays connected to the grid (taking power from it) until 9:01.

MPPT - This section of the menu allows setting the parameters of the maximum power point tracking (MPPT) function. This function is useful when there are shaded areas on the PV array that can create several maximum power points in the work curve.

- MPPT amplitude: the amplitude of the interference introduced in DC is chosen through the setting of this parameter to establish the optimal working point. There are three settings to choose from (LOW, MEDIUM, and HIGH). The default setting is MEDIUM.
- Multi-max scan: by setting this parameter, the user can enable/disable the scan, decide the frequency with which the scan is carried out, and override it manually.

a. Enable/Disable: Enables/Disables the scan for identifying the system's maximum power point.
b. Scan Interval: this allows setting the interval of time between scans. The shorter the interval between scans, the greater the loss of production due to the fact that, during the scan, energy is transferred to the grid but not at the maximum power point. Each scan takes two seconds.

Reactive Power – This section of the menu can be used to manage the input of reactive power to the grid. From the Settings menu choose Reactive Power and scroll DOWN to select one of five possible types of management (Mode 0 is enabled by default). Values of power factor and active power management are generally specified by the utility to which the inverter is connected. The user must obtain appropriate settings from the utility.

- *Mode 0 (default) - No regulation or Unity Power factor mode*: enabled by default.
- *Mode 1 - Fixed cos-phi:-* sets power factor to a fixed value.
  To enable this mode, select Enable and then OK (using the UP / DOWN arrows).
  When enabled, *Power Factor (cos-phi) can be set from - 0.85 to 1.0 (unity) to +0.85*.
- *Mode 2 - Fixed Q:* sets reactive power to a percentage, input in % required.
  To enable this mode, select Enable and then OK (using the UP / DOWN arrows).
  When enabled, *Set value* will appear on the display allowing you to set the value of Cos-Phi (either Over or Under excited from 1.000 to 0.800).
- *Mode 3 - cos-phi = f(P)*: Power factor as a function of active power generated by the inverter. To enable this mode, select Enable and then OK (using the arrows). When enabled, *Use def curve* will appear on the display, allowing you to set the control curve.*
- *Mode 4 - Q = f(U)*: Reactive power as a function of the grid voltage measured by the inverter. To enable this mode, select Enable and then OK (using the UP/DOWN arrows). When enabled, *Use def curve* will appear on the display, allowing you to set the control curve.*

*The curves can be edited using the Aurora Manager LITE software available at https://registration.abbsolarinverters.com/.

Power Reduction – This section of the menu is used to adjust the limit of active power that the inverter can input to the grid. This is done by setting a limit based on a percentage of the inverter's rated power. It can be set from 0% to 100% in 1% steps.

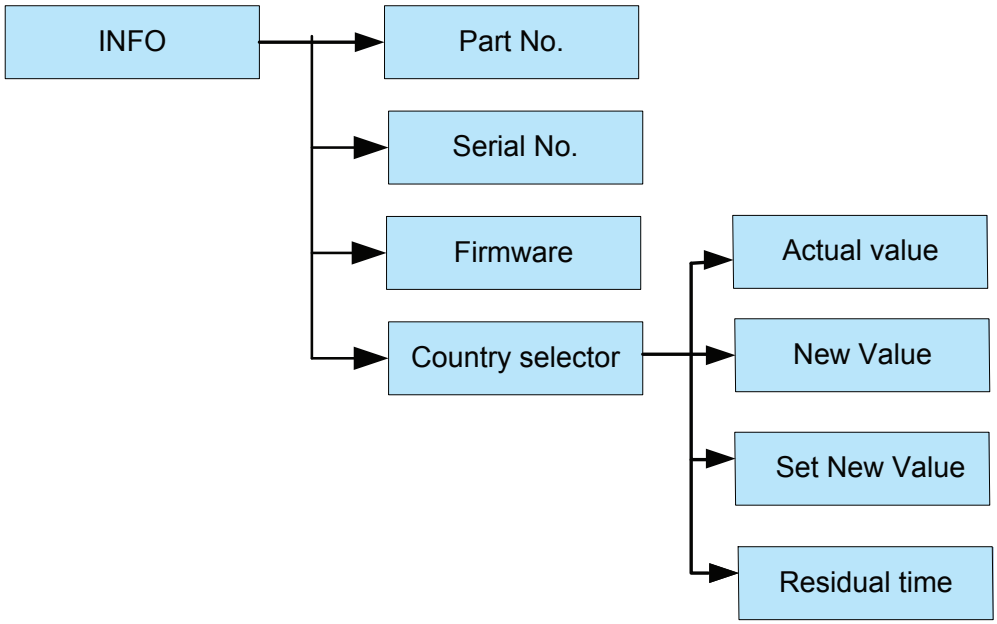
Analog Inputs – Used to set up the two analog sensor input channels (AN1 and AN2), available on all TRIO models. The set-up parameters include:

- Set Gain: adjustment of the gain of the sensor
- Set Offset: adjustment of the offset of the sensor
- Set M.Unit: set up of the unit of measure of the sensor

The power supply for these sensor inputs is not available from the inverter and must be provided separately. See additional information in the Appendix, section 7.
PMU RS-485 Protocol – Used to change default MODBUS protocol to AURORA protocol.
PMU RS-485 Baud – Used to change the default baud rate from 9600 to one of the following: 2400, 4800, 19200, 38400, 57600, 115200.

Information menu

The INFO menu provides information about the inverter and access to modify the country standard for grid connection.



Part No. - Displays the TRIO part number.
Serial No. - Displays the TRIO serial number and the week (from 1 to 52) and year of manufacture.
Firmware - Displays the revision of the firmware installed in the equipment.
Country selector - Displays information regarding the grid standard set with the rotary selectors.

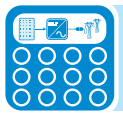
- **Actual value:** Displays the set grid standard.
- **New value:** If the position of the rotary switches is changed (a new grid standard is selected) during operation, the new standard selected will be displayed but will be made effective only after the equipment has been switched off and then on again and only if the time remaining for carrying out this operation has not expired (24 hours of operation).
- **Set new value:** Allows confirm/set of the new grid standard set in the “New value” section of the previous menu. When this function is used, there will be no correspondence between the standard selected on the display and the position of the rotary selectors.
- **Residual time:** Displays the time remaining in which it is still possible to set a new grid standard. When the time expires, “Locked” will be displayed.

Commissioning

WARNING! Do not place any items on the inverter during operation. Do not touch the heat sink when the inverter is operating, as some parts may be hot and cause burns.
The incoming voltage must not exceed the maximum values shown in the technical data in order to prevent damage to the equipment. Consult the technical data table in the Appendix, section 7, for further details.

Configure inverter settings

The following settings can be configured before or after commissioning the inverter using the display menu. If the settings are configured prior to grid connection the inverter display only needs DC power to use the menus. DO NOT connect the AC power (grid side) at this time!



With only the array connected, turn the DC disconnect switch to the ON position. The GREEN POWER LED will flash and the YELLOW ALARM LED will be steady. The LCD will display *Missing Grid*.

Press the ESC button to open the three main menus. Use the DOWN button to scroll to *Settings* and press ENTER. A password screen will open; the default password is 0000. Pressing ENTER four times loads four zeros on the display and opens the Settings submenu.

Address (RS-485) - Default address is set at 2 for a single inverter. The RS-485 address may need to be changed or assigned. Address values are assigned manually using any value in the range 2 to 64.

- From the *Settings* menu, scroll to *Address* and press ENTER.
- *New Address* screen opens; press DOWN to select number field and press ENTER.
- Press UP or DOWN key to scroll through numbers; press ENTER to select new number.
- Press ESC to return to main menus.

Vstart: the Vstart parameter may need to be adjusted when short strings are used in the PV array.

MPPT scan: The MPPT scan setting allows the time interval between scans to be increased, decreased or disabled. The default setting is enabled with a time interval set for 15 minutes (900 seconds) between scans.

Limitation active power setting (where present): Allows access to settings necessary to set a limit on active power output of the inverter ("Power reduction" parameter).

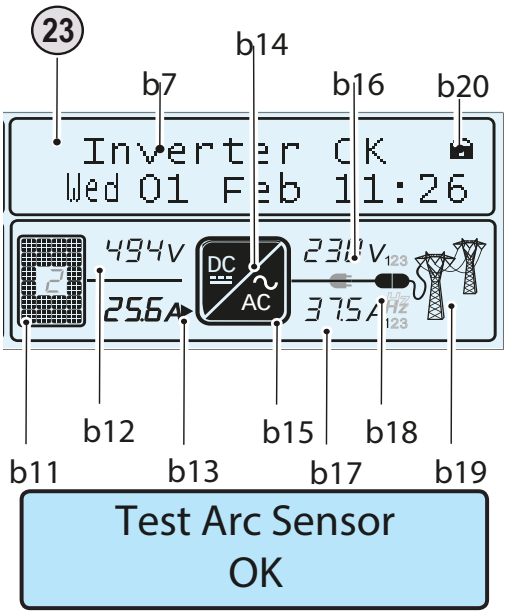
Power ON the inverter

1. First, close any external AC disconnect switch. If there are external DC disconnect switches installed, close those before turning the inverter's DC disconnect switch to the ON position.

2. Once the inverter is powered, icon **b11** comes on to indicate that the voltage from the photovoltaic array has reached the Vstart threshold (voltage necessary for connecting the inverter to the grid).

For input voltages lower than Vstart, the icon **b11** remains off, the *Waiting Sun* message is shown on the display and the voltage and current values are present (icons **b12** and **b13**).

3. ***For -A models*** only, as soon as *Waiting Sun* conditions are met, the inverter display shows the AFD board self-test running. The results are displayed in the two-line graphic display area **b7**.



If a problem on the AFD board is detected, the self-test will result in an error. Refer to Troubleshooting, section 5, to clear the error and possible solutions.

4. If there are no irregularities after checking the grid voltage and frequency parameters, the grid connection sequence starts. Once all the checks are finished, and all grid parameters are observed, icon **b19** comes on.

During these checks, icon **b19** is flashing. This check can take several minutes depending on grid conditions and grid standard settings.

5. At this point icon **b14** flashes to indicate the start-up phase. This icon will remain permanently switched ON when the DC-DC is operating at steady state.

At the same time as icon **b14** comes on (steady), icon **b15** will come on to indicate that the inverter circuit has begun working (DC- AC).

6. The grid connection will start immediately. During this phase the icon **b18** will be displayed in steps until the connection of the inverter is complete. After the inverter is connected, icon **b18** will stay plugged in as shown below.

Icon **b18** – inverter connected to network (plugged in)

Icon **b18** - inverter not connected to network (unplugged)

Once the connection sequence is complete, the inverter starts to operate and indicates correct operation by the steady green LED light on the panel. This means there is sufficient sunlight to feed power into the grid.

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If there is not sufficient sunlight, the unit will repeat the procedure until all the parameters controlling connection to the grid (grid voltage and frequency, confirmation of no ground fault) are within the range. During this procedure, the green LED flashes ON and OFF.

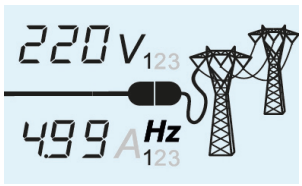
Dynamic behavior of the display during operation

If the MPPT scan function is enabled (on by default), icon **b6** will be shown on the display and flash during scanning.

During operation, the following values are displayed in rotation:

Voltage **b12** and current **b13** from the PV field.

Depending on the configuration or model of the inverter, the voltages and currents of one or both channels will be displayed.
The input channel measured is indicated by the value displayed in **b11**.

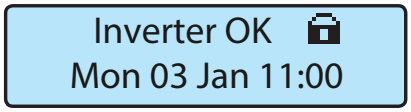


The grid voltage is displayed at **b16** and the grid frequency and inverter output current cycle at **b17**.

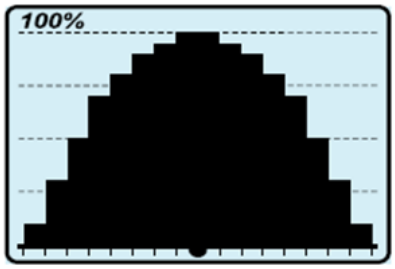
The display of AC voltage, current and frequency cycle through line one through three before starting again.

At the end of the display cycle described above, the inverter output current will be indicated in **b17** and the grid voltage will be indicated in **b16**.

At the same time, the main readings made by the inverter will be displayed in rotation on the two-line graphic display **b7**.



Power graph **b8** is a histogram that includes 16 horizontal units and 20 vertical units. The period of time is represented by the horizontal axis of the graph and can be set by the user to 8, 16 or 24 hours; each horizontal unit can represent 30, 60 or 120 minutes.



The vertical axis represents the power produced. 100% corresponds to the maximum power of the inverter. The power value expressed by each column of the graph represents the average value of the power during the period relating to the time unit.

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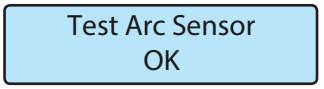
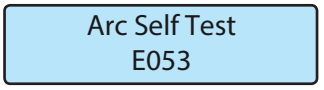
Arc fault detection self-test errors

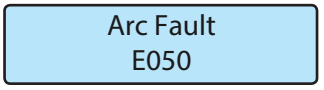
For -A models only, an autotest circuit is included in the module design of the DC arc fault detection (AFD) solution. The AFD performs a self-test when the system is started, (e.g., every morning when sunlight is sufficient for grid connection). The inverter display shows the results of the self-test:

If the self-test results are OK, the inverter will continue to AC grid connection.
If a potential problem on the AFD board is detected, the self-test will result in an error. Refer to table 5 in this section for possible solutions to the error.





During normal operation, (while the inverter is connected to the grid), the input current is continually measured and analyzed. If a DC arc fault is detected during operation, the inverter is disconnected from the AC grid and an E050 error will be shown on the inverter display.



Press and hold the ESC key for three seconds to clear the error which will start the self-test. If self-test results are OK, the inverter will reconnect to the AC grid.

If the DC arc fault is still present, the self test will result in error E053. Refer to table 5 in this section to clear the error and possible solutions.

It is recommended to complete an accurate check of DC and AC connections when the AFD protection trips continuously when an arc has occurred.

The AFD self-test can be manually started anytime using the following procedure:
1. Turn off the inverter (switching off both DC and AC switches) and,
2. Turn on both the DC and AC switches waiting for the display to communicate the self-test result.

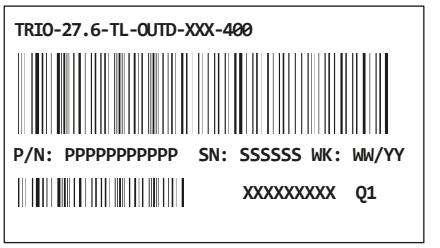
Obtaining the service level password

An advanced password can be provided to authorized installers to allow access to the service menu, upon completion of required documentation. Contact ABB technical support at 877-261-1374 to request this password. The password obtained is valid for 15 days.

NOTE! Because the service level password is date sensitive, it is necessary to have the correct date and time set on the inverter display to successfully use the password. Refer to the Settings menu in section 4 for instructions to set the date and time.

The password to access the Service menu is to be used by trained service personnel only. It is based on data associated with a specific serial number and different for every inverter.

Locate the following information, which is necessary to generate the password, from the product label of the inverter as shown in the label example to the left.



- Serial number - SN
- Week of manufacture -WK

The same data can also be found on the INFO menu on the inverter display.

Resetting the inverter/switchbox association

The inverter chassis and wiring box are automatically associated at first installation by the internal software. If the inverter chassis/wiring box pair are disassociated from one another due to replacement of the wiring box or inverter, the new system part will need to be associated with the old system part.
Once the new parts are assembled and the inverter control power (from DC side) is connected, the following message will be displayed to indicate the disassociated state:
To allow the inverter to operate properly, the new component (inverter or wiring box) must be logically associated with the original component.

The association of the parts comprising the inverter is carried out as follows:

1. Open the AC connection using an external switch or circuit breaker.
2. Ensure the DC switch is closed and there is sufficient energy to power the inverter controls.
3. Access the SETTINGS menu by entering the first-level password (default 0000) .
4. Set the date and time in the Date/Time sub-menu.
5. Access the Service sub-menu by entering the service menu password (described above).
6. Select menu item Accept Boards to associate the two parts of the device.
7. Use the ESC key to exit out of the menu.

Once the above steps have been carried out the inverter/wiring box pair will be properly associated and the system will resume its normal operation automatically.

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Display messages and error codes

The equipment indicates errors/warnings on the display only if the input voltage is higher than the Vdcmin voltage (POWER LED flashing or on - see section 4, Operations). Next to each state of the inverter, (indicated through the steady or intermittent lighting of the relevant LED), a message that identifies the operation it is carrying out or the detected fault/anomaly is also indicated in the two-line display. Messages identify the current status of the inverter and do not relate to a fault.

When a (W) with a number after it appears in the display, it indicates a Warning Code and is usually cleared through an orderly shutdown/reset or a self-corrective action performed by the inverter. Alarms or (E) codes identify a possible equipment failure, fault, or incorrect inverter setting or configuration. Some of the (E) codes may require technical support to assist in correcting a fault. Any and all attempts to correct or clear a fault must be performed by qualified personnel. Typically, the (E) code can be cleared once the cause or fault is removed. Some of the (E) codes may indicate a fatal error and require technical support for diagnostics and/or a product replacement.

When the red LED comes ON, try to reset the warning using the multi-function ESC button on the panel. If the inverter reconnects to the grid, the fault was due to temporary phenomena.

WARNING! In the event of malfunction, it is extremely dangerous to try to eliminate the fault. Follow the instructions given below or contact a specialized technician if you do not have the experience and necessary qualifications to work safely.

Table 5 - Display message errors and warnings

Display Message	Causes	Solution
Ground Fault Red LED	The alarm is generated when ground leakage current is detected in the DC section of the system. The alarm is accompanied by the lighting up of the red LED on the front of the inverter.	If possible, measure the insulation resistance using a megohmmeter positioned between the photovoltaic field (positive terminal short-circuited to the negative pole) and ground. If the measured value is less than 1 megohm, the photovoltaic array must be checked by a technician/ installer to identify and eliminate the problem. If the measured value is greater than 1 megohm and the error warning continues to be present, contact ABB technical support.
E001 Input OC (Input Overcurrent)	The alarm appears when the inverter input current exceeds the set overcurrent threshold.	Check whether the configuration of the PV array allows an input current that exceeds the maximum threshold allowed by the inverter and that the configuration of the (independent or parallel) inputs is carried out correctly. If the configuration of the PV array and the setting of the input channels are suitable, contact ABB technical support.

Display Message	Causes	Solution
E002 Input OV (Input Overvoltage)	This alarm is indicated when the inverter input voltage (coming from the PV array) exceeds the operating threshold. The alarm is triggered before reaching the absolute threshold beyond which the inverter will be damaged. When the inverter input voltage exceeds the Over Voltage threshold, the inverter will generate the alarm and not start.	Measure the input voltage in the inverter with a voltmeter. If it is higher than the maximum voltage of the operating interval, the alarm is valid. Check the configuration of the PV array. If it is lower than the maximum voltage of the operating interval, the alarm is caused by an internal malfunction. Contact ABB technical support.
E003 No Pars (DSP) (Internal Parameters Error)	The main microcontroller is unable to correctly initialize the two DSPs (boost stage and inverter stage). This is usually due to communication problems on the internal bus of the inverter.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E004 Bulk OV (Bulk Overvoltage)	Error inside the inverter. The alarm is raised when the voltage at the ends of the bulk capacitors exceeds the Over Voltage threshold.	The alarm can be triggered by causes external to the inverter. An excessive inverter input voltage can be detected as a bulk overvoltage condition. In this case, it is advisable to check the inverter input voltage and if this value is near the input OV threshold, reexamine the configuration of the photovoltaic array. The alarm can be triggered by causes internal to the inverter; If input voltage is O.K. and alarm is still present, contact ABB technical support.
E005 Internal Error (Internal Communication Error)	The alarm occurs when there are communication problems between the control devices inside the inverter.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E006 Output OC (Output Overcurrent)	The alarm appears when the inverter output current exceeds the output overcurrent threshold of the inverter.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E007 IGBT Sat. (IGBT Saturation)	The alarm appears when one of the active devices of the inverter is in saturation state.	Once the error appears, the inverter attempts to resume normal operation. If the error occurs sporadically, it may be caused by a sharp transition of the grid voltage or the input voltage, but is not attributable to inverter malfunctioning. If the error is associated with an internal fault, it will continue to appear; contact ABB technical support.

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Display Message	Causes	Solution
E009 Internal fault (Internal error)	Internal error	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E010 Bulk UV (Low Bulk Voltage)	Voltage at a specific part of inverter input circuit is not sufficient for grid connection. The alarm can be triggered by causes external to the inverter -- a low inverter input voltage (just above the activation voltage) that is not accompanied by sufficient availability of power from the photovoltaic array (typical condition of periods of insufficient sunlight).	If the error warning appears sporadically, it can be attributed to causes external to the inverter (insufficient sunlight, and therefore little power available from the PV array). If the problem appears systematically even in conditions of high sunlight and with input voltage significantly higher than the activation voltage, contact ABB technical support.
E011 Ramp Fail (Bulk ramp timeout)	Error inside the inverter regarding the time for starting steady state operation of the DC-DC circuit part (Boost). It can be caused by an external string voltage too low or due to reduced power from PV arrays (typically in the morning).	If the alarm is present early in the morning, it could be useful to increase the starting voltage to allow the grid connection of the inverter when more power is available from the PV array. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E012 Internal error (Boost module error revealed by inverter module)	Error inside the inverter regarding the operation of the DC-DC circuit part (Boost).	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E013 Wrong input mode (Wrong input mode-parallel instead of independent)	The alarm is generated only when the inverter is configured with parallel inputs. In this particular configuration, the inverter carries out the input voltage check of each of the two channels, and the alarm is raised if the two voltages differ by more than 20Vdc.	Make sure the setting of the “IN MODE” switch has been intentionally positioned on “PAR” and that the jumpers have been inserted between the two input channels. If the configuration of the inverter is correct, check that the input strings have the same number of modules in series, of the same make and with the same inclination/orientation. If both the configuration of the inverter and the characteristics of the PV array comply with the specifications, contact ABB technical support.

Display Message	Causes	Solution
E014 Overtemperature (Over temperature parameters)	Internal inverter temperature above maximum temperature allowed. Lack of adequate ventilation in location where inverter is installed can be the cause. If ambient temperature is within the allowed range for inverter operation, the error could be due to a problem in the temperature sensors inside the inverter.	Wait for the temperatures to which the inverter is exposed to return within operating range and for the inverter to cool down, If the problem persists (once the ambient temperature has returned within the range), contact ABB technical support. Remember to wait for the time necessary to allow the inverter to cool down.
E015 Bulk Cap Fail (Bulk capacitor failure)	Error inside the inverter regarding a problem in the bulk capacitors.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E016 Inverter error (Inverter module error revealed by booster module)	The alarm is generated when a problem is detected in the inverter circuit part (DC/AC).	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E017 Internal error (Inverter module start- up timeout)	Error inside the inverter regarding the time for starting steady state operation of the DC-AC circuit part (Inverter). It can be caused by an external string voltage too low or due to reduced power from PV arrays (typically in the morning).	If the alarm is present early in the morning it could be useful to increase the starting voltage to allow the grid connection of the inverter when more power is available from the PV array. Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E018 Leak Fault (Leakage current fail)	The alarm is generated when, during normal operation of the inverter, a ground leakage current is detected in the DC section of the system. The alarm is accompanied by the lighting up of the red LED on the front of the inverter. The inverter may even also generate the E018 alarm message for AC leakage currents associated with the capacitive nature of the photovoltaic array compared to ground.	If possible, measure the insulation resistance using a megohmmeter positioned between the photovoltaic field (positive terminal short-circuited to the negative pole) and ground. If the measured value is less than 1 megohm, the PV array must be checked by a technician/installer to identify and eliminate the problem. If the measured value is greater than 1 megohm and the error warning continues to be present, contact ABB technical support.

Display Message	Causes	Solution
E019 Internal error (Leakage current sensor self- test fail)	Before connecting to the grid, the inverter carries out an autotest that tests the leakage current sensor. The test is carried out by “forcing” a current of known value in the leakage current sensor: the microprocessor compares the read value with the known value. The error is generated if the comparison between the read value and the known value during the test is not within the allowed tolerance.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support. By its nature, the alarm appears only before connection to the grid.
E020 Internal error (Booster relay self-test fail)	Before connecting to the grid, the inverter carries out some internal tests. One of these tests regards the correct operation of the boost relay. The test is carried out by “forcing” the switching of the relay and checking its functionality. The error is generated if a problem is found with the operation of the relay.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support. By its nature, the alarm appears only before connection to the grid.
E021 Internal error (Inverter relay self-test fail)	Before connecting to the grid, the inverter carries out a test that regards the operation of the inverter relay. The test is carried out by “forcing” the switching of the relay and checking its functionality. The error is generated if a problem is found with the operation of the relay.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support. By its nature, the alarm appears only before connection to the grid.
E022 Internal error (Relay self-test timeout)	Time taken to execute the autotest carried out on the relays of the DC-AC circuit part (inverter) is too long. This may indicate a problem associated with the aforesaid relays.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.

Display Message	Causes	Solution
E023 DC injection (DC-Injection out of range)	The error is generated if the direct component of the current supplied to the grid exceeds the threshold of 0.5% of the rated operating current. The error does not stop the inverter; instead the inverter tries to connect to the grid again. Sporadic repetition of the error is a sign of large grid distortions or sudden changes in sunlight; whereas systematic repetition of the error warning will be a sign of an inverter fault.	If the grid voltage is strongly distorted, report this anomaly to the utility company for the resolution of the problem. If there is an inverter fault, contact ABB technical support.
E024 Internal error	Error inside the inverter.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E025 Riso Low (Low insulation resistance)	Before connecting to the grid, the inverter measures the insulation resistance of the PV array compared to ground. If the insulation resistance measured by the inverter is less than 1 MOhm, the inverter does not connect to the grid and shows the “Riso Low” error. The causes may be: - Damaged PV module(s). - Junction box(es) not properly sealed, allowing water intrusion; - Loose connections between modules allowing humidity leakage; - Poor quality cable junctions; - Presence of unsuitable (trigger voltage lower than the characteristics of the PV array strings) or damaged overvoltage surge arresters outside the inverter in the DC section. - Presence of humidity inside the photovoltaic module.	If possible, measure the insulation resistance using a megohmmeter positioned between the photovoltaic field (positive terminal short-circuited to the negative pole) and ground (as described in the relevant section: “checking the ground insulation of the PV array”). If the measured value is less than 1 mega ohm, the photovoltaic array must be checked by a technician/installer to identify and eliminate the problem. If the measured value is greater than 1 mega ohm and the error warning continues to be present, contact ABB technical support. (High humidity increases leakage and can therefore be the cause of a reduction in insulation resistance).

Display Message	Causes	Solution
E026 Internal error (Bad internal reference voltage)	Wrong measurement of the reference voltage inside the equipment.	Internal error that cannot be checked externally. If the problem persists (even after switching the inverter off and then on again), contact ABB technical support.
E027 Internal error (VGrid Measures Fault)	Error in the internal measurement of the grid voltage (imposed by regulations) to have a measurement redundancy (2 measurements on the same parameter carried out by two different circuits).	This is an error inside the inverter that cannot be checked externally. If the problem is persistent (even after switching the inverter off and then on again), contact ABB technical support.
E028 Internal error (FGrid Measures Fault)	Error in the internal measurement of the grid frequency (imposed by regulations) to have a measurement redundancy (two measurements on the same parameter carried out by two different circuits).	This is an error inside the inverter that cannot be checked externally. If the problem is persistent (even after switching the inverter off and then on again), contact ABB technical support.
E029 Mid-bulk OV (Mid-bulk overvoltage)	Error in the internal measurement of the insulation resistance of the PV array compared to ground (imposed by regulations) to have a measurement redundancy (two measurements on the same parameter carried out by two different circuits).	Error inside the inverter that cannot be checked externally. The error occurs if the internal measurement is carried out before connection to the grid). If the problem is persistent (even after switching the inverter off and then on again), contact ABB technical support.
E030 Internal error (ILeak Measures Fault)	Error in the internal measurement (carried out when the inverter is connected to the grid) of the leakage current of the DC side (PV array) compared to ground (imposed by regulations) to have a measurement redundancy (two measurements on the same parameter carried out by two different circuits).	This is an error inside the inverter that cannot be checked externally. If the problem is persistent (even after switching the inverter off and then on again), contact ABB technical support.

Display Message	Causes	Solution
E031 Error Read V (Wrong V measure)	Measurement of the internal voltage at the ends of the output relay out of range. There is too great a difference in voltage between the input and the output of the output relay that can be caused by grid voltage instability.	Check the grid conditions for instabilities caused by the switch of heavy loads or reactive loads (like motors, welding machines, etc.). If the problem appears repeatedly, contact ABB technical support.
E032 Error Read I (Wrong I measure)	Measurement of the output voltage unbalance (carried out between the three phases) out of range (only in three-phase models).	This is an error inside the inverter that cannot be checked externally. If the problem appears repeatedly, contact ABB technical support.
E033 Undertemperature (Under Temperature (UT))	Alarm is triggered when internal temperature is below low temperature threshold. Depending where the inverter is located, the ambient temperature can reach values below UT limits. In the case in which ambient temperature is above the UT limits, a failure of the temperature sensing circuitry has occurred.	Wait for the temperatures to which the inverter is exposed to return within operating range. If the problem persists, contact ABB technical support. Remember to wait for the time necessary to allow the inverter to warm up.
E034 IGBT not ready (IGBT not ready)	Error inside the inverter.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact ABB technical support.
E035 Remote Off (Awaiting remote ON)	The inverter has been switched off remotely (remote OFF) and remains in waiting state for the signal that will switch it on again (remote ON).	Switch on the inverter remotely. If the unit does not switch on, disable the remote on/off function and switch the equipment off completely and then switch it on again. If the problem persists (after re-enabling the Remote ON/OFF function from the display), contact ABB technical support.

Display Message	Causes	Solution
E036 Vout Avg error (Average Vout out of range)	The average grid voltage value (every 10 minutes) does not fall within the allowed ranges. The grid voltage at the point connected to the inverter is too high. This may be caused by grid impedance that is too high. Towards the end of the timeout, the inverter limits the power to check whether the grid voltage stabilizes within the normal parameters. If this does not happen, the inverter disconnects from the grid.	Check the grid voltage at the inverter connection point. If the grid voltage diverges from the range because of grid conditions, ask the grid company to adjust the grid voltage. If the grid company authorizes a change to the inverter parameters, arrange the new limits with ABB technical support.
E049 Internal error AC feed-forward error (for OLD models - “degaussing state fail”)	Internal error.	Error inside the inverter and cannot be checked externally.
E050 AFD Activated (-A version ONLY - arc fault protection was triggered)	An electrical arc has been detected on DC cables. This error latches the inverter in a disconnected state.	Check DC cables and connections to identify the source of possible arcing. See section 5 of this manual for more information on Arc Fault troubleshooting. Press ESC as indicated in the display in order to unlatch the inverter.
E051 Safety mem. fault (“Safety” memory area (ROM or RAM) was found to be corrupted)	Internal memory error.	There is an error inside the inverter and it cannot be checked externally. Turn the inverter off and back on. If the problem persists, contact ABB technical support.
E053 AFD Fault (-A version ONLY- arc fault detector sensor self-test failed)	Self-Test performed by AFD board failed. The board will try another self-test after user turns inverter off and on.	Press ESC as indicated in the display in order to unlatch the inverter. See section 5 for more information on Arc Fault troubleshooting. If the problem persists (after switching the inverter off and on), contact ABB technical support.

Display Message	Causes	Solution
E054 Communication loss with Communication Board	Wiring box is not communicating with the inverter.	Check memory card on communication board. Check all conductors on communication board are properly connected. Run the “Accept new board” program through the service menu. Contact ABB technical support for advanced password and/or if problem persists.
E055 Arc Fault wrong config.	AFD configuration is incorrect.	Check that the AFD cables are properly connected. Otherwise, this may be an internal error and ABB technical support is needed.
E056 Over Temp. (Over temperature from external box)	Excessive temperature measured inside the inverter’s wiring box (high internal temperature). This error relates to the temperature measured on external boxes.	Check that the inverter is not exposed to direct sunlight. If in direct sunlight, order and install an ABB sun shield or create sufficient shade by other means while maintaining airflow around the inverter. Wait for the temperatures to which the inverter is exposed to return to the operating range and for the inverter to cool down. If the problem persists (once the ambient temperature has returned to the range), contact ABB technical support.
E057 Vbulk reading error (Error if Vin is > Vbulk +1OV)	Input voltage (Vin) higher than booster voltage (Vbulk). The error occurs if the input voltage exceeds the bulk voltage (voltage on the DC-DC circuit inside the inverter).	Measure the input voltage inside the inverter with a voltmeter. If it is higher than the maximum voltage of the operating range, it is necessary to check the PV array configuration. If the voltage has also exceeded the maximum input threshold, the inverter could be damaged. If it is lower than the maximum voltage of the operating range, the alarm is caused by an internal malfunction and it is necessary to contact ABB technical support.
E058 Pin vs. Pout check error (Error if Pout-Pin > Pdelta	The error occurs if the difference between the measured value of input power and that of output power is greater than the limit imposed internally to the inverter.	Error inside the inverter that cannot be checked externally. After switching the inverter off and then on again, if the problem persists, contact ABB technical support.
E077 Internal error (System configuration error)	Error inside the inverter.	Error inside the inverter that cannot be checked externally. After switching the inverter off and then on again, if the problem persists, contact ABB technical support.

Display Message	Causes	Solution
E078 Riso test fail (Inverter returns a value different from OK or Riso low)	Before connection, the inverter made two different Riso circuit self tests: 1. Riso relay self test (displayed as self test 1) 2. Algorithm self test (displayed as self test 2) The inverter failed one of the two RISO tests.	Check PV strings for leakage current. If there is any leakage current found, contact ABB technical support.
W001 Sun Low (Low input voltage-cannot connect to grid)	Insufficient sunlight. Wrong configuration of the PV array or a configuration “at the limit” relative to the minimum input voltage of the inverter.	Check the inverter input voltage. If it does not exceed the Vstart, check that there is sufficient sunlight and that the configuration of the system is correct. If the input voltage exceeds the Vstart, contact ABB technical support.
W002 Input UV (Low input voltage during inverter switch-off)	Insufficient sunlight, wrong configuration of the photovoltaic array or a configuration “at the limit” relative to the minimum input voltage of the inverter.	Check the inverter input voltage. If it does not exceed the Vstart, check that there is sufficient sunlight and that the configuration of the system is correct. If it exceeds the Vstart, contact ABB technical support.
W003 Grid Fault (Grid parameters outside the limits)	This error warning appears during normal inverter operation when the grid parameters fall outside the limits set by the grid company. No grid voltage (after the warning, the inverter goes on “No Vac”). Unstable grid voltage (downwards and upwards). Unstable grid frequency.	Check the grid voltage on the inverter. If absent, check for the absence of grid voltage on the supply. If the voltage tends to rise (when the inverter is connected), there are high line or grid impedances. Check the grid voltage on the supply as well -- if it is high, there is high grid impedance. In this case, ask the grid company to adjust the grid voltage. If the grid company authorizes a change to the inverter parameters, arrange the new limits with ABB technical support. If the voltage at the supply point is much lower than that measured on the inverter, the line must be adjusted (inverter-counter). If the grid voltage and frequency fall within the limits (even when the inverter is connected to the grid), contact ABB technical support.
W010 Fan Fault (Fan fail -- alarm not shown on the display; only a flashing yellow LED)	This error appears when a fan inside the inverter has failed. In this condition, the yellow LED on the front panel flashes.	Error inside the inverter that cannot be resolved with external operations. If the alarm is persistently repeated, contact ABB technical support.

Display Message	Causes	Solution
W011 Bulk UV (Bulk undervoltage)	The voltage over the bulk capacitors does not reach the threshold for the operation of the inverter.	• Increase the value of the activation voltage (Vstart) to have sufficient power from the PV generator during the inverter's grid connection. • Check the input voltage on the inverter. - If it does not exceed Vstart, check for the presence of sufficient irradiation and the correct composition of the system. - If it exceeds Vstart, contact ABB technical support.
W012 Battery low Low internal clock battery voltage	Internal battery for maintenance of the date/time settings is discharged or damaged.	Replace the battery (CR2032) with the inverter completely switched off (disconnect AC side and DC side), and ensure the correct polarity.
W013 Clk fault (Internal clock failure)	The alarm appears when the time shown on the display differs by more than one minute from the internal time of the microprocessors and indicates clock circuit malfunctioning.	This is an error inside the inverter that cannot be resolved with external operations. If the alarm is persistently repeated, contact ABB technical support.
W015 Island Detected (Islanding condition)	Inverter shut down due to missing grid.	No action required: Grid must return before inverter can reconnect.
W018 DC SPD tripped (SPD DC protection open)	Overvoltage surge arresters situated on the DC side are damaged. (-S1, -S1A and -S1B models only).	Look at the inspection window present on the surge arrester (DC side). If it is red, the surge arrester is damaged and the cartridge must be replaced. If the alarm status continues to be present even though all the surge arresters have a green inspection window, contact ABB technical support.
W019 AC SPD tripped (SPC AC protection open)	Overvoltage surge arresters situated on the AC side are damaged. (-S1A models only)	Look at the inspection window present on the surge arrester (AC side). If it is red, the surge arrester is damaged and the cartridge must be replaced. If the alarm status continues to be present even though all the surge arresters have a green inspection window, contact ABB technical support.
W022 Q-Mode changed (Reactive power mode was changed)	Variation in the means of managing reactive power. This change is made through the display or advanced configuration software.	Notification of change that is saved in the historical log of inverter events.

Display Message	Causes	Solution
W023 Date/time mod. (Inner date/time changed)	Variation of the inverter's date and time. This change is made through the display or advanced configuration software.	Notification of change that is saved in the historical log of inverter events.
W024 Energy data rst. (notification only)	Zeroing of the statistical energy data stored in the EEPROM -- reset of the energy data saved in the inverter. This operation can be handled through the display or advanced configuration software.	Notification of change that is saved in the historical log of inverter events. The notice may also occur on substitution of the Memory Card where the statistical production data is saved.
W025 P-reduction End (Power reduction was removed)	Information only: Indicates the power reduction mode is deactivated.	No action required.
W026 AFD user reset (Arc fault reset by user from display)	Information only: AFCI error was cleared.	No action required.
W027 Latch-manual rst. (Warning if latch state manual reset)	Too many ground faults detected.	Check system for ground faults.
W047 Update not completed (There is a system firmware bundle misalignment)	Firmware does not match inverter firmware bundle	Confirm firmware versions match and re-upload firmware.
W048 Periodic Grid Off	Grid disconnection caused by grid std rule (e.g., conducting Riso test)	No action required.

Making a service call

When calling ABB technical support at 1-877-261-1374 to make a service call, the following information is required:

1. Model number*
2. Serial number*
3. Week of production*
4. State of the LCD:
   a. Status of warning lights (LEDs): what are the colors of the lights and are they steady or flashing?
   b. What is the error message or code?
5. System configuration:
   a. Brand and model of photovoltaic modules
   b. Maximum array voltage and current values
   c. Number of strings in each array
   d. Number of photovoltaic modules for each string
6. System condition:
   a. Can the fault or error be reproduced? If so, how?
   b. Is the fault cyclical in nature? If so, how often?
   c. Was the fault apparent at the time of installation? If so, has it worsened?
   d. Describe the atmospheric conditions at the time the fault/error appears or appeared.

*Can be found on the inverter's INFORMATION menu or on the product label.

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Maintenance

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Maintenance operations are required to be carried out by personnel familiar with and specifically trained in the operations of this inverter. ABB recommends personnel having appropriate North American Board of Certified Energy Practitioners (NABCEP) certification and/or other professional licensing and/or having received training through ABB or other authorized organizations perform maintenance operations.

DO NOT allow the equipment to be used if problems of any kind are found.

WARNING! Maintenance operations must be carried out with the equipment disconnected from the grid, unless otherwise indicated.

After shutdown, wait at least 10 minutes before removing guards or covers in order to allow devices inside the unit to cool and allow any electrostatic charges and parasitic voltages to dissipate.

For cleaning, DO NOT use rags made of filamentary material or corrosive products that may damage parts of the equipment or materials which may generate electrostatic charges. Avoid temporary repairs. All repairs should be carried out using only genuine spare parts. The maintenance technician is under an obligation to promptly report any anomalies.

Always use the personal protective equipment (PPE) provided by the employer and comply with the safety conditions in the Introduction and safety, section 1, of this manual. ABB accepts no liability if the periodic checks and maintenance cycles indicated in this manual and in the attached documentation are not complied with correctly, or if maintenance is entrusted to unqualified staff.

Routine maintenance

Routine maintenance operations noted below can be carried out by the user or by the installer.

	Clean the equipment at least annually; in particular, the lower grill on the wiring box through which the air for cooling the heatsink passes and the heatsink itself. If possible, use an extractor or suitable pipe cleaners to remove debris.
	**Annually** or in the event of malfunction, check that the environmental conditions have not changed drastically (exposure to weather conditions); also check that the inverter chassis has not been isolated by foreign bodies such that airflow may be affected.
	**Annually** or in the event of malfunction, check the tightness of the cable opening plugs, the fitting of the connectors and front covers. Loose fittings can allow water seepage into the cabinet, possibly leading to short-circuit conditions due to high humidity.

Recommended system maintenance

If not performed more often, ABB recommends having the systems checked after about five years of activity to maintain the correct working performance.

Clean the photovoltaic modules every six months, at the change of season or as necessary. The performance of the system depends on the condition of the PV modules. To clean, follow the specifications of the PV module supplier.

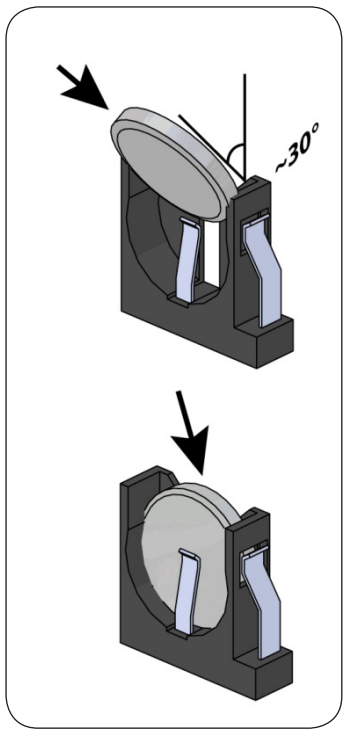
Preventative maintenance

These maintenance operations MUST be carried out by the installer or trained maintenance personnel. If repairs to the inverter are required for any reason, recheck all items after repairs are completed.

Interval	Inverter maintenance item
Annually	Check the cooling air path and heatsink for blockages
Annually	Check the DC OV surge arresters **15** (W019 via RS-485 or fault log)
Annually	Check the AC OV surge arresters **18** (W018 via RS-485 or fault log)
Annually	Check internal cooling fan operation (monitor start-up for warning)
Annually	Check all electrical connections using an infrared (IR) camera or equivalent to determine hot spots. Check torque value for any connection indicated*
Annually	Check AC pressure connectors of the inverter output circuit
Annually	Check DC pressure connectors of the inverter input circuit
Annually	Check torque of screws on chassis access covers to insure NEMA4X compatibility*
Annually	Check all connections terminals for discoloration or signs of high temp/current*
3 years	Remove and replace the memory back-up battery, see instructions in this section.
*ABB recommends checking this item after the first six months of operation, and then annually.	

T012C6

CR2032 battery replacement



The CR2032 battery, located in the switchbox on the communication card **09**, powers the time of day clock. When this battery is at end-of-life a message will appear on the display alerting the need for replacement. This battery can be purchased at any retail store that sells coin cell batteries.

- Remove the wiring box front cover **08**.
- The communication card **09** is protected by two removable covers.
- Remove the cover housing the battery area.
- Remove the old battery.
- Insert the new battery into its holder, sliding in at a 30° angle.
- The battery should seat into the correct position within the holder.
- After battery replacement is complete, replace the clear protective cover and the cover of the wiring box **08** and torque screws to at least 21 in-lbs (2Nm) to ensure proper waterproof sealing.

Storage and dismantling

If the equipment is not used immediately or is stored for long periods, check that it is packaged correctly and contact ABB technical support at 1-877-261-1374 for storage instructions. The equipment must be stored in well-ventilated indoor areas in a noncorrosive environment. Restarting after a long storage period requires the removal of oxidation and dust that may have settled inside the equipment if not suitably protected.

ABB CANNOT be held responsible for disposal of the equipment, displays, cables, batteries, etc. The customer must dispose of these substances, which are potentially harmful to the environment, in accordance with the regulations in force in the country of installation.

If the equipment is dismantled, follow the regulations in force in the country of destination and avoid causing any kind of environmental hazard upon disposal. Use dumps suitable for disposal of the various types of materials listed below.

Component	Construction material
Frame, brackets, supports	Carbon steel or stainless steel
Casing or covers	Aluminum
Paint	Epoxy based powder coat
Plugs and seals	Rubber/(Neoprene and/or Butadiene)/Polyimide PA6
Electrical cables	Copper/PVC jacket
Backup battery	Nickel/Lithium
Component parts	May contain small amounts of lead; product uses lead-free solder.

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Appendix 7

System description

TRIO grid-tied inverters provide the capability to supply the utility grid with energy obtained from photovoltaic modules. To efficiently use the DC generated by a photovoltaic field, it must be transformed into alternating current (AC) via a conversion process known as DC-AC inversion.

This process is the basis of all grid-tied inverters and is achieved very efficiently by the inverter without the use of rotating elements. When the inverter output is connected in parallel to the utility power grid, the alternating current output from the inverter flows directly into the distribution circuit, and is connected in turn to the public distribution utility grid.

The photovoltaic energy system can thus feed all the connected user electrical loads:

- If the energy supply from the photovoltaic system is lower than the user's load requirement, the additional energy necessary to guarantee normal functioning of the connected appliances is taken from the public distribution network.
- If the energy supply from the photovoltaic system is greater than the user's load requirement (i.e. an excess of energy is produced), the loads are supplied and the excess energy is sent directly into the public network, becoming available to other users.

Depending on prevailing codes and regulations of the installation area, the energy produced can be sold to the utility or credited against future consumption, producing energy savings.

STRINGS AND ARRAYS

A photovoltaic module consists of many photovoltaic cells designed to generate DC power when exposed to sunlight. When multiple photovoltaic modules are electrically connected in series, this is commonly referred to as a photovoltaic string. An array consists of a mechanically integrated assembly of modules or strings to produce a DC system.

Large photovoltaic systems can be made up of several arrays, connected to one or more inverters. By maximizing the number of photovoltaic modules inserted into each string, the string output voltage is increased, which reduces the cost and complexity of the photovoltaic system. The current of each string and/or array must fall within the limits of the inverter.

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Notes on the sizing of the system

Decisions about how to structure a photovoltaic system depend on a number of factors and considerations such as the type of modules, the availability of space, long-term energy production goals, etc. A configuration program to correctly size the photovoltaic system is on the the ABB website at www.stringsizer.abb.com.

Protective devices within the inverter

Anti-Islanding

In the event of a local utility company grid outage, or when the equipment is switched off for maintenance operations, the inverter must be physically disconnected safely, to ensure protection of people working on the grid, all in accordance with the relevant national standards and laws. To prevent possible islanding (the condition in which a distributed generator (DG) continues to power a location even though electrical grid power from the electric utility is no longer present), the inverter is equipped with an automatic protective disconnection system called an Anti-islanding system.

Ground fault in the photovoltaic modules

This inverter must be used with photovoltaic modules connected with “floating” connections -- that is with positive and negative terminals that are not grounded. An advanced ground fault protection circuit continuously monitors the ground connection and disconnects the inverter when a ground fault is detected. The ground fault condition is indicated by a red LED on the front panel.

Overvoltage surge arresters

As additional protection to prevent damage caused by lightning discharges and electrostatic induction phenomena, DC overvoltage surge arresters (-S1, -S1A, -S1B versions) and AC overvoltage surge arresters (-S1A version only) are integrated inside the wiring box.

Arc Fault Detection (AFD)

This safety function allows the inverter to recognize series electrical arcing on DC cables. Once the arcing has been detected, the inverter will fall into a secure, disconnected state. The inverter will remain in this disconnected state even after turning it off and on again until the fault has been cleared.

It is possible to clear the fault and unlatch the unit by pressing the ‘ESC’ button on the display after a complete check of DC cables. The AFD board performs a safety Self-Test at each start-up providing the result of the test on the inverter display.

Additional protective devices

The inverter is equipped with additional protective devices to guarantee safe operation in any circumstance. These protective devices include:

- Continuous monitoring of the grid voltage to ensure the voltage and frequency values stay within operating limits.
- Control of internal temperatures to automatically limit the power if necessary to ensure the unit does not overheat (derating).

Ground fault detection and interruption scheme

As required by UL1741 CRD 2010, the TRIO inverter incorporates two separate methods for detecting a ground fault in the ungrounded PV array, as described below:

Method 1: Pre-Start (Static RISO)
Any time conditions are suitable for the inverter to be connected to the grid, prior to connection internal circuitry measures the insulation resistance (RISO) of the PV array conductors relative to ground. If the result of this static insulation resistance test is less than the pre-programmed threshold value, the connection is aborted, the inverter will show an error on the LCD screen and illuminate the red LED GF indicator on the inverter front panel. This test is conducted prior to any attempt to connect to the grid; e.g., at daybreak and any other time during the day where the inverter has been disconnected from the grid.

Method 2: Post Grid Connection (Dynamic Leakage Current)
Any time the inverter is connected to the grid, the inverter circuitry continuously checks for ground fault conditions using a differential measurement of the three-phase AC lines, searching for any values that would indicate leakage of current to ground. Measurement of the ground leakage current is carried out simultaneously by two independent and redundant processors. If either processor detects an unacceptable value as defined below, the inverter will immediately be disconnected from the grid, display an error on the LCD screen, and illuminate the red LED GF indicator on the inverter front panel.

The inverter responds differently depending on the level and duration of leakage current detected. If any of the following conditions is detected in measured values of differential current (IDIF) or a rapid change of IDIF over time (ΔIDIF/Δt), the inverter will automatically disconnect from the grid and the front panel GF indicator will be illuminated:

- If IDIF > 300 mA for a period of 300 msec
- If ΔIDIF/Δt > 30 mA/sec for a duration of 300 msec
- If ΔIDIF/Δt > 60 mA/sec with duration of 150 msec
- If ΔIDIF/Δt > 150 mA/sec with duration of 40 msec

As a further safety precaution, in compliance with UL1741 CRD 2010, the inverter conducts an isolation monitor interrupter self-test before connecting to the grid or every 24 hours, whichever is sooner. This test validates that the circuitry needed to perform the isolation test operates normally and has not been damaged.

All errors generated from a detected ground fault are permitted to occur up to four times within a 24-hour period, and ground fault errors require a manual reset of the inverter by a trained technician on the fifth occurrence. This is intended to ensure equipment with a ground fault is not connected to the grid.

Topographic diagram of the equipment

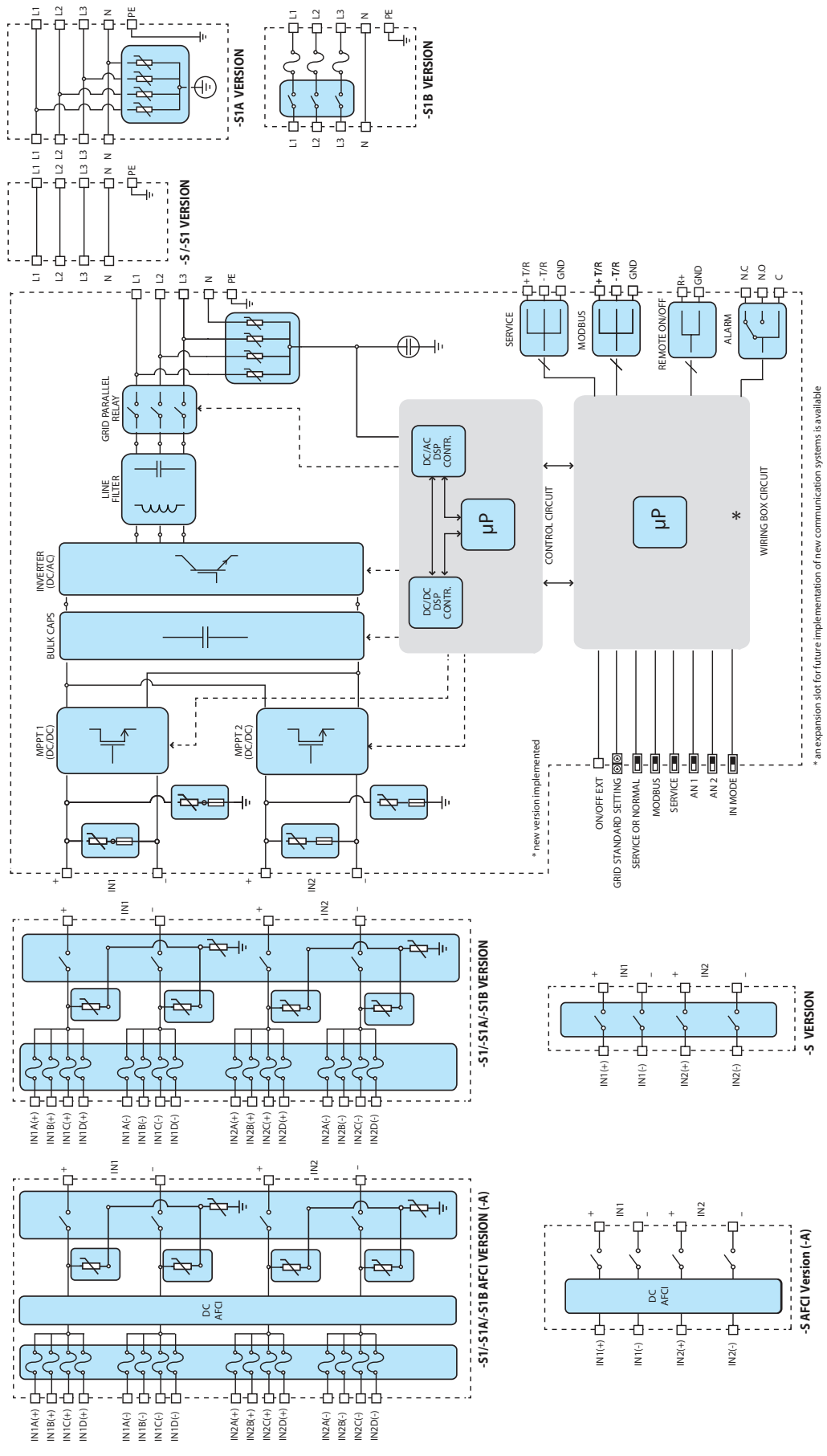
The block diagram on the next page displays the inverter's operational parts. The main blocks are the input boost converters and the output inverter. Both the boost converters and the output inverter operate at high-switching frequencies, resulting in a compact size and relatively light weight.

Each of the input converters is dedicated to a separate array with independent maximum power point tracking (MPPT) control. This means that the two arrays can be installed with different positions and orientation. Each array is controlled by an MPPT control circuit. The two trackers on non-AFD models can be configured in parallel, to handle power and/or current levels higher than those a single tracker can handle.

This inverter was designed without an isolation transformer, which results in increased efficiency and enables a further increase in conversion efficiency. The inverter is already equipped with all the necessary protective devices for safe operation in compliance with regulations, even without an isolation transformer.

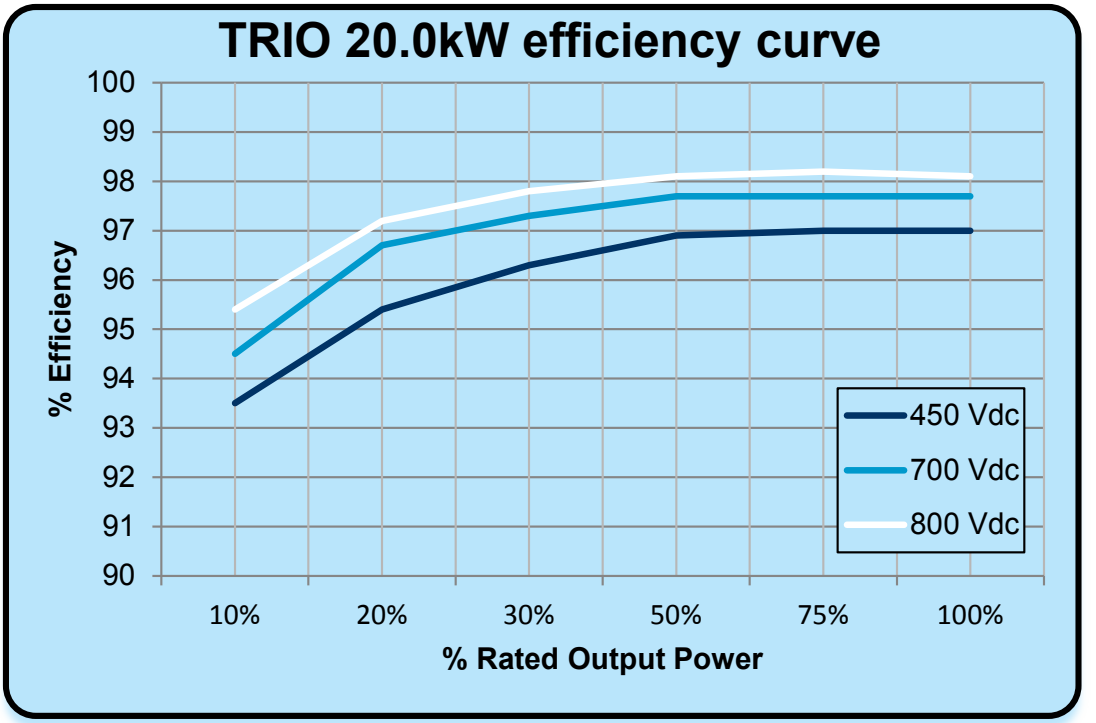
The inverter is controlled by two independent DSPs (Digital Signal Processors) and a central microprocessor. The connection to the utility grid is therefore controlled by two independent computers, in full compliance with electrical standards regarding system powering and safety.

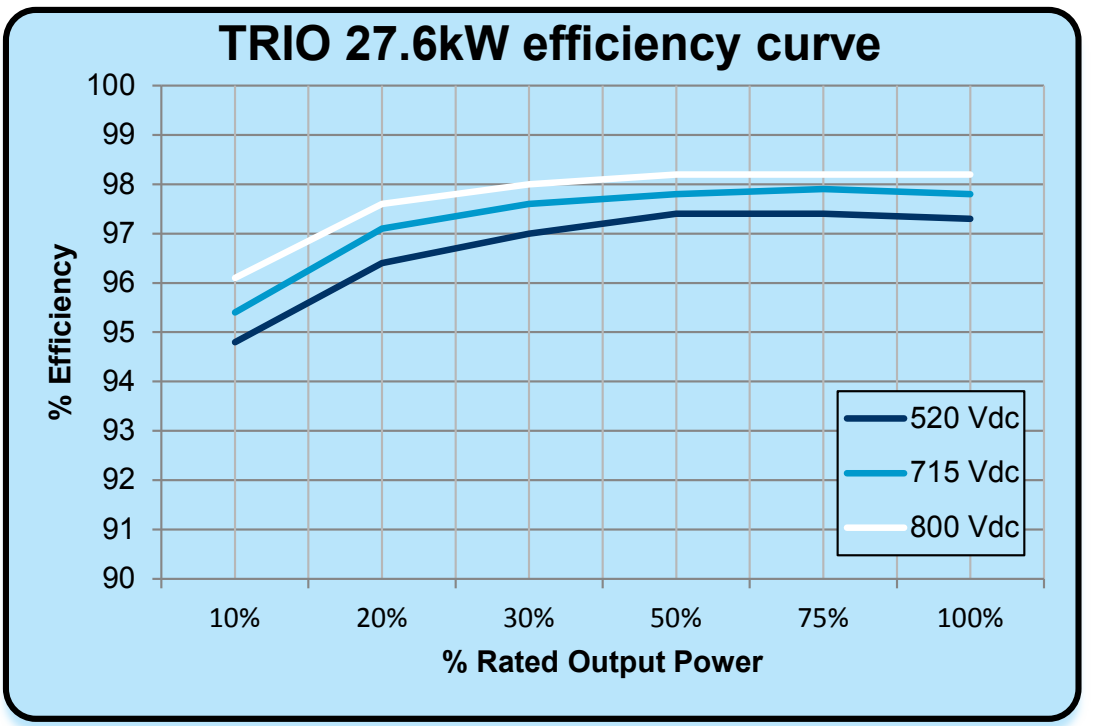
The operating system performs the operation of communicating with the relevant components to carry out data analysis. This guarantees optimal operation of the entire unit and high efficiency in all insolation and load conditions, always in full compliance with relevant directives, standards and provisions.


-S1A VERSION
-S1B VERSION
-S /-S1 VERSION
L1
L2
L3
N
PE
SERVICE
MODBUS
REMOTE ON/OFF
ALARM
+ T/R
- T/R
GND
IR+
N.C
N.O
C
GRID PARALLEL RELAY
LINE FILTER
INVERTER (DC/AC)
BULK CAPS
MPPT 1 (DC/DC)
MPPT 2 (DC/DC)
DC/AC DSP CONTR.
DC/DC DSP CONTR.
µP
CONTROL CIRCUIT
WIRING BOX CIRCUIT
* new version implemented
* an expansion slot for future implementation of new communication systems is available
ON/OFF EXT
GRID STANDARD SETTING
SERVICE OR NORMAL
MODBUS
SERVICE
AN 1
AN 2
IN MODE
IN1
IN2
-S1/-S1A/-S1B VERSION
IN1A(+)
IN1B(+)
IN1C(+)
IN1D(+)
IN1A(-)
IN1B(-)
IN1C(-)
IN1D(-)
IN2A(+)
IN2B(+)
IN2C(+)
IN2D(+)
IN2A(-)
IN2B(-)
IN2C(-)
IN2D(-)
-S VERSION
IN1(+)
IN1(-)
IN2(+)
IN2(-)
-S1/-S1A/-S1B AFCI VERSION (-A)
DC AFCI
-S AFCI Version (-A)

Efficiency curves

The equipment was designed in compliance with energy conservation standards to avoid waste and unnecessary leakage. Graphs of the efficiency curves of the inverters are shown below. The efficiency curves are affected by technical parameters that are continually being developed and improved and should be considered approximate.





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Voltage and temperature derating due to altitude

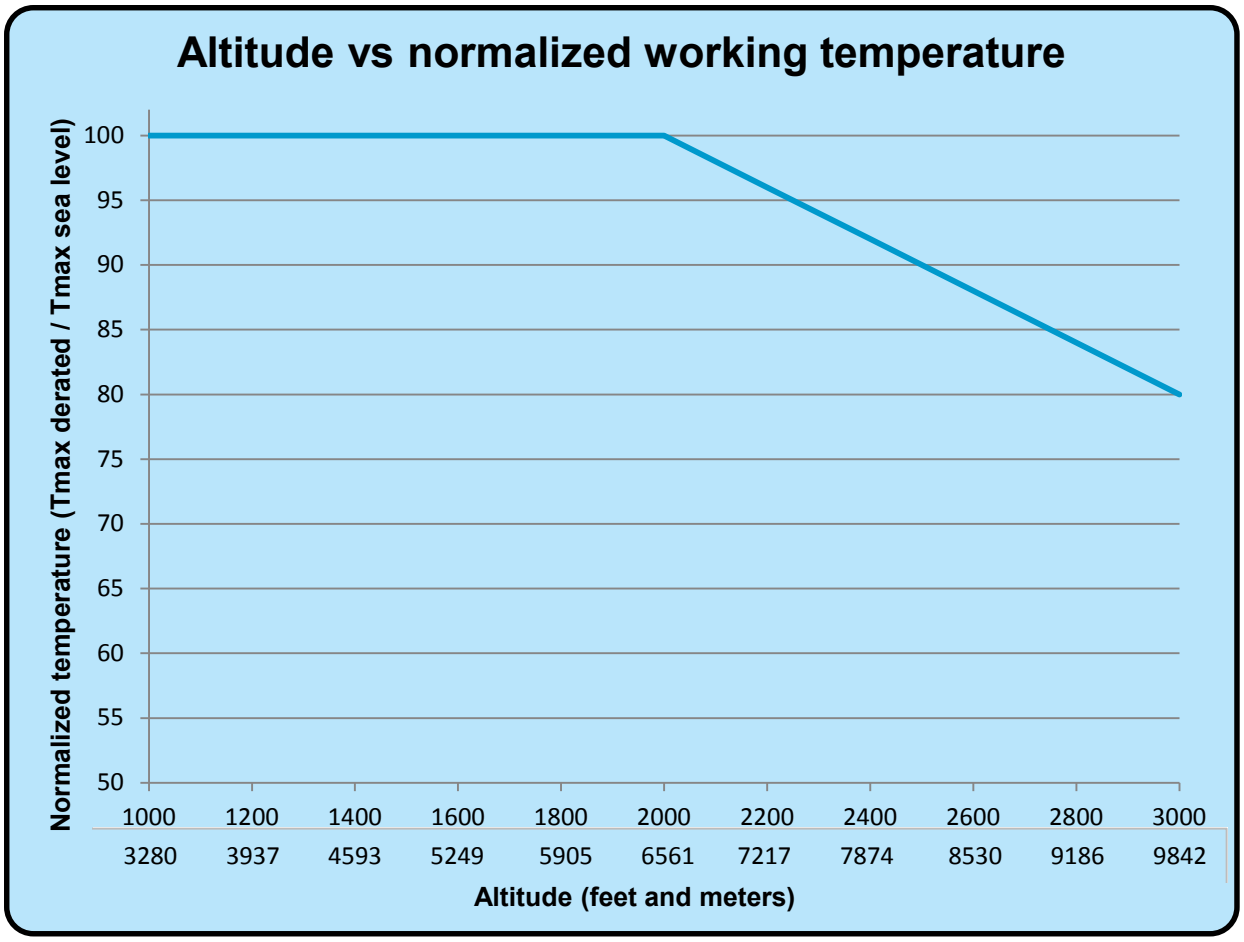
Certain conditions should be considered when choosing an installation location at high altitudes. Air pressure decreases as altitude above sea level increases. The reduced air density results in less effective heat dispersal, hence the need to reduce rated operating temperatures. The dielectric strength of air also drops as the air pressure drops, necessitating a reduction in rated operating voltages so to avoid electric arcs in high voltage circuits.

Standard design guidelines cover normal operation up to 6,600 feet (2,000 meters) elevation. Guidelines provided below will aid the designer in planning installations above 6,600 feet. These are not invariable rules, rather guidelines to aid the designer.

Temperature derating

The Y-axis of the graph below is the normalized temperature derating. The inverter's rated maximum ambient temperature applies up to altitudes of 6,600 feet (2,000 meters). Between 6,600 and 10,000 feet, the ambient temperature for the inverter must be decreased by the corresponding fraction shown on the Y-axis of the graph.

These derating guidelines are applicable to both indoor and outdoor applications.The system designer should consider the site layout, wind, typical maximum temperatures, and other environmental parameters in determining whether less derating is acceptable. Examples of altitude derating calculation can be found on the next page.



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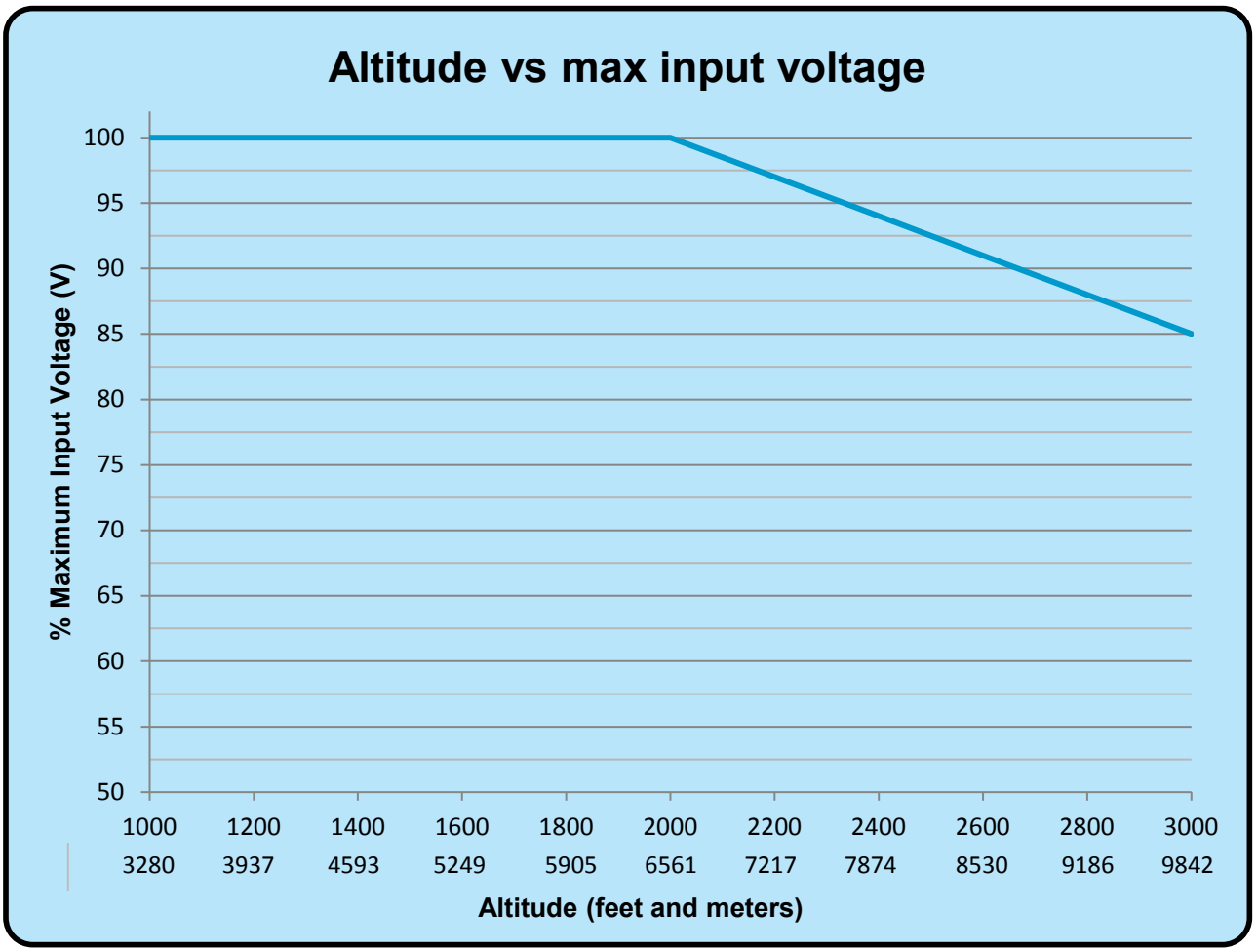
Example – temperature derating calculation for a TRIO-20.0/27.6-TL-US installed at 7500 feet:

- The maximum rated temperature, for full power operation at sea level, from the TRIO-20.0/27.6-TL-US series datasheet, is 113°F (45°C).
- The normalized temperature derating factor from the graph on page 97, at an altitude of 7500 feet is .945.
- The maximum full-power temperature for operation at 7500 feet would be 113°F * .945 = 107°F --OR-- 45°C * .945 = 42.5°C.

Voltage derating

The dielectric strength of air decreases with altitude, so the maximum DC input inverter voltage must be decreased at high altitudes to avoid unwanted electrical arcs. The graph below shows normalized voltage derating factor with increased altitude.



Automatic power reduction

In order to maintain safe inverter operation under adverse environmental conditions or due to improper input voltages, the unit automatically reduces the amount of power it feeds to the grid. The conditions for power reduction due to environmental conditions and input voltage can occur at the same time, but the power reduction will always be determined by the more severe factor.

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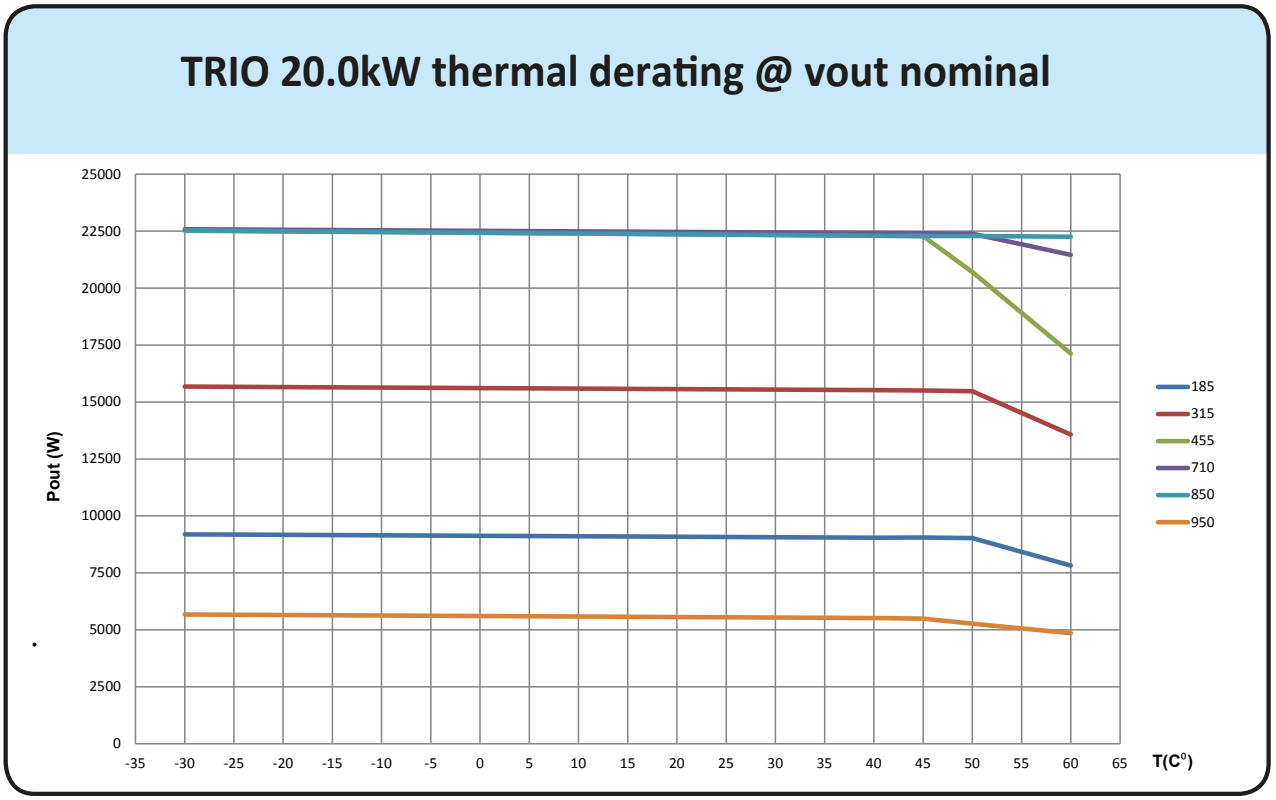
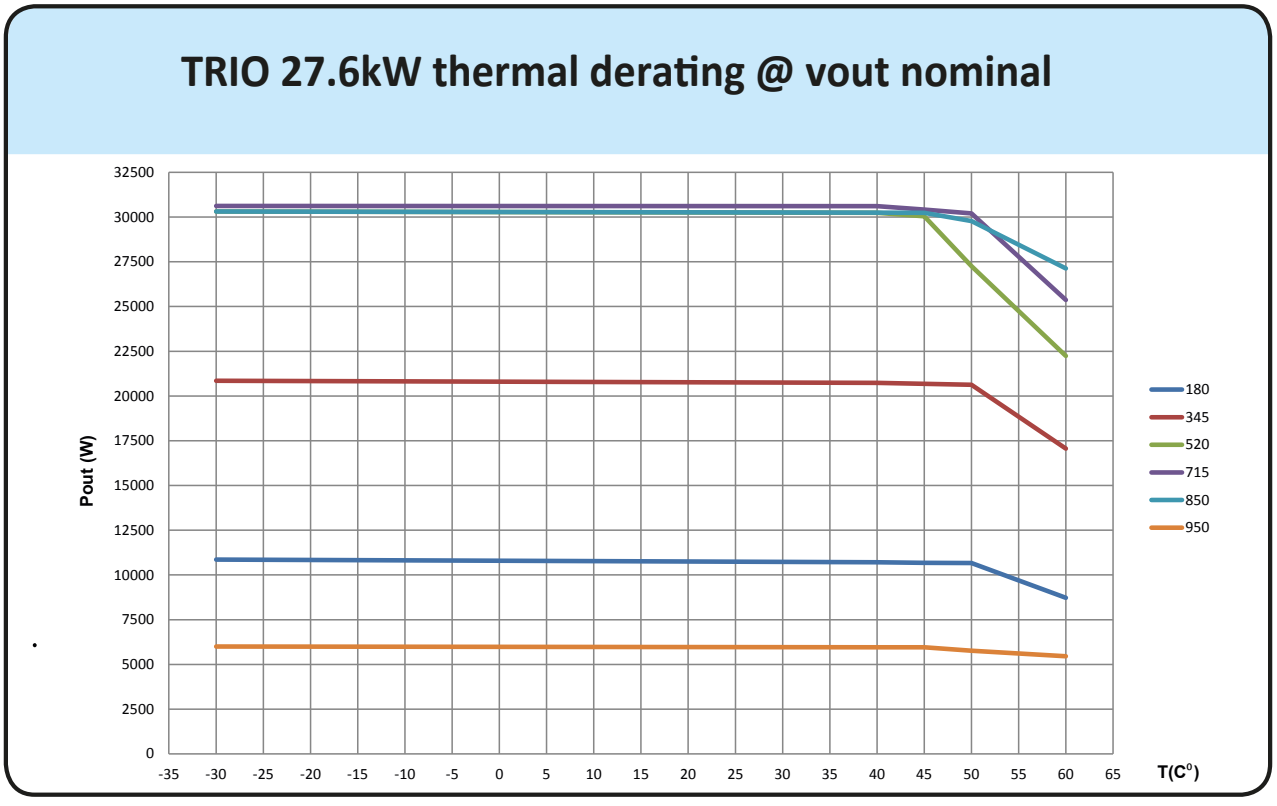
Power reduction due to temperature

Power reduction due to ambient or inverter temperature depends on many operating parameters, such as input voltage, grid voltage and power available from the photovoltaic arrays. The inverter may reduce its output power during the day according to the value of these parameters. The following graphs show the automatic reduction in output power in relation to ambient temperature.





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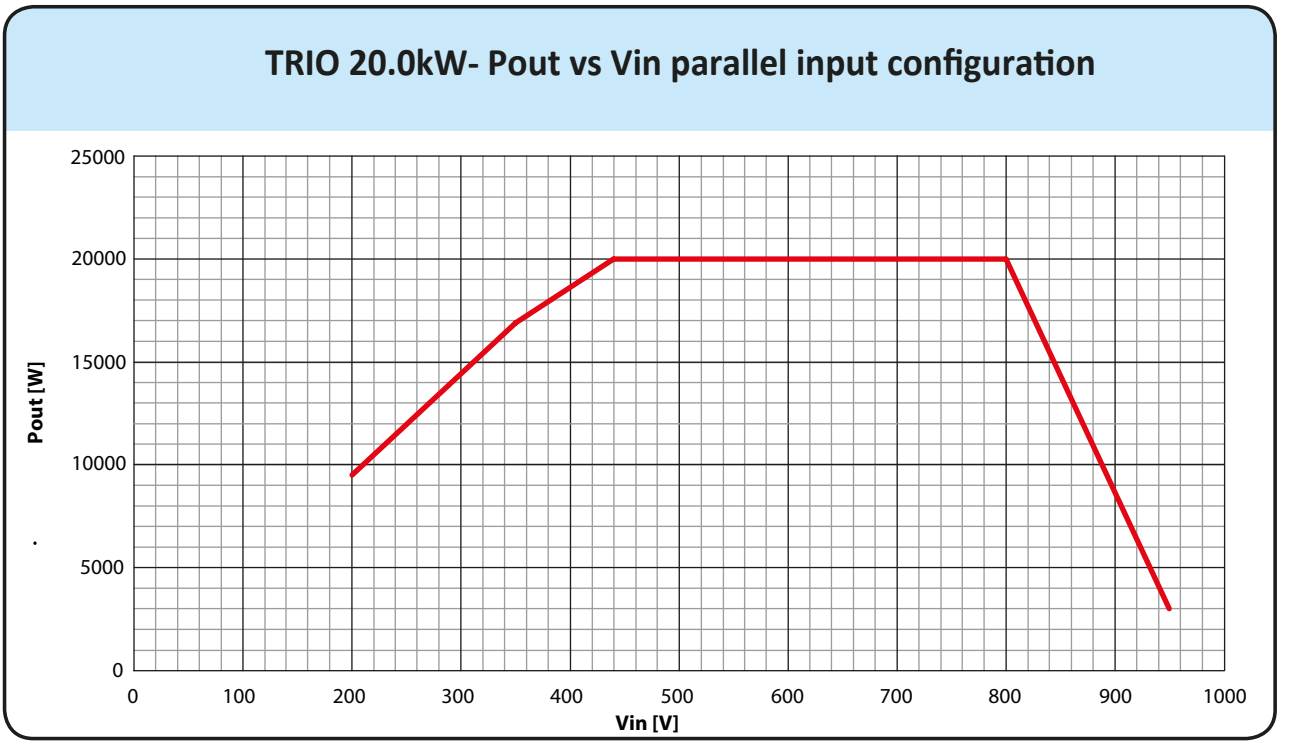
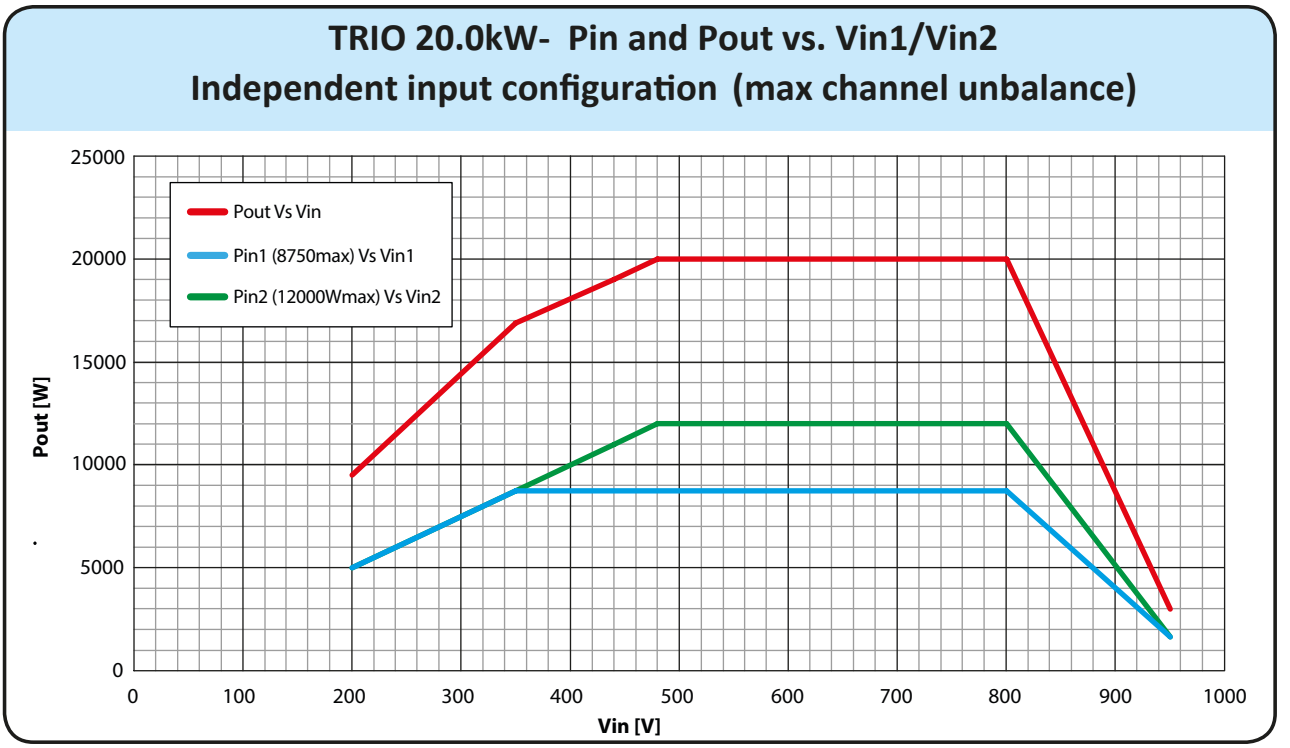
Power reduction due to input voltage

The following graphs show the automatic reduction in output power when the input voltage is too high or too low.





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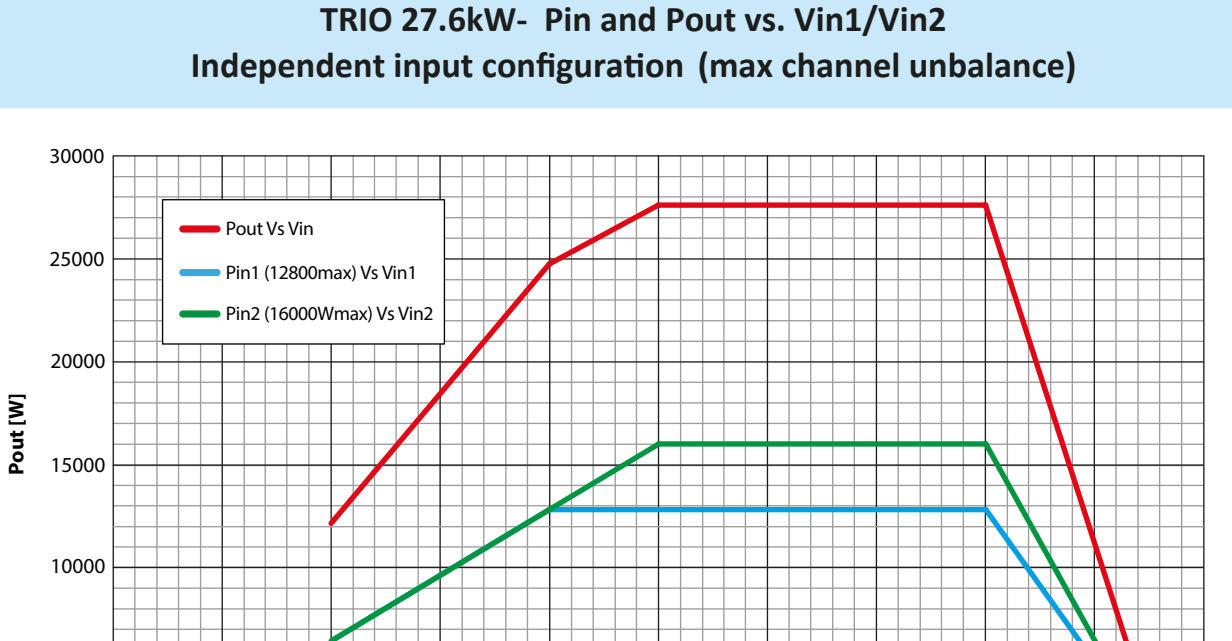
TRIO 27.6kW- Pout vs. Vin parallel input configuration

TRIO 27.6kW- Pin and Pout vs. Vin1/Vin2
Independent input configuration (max channel unbalance)



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MPPT configuration examples

PV field characteristics	MPPT configuration	Notes
• The photovoltaic array consists of strings having a different number of modules in series. • The photovoltaic array consists of strings that have different environmental conditions (shading, tilt, etc.). • The inverter is an arc fault model denoted by "-A" at the end of the model number.	MPPT configuration has to be INDEPENDENT (i.e., two MPPTs active)	For two active MPPTs in the independent mode, each photovoltaic array is to be connected to each of the inputs with a power lower than the power limit of a single input channel AND a maximum current lower than the current limit of the single input channel. A group of strings connected to MPPT 1 may have different conditions or quantity than the strings connected to MPPT 2 while operating in Independent Mode. However, within each group of strings on an MPPT channel, each string must consist of the same number of modules and environmental conditions.
• The photovoltaic array consists of strings having the same number of PV modules in series. • The photovoltaic array consists of strings that have the same installation conditions, i.e., all the strings have the same tilt and azimuth. • The photovoltaic array connected to each of the inputs has a power lower than the power limit of the input channel AND a current lower than the current limit of the input channel.	Possibility of choosing between INDEPENDENT or PARALLEL MPPT configuration (Note: AFD models cannot use parallel)	For two active MPPTs in the independent mode, each photovoltaic array is to be connected to each of the inputs with a power lower than the power limit of a single input channel AND a maximum current lower than the current limit of the single input channel. A group of strings connected to MPPT 1 may have different conditions or quantity than the strings connected to MPPT 2 while operating in Independent Mode. However, within each group of strings on an MPPT channel, each string must consist of the same number of modules and environmental conditions.
• The photovoltaic array consists of strings having the same number of modules in series. • The photovoltaic array consists of strings that have the same installation conditions, i.e., all the strings have the same tilt and azimuth. • The photovoltaic array connected to each of the inputs has a power higher than the power limit of the input channel OR a current higher than the current limit of the input channel. Non-AFD models cannot be in parallel.	MPPT configuration has to be PARALLEL (i.e., one MPPT active)	A SUFFICIENT condition* for the two MPPTs to be used in parallel mode is for the photovoltaic array connected to each of the inputs to have a power higher than the power limit of the single input channel OR a maximum current higher than the current limit of the single input channel. An ADVISABLE (*) condition for the two MPPTs to be connected in parallel is for the photovoltaic array connected to the two inputs to consist of strings comprised of the same number of modules in series and for all the modules to have the same installation conditions.
*This condition is sufficient from the point of view of the energy production of the system, not from the point of view of inverter operation.		

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Environmental sensors

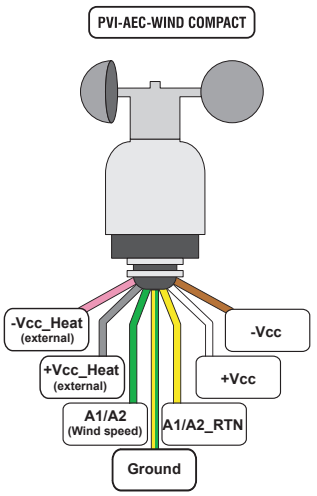
Tables containing the technical data of the main sensors available from ABB are shown below.

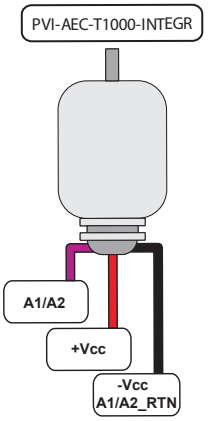
Model	Output signal	External power supply	TRIO compatible
PVI-AEC-IRR	0...10Vdc	YES	YES
PVI-AEC-IRR-T	0...10Vdc	YES	YES
PVI-AEC-RAD-13TC	0...10Vdc	YES	YES
PVI-AEC-RAD-13-TC-T	0...10Vdc	YES	YES
PVI-AEC-CONV-T100	0...10Vdc	YES	YES
PVI-AEC-T1000-INTEGR	0...10Vdc	YES	YES
PVI-AEC-WIND-COMPACT	0...10Vdc	YES	YES
PVI-AEC-PYR-1300	0...20mA	YES	NO
PVI-AEC-T100-ADH	3-wire connection on terminals: RTD1PT100 RTD2PT100 RTD3PT100	NO	YES
PVI-AEC-T1000-BOX	3-wire connection on terminals: RTD1PT1000 RTD2PT1000 RTD3PT1000	NO	YES

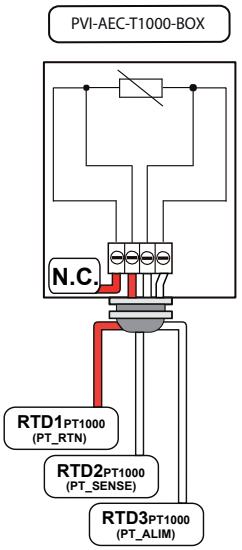
Model	Type	Gain	Offset	U.d.M
PVI-AEC-IRR	Irradiance sensor	120	0	W/mq
PVI-AEC-IRR-T	Irradiance sensor with integrated cell temp. sensor	Irradiance: 120 Cell temp.: 10.869	Irradiance: 0 Cell temp.: -20	Irradiance: W/m2 Cell temp.: °C
PVI-AEC-RAD-13TC	Irradiance sensor	130	0	Wm2
PVI-AEC-RAD-13-TC-T	Irradiance sensor with integrated cell temp. sensor	Irradiance: 130 Cell temp.: 11.507	Irradiance: 0 Cell temp.: -26.1	Irradiance: W/m2 Cell temp.: °C
PVI-AEC-CONV-T100	PT100/0...10V converter	15	-50	°C a 0...10V
PVI-AEC-T1000-INTEGR	Ambient temperature sensor with integrated converter	10	-50	°C
PVI-AEC-WIND-COMPACT	Wind speed sensor	5	0	m/s
PVI-AEC-PYR-1300	Pyranometer (0...1300W/m2)	65	0	W/m2
PVI-AEC-T100-ADH	Adhesive PT100 module temperature sensor (back cell)	N/A	N/A	N/A
PVI-AEC-T1000-BOX	PT1000 ambient temperature sensor	N/A	N/A	N/A

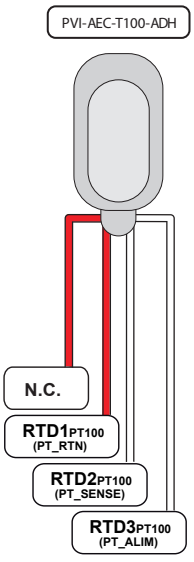
Connection diagrams for environmental sensors

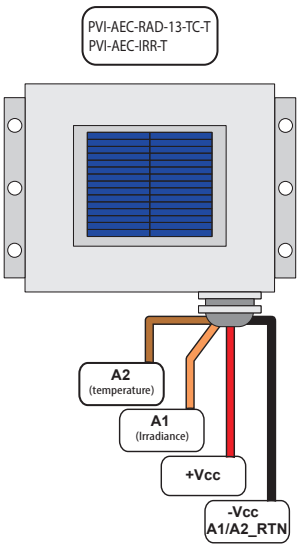
Connection diagrams for the main sensors sold by ABB are shown below: Each of the environmental sensors listed above, with the exception of the PVI-AEC-PYR-1300 Pyranometer should be connected directly to the analog input of the Trio inverter. This data is then transmitted along with the inverter's data to the system's data logger (VSN700 sold separately). For non-conventional installations or additional information about the connections, please contact the technical support department. Information on Weather Stations (VSN800) can be found at http://www.abb.com/solarinverters (select Monitoring and Communication, then Environmental Monitoring).

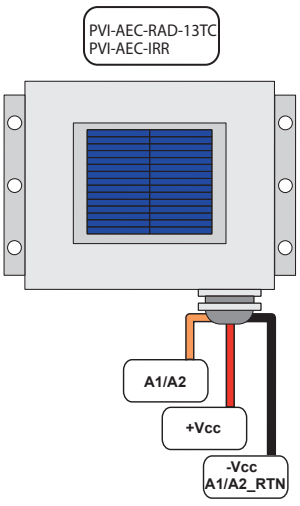












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Technical data and types

Type code	TRIO-20.0-TL-OUTD	TRIO-27.6-TL-OUTD
Nominal output power	20000W	27600W
Maximum output power	22000W[1]	30000W[1]
Rated grid AC voltage	480V	
Input side (DC)		
Number of independent MPPT channels	2; Programmable for 1 MPPT	
Maximum usable power for each MPPT channel	12000W	16000W
Absolute maximum voltage (V_{max})	1000V	
Start-up voltage (V_{start})	360V (adj. 250-500V)	
Full power MPPT voltage range	450-800V	520-800V
Operating MPPT voltage range	200-950V	
Maximum usable current (Idc max) per MPPT channel	25.0A	30.9A
Maximum short circuit current (Isc max) per MPPT channel	30.0A	36.0A
Number of inputs (strings) per MPPT channel	-S version: 1; -S1, -S1A, -S1B versions: 4	
Array wiring termination type	Terminal block, screw terminal, copper only, -S: 12AWG-2AWG; -S1, -S1A, -S1B: 12AWG-6AWG	
Output side (AC)		
Grid connection type	3Ø/4W + Ground	
Default operating voltage range	422-528V	
Extended adjustable voltage range	240-552V[2]	
Nominal grid frequency	60Hz	
Adjustable grid frequency range	57-63Hz	
Continuous current	27.0 A_{RMS}	36.0 A_{RMS}
Contributory fault current (@ 1 cycle)	51.4A_{RMS}	42.72A_{RMS}
Power factor	> 0.995 (adj. ±0.8, or ±0.9 for active power >20kW)	>0.995 (adj. ± 0.8, or ±0.9 for active power >27.6kW)
Total harmonic distortion at rated power	<3%	
Grid wiring termination type	Pass-through terminal. Tension clamp. Copper 8AWG-4AWG	Pass-through terminal. Tension clamp. Copper 6AWG-4AWG
Input protection devices		
Reverse polarity protection	Yes, passive inverter protection only.[3]	
Supplementary over-voltage protection type for each MPPT	-S1, -S1A, -S1B version: plug-in class II modular surge arrestor	
PV array ground fault detection	Meets UL1741/NEC requirements	
Output protection devices		
Anti-islanding protection	Meets UL1741/IEEE 1547 requirements	
Supplementary over-voltage protection type	-S1A version: plug-in class II modular surge arrestor	
Optional AC fused disconnect current rating (per contact)	-S1B version: 35A	-S1B version: 45A
Maximum AC OCPD rating	40A	50A
Operating performance		
Efficiency (Max/CEC)	98.2% / 97.5%	
Feed-in power threshold	65W_{RMS}	70W_{RMS}
Communication		
User-interface display	5.5“ x 1.25“ graphic display	
Standard communication interfaces	(1) RS485 connection, can be configured for Aurora protocol or Modbus RTU. Support for optional monitoring expansion cards.	
Optional remote monitoring logger	VSN 700	
Environmental		
Ambient operating temperature range	-22°F to +140°F (-30°C to +60°C) Derating above +113°F (45°C)	
Ambient storage temperature range	-40°F to +185°F (-40°C to +85°C)	
Relative humidity	0-100% condensing	
Acoustic noise emission level	<50 db (A) @1m	
Maximum operating altitude without derating	6560ft (2000m)	
Mechanical specifications		
Enclosure rating	NEMA 4X	
Cooling	Natural convection	
Dimensions (H x W x D)	41.7 x 27.6 x 11.5 in. / 1061 x 702 x 292 mm.	
Unit weight	157lbs (71kg)	168lbs (76kg)
Conduit connections	Bottom: (2) concentric DC KOs 1“, 1 1/2“ on removable plate, (2) 1/2“ plugged comm. openings, (1) 1“ plugged AC opening	
Mounting system	Wall bracket	

1. Capability enabled within maximum input current, maximum input power, maximum output current, ambient operating temperature limits, and power factor at unity.
2. Extended voltage range is for trip settings only, not operational voltage ranges.
3. In -S1, -S1A and -S1B models, the string polarity must be verified before connection. Please refer to installation manual for the correct installation procedure.

-- continued on next page --

Technical data and types (continued)

Type code	TRIO-20.0-TL-OUTD	TRIO-27.6-TL-OUTD
Safety		
Isolation level	Transformerless. Floating array required.	
Safety and EMC standard	UL1741, IEEE1547, IEEE1547.1, CSA C22.2 107.1-01-2001, FCC Part 15 Sub-part B Class B Limits	
Safety approval	$_{C}$CSA$_{US}$	
Warranty		
Standard warranty	10 years	
Extended warranty	15 & 20 years	
Available models		
Standard with DC disconnect	TRIO-20.0-TL-OUTD-S-US-480	TRIO-27.6-TL-OUTD-S-US-480
With DC disconnect, DC fuses and DC surge protection	TRIO-20.0-TL-OUTD-S1-US-480	TRIO-27.6-TL-OUTD-S1-US-480
With DC disconnect, DC fuses, DC surge protection and AC surge protection	TRIO-20.0-TL-OUTD-S1A-US-480	TRIO-27.6-TL-OUTD-S1A-US-480
With DC disconnect, DC fuses, DC surge protection and AC fused disconnect	TRIO-20.0-TL-OUTD-S1B-US-480	TRIO-27.6-TL-OUTD-S1B-US-480
Standard with DC disconnect and Arc-Fault circuit interruption	TRIO-20.0-TL-OUTD-S-US-480-A	TRIO-27.6-TL-OUTD-S-US-480-A
With DC disconnect, DC fuses, DC surge protection and Arc-Fault circuit interruption	TRIO-20.0-TL-OUTD-S1-US-480-A	TRIO-27.6-TL-OUTD-S1-US-480-A
With DC Disconnect, DC fuses, DC surge protection, AC surge protection and Arc-Fault circuit interruption	TRIO-20.0-TL-OUTD-S1A-US-480-A	TRIO-27.6-TL-OUTD-S1A-US-480-A
With DC disconnect, DC fuses, DC surge protection, AC fused disconnect and Arc-fault circuit interruption	TRIO-20.0-TL-OUTD-S1B-US-480-A	TRIO-27.6-TL-OUTD-S1B-US-480-A

All data is subject to change without notice

Further information

For more information on ABB products and services for solar applications, navigate to www.abb.com/solarinverters

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TRIO-20.0-27.6-TL-OUTD-US (-A) Product Manual
BCG.00627.2_AB NA

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