APEX

POWERSTAR 10H SERIES
INSTALLER'S MANUAL

TABLE OF CONTENTS

TABLE OF CONTENTS

FIGURES

1. INTRODUCTION

1.1 WARNINGS AND CAUTIONS

A safety instruction (message) includes a hazard alert symbol and a signal word, WARNING or CAUTION. Each signal word has the following meaning:

HIGH VOLTAGE: This symbol indicates the presence of a high voltage. It calls your attention to items or operations that could be dangerous to yourself or others operating this equipment.
Read the message and follow the instructions carefully.

WARNING: Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

Caution, risk of electric shock, Energy storage timed discharge.
Time to discharge to safe voltage printed next to symbol.

Refer to the manual (this document) to understand the correct function and use before making connections.

GENERAL WARNINGS

DANGER OF ELECTRIC SHOCK. There are no user serviceable parts inside the inverter. DO NOT attempt to make repairs or alterations to the unit.
WARNING: This equipment should be installed, adjusted, and serviced by qualified electrical maintenance personnel familiar with the construction and operation of the equipment and the hazards involved. Failure to observe this precaution could result in personal injury.
This equipment needs to be commissioned and set up correctly for the application prior to turning on.
Please see commissioning further in this manual for instructions.

GENERAL CAUTIONS

CAUTION: Always wear personal protective equipment (protective clothing, gloves, and safety boots) while performing an installation or maintenance, to avoid the danger of injuries.
CAUTION: Proper grounds, disconnecting devices, e.g. bypass boxes and other safety devices and their location are the responsibility of the user and are not provided by Apex Inverters.
CAUTION: Do not cover the device or install it in a small space - always keep it well ventilated and away from flammable gases or powders. Components in the device could potentially cause a small electric spark that could ignite flammable gas or powders. Flammable gases are created by some batteries and can become a hazard in poorly ventilated spaces.
CAUTION: For indoor use only and MUST be installed indoors in a dry area free from conductive liquids or conductive debris. If part of the inverter becomes submerged in water look for a safe way to isolate it at the distribution board and if possible at the batteries as well.

1.2 CONTACTING APEX INVERTERS

1.2.1 PRODUCT SUPPORT

When contacting Product Support via telephone or email please provide the following information for the fastest possible service:

- Type of Inverter
- Serial number
- Battery type
- Battery bank capacity
- Battery bank voltage
- A description of the event or problem

Note that the serial number is available on the serial plate that is attached to the side of the machine.

1.2.2 CONTACT DETAILS

Telephone:	+27 (0) 80 782 4266
Online:	https://www.rubiconsa.com/pages/support
Email:	support@rubiconsa.com
Address:	Rubicon SA 1B Hansen Close, Richmond Park, Cape Town

1.2.3 TELEPHONE

You can reach technical support by telephone directly Monday to Friday between 08h00 and 17h00 (GMT +2 hours). Queries outside of these hours should be directed to support@rubiconsa.com and will be answered at the earliest opportunity. When contacting technical support, please ensure that you have the above listed information available.

1.3 SYSTEM SPECIFICATIONS

1.3.1 AC PARAMETERS

Phases / Rated AC voltage / AC voltage range	1ø / 230 V / 184 to 276 V
Rated frequency / frequency range	50 Hz / 48 to 58 Hz
Rated inverter power (for U_{nom} / f_{nom} / 25°C / cos ϕ = 1)	8 kW
Rated inverter output power at 25°C for 30 min when in stand-alone mode	10 kW
Inverter current (continuous / 20 minutes / 2s)	35 A / 45 A/ 80 A
Rated source current input	63 A
Rated load current output (with grid assist)	63 A
Inverter power factor range (cos ϕ)	+1 to -1
Total Harmonic Distortion (THD)	< 5 %

1.3.2 DC PARAMETERS

Nominal battery voltage / range	48 V / 42 V to 63 V
Rated input current (battery discharging) [1]	190A
Rated / maximum output current (battery charging) [1]	155 A / 190 A
Battery technologies	Lead-Acid, Li-Ion2
Recommended minimum Lead-Acid battery capacity	250 Ah
Lead-Acid charge control	DIN 41773-1 three-stage charging with equalisation charge

[1] At 25°C

2 Contact Apex Inverters for details on supported Batteries.

1.3.3 EFFICIENCY

Maximum Efficiency	92 % stand-alone / 95% with AC connected
Stand Alone Power Consumption	< 60 W
Standby Load Power Consumption	< 8 W

1.3.4 GENERAL

Mounting Method	Wall Mounted
Dimensions (W x H x D)	400 x 500 x 250 mm
IP/NEMA Rating	IP20 / NEMA1
Colour	white front with black sides
Weight	95 kg
Operating Temperature	-5 to 45 °C (23 to 113 °F)
Architecture	Galvanically Isolated, Forced Air Cooling

1.3.5 OPERATOR PANEL / COMMUNICATIONS

Display Type	Full Colour Touch Screen 4.3" LCD; 24h logs of source power, load power, battery state of charge and Events
Communications	CAN, LAN

All specifications listed above performed at nominal voltage, frequency and temperature unless otherwise noted.

1.3.6 ALTITUDE DERATING

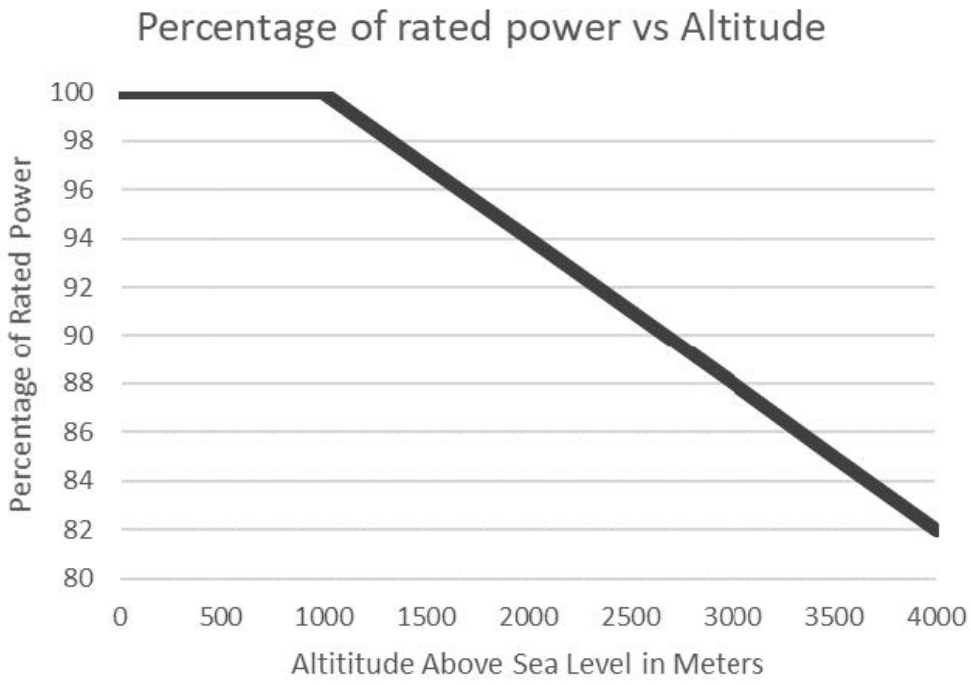


Figure 1. De-rating the Powerstar 10H inverter output power at high altitude

1.3.7 BATTERY BANK SIZE REQUIREMENTS

If using a lead-acid battery bank, please ensure that the battery bank size is a minimum of 250 Ah per inverter. Having too small a battery bank might cause system instability.
If using a Lithium battery it is recommended to have at least 10kWh per inverter, though is can be less as long as the battery can deliver at least 200A continuous.
Note that under double overload conditions, for instance during grid failure before the inverter disconnects it will essentially see a short circuit on its source, drawing approx. 400A from the battery for a short time, which must not trip the battery protection.
The above values are given as a guideline only. Depending on the type and technology of battery, as well as the size of the load, a larger or smaller bank might be acceptable.

1.4 SYSTEM DESCRIPTION

The Powerstar 10H inverter (see Figure 2) offers a cost-effective and reliable solution to the home and farm owners faced with unreliable or no grid electrical supply. Each Powerstar 10H inverter in a system can deliver 10 kW for half-an-hour and 8 kW continuously.
The inverter operates at low-voltage DC and is transformer-based, which translates to a robust and safe product that provides reliable power in the harshest environments. The Powerstar 10H inverter system can be configured in various ways, some examples are 3 units running as a three phase on or off-grid supply, an on or off-grid single phase installation, and on or off-grid with load control.

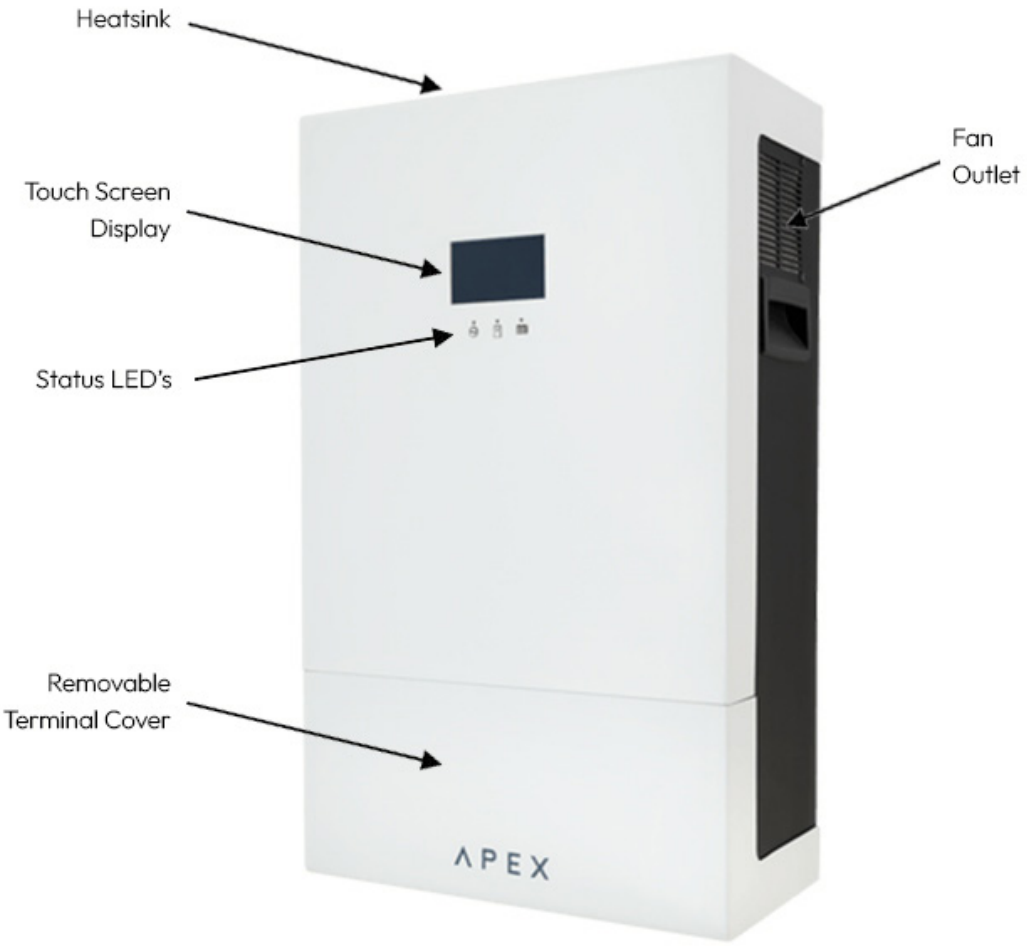
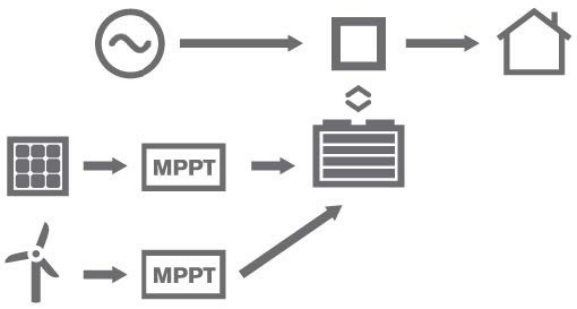


Figure 2. Identifying parts of the Powerstar 10H

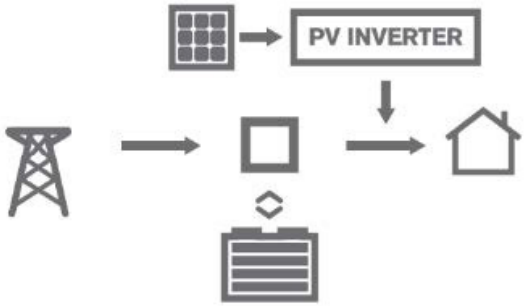
1.4.1 TYPICAL OFF-GRID OR SELF-CONSUMPTION APPLICATION

The Powerstar 10H inverter is ideal for off-grid installations where the renewable source of power is fed directly into the batteries. The Powerstar 10H converts the battery power into clean AC power that the load can use. The built-in battery charging function allows the use of a back-up generator or the grid without the need for external battery chargers.



1.4.2 TYPICAL GRID-TIED APPLICATION

The Powerstar 10H inverter will act as a back-up supply to provide power from the batteries in the event of a grid failure.
Installing a solar PV inverter on the load side will allow efficient use of solar energy and any excess generated power will automatically be used to charge the batteries or be exported to local loads.



1.4.3 BASIC GENERATOR OR LOAD CONTROL

In off-grid systems, the Powerstar 10H inverter can automatically start the generator when the battery voltage is low or there is high load. The Powerstar 10H synchronises with the generator before connecting to it. When the charge cycle is complete, or when the load is low again, the Powerstar 10H will turn off the generator and transition back to stand-alone mode.
The Powerstar 10H can also be used to turn specific loads on / off based on the battery status or load level.

2. INSTALLATION

A typical installation will include the inverter/charger(7), a battery bank(10), a battery cable fuse box(9), and an AC Bypass Box (3). The installation often also includes either some dc-coupled solar chargers or ac-coupled solar grid-tied inverters. An example of such a system is shown in Figure 3.

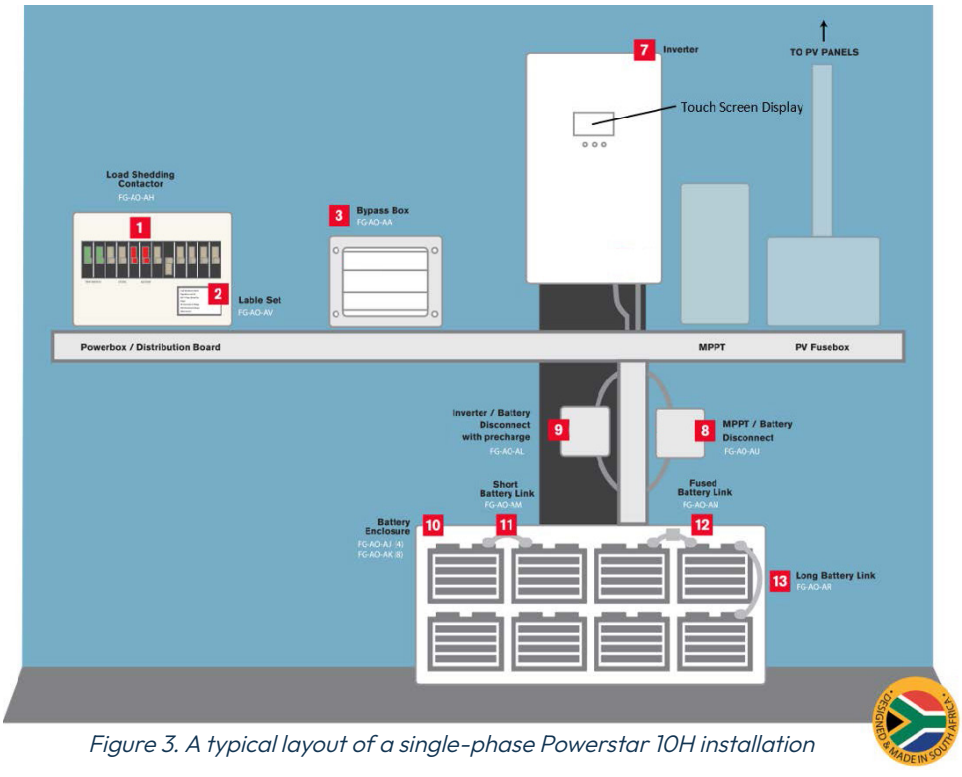


Figure 3. A typical layout of a single-phase Powerstar 10H installation

For optimal performance, please refer to the following instructions regarding the installation and setup of your inverter.

Here is the quick start guide to the installation, followed by a more detailed explanation of the steps:

- Plan the layout of the inverter(s), the solar chargers, and any relevant accessories (e.g. DC fuse-boxes and/or the AC bypass box).
- Ensure that there is adequate space around the components for ventilation.
- Mount the inverters and the solar chargers and install any of the relevant accessories.
- Install the DC and AC cables but leave the inverter isolated from any DC or AC supply.
- Run any necessary machine to machine communication cables (for example, the CAN cables between the Battery's Management System (BMS) and the inverters).
- Run any necessary cables necessary for remote monitoring, i.e. LAN cables between the inverters and the site's router.
- Run any of the cables required for any optional sensing or control (for example, external current sensing or generator control).
- Confirm that all AC and DC electrical wires, switches and circuit breakers have been installed correctly.
- Power up the inverters and any solar chargers (the Powerstar 10H and Apex's Nomad Solar Chargers are powered by their battery ports).
- Confirm that the communication between the machines is working.
- Confirm that the machine has an internet connection.
- Configure the machines as per the site requirements.
- Startup the machine

The following sections go through each of these installations steps as they apply to the Powerstar 10H.

2.1 PLANNING THE LAYOUT OF THE MACHINES ON SITE

The Powerstar 10H is a wall mounted unit with an ingress protection rating of IP20. The unit should be installed such that:

- Plan the layout of the inverter(s), the solar chargers, and any relevant accessories (e.g. DC fuse-boxes and/or the AC bypass box).
- The unit is not exposed to liquids dripping or condensing onto it;
- The unit is not exposed to excessive dust;
- The unit is not exposed to direct sunlight;
- There is adequate ventilation.
- The unit must be installed on a brick or reinforced wall that will be able to carry around 100kG of the inverter safely.

A typical single-phase installation is shown in Figure 3.
The minimum clearance around a unit (or between units) is shown Figure 4.

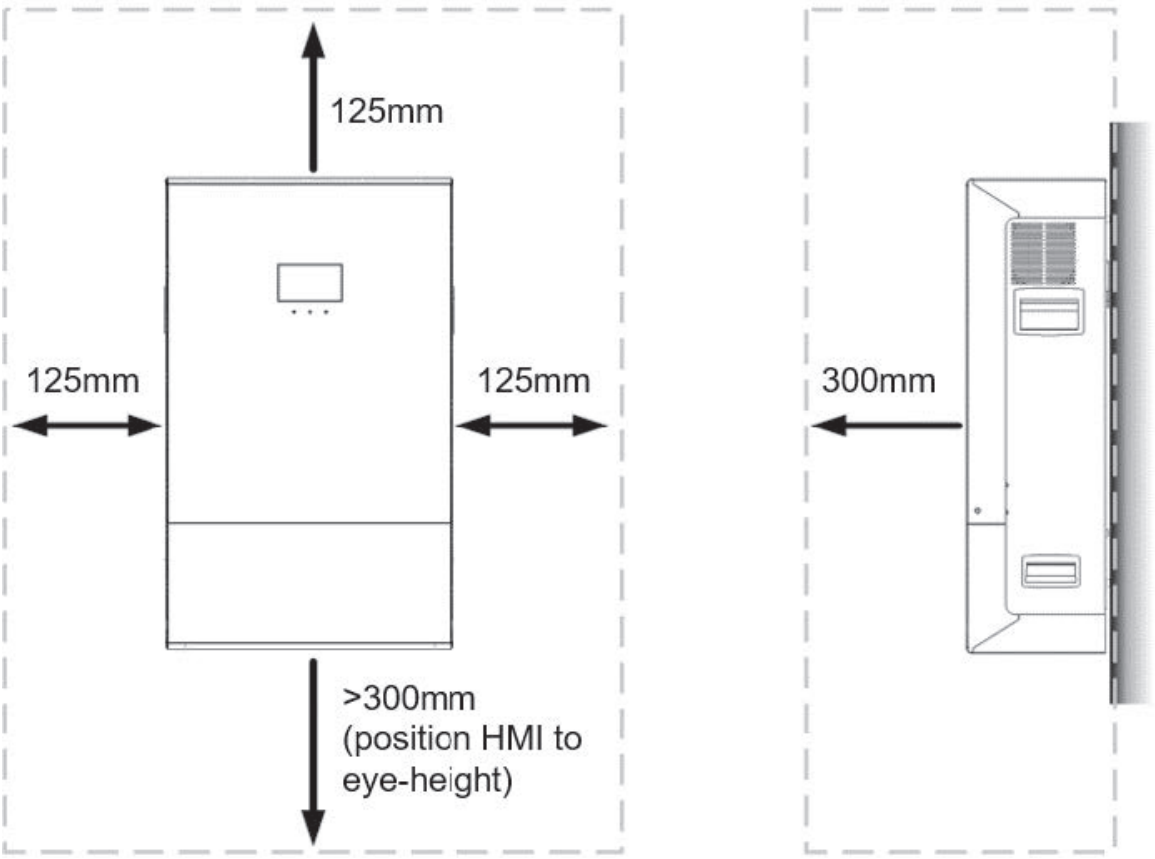


Figure 4. Minimum clearance distances around a unit or between units.

TIP | It is worth taking some time to consider the optimal arrangement of the inverters and their accessories before starting to mount the inverters.

2.2 TOOLS REQUIRED

For the installation, one will require the following tools:

- A drill and masonry drill bits for mounting the machine,
- An insulated Phillips screwdriver to access the AC and DC terminals, and to secure the AC cables into their terminals,
- A socket wrench with an extension and a 17mm socket (or 17mm hinge spanner or T-Handle wrench) for securing the DC cables,
- A precision screwdriver set for use with the plugs that plug into the Printed Circuit Board (PCB), and
- A RJ45 crimp tool (and cable tester) for making up custom length and pinout communication cables.

2.3 ESSENTIAL ACCESSORIES

The following accessories will be required for the installation but are not supplied with the inverter:

- AC Cables chosen in accordance with the local wiring code, at least 16mm^2.
- DC Cables chosen in accordance with the local wiring code, at least 70mm^2.
- M10 lugs to fit the DC cable on to the M10 studs used to bolt the battery cables to the inverter's DC terminals.
- There needs to be AC and DC disconnectors within arms reach of the inverter for safe servicing and isolation.
- Installation specific protection devices (i.e. circuit breakers, DC fuses) as per the requirements of the local wiring code.
- Please note the following:
    - The AC source and load ports on the inverter are rated for 63 A.
    - The integrated automatic transfer switch is rated for 80 A of resistive load or 30 A of slightly inductive load (AC-7a).
    - The integrated automatic transfer switch is not intended to break short circuit currents.
    - Suitably sized circuit breakers should be installed on the inverter's source side cables and on its load side cables.
    - The inverter should not be installed downstream of a RCD.
    - A RCD should be installed downstream of the inverter to protect the installation.

2.4 OPTIONAL ACCESSORIES

The following accessories might be required depending on the configuration of the installation:

- DC pre-charge circuit (which can be incorporated into the DC cable fuse box), to pre-charge the capacitor bank before turning the full battery current on. If using an Apex battery this is not needed, as the Apex battery has a pre-charge built in.
- An AC bypass box which can be used to isolate the inverter from the customer's electrical installation for the purposes of maintenance.
- Current Transformers (CTs) for monitoring and controlling power flow at the customer's metering point. NOTE: If the CT's signal is monitored by the Powerstar 10H then the CT must have a nominal a secondary current of 5A and be rated for 2.8 VA or more.
- Contactors for shedding non-essential loads.

CAUTION: The inverter includes a large capacitor bank on its DC input. If the battery is connected to the inverter without pre-charging the capacitor bank, the capacitor bank draws high current as it initially charges up. This high current can cause arcing and/or pitting at the terminal or fuse that is making the connection.

NOTE: Some Lithium battery brands trip if they detect very high DC current. This can be solved by the appropriate use of a pre-charge circuit.

2.5 MOUNTING THE INVERTER

2.5.1 MOUNTING CONSIDERATIONS

Please take note of the following before mounting the inverter:

- The Powerstar 10H is designed to be wall mounted. A solid support surface capable of bearing at least 100kG per inverter must be available for mounting, e.g. concrete, masonry, or a steel frame.
- The mounting location must be suitable for the weight and dimensions of the inverter.
- The mounting location must not be exposed to direct solar irradiation (sunlight). Direct solar irradiation can result in the premature ageing of the exterior plastic parts of the inverter and direct solar irradiation can cause the inverter to overheat. When becoming too hot, the inverter reduces its power output to avoid overheating.
- The inverter will be de-rated for altitudes above sea-level.
- The battery leads should be as short as possible, so the Powerstar 10H inverter will need to be near the batteries.
- The mounting location must not hinder access to disconnection devices.
- The mounting location should be freely and safely accessible at all times without the need for any auxiliary equipment (such as scaffolding or lifting platforms). Non-fulfilment of these criteria may restrict servicing.
- The ambient temperature should be below rated operational temperature to ensure optimum operation.
- Climatic conditions must be met.
- The inverter must only be mounted in an upright position (as shown in Figure 5).
- The inverter should be mounted in such way that display messages or LED signals can be read without difficulty and buttons operated.
- The mounting location must be inaccessible to children.
- The minimum clearances are shown in Figure 4. A minimum clearance of 125 mm on each side, the top, and 300 mm from the front must adhered to. If there is more than one unit, the horizontal distance between them can be 125 mm.
- A minimum clearance of 300 mm must be kept on the bottom of the inverter. Ideally, the inverter should be mounted such that the touch screen display is comfortable to use.

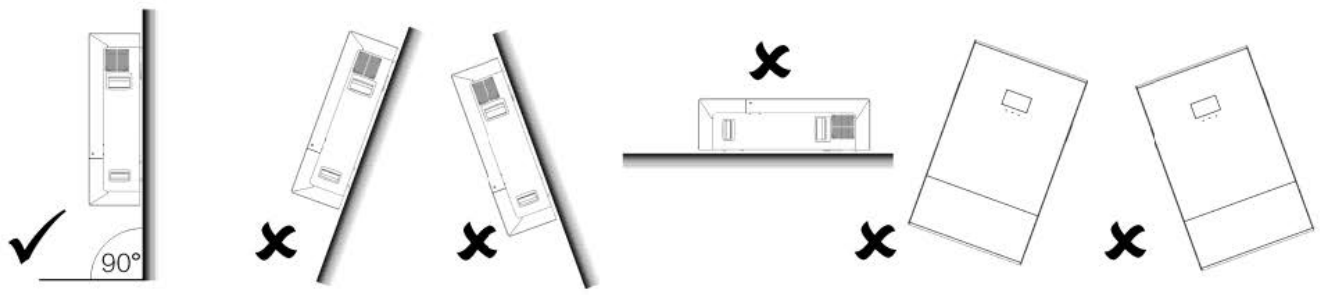


Figure 5. Permitted mounting orientation.

2.5.2 MOUNTING PROCEDURE

To mount the inverter, proceed as follows.

- 1. Choose a suitable location. The inverter must only be mounted upright.
- 2. Using a 10 mm masonry drill bit, drill 4 holes using the bracket as a template (Figure 6).
- 3. Insert the plastic plugs in to the holes.
- 4. Insert the M8 wall anchor bolts through the bracket into the plugs and tighten with a 13 mm spanner, fixing the bracket to the wall.
- 5. Using at least two people hold the Powerstar 10H vertically and lift it onto the mounting bracket.

Caution: The Powerstar 10H is quite heavy, weighing more than 80 kg; dropping it could result in personal injury and damage to the machine.
It recommended that mounting the inverter be performed by a minimum of two people.

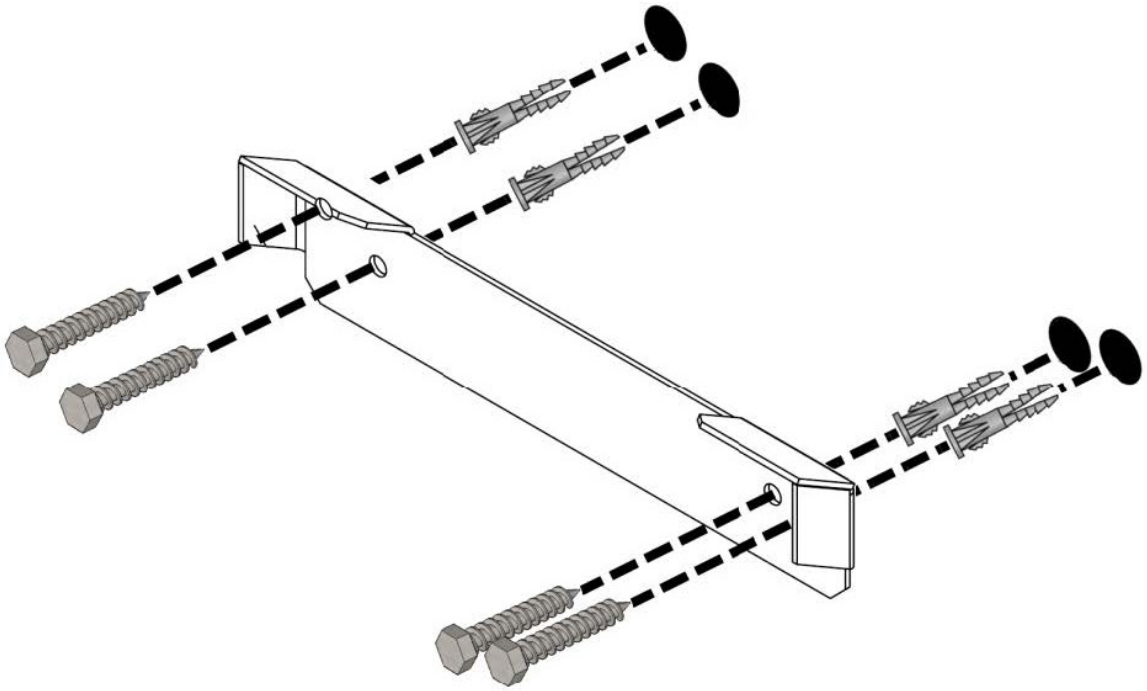


Figure 6. Wall mounting.

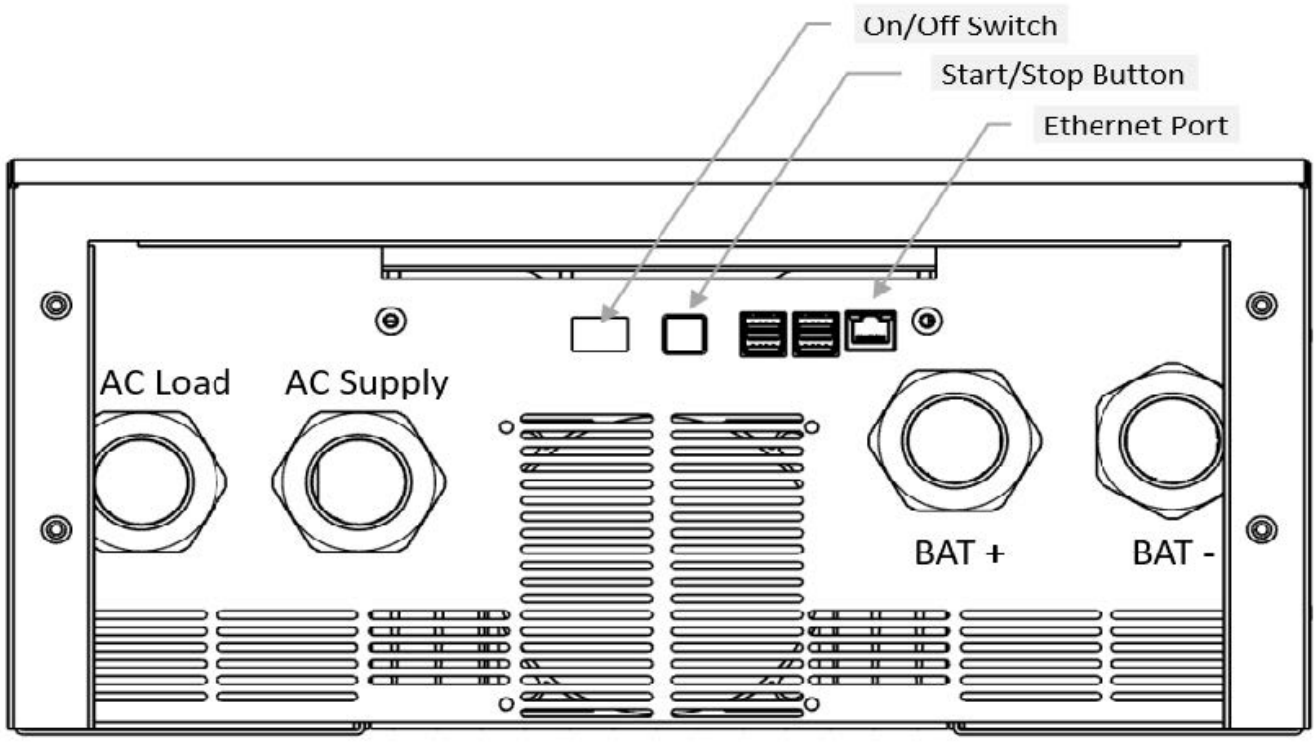


Figure 7. The AC and DC cable entries on the Powerstar 10H and the location of the On/Off switch.

2.6 ELECTRICAL CONNECTIONS

Once your Powerstar 10H has been mounted on the wall, you can begin making the electrical connections. The AC and DC cables enter the machine through M40 cable glands on the underside of the inverter as shown in Figure 7 and Figure 8. Please refer to your local wiring codes to determine what size cables are needed for the installation and what protection devices are needed between the various parts of your installation.
As a minimum 16mm^2 cable needs to be used for AC connections and 70mm^2 cables for DC.
On the DC side, the Powerstar 10H can accommodate cables with a cross sectional area up to 95mm².
On the AC side, the inverter can accommodate three-core cables with each core having a cross sectional area of up to 25mm².
To access the inverter's AC and DC terminals remove the bottom part of the front cover by unscrewing the four screws holding this cover in place. The screws are on the underside of the machine on the far left and right sides. The arrangement of the AC and DC terminals are shown in Figure 8.

TIP	Leave the On/Off switch (shown in Figure 7) in the Off position while installing the DC and AC cables so that the inverter cannot be inadvertently started.

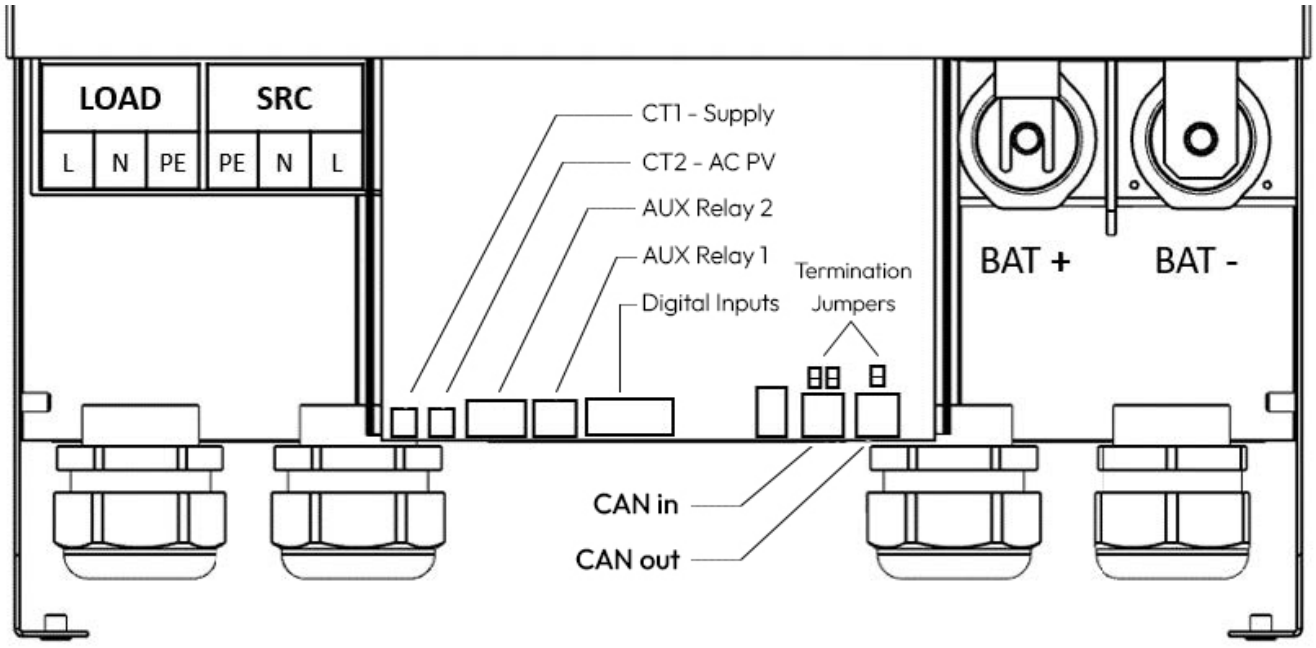


Figure 8. A figure showing the AC and DC terminals on the Powerstar 10H and the location of the PCB sockets used for CAN communication, auxiliary relay control, and external current sensing.

WARNING: In order to use the Powerstar 10H safely, batteries of sufficient capacity and battery cables with the sufficient cross-sectional area should be used. Please refer to your local wiring code for guidance on what cable size is required given the installation method you are using.

WARNING: In order to use the Powerstar 10H safely, batteries of sufficient capacity and battery cables with the sufficient cross-sectional area should be used. Please refer to your local wiring code for guidance on what cable size is required given the installation method you are using.

The inverter has a non-user-serviceable fuse (F-bat +) rated at 325A, however, this fuse is to protect the machine and not the DC cables. A pre charge facility is required to pre charge the inverters capacitor bank before closing the fuses.

CAUTION: Failure to follow these instructions carefully could increase the risk of personal injury, death or damage to property or equipment. Ensure that any electrical connections are dead before touching any potential live wiring. Certain electrical connections must be performed by a qualified electrician. If in doubt about anything, contact Apex Inverters for assistance. All wiring must be compliant with local legislation. All sizes given here are recommendations only.

2.6.1 MAKING THE DC ELECTRICAL CONNECTIONS

2.6.1.1 CONNECTING THE DC LEADS

When connecting the battery cables:

1. Note the position of the positive versus the negative terminal as labelled inside the machine (and shown in Figure 8). Installing the DC cables the wrong way round will damage the inverter!
2. Ensure that the external DC Fuses are removed and any voltage on the DC terminals are low enough to work safely with.
3. Connect the battery negative lead to the Negative (-) terminal of the battery and the inverter.
4. Connect the battery positive lead to the Positive (+) terminal via the DC Fuse(s).
5. Ensure that the terminals are tightened and secure.
6. Proceed to wiring up the AC side and all other signal cables.
7. Close the bottom cover before powering up the inverter from the DC side.

CAUTION: Installing the DC cables the wrong way round will damage the inverter!

2.6.1.2 DISCONNECTING THE DC LEADS

If it is necessary to turn off and disconnect your Powerstar 10H for some reason, follow these simple steps:

1. Turn off the inverter.
2. If a source such as a generator or utility is connected, make sure it is turned off, and that the breakers to the source are disconnected.
3. Remove the DC Fuse.
4. Wait for the inverter's DC capacitor bank to discharge to safe levels. Wait at least 5 minutes.
5. Open the bottom cover of the inverter to access the terminals.
6. If required, the Powerstar 10H can now be disconnected from the batteries.

2.6.2 MAKING THE AC ELECTRICAL CONNECTIONS

The AC terminals inside the inverter are shown in Figure 8.

The “Load” connections inside the Powerstar 10H will need to be connected into a distribution board to provide power to the loads.

The “Source” connections should connect to your mains/generator supply (via appropriate circuit breakers and if required a bypass switch).

All cables will need to be sized in accordance with the local wiring code. External protection devices must also be installed in accordance with the local wiring code.

CAUTION: With the DC input side powered it is possible to start the inverter. Make sure that the inverter is in System Off mode before making the AC connections and that the AC terminals inside the inverter are not live.

CAUTION: Isolate all AC supply to the cables and/or terminals you are working with before connecting the cables to the AC terminals of the inverter.

CAUTION: Installing the AC cables the wrong way round can damage the inverter! Note the arrangement of AC terminals as labelled inside the machine on the PCB (and shown in Figure 8).

Connect the AC cables as follows:

1. Confirm the Load terminals inside the machine are not live.
2. Connect the load cables to the “Load” terminals. Take care to connect:
    - The Live wire to the “LOAD_L” terminal,
    - the Neutral wire to the “LOAD_N” terminal, and
    - the Protective Earth wire to the “LOAD_PE” terminal.
3. Confirm the Load terminals inside the machine are not live.
4. Connect the load cables to the “Load” terminals. Take care to connect:
    - The Live wire to the “SRC_L” terminal,
    - the Neutral wire to the “LOAD_N” terminal, and
    - the Protective Earth wire to the “LOAD_PE” terminal.
5. Once all the electrical connections have been made, double-check that they are secure. A loose connection is a fire hazard.

In addition, please note the following regarding earthing the inverter and the backed-up loads:

- The Protective Earth (PE) terminal inside the Powerstar 10H must be grounded to reduce the risk of electrical shock and to ensure that external earth-leakage protection device can operate correctly.
- The Powerstar 10H includes a relay that can be configured to automatically bridge the Inverter Load Port Neutral connection to the site’s earthing point while running isolated from the Mains, i.e. in Stand-Alone mode. This relay will close while the inverter is running isolated from the mains if the Enable PE Relay setting is set to Yes. (How settings are adjusted is described later in this manual).

NOTE: External protection devices such as fuses, circuit breakers and earth-leakage protection (RCD) are the responsibility of the owner, and not of Apex Inverters. Apex Inverters cannot be held responsible for personal injury, death or damage to property or equipment caused by the improper use or installation of this equipment. It is therefore recommended that all the electrical connections be made by a qualified electrician or an Apex approved installer.
The Powerstar 10H is a safety class I product (supplied with a ground terminal for safety purposes). Its AC input and/or output terminals and/or grounding point on the outside of the product must be provided with an uninterruptable grounding point for safety purposes.
The Powerstar 10H is provided with a ground relay that can be configured to automatically connect the Neutral output to the Protective Earth (PE) when running isolated from source.

2.7 COMMUNICATION WIRING

The Powerstar 10H has facilities for communicating with other machines over a Controller Area Network (CAN) bus and for remote monitoring and control over an ethernet connection. The following sections describe how to connect cables to allow for communication between:

- The Powerstar 10H and the Battery Management System (BMS),
- The Powerstar 10H and other Apex products, and
- The Powerstar 10H and Apex Portal, which is used for remote monitoring and control.

NOTE: Both the CAN bus and the ethernet connections on the Powerstar 10H use RJ45 sockets. Plugging communication cables into the wrong socket could damage the inverter and/or other machinery!

2.7.1 THE APEX BUS RJ45 SOCKET

The Powerstar 10H's control card includes two RJ45 sockets which are used for connecting cables used for communication between machines on a particular site. This socket accommodates connections for:

- Communication between the inverter, the BMS, and other Apex machines over CAN bus.
- a signal used for synchronizing multiple Powerstar 10H's which have been configured to run as a System (or an "Inverter Set").
- Communication between the "master" machine and "slave" machines over CAN bus.

These two sockets are labelled as "CAN in" and "CAN out" in Figure 8, on the inverter's control card.
The cable used for this communication must consist of twisted pairs, for example Cat 5 cable. The pin numbering scheme used on a RJ45 plug shown in Figure 9. The pin designation on the RJ45 socket is shown in Table 1.

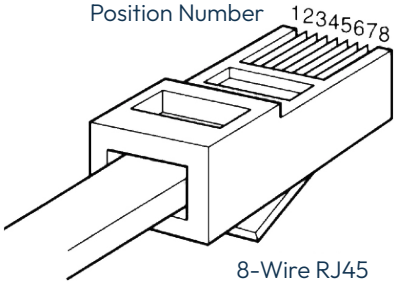


Figure 9. RJ45 plug pin numbers

Pin	CAN
1	RS485 GND
2	CAN/APEX SYNC GND
3	APEX SYNC H
4	CAN H
5	CAN L
6	APEX SYNC H
7	CAN2 H - Reserved
8	CAN2 L - Reserved

Multiple machines can be connected to the same CAN bus, with the connection daisy-chained from one machine to the next. For example, on a single-phase Powerstar 10H installation, besides the inverter and the BMS, there could also be a solar charger connected to the CAN bus. To accommodate daisy-chain connections, the Powerstar 10H has two CAN ports (distinguished arbitrarily as "In" and "Out"). These two ports are in parallel on the PCB and can be used interchangeably.

NOTE: The communication cables between Powerstar 10H machines can be wired using "straight" ethernet cables. However, for the cables used to connect to a Powerstar 10H to other machines, for example an Apex Nomad, only the three wires used for CAN communication must be connected.

All machines on the same CAN Bus must be configured to use the same Baud rate. A Baud rate of 500 kBits/s is typical for BMS's. The Baud rate that the Powerstar 10H uses can be set using its touch screen display.

Each of the communication busses must be terminated at either end of the bus with a termination resistor. The Powerstar 10H's control card includes space for 2 Pin Jumper Headers to enable termination for each of the busses (see Figure 8). For an installation with only one Powerstar 10H, jumpers must be installed on the "APEX Sync" and on the "APEX RS 485" pins. For an installation with multiple Powerstar 10H's, the jumpers must be installed only on the devices that at either end of the particular communication bus. Similarly, the CAN bus must be terminated only at either end. However, for the CAN bus this might not be a Powerstar 10H. For example, the BMS or a solar charger might be at one end of the bus. If this is the case, refer to the documentation from the relevant vendor on how to terminate the CAN bus on their devices.

TIP | For a particular communication bus (i.e. the CAN Bus, the APEX Bus, or the RS 485 Bus) termination must be enabled on two devices only, i.e. the devices at either end of the line.

2.7.2 THE ETHERNET PORT

The Powerstar 10H includes an ethernet port which can be used to connect it to a LAN and the internet. The inverter's ethernet port can be found in the center of the control card as shown in Figure 7. Use a "straight" cable between the inverter and the router.

Like the CAN port, the ethernet port uses a RJ45 socket. Be careful not to plug the communication cable into the wrong socket!

When the inverter is connected to the internet, it will automatically connect to and log data to the Apex Portal. Users can use the Apex Portal to monitor machines that are linked to their account. Your installer can assist you with registering on the Apex Portal.

2.7.3 COMMUNICATION BETWEEN THE MACHINES AND THE BATTERY BANK

Most Lithium-Ion Battery Banks include a Battery Management System (BMS) that requires the inverter/charger to communicate it with over a Controller Area Network (CAN) bus. As already described, to connect the inverter to the CAN bus use a twisted pair cable plugged into the APEX Bus RJ45 Socket.

Unfortunately, there is not a standard connector or pinout used by all the battery manufactures. Please refer to the battery manufacture's documentation to find the connector and pinout they use and match this up to the relevant CAN signals shown in Table 1. Their documentation should also explain how to enable/disable the termination resistor on the battery.

NOTE: CAN communication uses 3 wires, CAN-High, CAN-Low, and CAN-GND. The CAN-High and CAN-Low should be put on a twisted pair. For example the blue and blue-white pair of an ethernet cable. The CAN-GND should not be paired with another signal wire but can be paired with another “low-noise” wire. The CAN communication will often work without the CAN-GND wire, however, this could result in less robust communication. If used CAN-GND must be tied to ground at one end only.

If using an Apex battery one can just take a straight ethernet cable from the battery’s CAN out to the inverters CAN port. The Apex battery is always terminated on its CAN ports.

2.7.4 COMMUNICATION BETWEEN POWERSTAR 10H’S

When multiple Powerstar 10H’s are installed at a site, they can be setup to run as a system. For the machines to run as a system, the machines communicate with each other over a set of communication busses collectively referred to here to as the APEX Bus. Please take note of the following:

- The cable used for these communication signals must include 4 twisted pairs suitable for a RJ45 plug (for example, Cat 5 ethernet cable);
- The cables will plug into the “APEX Bus” RJ45 socket and must be wired as “straight” type B cables;
- The cables can be daisy-chained from one machine to the next.
- The machines on either end of the chain should have the termination jumpers installed (as already described).

NB | The cable used for communication between Powerstar 10Hs must include 4 pairs, i.e. 8 wires. Each pair must be wired up correctly as per Table 1. The simplest option is to use a standard straight ethernet cable.

NB | Before the machines are started up for the first time, the installer must check that the communication between the machine(s) and the BMS is working!

2.7.5 COMMUNICATION BETWEEN POWERSTAR 10H’S AND OTHER APEX MACHINES

The Powerstar 10H can communicate with other Apex products, for example the Nomad Solar Charger and the Apex battery over the same CAN bus. Please refer to the relevant product’s documentation to find the connector and pinout used for that particular machine. This documentation should also explain how to enable/disable the termination resistor on the battery or device.

2.7.6 COMMUNICATION BETWEEN POWERSTAR 10H’S AND APEX PORTAL

The Apex Portal is a web-based tool that allows one to remotely monitor and control Apex machines. Communication between the Powerstar 10H and Apex Portal is done over the internet. To connect the Powerstar 10H to the internet, simply connect an ethernet cable between the inverter and a router with an internet connection. The Powerstar 10H is set to get it’s IP address via DHCP.
Your installer can assist you with registering on Apex Portal.

2.8 EXTERNAL CURRENT SENSING

The Powerstar 10H can monitor the current measured by an external Current Transformer (CT). This signal can be used to control the flow of power at the customer's metering point (i.e. just after their service circuit breaker), as well as having a second CT input for AC coupled solar, so that one is able to determine accurate production of AC coupled solar.
Please take note of the following:

- The CT must have a nominal a secondary current of 5A and be rated for 2.8 VA or more.
- It is recommended to use twisted pair wire for the CT, it has to be rated for at least 5A.
- The polarity of the measurement for grid is important.
    - Power flowing from the mains into the customer's loads must be measured as positive power. So, assuming there is no AC coupled PV inverter on site and with the Powerstar 10H in Standby or System Off mode, the power measured by the CT should be positive.
    - Power measured for AC coupled solar will always measure positive irrespective of CT polarity.
- It is important to confirm that the two CTs are connected to the correct ports (EXT CT to the left {J5}, AC solar CT to the right of it {J7}, as per Figure 8. Incorrect connection can cause unexpected behaviour.

The socket for the External CT's signal wires is on the bottom left corner of the inverter's control card as shown in Figure 8.

2.9 DIGITAL INPUT/OUTPUT SIGNALS

The Powerstar 10H has two auxiliary relays that can be used as digital outputs to shed loads or start/stop a generator. The Powerstar 10H also has a set of inputs which can be used to send digital inputs signals such as the position of an external contactor (ExtCB) or the position of an emergency stop (Estop)/fireman's switch.
The position of the PCB sockets for these signals are shown in Figure 8.
Please take note of the following:

- The auxiliary relays, and the corresponding plugs and sockets, are rated for: 5Aac, 250 Vac, and 5Adc, 30 Vdc.
- Both auxiliary relays can be used to in either a Normally Open (NO) or Normally Closed (NC) configuration.

The labels used on the inverter's control card used to designate the auxiliary relays' contacts are described in Table 2.

Table 2. The labels used for the inverter's auxiliary relays' contacts.

Label	Description
R1_COM	Auxiliary Relay 1 Common contact
R1_NO	Auxiliary Relay 1 Normally Open contact
R1_NC	Auxiliary Relay 1 Normally Closed contact
R2_COM	Auxiliary Relay 2 Common contact
R2_NO	Auxiliary Relay 2 Normally Open contact
R2_NC	Auxiliary Relay 2 Normally Closed contact

2.9.1 GENERAL PURPOSE DIGITAL INPUTS

The digital inputs on the Powerstar 10H can monitor whether a switch/circuit is open or closed. The signal wires used for these inputs should not have any voltage applied to them, ie. they should be potential free dry contacts.

Currently, the only inputs that are monitored are the Emergency Stop (Estop), remote on and source disconnect request inputs. The other inputs on these sockets are not used and are likely to be removed in future versions of the machine. Do not connect any wires or signals onto these inputs.

---

3. POWERING UP THE POWERSTAR 10H

Before powering up the inverter for the first time, it is recommended that you read this manual in its entirety, specifically the sections on how to test the communication wiring and how to configure the machine.

The Powerstar 10H is powered from the DC side. To power up the machine the DC port needs to be connected to the battery bank.
With the AC and DC supply isolated from the inverter, proceed as follows: Make sure all source (generator or mains) and load AC wires and the DC cables are connected correctly to the inverter.

- Use the pre-charge circuit to charge up the inverter's capacitor bank to a level close to that of the battery bank's voltage.
    - As the machine's DC bus is charged up the display will turn on and you will be able to monitor the battery voltage on the screen.
    - Tap the screen twice to view voltages.
- Once the battery voltage shown on the display is close to that of the battery's voltage, close the DC Fuses (if that is how DC is isolated), or close the isolator if there is a DC isolator installed.
- The battery voltage shown on the touch screen display should now match that of the battery bank.
- If using an Apex battery you can turn the battery on with the fuses already closed, as the Apex battery has a built in 10A pre charge circuit.

With the machine powered up it is now possible to configure the machine to suit the particular installation.
The following sections give instructions on how to confirm that all wiring is correct and then how to setup the machine before turning it on for the first time.

If you are familiar with the HMI you can go directly to section 5, Testing communication and wiring.

---

4. AN INTRODUCTION TO THE INVERTER'S HUMAN MACHINE INTERFACE (HMI)

Before the inverter(s) can be started up for the first time, the communication between machines should be tested and the inverters should be configured to match the particular installation. This will typically be done using the machines' touch screen displays. The touch screen display is the inverter's physical Human Machine Interface (HMI).

The Powerstar 10H's HMI includes:

- A touch screen display.
- Three status LED's.
- An on/off switch.
- A start/stop button.
- A buzzer for alerting the user to certain events or conditions.
- An ethernet port for web-based monitoring/control.

The touch screen display is the primary interface for local control and configuration. As such the screen is often referred to as the HMI. What follows is a brief description of how to navigate through the screens on the HMI, and then sections on how to confirm the communication between machines is working and how to configure the machine using the HMI.

4.1 NAVIGATING THE TOUCH SCREEN DISPLAY'S GRAPHICAL USER INTERFACE

As shown in Figure 10, the Powerstar 10H has a touch screen display on its front. The touch screen display is often referred to as the Human Machine Interface (HMI) in Apex documents, as it is the primary way the user will interact with the machine.

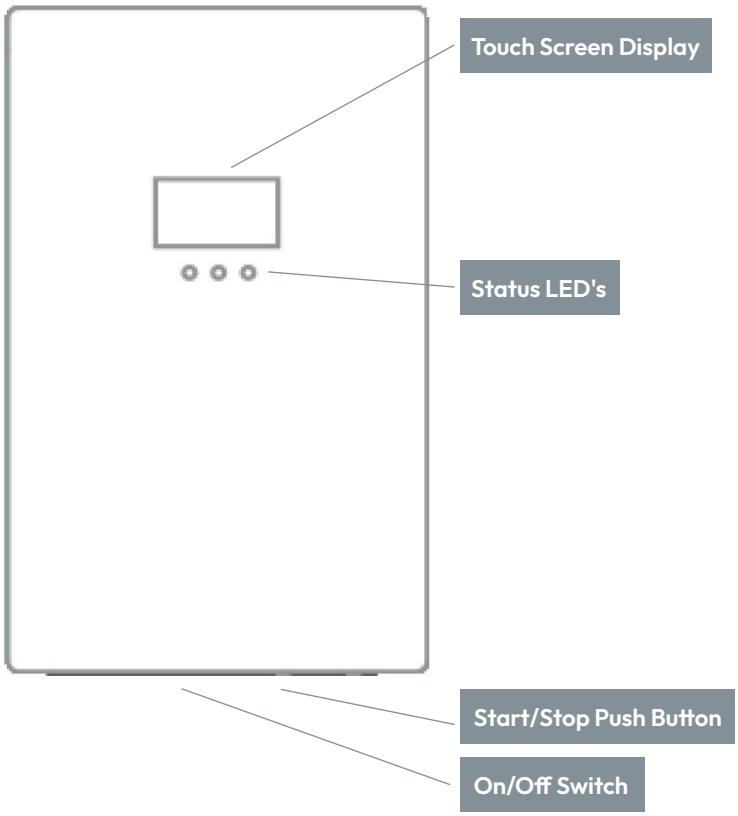


Figure 10. An image showing the position of the Powerstar 10H's touch screen display, the status LEDs, the start/stop button and the on/off switch.

The Powerstar 10H's HMI includes:

- Dashboard.
- Control.
- Charts/Logs/Data.
- Settings.

Examples of these four screens are shown in Figure 11. To navigate between these screens, tap on the relevant icon on the right-hand side navigation bar. The screen navigation icons are shown in Figure 12. The four main screens are briefly described in the following sections.

(If you are already familiar with the Powerstar 10H's display then you might want to move straight onto Testing the communication and signal wiring.)

a) Dashboard Screen

b) Control Screen

c) Charts/Info Screen

d) Settings Screen

Figure 11. The HMI's four main screens. Namely the dashboard, control, charts/info and settings. The navigation bar is shown on the right side of the screen. Use the icons in the navigation bar to move between the screens.

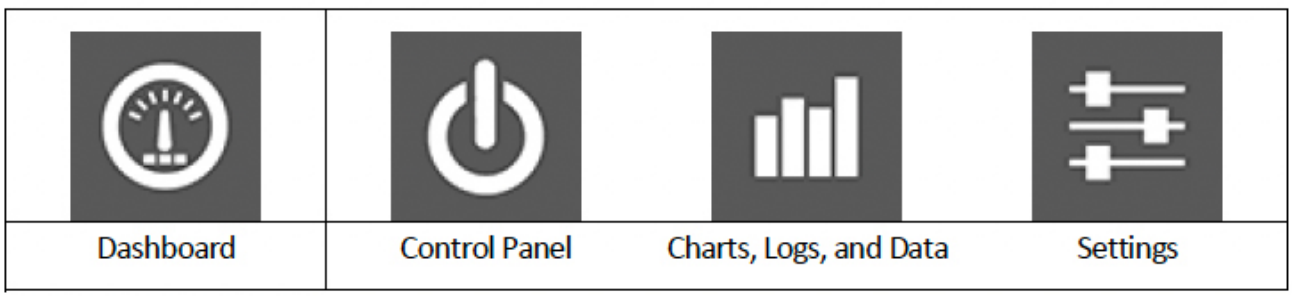


Figure 12. The display's screen navigation icons.

4.1.1 THE DASHBOARD

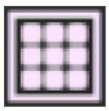
The dashboard screen gives a real-time view of the current state of the system. An example of how the dashboard might look is shown in Figure 11a. The dashboard shows a collection of icons which can show how power is flowing through the system or alternatively the voltage and currents measured at various points in the system. To cycle between showing power flow (i.e. kW or kVA) and/or voltage (V) or current (Amps) tap on the main part of the screen. The names and descriptions of data shown with each icon is described in Table 3.
The dashboard also shows the state of the battery and the state of the machine. A status bar is shown on the bottom of the screen. In the status bar, the inverter's operational mode is shown and underneath this any recent events or messages.
The status bar also shows the time and date as set on the inverter.

4.1.2 THE CONTROL SCREEN

The control screen allows the user to start/stop the inverter, to reset the inverter if it has detected some fault and to access the battery and relay control functions. An example of how the control screen might look is shown in Figure 11b. The control screen includes four buttons, namely a **start/stop button**, a **reset** button, a **battery control** button, and a **relay control** button. It also includes the status bar which shows the inverter's operational mode and any recent events/messages.

The **start/stop** button is used to start or stop the inverter. (Note, the inverter can only be started using this icon if the physical On/Off switch is in the On position. The On/Off button is on the underside of the inverter as shown in Figure 7 and Figure 10.)

Table 3. A table describing the icons shown on the dashboard screen.

Icon Name	Icon	Data Shown
AC Source Icon		Power (kW), Real Power (KVA), voltage (V), or current (Amps) as measured at the inverter's SOURCE PORT.
Inverter Icon		The Inverter.
AC Load Icon		Power (kW), Real Power (KVA), voltage (V), or current (Amps) as measured at the inverter's LOAD PORT.
Battery Icon		Power (kW), voltage (V), or current (Amps) as measured at the inverter's BATTERY PORT.
Ext. CT Icon		Power (kW), or current (Amps) as measured by the external Current Transformer (CT).
Solar Icon		Power (kW) or current (Amps) generated by the solar system. This icon will split if there is both AC and DC coupled solar, to indicate each separately.

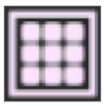
The reset button can be used to clear any temporary faults that the inverter has detected.

TIP | If the inverter's controller has detected some fault which will prevent it from starting then the icon on the left will not show a tick, a relevant message will be shown in the status bar, and the Inverter Status LED (described later) will not be green. Many of the faults the controller detects can be remedied easily (for example the communication cable between the inverter and the battery bank was unplugged). If you believe the fault has been remedied, then click on the reset icon. If the fault is still present, the controller will detect it again, otherwise the inverter will go into Standby mode (assuming the On/Off switch is in the correct position).
If the fault persists then contact your installer.

4.1.3 THE CHARTS, LOGS, AND DATA SCREEN

4.1.3 The charts, logs, and data screen
The charts, logs, and data screen provides access to charts, event logs, solar production logs, and collections of related real-time data which is not shown on the dashboard. An example of how the screen might look is shown in Figure 11c. This screen includes a number of icons placed at the bottom of the screen. Use these icons to navigate between the various charts, logs, and tables available. The icons and the charts/logs/data they navigate to are described in Table 4.

Table 4. A table describing the icons shown on bottom of the Charts, Logs, and Data screen

Icon Name	Data Shown
	Source Power Chart A plot of the power measured at the inverter's source port over the last 24 hours.
	Load Power Chart A plot of the power measured at the inverter's load port over the last 24 hours.
	Battery Status Chart The battery State of Charge (SoC) or voltage measured over the last 24 hours.
	Event Logs A list of recent events/messages.
	Production Logs A summary of the power/energy measured/recorded by the inverter.
	BMS Info A collection of recent data that the BMS has transmitted on the CAN Bus.
	Solar Info A collection of recent data that any Apex Solar Charges (i.e. Nomads) have transmitted on the CAN Bus. There are two solar icons,
	Inverter Set A collection of recent data that any Apex Powerstar 10H inverters have transmitted on the CAN Bus.

4.1.4 THE SETTINGS SCREEN

The settings screen provides the gateway to configuring the machine to match the installation's specific requirements. It also provides access to some tables of real-time data useful at the time of installation or for troubleshooting. As shown in Figure 11d, the setting screen includes five icons that will bring up a collection of commonly used and related settings. For example, the battery setup icon will bring up the battery setup wizard. The fifth icon, namely the advanced setup icon, will take the user to the advanced setup menu. The advanced setup menu allows the user/installer to access all the user settings as well as real-time data points. (If you feel that you need to change a setting, that is not described in this document, then contact your installer for assistance.)
Many of the settings are passcode protected to prevent the user from changing them unintentionally. The passcode to gain access is 1918. Advanced access allows the user to change settings that are specific to the site.
There are a few convenient setup wizards to help with:

- The alarm setup.
- Setting the date & time.
- The battery setup.
- The auxiliary relay setup.

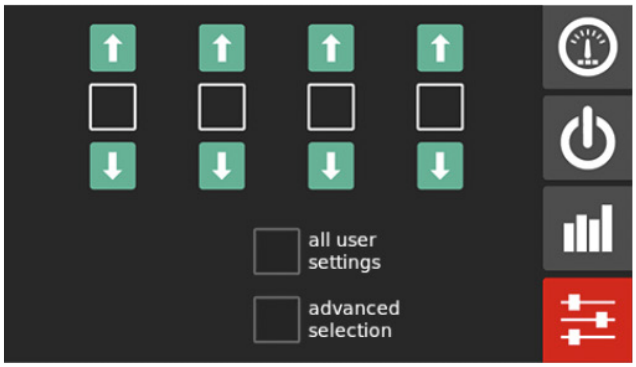
These wizards will be described more in following section on Configuring the machine.
Besides the settings shown in the setup wizards, one can also access all the user settings and some data relevant to advanced users (e.g. installers) by tapping on the advanced setup button. Doing this will bring up the screen shown in Figure 13a.

TIP	To get advanced access for editing settings enter the default passcode of 1918 before selecting either the user settings checkbox or the advanced selection checkbox. (To simply view most settings no passcode is needed.)

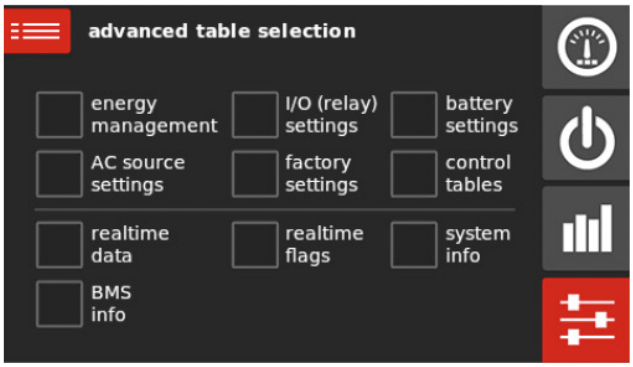
Once on the advanced setup menu, tapping the all user settings checkbox will bring up a screen, as shown in Figure 13c, that allows one to scroll through all the available user settings. If a setting can be changed the edit button will show. Clicking on this button will take you to a new screen, as shown in Figure 13d, where you can submit changes to the settings. The selected settings current value and unit is shown in the top left corner next to the setpoint number. Use the green up/down arrows to move to the new desired value. The left-most arrows will change the value in steps of 100, the middle arrows will change the value in steps of 10, and the right-most arrows will change the value in steps of 1.

NOTE: The setting will not be changed until you tap the submit button. Once you have tapped the submit button, confirm whether the new value has been accepted by noting the value shown in the top-left corner next to the setpoint number after a few seconds.

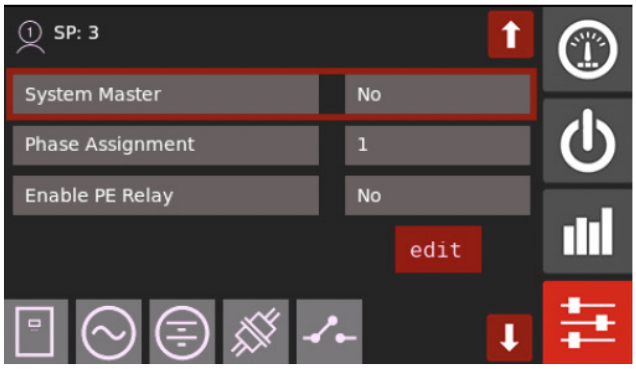
Selecting the advanced selection icon when on the advanced setup screen will bring up the advanced table selector screen shown in Figure 13b. From here one can navigate to groups of related user settings (i.e. the checkboxes shown in the top half of the screen) or collections of real-time data which can be helpful for setting up the machine or troubleshooting.



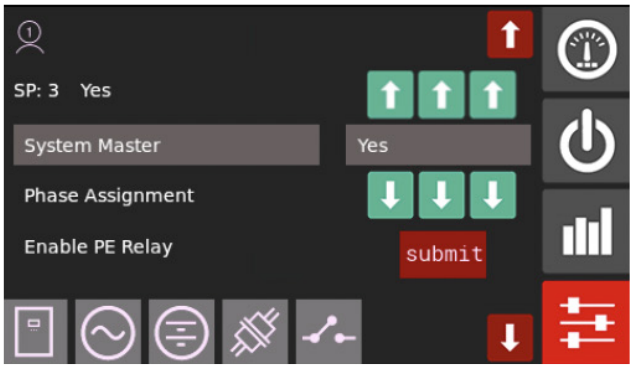
a) Advanced Setup



b) Advanced Selection



c)All User Settings (View Screen)



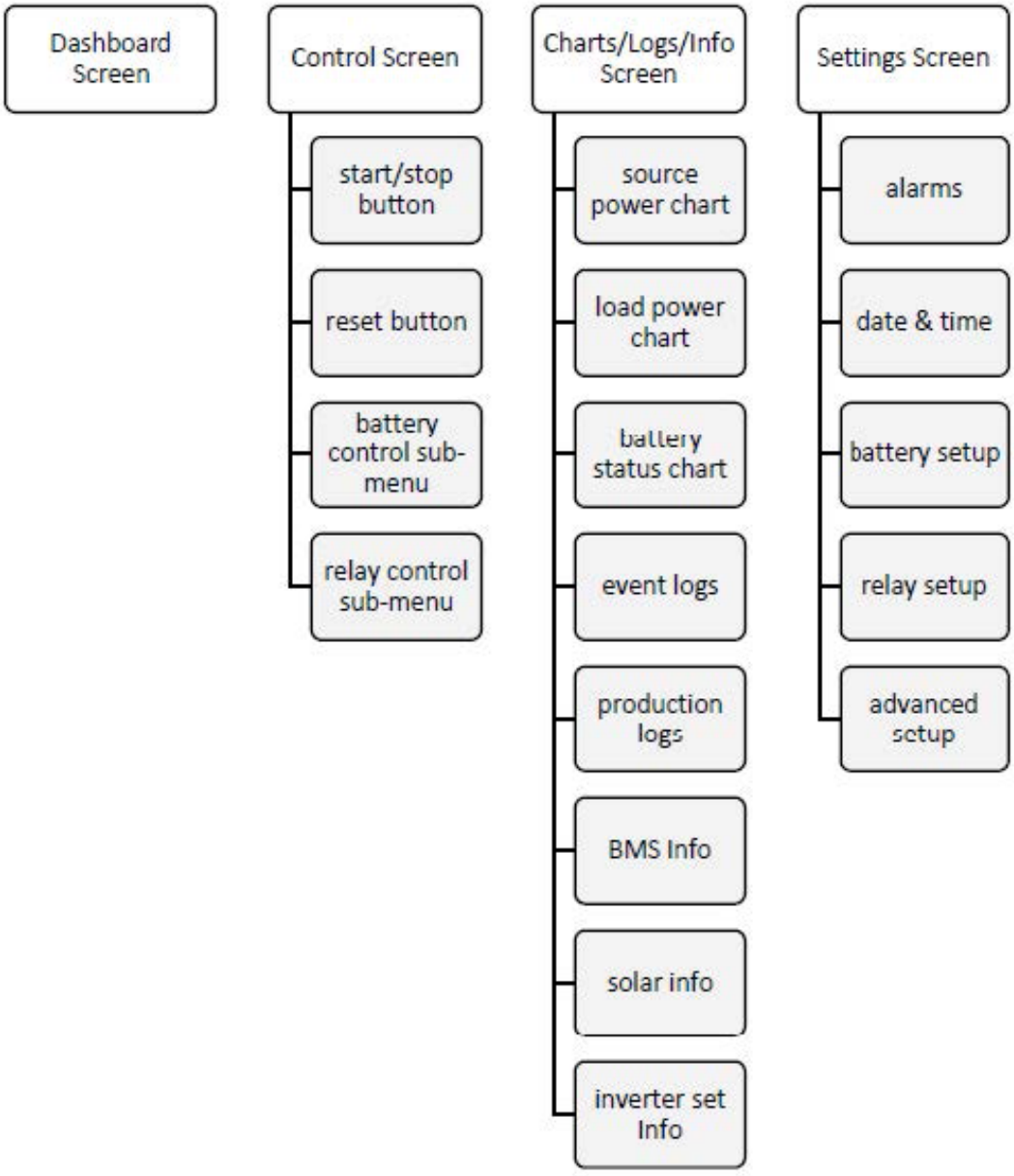
d) All User Settings (Edit Screen)

Figure 13. The HMI's advanced setup sub-screens. To view the full set of user settings select the all user settings checkbox. Note most of the settings are passcode protected. To edit a setting enter the default password (1918) before selecting one of the checkboxes. To access the advanced table selection screen select the advanced selection checkbox.

4.1.5 SCREEN SUMMARY

A summary of the four main screens and the controls, buttons, and data available on each of these screens is shown in Figure 14.

Figure 14. An overview of the screens and menus available on the touch screen display.



The following sections describe the rest of the inverter's HMI (e.g. the buttons and switches and status LEDs) and after that how to check the communication wiring and set the inverter up before turning on for the first time.

4.2 BUTTONS AND SWITCHES

In addition to the touch screen display, the Powerstar 10H has two switches that the user can use to control the inverter. These are the on/off switch and a start/stop push button on the underside of the enclosure as shown in Figure 7.

4.2.1 THE ON/OFF SWITCH

When this switch is in the off position the inverter will stay in System Off mode and will not respond to start/stop instructions from the screen or remote input. When the switch is in the on position, the inverter will go into Standby mode and will respond to start/stop instructions.

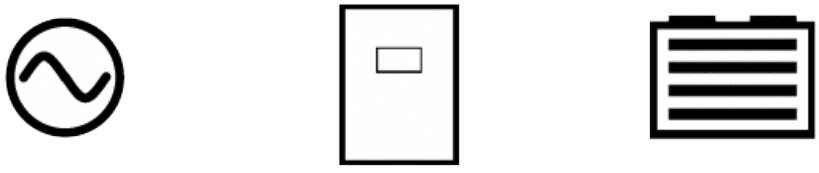
4.2.2 THE START/STOP (AND FAULT RESET) BUTTON

On the underside of the inverter, there is a start/stop push button located next to the on/off switch (see Figure 7). This button also acts a fault reset button.
Normally one would use the display to start and stop the inverter or to reset faults. The start/stop push button is included only as secondary means to start and stop the inverter.
The start/stop push button has a few functions depending on the operating mode of the inverter and for how long the button is pushed:

- If the inverter is running and the button is pushed the inverter will stop running and return to Standby mode;
- If the inverter is Tripped, Off, or in Standby mode and the button is pushed any faults will be reset;
- If the inverter is in Standby mode and the button is pressed in for 3 seconds or more the inverter will go into Full Auto mode, i.e. the inverter will start up into Stand-Alone mode.

4.3 THE STATUS LED INDICATORS

On the front of the inverter, underneath the touch screen display, there are three status LEDs that can flash green, orange, and/or red. There is a status LED for the AC source, the inverter, and the battery. The icons used to label the LEDs are shown in Figure 15.



AC Source Status | Inverter status | Battery status

Figure 15. The icons used with the status LEDs.

The following tables describe what the status LEDs indicate based on their colour and whether they are blinking or not.

4.3.1 The AC Source LED

LED Status	Notes
Off	No (or very low) voltage is detected on the inverter's source port.
Green - Blinking	The source is within acceptable bounds, but the inverter's internal source relays are still open, i.e. the load port is still isolated from the source port.
Green - Solid	The source is within acceptable bounds and the source relays have been closed, i.e. the load port is electrically connected to the source port.
Orange - Solid	The inverter and the load are connected to the source, but the source's frequency is higher than the power curtailment threshold.
Red - Solid	The source voltage/frequency is out-of-bounds (as specified by the local grid code).

4.3.2 The Inverter LED

LED Status	Notes
Off	The inverter's On/Off position is in the Off position but no other faults are detected.
Green - Blinking	The inverter is in Standby or Startup mode and is ready to start.
Green - Solid	The inverter is running.
Orange - Solid	The inverter is switched off and there are faults detected that will stop the inverter from starting.
Red - Solid	The inverter has tripped. If the machine does not reset automatically, use the reset icon on the HMI's control screen.

4.3.3 The Battery LED, which is linked to the battery settings of the inverter

LED Status	Notes
Blinking	The battery is being charged (i.e. current is flowing into the battery).
Green	The battery State of Charge (SoC) is above the "Charge Disable" SoC or voltage.
Orange	The battery SoC is between "Battery critical" and "Charge Enable" SoC or voltage.
Red	The battery SoC is below "Battery critical" SoC or voltage.

5. TESTING THE COMMUNICATION AND SIGNAL WIRING

On an installation that includes multiple Apex machines (e.g. a Powerstar 10H and a Nomad, or multiple Powerstar 10Hs), a battery bank with a Battery Management System (BMS) it is necessary to test that all the machines are communicating with each other before starting up the machines. This machine to machine communication is done over the Controller Area Network (CAN) bus. The Powerstar 10H inverters use the "BMS CAN" bus to send messages to each other and also a seperate "Apex comms" which includes signals only relevant to the Powerstar 10Hs.
Besides the machine-machine communication, it is also good practice to test that the Powerstar 10H's connection to the internet is good. Without a stable internet connection the inverters cannot connect to Apex Portal and support from Apex Inverters will be hampered.
If external Current Transformer/s (CT) have been installed, then one needs to check that they are installed with the correct polarity.
The following sections describe how to test the communication between machines, their connection to the internet, and the polarity of the external CT.

5.1 COMMUNICATION BETWEEN MACHINES AND THE BATTERY MANAGEMENT SYSTEM.

With Li-Ion batteries, a Battery Management System (BMS) must be installed. The BMS will communicate with the inverter over a Controller Area Network (CAN) bus.

NB | Before the machines are started up for the first time, the installer must check that the communication between the machine(s) and the BMS is working!

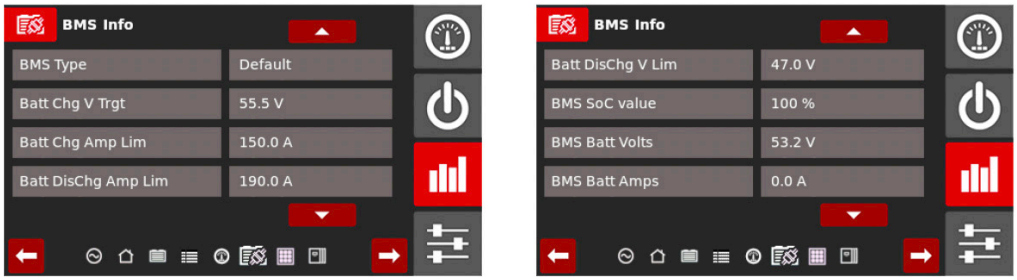
This can be checked using the HMI's BMS Info screen (see Figure 16). To navigate to this screen:

- Click on the **charts/data** icon in the HMI's navigation bar > click on the **BMS Info** icon shown on the bottom of the screen.

If a recognized BMS is detected its name will be shown on the screen. If a valid BMS is detected that does not broadcast its name, the **BMS type** will be displayed as **Default**.

NB | If the BMS Type shows NA (i.e. Not Available) then the CAN communication is NOT working, and you need to rectify this before starting up the inverter.

Besides the **BMS Type**, one can also find other data sent by the BMS to the inverters on the BMS Info screen, for example: the battery charge voltage target **(Batt Chg V Trgt)**, the battery State of Charge **(BMS SoC value), etc.** Use the up and down arrows to scroll through the data.



a) BMS Info b) BMS Info (Continued)

Figure 16. The BMS Info screen.

5.2 COMMUNICATION BETWEEN THE INVERTERS AND/OR SOLAR CHARGERS

If there are multiple inverters installed on a particular battery bank, then they need to communicate with each other over a Controller Area Network (CAN) bus and the "Apex comms" bus.

> NB | Before the machines are started up for the first time, the installer must check that the communication between all the machine(s) is working!

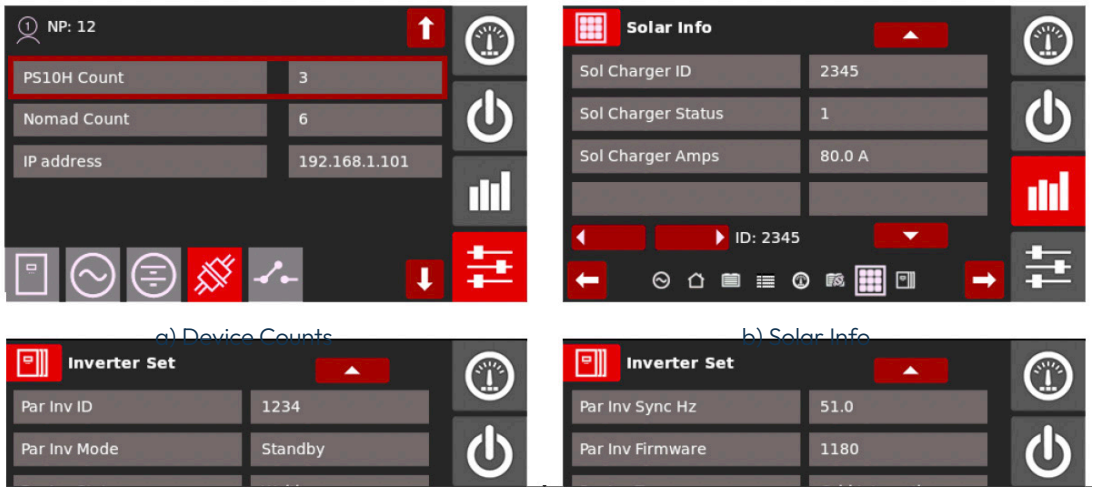
This can be checked using a combination of the information shown on the HMI's System Info screen (Figure 17a) and the information shown on the Inverter Set screen(Figure 17c) and the Solar Info screen (Figure 17b).

5.2.1 CONFIRM THE DEVICE COUNTS ON THE CAN BUS

The System Info screen includes two lines that show how many Apex Powerstar 10Hs and Nomads the particular machine detects on the CAN bus. To navigate to the System Info screen:

- Click on the **settings** icon > then the **advanced setup** icon > enter the default password 1918 and then select **advanced selection** > click on the **system info** checkbox.

Once on the System Info screen select the **communication** filter button and then scroll down until you see PS10H Count and Nomad Count as shown in Figure 17a. These two counts must match the number of Powerstar 10H and Nomads connected up to the CAN bus. Confirm that the PS10H Count datapoint shown on the **System Info** screen of EVERY inverter matches the number of Powerstar 10H inverters installed together.



a) Device Counts b) Solar Info

Figure 17. Solar Info and Inverter Set screens.

5.2.2 CONFIRM THE SERIAL NUMBERS AND SYNC MESSAGES ON ALL INVERTERS

Once the device counts have been confirmed, one must also confirm that the Powerstar 10H inverters are reading both the CAN messages and the Sync signals from the other devices correctly. This can be done using the Inverter Set screen. To navigate to this screen:

- Click on the **charts/data** icon in the HMI's navigation bar; and then click on the **Inverter Set** icon shown on the bottom of the screen (see Figure 17c).

Once on the Inverter Set screen, use the up and down arrows to scroll through the data for a particular machine. Use the left and right arrows to browse to data from a particular machine. The selected machine's serial number is shown just to the right of these arrows.

To confirm that the Powerstar 10H CAN messages are being sent and received correctly, use the left and right arrows on the Inverter Set screen to check that the master machine has correctly read all the serial numbers of the slave machines. The **Par Dev ID** shows the serial number of a device (i.e. inverter). EVERY inverter should be accounted for! Then confirm that each of the slaves has correctly read the serial number of the master and all the other slaves.
The Inverter Set screen can also be used to confirm that the Powerstar 10H Sync signals are being sent and received correctly. Scroll down until you find the row showing the Par Inv Sync Hz datapoint, which is the Synchronisation Frequency set by the master (see Figure 17 d). With the machines in Standby mode, the Synchronisation Frequency should be 1 Hz more than the nominal mains frequency, so typically 51 Hz.

5.2.3 CONFIRM THE CAN COMMUNICATION FROM THE APEX NOMADS

If there are Apex Solar Chargers (e.g. Nomads) installed on the site, they should also be put onto the same CAN bus so that some of their data can be displayed on the inverter's HMI and logged to Apex servers. To check that the inverters are reading the CAN messages sent all by the Nomads correctly use the HMI's Solar Info screen (see Figure 17 c). To navigate to this screen:

- Click on the **charts/data** icon in the HMI's navigation bar; and then click on the **Solar Info** icon shown on the bottom of the screen.

Once on the Solar Info screen, use the left and right arrows to browse to data from a particular Nomad. The selected Nomad's serial number is shown just to the right of these arrows and also as the Sol Charger ID. Confirm that all Nomads are accounted for.

5.3 TESTING THE INTERNET CONNECTION

If the inverters are connected up to the internet the inverters will connect to Apex Inverter's servers which enables remote monitoring via the Apex Portal. Any support will be dramatically hampered if the machines are not connected up to the internet. The internet connection should be checked as part of the installation.
Once the machine has been connected to the Local Area Network and is powered up one can check whether it has been assigned an IP address. The IP address of the machine can be found under the HMI's System Info screen. To navigate to the System Info screen:

- Click on the **settings** icon > then the **advanced setup** icon > enter the default password 1918 and then select **advanced selection** > click on the **system info** checkbox.

Once on the System Info screen, select the communication filter button, and then scroll down until you see IP address (see Figure 18). The IP address shown should be similar to that of the customer's router. If the IP address is 0.0.0.0 then the inverter has not been able to connect to the network.

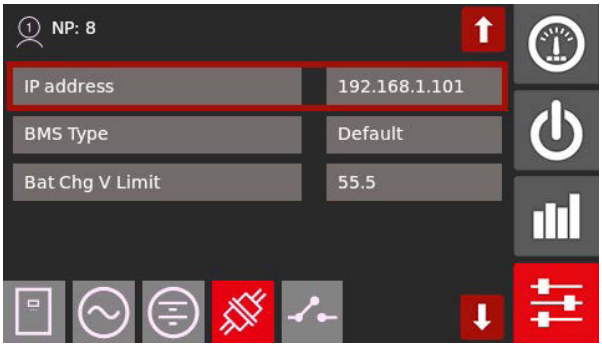


Figure 18. The IP address of the machine is shown on the HMI's System Info screen.

Once you have confirmed that the inverter has been able to connect to the local network check that is connecting to Apex servers. Log onto Apex Portal, search for the inverter using its serial number. If the machine is connected to Apex servers it will be shown as “online”. Click on the relevant row, then on “Open Device”, and then on the dashboard icon. A screen similar to that shown in Figure 19 should come up. The inverter mode shown on Apex Portal status bar should match the mode shown on the HMI’s dashboard screen.

Figure 19. An example of Apex Portal version of the Dashboard Screen.

5.4 TESTING THAT THE EXTERNAL CURRENT TRANSFORMER IS WIRED IN CORRECTLY

If installed, the external Current Transformer (CT) must be wired in with the correct polarity! If the source port of the Powerstar 10H is powered (i.e. it measures an in-spec AC voltage) and the **Ext CT** used setting is set to Yes, an additional icon will appear on the Powerstar 10H’s HMI’s dashboard screen. This icon will show the power and/or current measured by the external CT.

Normally you will use the dashboard screen to see the direction of the external CT power. However, if you need to test the polarity is correct before setting **Ext CT** used to Yes then you can use the real-time data screen which is found in the advanced setup menu system. To navigate to the real-time data screen:

- Tap on the **settings** button > tap on the **advanced setup** button > select the **advanced selection** checkbox > select the **real-time data** checkbox.

Once you are in the real-time data screen, tap on the **AC filter** button (second from the left on the bottom of the screen), and then scroll down until you reach **Ext CT** Power.

When the Grid/Generator is supplying power to the property the Powerstar 10H must measure this as **positive** power.

To test this:

- Ensure that the Grid/Generator is supplying power to the loads.
- The Powerstar 10H and all PV inverters should be left in a Standby mode where they do not generate any power,
- The Powerstar 10H might also need to be bypassed so that any essential loads are powered.
- Turn on a fairly large resistive load (for example a kettle).
- You should see an appropriate increase in the external CT power as shown on the dashboard panel of the Powerstar 10H’s HMI.
- If the external CT power is negative then you need to turn off the load, reverse the polarity on the connector (Swap the wires coming in to the connector with each other), plug the CT back in and repeat the above test.

External Solar CT

If the Ext Solar CT enable setting is set to YES the solar icon will show AC coupled solar production. Since this can only be a positive value it will always be read as positive irrespective of the CT polarity.

Once all the communication and signalling wiring has been tested, you can move onto configuring the machine(s).

6. CONFIGURING THE MACHINE

On first power up, the Powerstar 10H will have default factory settings. However, as the Powerstar 10H can be installed and used in a variety of configurations it is necessary to configure the machine (or machines) to match the requirement of the particular installation. Configuration can be done either on the local HMI or via the network using a computer (discussed later in this section). As an overview the following questions need to be considered:

- Does the installation include more than one Powerstar 10H?
- Does the inverter need to link the PE and Neutral wires when running off-grid?
- How will the inverter(s) interact with the AC supply?
    - Does the grid-tied capacity of the inverter need to be de-rated to comply with local by-laws and to fit the particular installation?
    - Will an external Current Transformer be used increase self-consumption without back-feed to the grid/generator?
- What type of battery bank is installed?
    - Will the battery bank be used to increase self-consumption of any installed solar power?
- Should any alarms be activated to notify the user of certain conditions (e.g. low battery)?
- Will the auxiliary relays be used to shed loads or start a generator?
- This section of the manual ends with some configuration examples and what to do leading up to planned load-shedding/ rolling black-outs.

6.1 SETTING UP THE "INVERTER/CHARGER SET"

After all communication on the CAN bus has been checked, one can continue with setting up the machines. The Powerstar 10H can be setup as either a single-phase system or as part of a three-phase system. At a particular site, there must always be one (and only one) inverter that is setup as the "system master". This inverter should also be assigned to Phase 1 (or similarly Phase A or the Red Phase). All other inverters should be setup as "slaves". All the machines must be assigned to the phase that matches how they are physically wired into the AC network, i.e.:

- Machines on the Red Phase must be assigned to Phase 1.
- Machines on the Yellow Phase must be assigned to Phase 2.
- Machines on the Blue Phase must be assigned to Phase 3.

The installer also needs to decide if the "system master" inverter must link the Neutral and PE wire when running off-grid (for RCD to function) and whether the master should use frequency shifting to throttle the production of any AC coupled solar. These two settings need only be set on the master, these functions should be disabled on the slaves.

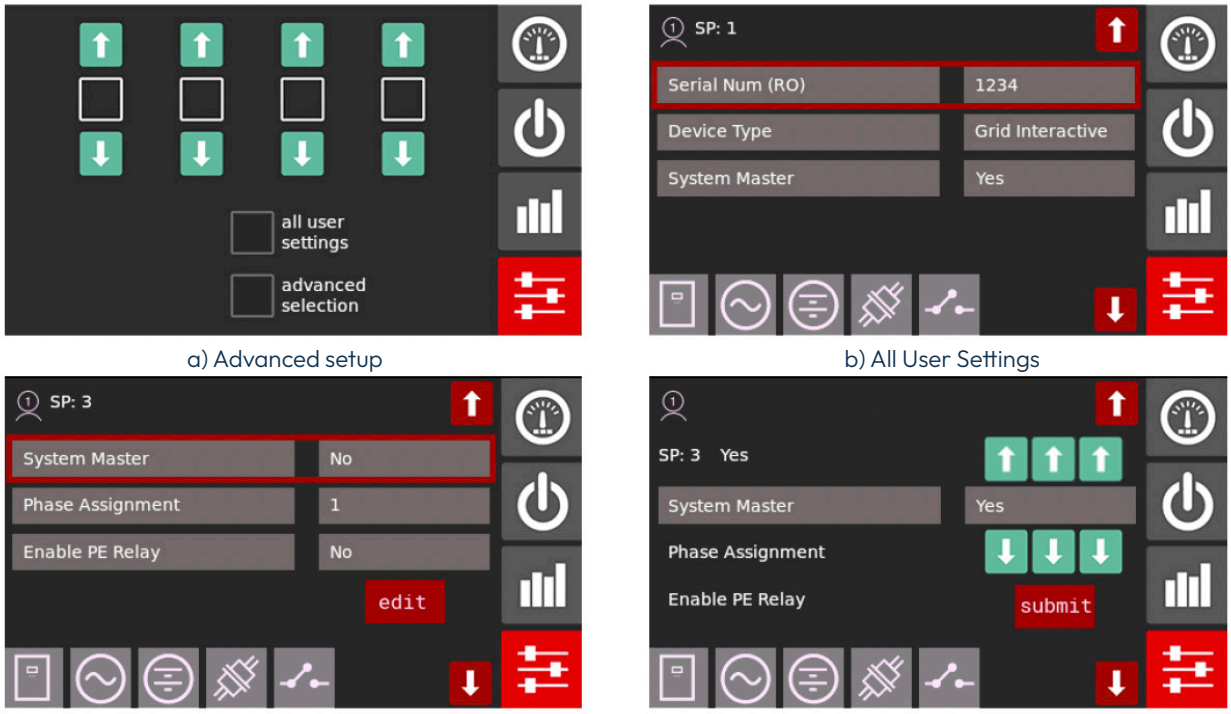
The relevant settings are shown in Table 5. All these settings can be accessed via the advanced setup screen on the HMI. To access these settings:

- Click on the **Settings** icon > click on **advanced setup** > enter the passcode 1918 > select the **all user settings** checkbox.

Once you have found a setting that needs to be updated: click the edit button; use the up and down arrows to adjust the relevant setting; and then click the submit button. Finally, confirm that the setting has updated (the current value of the highlighted setting is shown just to the right of the setting's setpoint number). Some examples of relevant HMI screens are shown in Figure 20.

Table 5. Setting relevant to the setting up of the "Inverter Set" and the PE relay.

Variable	Unit	Description
Serial Num (RO)		**Device Serial Number** A read-only copy of the device's serial number.
Device Type		**Device Type** The device type, i.e. grid-interactive or standby-UPS.
Inverter Role		**Inverter Role** This setting specifies whether the device is the "System Master",or a "Slave". The "System Master" must be on Phase 1. All other machines must be specified as "Slave".
Phase Assignment		**Inverter Role** This setting specifies which phase (1, 2, or 3) the device has been connected to. The 'System Master' must be assigned to Phase 1 (i.e. the red phase).
Enable PE Relay		**Enable Protective Earth (PE) Relay** Use this setting to enable/disable the use of the built-in PE to Neutral link relay. If the Neutral must be bridged to the PE when running in Stand-Alone mode then set to 'Yes' .
Disable Freq Shift		**Disable Frequency Shifting** Solar Inverters should throttle back their production as the grid frequency climbs. The PS10H master inverter will use this to throttle AC coupled solar if the system is running in "Stand Alone" mode. If there are no AC coupled inverters on the output of the inverters then one can disable frequency shifting.



a) Advanced setup

b) All User Settings

c) Edit

d) Submit

*Figure 20. Screenshots showing how to access and edit user settings. From the advanced setup screen, enter the default passcode (1918), select **all user settings**, scroll to the relevant setting, click **edit** and then **submit** the new value.*

6.2 SETTING UP THE INVERTER-AC SUPPLY INTERACTION

The Powerstar 10H can be setup as an Energy Management and Storage System where it dynamically adjusts how much power it draws from or exports to the AC supply. Some of the settings that relate to this will be set while setting up the battery control, i.e. partial charging, inhibited charging thresholds, peak-load shaving thresholds, and load-lopping settings. However, there are a few settings that specifically relate to source power import and export control which are found under the advanced setup menu. To access these settings:

- Click on the Settings icon > click on **advanced setup** > enter the passcode 1918 > select the **all user settings** checkbox.

The relevant settings with their descriptions and setpoint numbers are in Table 6.

Table 6. Settings relevant to the inverter's interaction with the AC supply.

Variable	Unit	Description
Source Size	kVA	**Source Size** The limit on the amount of power (kVA) that can be drawn from (or supplied to) the source (e.g. the mains supply) as measured by the inverter's internal current sensor or the external current transformer. This value when converted to Amps should be equal to or smaller than the rating of the Circuit Breaker (CB) installed on the source side of the inverter (or if an External CT is used then less than or equal to the rating of the CB installed upstream of the CT).
Inv Max Imp Amps	%	**Inverter Maximum Import Limit** The maximum current, as a percentage of the nominal rating of the inverter, that the inverter can generate while running connected to the mains/generator.
Inv Max Imp Amps	%	**Inverter Maximum Export Limit** The maximum current, as a percentage of the nominal rating of the inverter, that the inverter can generate while running connected to the mains/generator.
Ext CT used		**External Current Transformer (CT) Used** Use this setting to specify whether the inverter will use the external or internal source current measurement to control peak-load shaving, inhibited charging, and logic related to the 'Source Size'.
Ext CT Nom Amps	A	**External Current Transformer (CT) Nominal Amps** If an external CT is used, then this setting must match the rating of the CT so that the inverter can calculate the measured current correctly.

6.3 SETTING UP THE BATTERY CONFIGURATION FOR THE FIRST TIME

When setting up the battery configuration one needs to consider:

- What type of battery bank is installed?
- Will the battery bank be used to increase self-consumption of any installed solar power?

The Powerstar 10H can be used with a Lead-Acid or Li-Ion Battery Bank.

- The voltage and capacity of the battery bank must be suitable given the specifications of the inverter (see section 1.3).
- When using a Li-Ion Battery Bank the battery bank must be fitted with a Battery Management System that communicates with the inverter(s) over a CANbus.

On first setup the installer or user must:

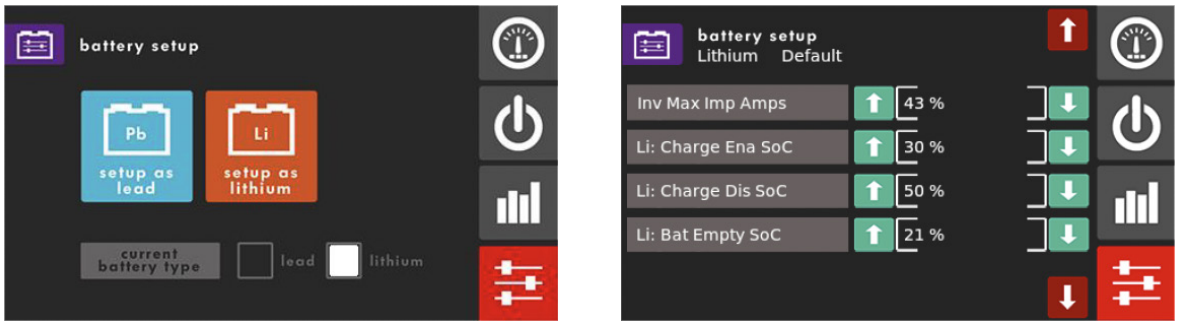
- Set the battery type.
- Test that any communication between the inverter and the BMS is operating correctly.
- Adjust the battery charge settings to match the battery bank's specifications.
- Adjust settings relating how to use the stored battery power for energy management.

6.3.1 SETTING THE BATTERY TYPE

To set the battery type, use the Battery Setup menu. To access this menu:

- Click on the **Settings** icon > click on **Battery Setup** > enter the passcode 1918.

Click on **Setup as Lead** or **Setup as Lithium** as appropriate (see Figure 21).



a) Battery Type Select

b) Battery Setup

Figure 21. Examples of the battery setup screens.

If the battery type has already been set as Lithium and valid BMS messages are detected on the CAN bus. The battery type selector screen will be skipped.

6.3.2 ADJUSTING THE INVERTER'S BATTERY CHARGE/DISCHARGE SETTINGS

Continuing from the previous section, you will now be in the Battery Setup menu. This menu provides an abbreviated list of settings that relate to how the inverter controls the charging and discharging of the battery.

For both Lead-Acid and Lithium-Ion batteries you will need to set the battery capacity, the bulk charge rate, and the charge voltage thresholds, etc. For Lithium-Ion batteries, the BMS controls how the inverter charges the battery bank. However, one should still setup applicable charge limits that the inverter will fallback to if there is a break in communication between the inverters and the BMS. If communication with the BMS is interrupted, the master inverter will take over the role as the charge coordinator for the PS10H inverters. The relevant settings are described in Table 7, Table 8, and Table 9.

If the inverter detects a known battery type (ie. Apex) it will automatically load default fallback values for the battery manufacturer, though it is up to the installer to verify these settings.

For installations with Lithium-Ion batteries, the BMS will communicate the battery bank's State of Charge (SoC) to the inverters. The inverter can be setup to facilitate self-consumption based on the battery bank's SoC. The relevant settings are described in Table 10.

For both types of batteries, the user can choose how to use the stored battery energy for energy management. The user can choose to enable partial charging, inhibited charging, peak-load shaving, and time-based load-lopping. The relevant settings are described in Table 11.

Table 7. Settings found in the battery setup menu relevant to the size of the battery bank. These should be setup on the master inverter regardless of the battery type. If there is a BMS and comms to it is interrupted, the master inverter will take over the role as the charge coordinator for the PS10H inverters.

Variable	Unit	Description
Batt Capacity (C5)	Ah	**Battery Capacity** The installed battery banks nominal capacity in amp hours (Ah)
Batt Bulk Chg Amps	%C	**Battery Bulk Charge Amps** The recommended amount of the combined renewable and inverter(s) charging current into the batteries as a percentage of the C5 capacity rating of the battery bank. This setpoint is included for the case where there are multiple solar chargers and inverters on a single battery-bank and the inverters can monitor the combined charging current. This setpoint should not be confused with Max Inverter Import, which represents a percentage of the rated capacity per phase that the specific inverter will commit to charging.
Inv Bulk Chg Amps	%C	**Inverter Bulk Charge Amps** This read-only variable is the bulk charge amps the specific inverter can contribute to the bulk charge expressed as a percentage of the C5 charge rate of the battery bank. It is calculated as a convenience to the user and is the minimum of the 'Batt Bulk Chg Amps' and the 'Inv Max Imp'.
End of Chg Amp Limit	%C	**End of Charge Amp Limit** Assuming the maximum charge time has not been reached yet, if the charge current drops below this threshold, the inverter(s) will end the absorption charge and move onto the float stage.
Total Chg Period	min	**Total Charge Period** The maximum time the system will remain in the bulk and/or absorption stage before moving onto the float stage. This setpoints can be used to prematurely end the Bulk/Absorption Stage and should only be set low if there is a DC coupled solar charger(s) that will carry out the full charge on the batteries. NOTE: If set to 0, the setpoint is ignored, and the absorption charge will only end once the charge current drops below "End of Charge Amp Limit".
Absorp (CV) Chg Ena		**Absorption Charge Enable** If set to Yes the inverter(s) will follow the bulk charge stage (i.e. the constant current stage) with an absorption charge stage (i.e. an constant voltage stage). If set to No, the inverter(s) will skip the absorption stage and go straight from the bulk charge into the float stage.
Absorp Chg Period	min	**Absorption Charge Period** The maximum time the system will remain in the absorption stage of the normal charge region. This setpoints prevents prolonged charging of the batteries, which may not reach the End of Charge (EoC) amps due to high leakage on the batteries. The absorption charge region will terminate if this setpoint is reached or when the charge current has dropped below the EoC current limit.
Chg Start Time (HH)		**Charge Start Time** The preferred charge start time. If there is no BMS, once the battery voltage drops below the charge enable voltage, a charge will be scheduled to start at the specified hour. Once a Bulk/Equalisation charge has been started, any peak-load shaving will only start if the battery voltage is 0.2V higher than the current battery charge stage's target voltage. NOTE: If there is no BMS, and a bulk charge is started every time the inverters connect to the grid unless partial charging is enabled.NOTE: If there is no BMS, and a bulk charge is started every time the inverters connect to the grid unless partial charging is enabled.

Table 8. Lead-Acid Charge Voltage settings found in the battery setup menu.

Variable	Unit	Description
Pb:Absorp Chg	VpC	**Absorption Charge Voltage Target** The charge voltage target (per cell) for the absorption charge stage (i.e. the constant voltage stage). The battery charge cycle starts with a bulk (constant current) stage. During this stage the battery voltage will rise. When the battery voltage reaches the 'Absorption Charge Voltage Target', the inverters move onto the absorption (constant voltage) charge stage, where the inverters hold the battery voltage at the charge voltage target. Once the charge current has dropped below the "End of Charge Amp Limit", the inverter will move onto the float stage after a short transition stage. Consult the battery manufacturer for the bulk charge voltage.
Pb:Equ Chg	VpC	**Equalisation Charge Voltage Target** The charge voltage target (per cell) for the absorption stage of an equalization charge. Consult the battery manufacturer for 52qualized52on voltage and 52qualized52on frequency. (Note: Gel or sealed batteries should not be 52qualized.)
Pb:Float Chg	VpC	**End of Charge Amp Limit** Assuming the maximum charge time has not been reached yet, if the charge current drops below this threshold, the inverter(s) will end the absorption charge and move onto the float stage.
Total Chg Period	VpC	**Float Charge Voltage Target** The charge voltage target (per cell) for the float stage.
Pb:Low Shutdown VpC	VpC	**Low Shutdown VpC** If the battery voltage (per cell) drops below this level for 5 minutes while the inverter is running in Stand-Alone mode, the system will shutdown and go into Low Battery Mode. If the inverter is grid-connected and the battery voltage drops below this level, the inverter will ignore any charge inhibit and peak-load shaving settings and only limit its charging based on the 'Source Size' and 'Max Inverter Import' settings. This setting is also used for the Auxiliary Relay and Alarm logic. If the battery voltage is below this threshold, the battery voltage is considered "Critically Low".
Pb:Charge Ena VpC	VpC	**Charge Enable VpC** If the battery voltage (per cell) drops below this setting, a 'bulk' charge will automatically be initiated at the time set by the bulk charge time. Once a Bulk/Equalization charge has started, peak-load shaving will only occur if the battery voltage is more than the bulk/equalization charge volt target. The charge inhibit limits will still be enforced, so as to allow the solar chargers or solar inverters to do most of the charging. This setting is also used for the Auxiliary Relay and Alarm logic. If the battery voltage is below this threshold, the battery voltage is considered "Low".
Pb:Charge Ena VpC	VpC	**Load Reconnect VpC** The battery voltage (per cell) at which the inverter can automatically restart after it has entered Low Battery Mode (assuming there is some external charger, e.g. a solar charger, also connected to the battery). If grid-connected, once the battery voltage (per cell) drops below this threshold, the inverter will ignore any charge inhibit and peak-load shaving settings and only limit its charging based on the 'Source Size' and 'Max Inverter Import Amps' settings. This setting is also used for the Auxiliary Relay logic. The battery voltage is considered "Ok" if it is greater than this voltage. If the relay has been turned on because of a low (or critically low) battery voltage, it will not be turned off until the battery voltage is above the "Reconnect Load Voltage". (It is similar to the Charge Disable SoC).

Table 9. Lithium-Ion Charge Voltage settings found in the battery setup. These values will be used if there is no BMS or if there is a long break in comms between the BMS and the inverters.

Variable	Unit	Description
Reset Li Defaults		**Reset Lithium-Ion Defaults** If set to Yes and a known BMS is identified, the lithium charge voltage limits will be set to the pre-saved defaults for the particular BMS. This setting will automatically reset back to No once the default settings have been adopted.
Li: Default Charge V	V	**Default Charge Voltage Target** The charge voltage target for the absorption charge stage (i.e. the constant voltage stage). The battery charge cycle starts with a bulk (constant current) stage. During this stage the battery voltage will rise. When the battery voltage reaches the 'Default Charge Voltage', the inverters move onto the absorption (constant voltage) charge stage, where the inverters hold the battery voltage at the charge voltage target. Once the charge current has dropped below the "End of Charge Amp Limit", the inverter will move onto the float stage after a short transition stage. Consult the battery manufacturer for the default charge voltage.
Li: Float V	V	**Float Charge Voltage Target** The charge voltage target for the float stage.
Li: Crit Low V	V	**Critically Low Battery Voltage** If the battery bank voltage drops below this level for 5 minutes while the inverter is running in Stand-Alone mode, the system will shutdown and go into Low Battery Mode. If the inverter is grid-connected and the battery voltage drops below this level, the inverter will ignore any charge inhibit and peak-load shaving settings and only limit its charging based on the 'Source Size' and 'Max Inverter Import' settings. This setting is also used for the Auxiliary Relay and Alarm logic. If the battery voltage is below this threshold, the battery voltage is considered "Critically Low".
Li: Charge Ena V	V	**Charge Enable Volts** If the battery bank voltage drops below this setting, a 'bulk' charge will automatically be initiated at the time set by the bulk charge time. Once a Bulk/Equalization charge has started, peak-load shaving will only occur if the battery voltage is more than the bulk/equalization charge volt target. The charge inhibit limits will still be enforced, so as to allow the solar chargers or solar inverters to do most of the charging. This setting is also used for the Auxiliary Relay and Alarm logic. If the battery voltage is below this threshold, the battery voltage is considered "Low".
Li: Recon Load V	V	**Load Reconnect Volts** The battery bank voltage at which the inverter can automatically restart after it has entered Low Battery Mode (assuming there is some external charger, e.g. a solar charger, also connected to the battery). If grid-connected, once the battery voltage drops below this threshold, the inverter will ignore any charge inhibit and peak-load shaving settings and only limit its charging based on the 'Source Size' and 'Max Inverter Import Amps' settings. This setting is also used for the Auxiliary Relay logic. The battery voltage is considered "Ok" if it is greater than this voltage. If the relay has been turned on because of a low (or critically low) battery voltage, it will not be turned off until the battery voltage is above the "Reconnect Load Voltage". (It is similar to the Charge Disable SoC).

Table 10. Battery settings found under the Battery Setup Menu relevant to installations with Li-Ion batteries with a Battery Management System (BMS).

Variable	Unit	Description
Li: Charge Ena SoC	%	**Charge Enable SoC** If the battery SoC is below this threshold, any charge inhibit and peak load shaving limits will be ignored and the inverter will attempt to charge within the limits specified by the 'Inverter Maximum Import' and 'Source Size' settings and the limits set by the BMS. This setting is also used for the Auxiliary Relay and Alarm logic. The battery SoC is considered "Low" if it is less than this SoC.
Li: Charge Dis SoC	%	**Charge Disable SoC** If partial charging is enabled, the inverter will not charge the battery above this threshold (and it is assumed that external chargers, e.g. solar chargers, will complete the charge). If 'Charge Inhibit' is enabled, the inverter will charge the battery at the 'Charge Inhibit Limit' up to this SoC. This setting is also used for the Auxiliary Relay logic. The battery SoC is considered "Ok" if it is greater than this SoC. If the relay has been turned on because of a low (or critically low) battery SoC, it will be turned off when the battery SoC is above this threshold.
Li: Bat Empty SoC	%	**Battery Empty SoC** If the inverter is in stand-alone mode and the Battery SoC stays below this threshold for more than 5 minutes, the inverter will enter "Low Battery Mode" where it will not produce an output voltage. The inverter will start up automatically if mains (or a generator) is detected on the inverter's AC Source Port or if the battery SoC has risen above the 'Charge Enable SoC' due to charging from an external (e.g. solar) charger. This setting is also used in the Auxiliary Relay and Alarm logic. If the battery SoC is below this threshold, the battery state is considered "Critically Low".
Li: Bat Saver Enable		**Battery Saver Enable** Lithium batteries need to regularly be full for a few hours to allow the BMS to balance the cells. The battery saver strives to get the battery full at least every 5 days. There are 3 options: **Off** – Battery saver disabled. **Grid only** – if the battery has not been full for five days then the inverter will charge the battery completely from grid and hold it full for two hours. **Solar Priority** (Default) – The inverter will try to use solar power instead of grid to charge the batteries by raising "BAT discharge enable" set point at a percentage every day, to gradually use less battery and allow the solar to gradually charge the batteries. If the batteries have not been full for five days the inverter will grid charge the batteries.
Li: Bat Full SoC		**Battery Full SoC** Not all manufacturers have 100% as their battery full capacity, hence the battery saver could stop charging before the battery is full, or keep on trying to charge when the BMS has reached its maximum charge at a lower SoC. This setting sets the maximum SoC for the battery bank in order to align the battery saver with the batteries being used.
BMS CAN Baud Rate	kbps	**CAN BMS Baud Rate** The Baud Rate that the Battery Management System (BMS) uses on the CAN Bus. (This value will be rounded to 250 or 500 Kbps).

Table 11. Battery settings found under the Battery Setup Menu relevant to both Lead-Acid and Li-Ion battery installations.

Variable	Unit	Description
Partial Chg Ena		**Partial Charge Enable** If partial charging is enabled, then the inverter will stop charging once the battery SoC is above the 'Chg Disable SoC'.
Chg Inhibit Enable		**Charge Inhibit Enable** If charge inhibit is enabled then the inverter will limit (inhibit) its charging so that power drawn from the source power (as measured at the inverter's source port or at the external CT) does not exceed the specified 'Chg Inhibit Limit' unless the battery SoC drops below the 'Charge Enable SoC'.
Chg Inhibit Limit	kW	**Charge Inhibit Limit** See Above
Peak Load Shave Ena		**Peak Load Shave Enable** If peak load shaving is enabled then the inverter will start to export battery power to keep the source power (as measured at the inverter's source port or by the external CT) below the specified threshold.
Peak Load Shave Lim	kW	**Peak Load Shave Limit** See Above
Load Lop Start Time	h00	**Load-Lopping Start Time** To allow for time-based self-consumption, a load-lopping limit can be set for a specified time each day. During this time, if the battery level is not low, the charge inhibit limit will drop to 0 kW and the Peak Load Shave Limit will be the smaller of the Peak Load Shave Limit and the Load Lop Limit.
Load Lop Duration	hrs	**Load-Lopping Duration** See Above
Load Lop Limit	kW	**Load-Lopping Limit** See Above

TIP

If large changes need to be made to any of the settings, then it might be more convenient to use the "Advanced Setup" menu system. To access battery settings via the "Advanced Setup": click on the "Settings" icon in the HMI's navigation bar > click on the "Advanced Setup" icon > enter the 1918 password and then select the "All User Settings" checkbox > click on the battery/DC icon as shown on the bottom of the screen to jump to the battery settings. Use the up and down arrows to scroll through the setting. If a setting can be adjusted an edit button will appear. Once you select a setting to edit, you will then be taken to a new view where you can adjust the value using a set of up and down arrows. Once you are happy with the new value click on the submit button and verify that the setting is updated, as shown to the right of the settings setpoint number.

6.4 SETTING UP ALARMS AND THE AUXILIARY RELAYS

The Powerstar 10H can be setup to play an alarm and/or engage one of its auxiliary relays under user-selected conditions. These conditions are described in Table 12. The alarm sound and the interval at which it is repeated is shown in Table 13.

Table 12. The list of conditions that can be used to trigger alarms and/or the auxiliary relays.

Condition	Description
Loss of Mains (alarm only)	This alarm will trigger if the machine is running in Stand-Alone mode, i.e. due to the loss of (or unavailability of) the mains AC supply.
Battery Critical (alarm and/or relay	The alarm and/or relay will trigger when: • The battery State of Charge (SoC) is below the 'Battery Empty SoC'*. or • The battery Volts per Cell (VpC) is below the 'Low Shutdown VpC'†.
Battery Low (alarm and/or relay)	The alarm and/or relay will trigger when: • The battery SoC is below the 'Charge Enable SoC'*. or • The battery VpC is below the 'Charge Enable VpC'†.
High load (alarm and/or relay)	The alarm and/or relay will trigger when the load on the inverter's output port is above either of the 'High Load' thresholds setup for the auxiliary relay control. Once triggered, the alarm will continue to play until the relay disengages. **Note**, the alarm will trigger immediately. However, the relay will only engage after the 'High Load Delay' and will stay on for at least the 'Minimum On-Time'.
Overload (alarm and/or relay)	The alarm and/or relay will trigger when the inverter is generating more than 10 kVA. **Note**, the alarm will trigger immediately. However, the relay will only engage after a delay dependent on how heavily overloaded the inverter is. Once engaged, the relay will stay on for at least the 'Minimum On-Time'.
Warnings (alarm only)	The alarm will trigger on a list of conditions each of which indicate that the user or installer might need to take some corrective action (for example, the machine's internal temperature is high). A corresponding flag will be shown on the machine's touch screen display.
Warnings (alarm only)	The alarm will trigger on a list of conditions each of which indicate that the user or installer might need to take some corrective action (for example, the machine's internal temperature is high). A corresponding flag will be shown on the machine's touch screen display.
Grid-Tied (relay only)	The relay will engage once the inverter is running grid-tied and will disengage otherwise. (This function can be used to allow big loads to run only when the mains is available and the inverter is running connected to it.)

** Lithium (Li) Ion Batteries; † Lead (Pb) Acid Batteries*

Table 13. The sounds and the repeating interval used for each of the alarms.

Condition	Sound	Repeating Interval
Loss of Mains	One Long Beep	15 minutes
Battery Critical	Two short beeps	15 minutes
Battery Low	Two short beeps	15 minutes
High load	Two short beeps	15 minutes
Overload	Two short beeps	15 minutes
Warnings	Two short beeps	15 minutes

6.4.1 SETTING UP THE ALARMS

On the master inverter's touch screen display, click on the settings icon (bottom right) and then click on the alarms button. Then select which alarms you would like to enable.

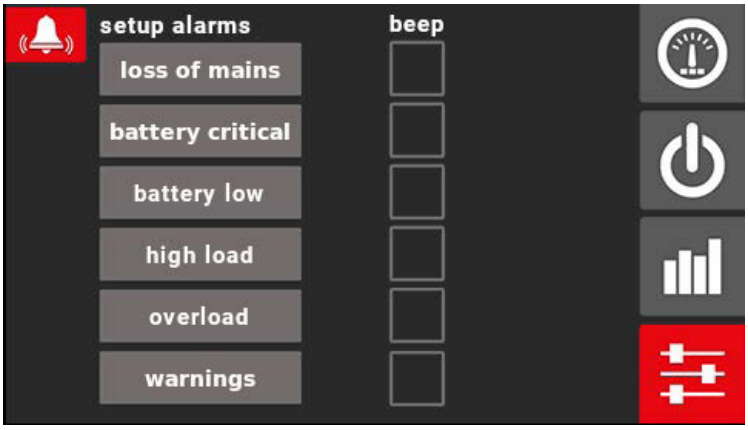


Figure 22. The alarm setup menu.

6.4.2 MUTING AN ALARM

Once an alarm is activated, it can be temporarily muted using the **play/pause** button which is also found on the alarm setup Screen. The mute state will automatically be cleared once the event/condition that triggered the alarm clears leaving the alarm to play again if a new event triggers the alarm.

6.4.3 SETTING UP THE AUXILIARY RELAYS

The events and conditions that can be used to activate the auxiliary relays are described in Table 12. You can use the relay set-up screen (shown in Figure 23) to select which conditions will activate the relay(s). To navigate to this screen:

- Click on the settings icon, click on relay setup, enter the default password (i.e. 1918).

There is also the option to specify that the relay is used to start/stop a generator. Selecting this option will activate some additional logic that is relevant to starting a generator but not relevant to shedding of loads.

After selecting what conditions activate the relays, one also needs to setup some other parameters that govern how the relays are used. For example, the minimum on-time of the relay, the high load threshold, etc. These settings are shown in Table 14. To access these settings:

- Click on the **settings** icon (bottom right) > click on **advanced setup** > enter the 1918 passcode > select the **advanced selection** > select **I/O (relay) settings.**

Browse through the available settings and submit changes as needed.

a) Relay Function Setup

b) Relay Behaviour Setup

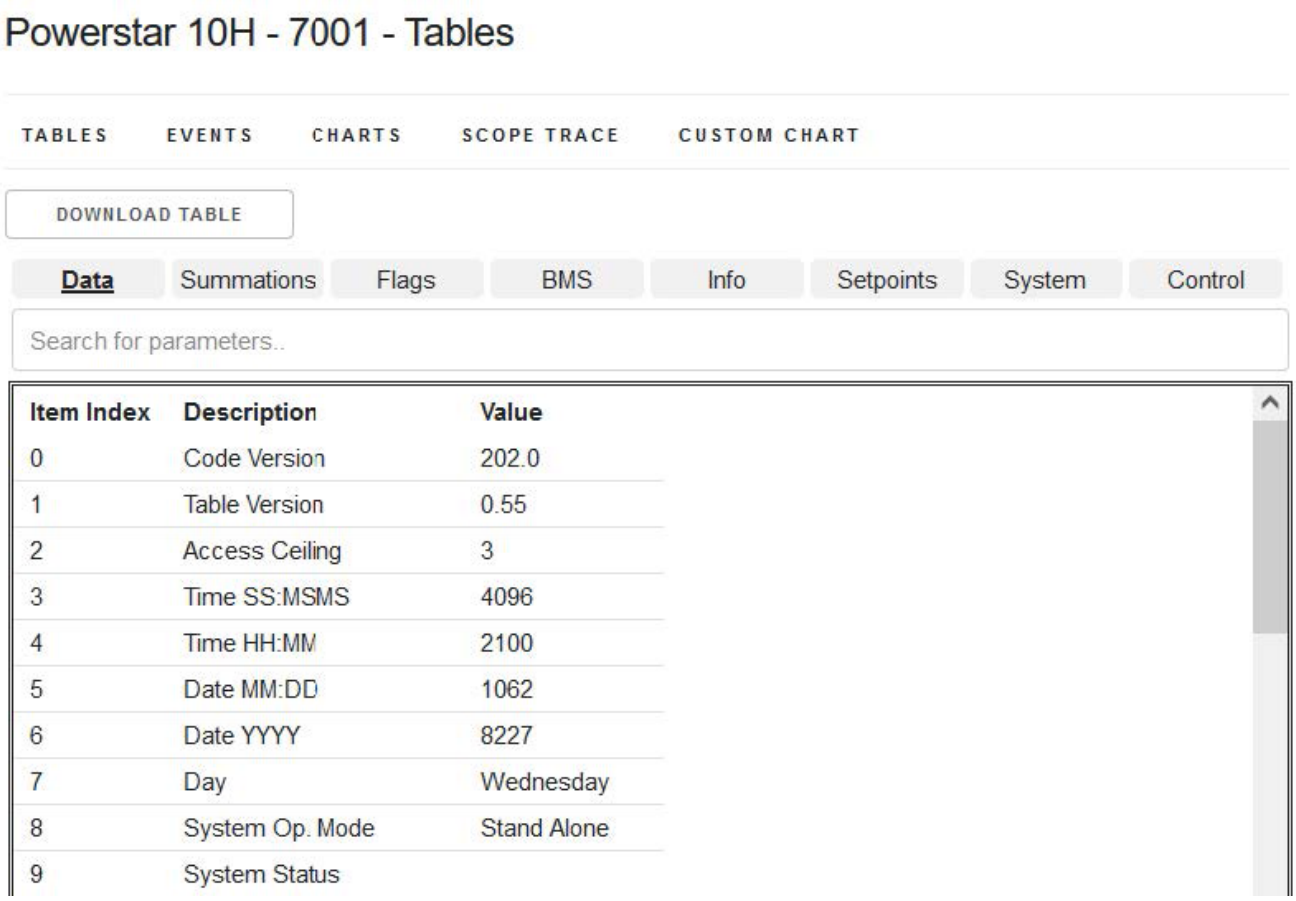
Figure 23. The auxiliary relay setup screens.

Table 14. Auxiliary relay settings

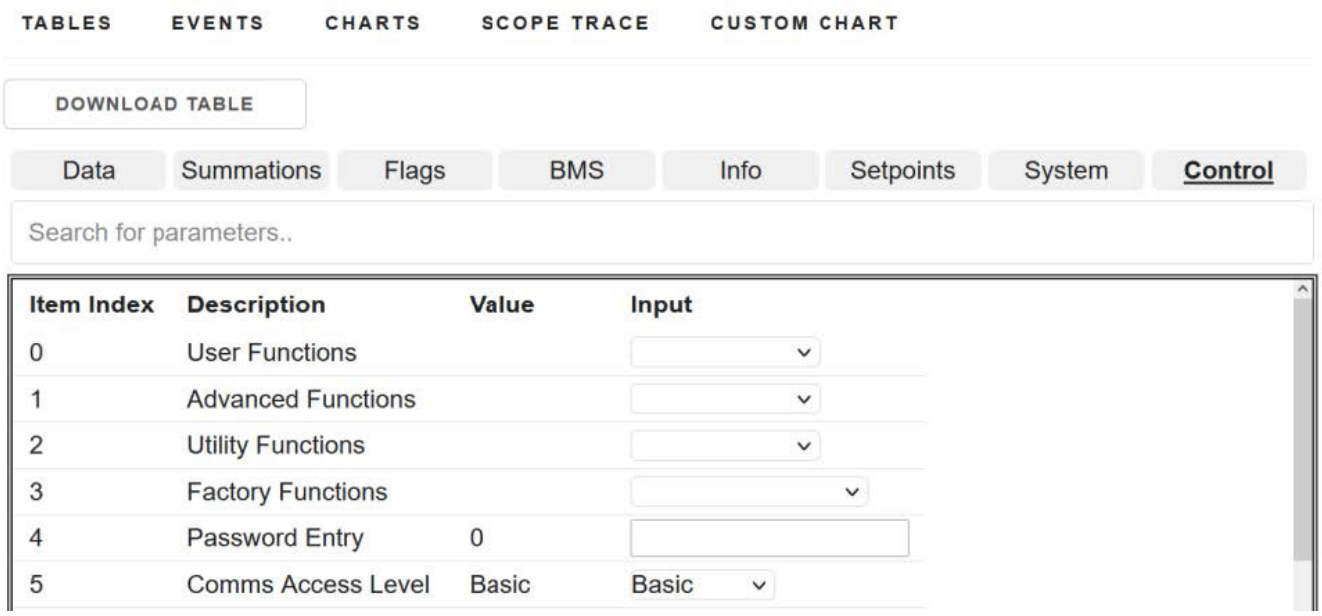
Variable	Unit	Description
Relay1 Control		**Relay 1 Control Selector Bitfield** This setting is used to specify under conditions the auxiliary relay will engage.
Relay1 Min On-Time	min	**Relay 1 Minimum On-Time** The minimum time the relay will stay engaged once it has been turned on.
Relay1 Hi Phs Load	kVa	**Relay 1 Control: High Load per Phase** The high load threshold per phase used when the relay is set to engage on high load.
Relay1 Hi Total Load	kVa	**Relay 1 Control: High Total Load** The high load threshold, summed across all three phases, used when the relay is set to engage on high load.
Relay1 Hi Load Delay	s	**Relay 1 Control: High Load Delay** The delay, in minutes, before engaging the relay on high load.
Relay1 Ok Load Delay	min	**Relay 1 Control: Ok Load Delay** The delay, in minutes, before disengaging the relay once the load is no longer above the high load threshold.
Relay1 Min Load	kVa	**Relay 1 Control: Minimum Load** If the relay is used to start/stop a generator, then this setting specifies the preferred minimum loading allowed on the generator. If the total load provided by the generator is less than this threshold for 2.5 minutes and the battery is not low (e.g. the battery SoC is above the charge enable SoC) the relay will be disengaged.
Relay1 Function		**Relay 1 Function** This setting specifies the relay function, e.g. generator start/stop or load-shedding.

6.5 CONFIGURING THROUGH A NETWORK INTERFACE

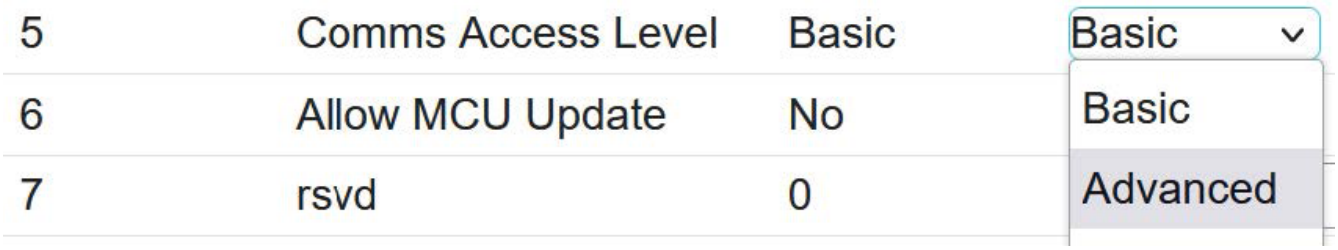
Once the inverter is connected to the local network it is possible to connect to it's interface on port 81. Either by using the ip address:81, i.e. 192.168.1.2:81 Or by using it's hostname:81, i.e. PS10-8000:81
That will open an interface similar to the following:



To change settings go to Tables > Control



Enter the default password of 1111 (Enter), then choose Advanced from the comms access level.



You can now go to Setpoints and view all setpoints as a list, making it easy to change all the settings to the correct values for the installation.

6.6 ENERGY MANAGEMENT CONFIGURATION EXAMPLES

This section of the manual provides some configuration examples and what to do leading up to planned load-shedding/rolling black-outs. Four scenarios are considered:

- How to setup your machine as a back-up system.
- How to setup your system to maximise renewable production and self-consumption with DC coupled solar charge.
- How to setup your system to maximize renewable production and self-consumption with AC coupled solar inverters.
- What to do prior to planned load-shedding/rolling black-outs.

NOTE: In all cases the battery charge limits should be first setup to match those relevant to the particular battery bank. Furthermore, the **Source Size, Inverter Max Import Amps** and **Inverter Max Export Amps** should be set in accordance with the circuit breakers supplying your loads and/or inverter.

6.6.1 BACK-UP POWER SYSTEM

If your PS10H is being used as a back-up inverter, then you will want to keep the batteries fully charged at all times. Therefore, **Partial Charge Enable, Charge Inhibit Enable**, and **Peak Load Shave Enable** should all be set to **No**. The **Load Lop Duration** should be set to 0 hrs.
In this state the inverter will charge the batteries from grid, will not consume any excess solar and will not assist the grid at any time, the system is essentially a UPS.

6.6.2 ENERGY MANAGEMENT WITH DC COUPLED SOLAR

With a DC coupled system the solar chargers will generate energy and push it onto the DC bus that links the solar charges, the battery, and the battery inverters. The battery inverters can then use this energy to generate AC power so as to reduce the power you draw from mains. Any excess solar power will be stored in the batteries for the inverter to use later. If you want to maximise self-consumption and you have sufficient DC coupled solar then you should enable inhibited charging and peak-load shaving. Enabling inhibited charging limits charging from the mains while your battery level is ok. With peak-load shaving enabled the PS10H will use the stored DC energy to assist in powering your loads, while the battery level is ok, and thus reduce how much power you draw from the mains. The PS10H will drain the battery throughout the day and night while the DC coupled solar will charge up the batteries during the day. To optimise self-consumption the batteries must be allowed to cycle deeply every day. Thus, the Charge Enable SoC will be set low as will the Charge Inhibit Limit and the Peak Load Limit.
If there are regular power outages (i.e. 2h “load shedding” per day from the power provider) one would set the Charge Enable

SoC to a % that will allow at least the expected outage time (i.e. 2h) of nominal load without draining the batteries to critical state.
It is also important to allow batteries to fill up every day, so there needs to be enough renewable energy to expect to recharge the batteries from this point in an average day.

Table 15. Example setup to enhance self-consumption on a DC coupled system.

Variable	Value	Notes
Li: Charge Ena SoC	30%	**Charge Enable SoC** To promote self-consumption the batteries must be allowed to cycle deeply every day. Set this value to the daily discharge limit recommended by your battery supplier.
Li: Charge Dis SoC	90%	**Charge Disable SoC** This setting will not be applicable but leave it high as this will mean you have less settings to change before and after a bout of load-shedding.
Li: Bat Empty SoC	20%	**Battery Empty SoC** Set this to discharge limit recommended by the battery supplier. Do not set this value too low as you will run the risk of tripping the battery. The inverter will go into Low Battery Mode if the inverter is in Stand-Alone mode and the battery SoC stays below this limit for 5 minutes.
Partial Chg Ena	Yes	**Partial Charge Enable** Set to YES so that charging from the mains is stopped altogether once the battery SoC is above the Charge Disable SoC. (This setting is superfluous if the charge inhibit limit is set to 0 kW).
Chg Inhibit Enable	Yes	**Charge Inhibit Enable** Set to YES so that charging from mains is limited once the battery SoC is above the charge enable limit.
Peak Load Shave Ena	Yes	**Peak Load Shave Enable** Set to YES so that the battery inverter can generate power to reduce your consumption from mains.
Peak Load Shave Lim	0kW	**Peak Load Shave Limit** Set this value low so that you only draw limited power from the mains while the battery level is ok, i.e. its SoC is above the Charge Enable SoC.
Load Lop Start Time		**Load-Lopping Start Time** Not applicable for a DC coupled system setup as above.
Load Lop Duration		**Load-Lopping Duration** Not applicable. See above.
Load Lop Start Time		**Load-Lopping Limit** Not applicable. See above.

6.6.3 ENERGY MANAGEMENT WITH AC COUPLED SOLAR

With an AC coupled system the solar inverters will generate energy and push it onto the AC bus that links the solar inverters and the battery inverters. This power will go directly to the load and if there is excess power the battery inverter can absorb this power and store it in the batteries. When the load consumption is larger than the solar generation, the battery inverter can use the stored energy to limit the power needed from mains. If you want to maximise self-consumption and you have sufficient solar power then you should enable inhibited charging, peak-load shaving, and setup time-based load-lopping. Enabling inhibited charging limits charging from the mains while your battery level is ok. With peak-load shaving enabled the PS10H

will use the energy stored in the battery to assist in powering your loads, while the battery level is ok, and thus reduce how much power you draw from the mains. Setting up time-based load-lopping outside of sunlight hours allows you to set aggressive load-lopping limits (that would otherwise interfere with solar production) for the early morning and evening load peaks. To optimise self-consumption the batteries must be allowed to cycle deeply every day. Thus, the Charge Enable SoC will be set low as will the Charge Inhibit Limit and the Peak Load Limit.

Table 16. Example setup to enhance self-consumption on an AC coupled system.

Variable	Value	Notes
Li: Charge Ena SoC	30%	**Charge Enable SoC** To promote self-consumption the batteries must be allowed to cycle deeply every day. Set this value to the daily discharge limit recommended by your battery supplier.
Li: Charge Dis SoC	100%	**Charge Disable SoC** Set this all the way up to 100% as the PS10H will use AC power (generated by the solar inverter) to charge up the battery.
Li: Bat Empty SoC	20%	**Battery Empty SoC** Set this to discharge limit recommended by the battery supplier. Do not set this value too low as you will run the risk of tripping the battery. The inverter will go into Low Battery Mode if the inverter is in Stand-Alone mode and the battery SoC stays below this limit for 5 minutes.
Partial Chg Ena	No	**Partial Charge Enable** Set to NO as the PS10H needs to charge up the battery until it is full.
Chg Inhibit Enable	Yes	**Charge Inhibit Enable** Set to YES so that charging from mains is limited once the battery SoC is above the charge enable limit.
Chg Inhibit Limit	0 kW to 0.2 kW	**Charge Inhibit Limit** If you have permission to export power to your utility set this to 0 kW. If you do not have permission to export you will need to install the solar inverters' export power manager (sometimes referred to as a grid-feedback limiting device) and set the charge inhibit limit on the PS10H slightly higher than the import limit set on the solar inverter's export power manager.
Peak Load Shave Ena	Yes	**Peak Load Shave Enable** Set to YES so that the battery inverter can generate power to reduce your consumption from mains if your load consumption is not met by the solar production.
Peak Load Shave Lim	≥ 0.3 kW	**Peak Load Shave Limit** Set this value higher than the charge inhibit limit and also high enough so as not to block the solar inverters from producing. As a rule of thumb set this equal to the daytime base load.
Load Lop Start Time	18h00	**Load-Lopping Start Time** Typically time-based load-lopping should start just before or soon after sunset, i.e. once the solar production for the day has tapered off.
Load Lop Duration	12 hrs	**Load-Lopping Duration** Set this so that load lopping stops a bit before or after sunrise, i.e. before solar production picks up for the day.
Load Lop Limit	0kW	**Load-Lopping Limit** Typically this will be set to 0 kW or at least lower than the Peak Load Limit.

6.6.4 PLANNED LOAD-SHEDDING/ROLLING BLACK-OUTS

If you know in advance that your suburb will experience planned load-shedding or rolling black-outs you might want to charge up your batteries and keep them charged so that you have sufficient stored energy to ride-out the load shedding.
Option A
If the load-shedding will happen in the evening then and there are still sufficient daylight hours for the solar chargers/inverters to charge up your battery then simply **disable peak load shaving**. If there is not sufficient time for your solar power to charge up the batteries then **disable inhibited charging** as well.
Option B
Alternatively, you could **increase the charge enable SoC** to a level high enough that you have sufficient power to ride through load shedding. When doing so remember to keep the charge disable SoC higher than the charge enable SoC.
For both Option A and Option B, once the bout of load-shedding is over remember to put the setting back to what they were if you want to optimize for self-consumption.
Option C
Alternatively, **use the battery control menu to force a charge** (which will also disable any peak load shaving or load lopping) and set the minimum charge time such that the charge will be scheduled to end only after load-shedding has started. Choosing this option has the advantage that you do not have to change back any settings once load shedding has stopped. However, you need to remember to force the charge a few hours before load shedding is scheduled to start.

Option A is suitable if load-shedding is likely to happen for a few days but will be limited to the evenings or early mornings.

Option B is a good choice if load shedding is likely to happen for a few days but will happen at a different time each day.

Option C is a good choice if the power-outage is a once-off event, i.e. scheduled maintenance rather than scheduled load-shedding.

---

7. STARTING THE MACHINE

Before starting up the inverter for the first time, ensure that you have tested the communication between the machines and configured the machine (or machines) appropriately as described earlier in this manual.

7.1 GENERAL INSTRUCTIONS

One will normally startup/stop the inverter using its touch screen display (referred to here as the Human Machine Interface or HMI for short). The inverter's HMI is described earlier in section 4 of this manual. The HMI is on the front of the inverter as shown in Figure 3. Every screen on the HMI includes the navigation bar on the right side. From top to bottom, the navigation bar is used to navigate between the dashboard panel, the control panel, the charts and events panel, and the settings panel (Figure 11).
Assuming that the machine is ready to startup, i.e. it is in Standby mode, navigate to the control screen by clicking on the controls symbol (second icon from the top right). Once on the control panel, click on the start/stop icon (see Figure 11b). The inverter will go into Startup mode, and then shortly afterwards Stand-Alone mode. (Note the inverter's operational mode is given in the status bar which is shown at the bottom of the dashboard and control screens).
If there are multiple inverters in parallel / 3 phase configuration, only the master can be used to start the system, it can be stopped from any machine.

Once the inverter is running in Stand-Alone mode it will be powering the loads on its load port but will not be connected to the mains supply on the source port. If the mains supply is available and within spec, the inverter will synchronise to it and after 60 seconds connect to it and go into Grid Tied mode.
The instructions just given assume that the inverter is in Standby mode and ready to start. If this is not the case, then:

- Check that the On/Off switch on the underside of the inverter is in the On position (see Figure 7).
- Reset any faults by navigating to the control panel and clicking the reset icon.

If for some reason the inverter does not start, then contact your installer or continue reading this manual.

7.2 THREE PHASE SPECIFIC INSTRUCTIONS

NOTE: For a three-phase system, one machine must be setup as the "master" machine, and it should be assigned to phase 1. The other machines should be assigned to phase 2 and 3 to match the phase rotation of the grid installation. The installer should setup this up before they start up the machines for the first time.
With all relevant settings set, starting up a three-phase system is similar to that of starting up a single machine. Firstly, the on/off switch on all the inverters must be in the on position. Then with all machines in Standby mode, the machines can be started up using the instructions from the previous section. The start instruction can only be given on the master machine. The Master machine will then check the communication and synchronization between the machines after which the machines will start-up together in Stand-Alone Mode. Similarly, the stop command can be given on any one of the machines.

---

8. MANUAL CONTROLS

The user might find that they sometimes want to manually start a charge or activate one of the auxiliary relays. This can be done via the control screen as described in the following sections.

8.1 FORCING A BATTERY CHARGE

If the Battery Type has been set to Li, any charge type started will start a bulk charge.
If the Battery Type has been set to Lead-Acid, the user can manually force a charge to start before one of the conditions that would automatically trigger a charge have been met. This can be done via the battery control menu. To access this menu:

- Click on the **control** icon > click on **battery control** > enter the 1918 passcode > browse through the available controls and submit commands as needed.

An example of the screen that allows the user to force a charge is shown Figure 24. The control points relevant to manual battery control are described in Table 17.

TIP | Before forcing a charge, update the *Maximum Forced Charge Time* to a value reasonable to your particular need.

a) Manual Charge Start

b) Manual Relay Control

Figure 24. The battery control and relay control screens.

Table 17. Battery Control Functions

Variable	Unit	Notes
Battery Functions		**Battery Manual Functions** Use this setting to manually start a bulk charge, equalization charge, etc.
Max Forced Chg Time	min	**Maximum Forced Charge Time** The maximum time the inverter will stay in the Bulk and/or Absorption Stage after a forced (manual) start before transitioning to the float stage.
Battery Comms Ctrl		**Battery Communication Control** Normally if a BMS is detected the inverters will use the charge limits the BMS specifies. If Battery Comms Ctrl is set to "Master", the Master will take over the role of the BMS and the inverter will use the charge limits that the Master inverter specifies.

8.2 FORCING AN AUXILIARY RELAY TO TURN ON

In some instances, the user might want to force a relay to engage (for example, they want the generator to start even though the logic used to automatically start the generator have not been met yet). This is possible using the Relay Control Menu:

- Click on the control icon > click on **relay control** > enter the 1918 passcode > browse through the available controls and submit commands as needed.

TIP | Before forcing a relay on, update the *Minimum On-Time* to a value reasonable to your particular need.

Table 18. Relay Control Functions

Variable	Unit	Description
Force Relay 1 On		**Force Relay 1 On** Use this to force auxiliary relay 1 to turn on either now or after the specified delay.
Relay 1 Min On-Time	min	**Relay 1 Minimum On-Time** The minimum time, in minutes, the relay will stay engaged for once it has been forced on. The relay will automatically disengage once the minimum on-time has passed and all the selected "turn-off" conditions are met. For example, once the battery SoC is above the 'Charge Disable SoC' threshold.
Relay 1 Forced Delay	min	**Relay 1 Forced On Delay** The delay that will be used before forcing the relay on.

Table 19. Battery Control Functions

Variable	Unit	Description
Battery Functions		**Battery Manual Functions** Use this setting to manually start a bulk charge, equalization charge, etc.
Max Forced Chg Time	min	**Relay 1 Minimum On-Time** The maximum time the inverter will stay in the Bulk and/or Absorption Stage after a forced (manual) start before transitioning to the float stage.
Battery Comms Ctrl		**Battery Communication Control** Normally if a BMS is detected the inverters will use the charge limits the BMS specifies. If Battery Comms Ctrl is set to "Master", the Master will take over the role of the BMS and the inverter will use the charge limits that the Master inverter specifies.

8.3 FORCING AN AUXILIARY RELAY TO TURN ON

In some instances, the user might want to force a relay to engage (for example, they want the generator to start even though the logic used to automatically start the generator have not been met yet). This is possible using the Relay Control Menu:

- Click on the control icon > click on **relay control** > enter the 1918 passcode > browse through the available controls and submit commands as needed.

TIP | Before forcing a relay on, update the *Minimum On-Time* to a value reasonable to your particular need.

Table 20. Relay Control Functions

Variable	Unit	Description
Force Relay 1 On		**Force Relay 1 On** Use this to force auxiliary relay 1 to turn on either now or after the specified delay.
Relay 1 Min On-Time	min	**Relay 1 Minimum On-Time** The minimum time, in minutes, the relay will stay engaged for once it has been forced on. The relay will automatically disengage once the minimum on-time has passed and all the selected "turn-off" conditions are met. For example, once the battery SoC is above the 'Charge Disable SoC' threshold.has passed and all the selected "turn-off" conditions are met. For example, once the battery SoC is above the 'Charge Disable SoC' threshold.
Relay 1 Forced Delay	min	**Relay 1 Forced On Delay** The delay that will be used before forcing the relay on.

9. EXAMPLE SETTINGS FOR VARIOUS SCENARIOS

These are some typical scenarios and the basic settings to use.
Please note that only the critical settings for each scenario is provided, the balance of settings need to be checked for the site / client use profile.

9.1 BACKUP ONLY, NO SOLAR

In this case the batteries remain full, the inverter is essentially a UPS.

1. Disable Freq Shift Yes
2. Partial Chg Ena No
3. Chg Inhibit Enable No
4. Peak Load Shave Ena No
5. Load Lop Duration 0

9.2 SYSTEM WITH SMALL AMOUNT OF DC COUPLED SOLAR

A small amount of DC coupled solar, or loads too big for solar to cope.
Here we set solar priority in the day, but allow more mains usage at night.

1. Disable Freq Shift Yes
2. Li:Charge Ena SoC 40% (As low as you're happy to take the battery, allowing for something like load shedding at night after the sun has set).
3. Li: Bat Saver Enable - Solar Priority
4. Partial Chg Ena - No
5. Chg Inhibit Enable - Yes
6. Chg Inhibit Limit - 1 kW (Ensure the battery gets charged at night)
7. Peak Load Shave Ena Yes
8. Peak Load Shave Lim 1 kW (Assuming 1 kW covers base load at night)
9. Load Lop Start Time 09:00 (Assuming the sun is shining by 09:00)
10. Load Lop Duration 8 (Assuming 8 hours of usable sunshine per day)
11. Load Lop Limit - 0 (This will use only battery in this time, no power from source)

9.3 SYSTEM WITH REASONABLE DC COUPLED SOLAR

Enough solar to run the system, but needs some extra charge (in brackets possible settings when there is sufficient solar to charge the batteries every day):

1. Disable Freq Shift - Yes
2. Li:Charge Ena SoC - 40% (As low as you're happy to take the battery, allowing for something like load shedding at night after the sun has set).
3. Li:Charge Dis SoC - 90% (Leaving the last 10% for the solar chargers to finish)
4. Li: Bat Saver Enable - Solar Priority
5. Partial Chg Ena - Yes (can be No if there is enough
6. Chg Inhibit Enable -Yes (can be No with enough solar)
7. Chg Inhibit Limit - 0,5 kW (Ensure the battery gets some charge from grid)
8. Peak Load Shave Ena - Yes
9. Peak Load Shave Lim 0,5 kW (Allow a constant load of 0.5 kW , with enough solar this can be set to 0 kW)
10. Load Lop Duration - 0

9.4 SYSTEM WITH A SMALL AMOUNT OF AC COUPLED SOLAR

A small amount of AC coupled solar will seldom have excess generation to the load, so we need to always allow power from the grid to charge the battery.

1. Disable Freq Shift - No
2. Li:Charge Ena SoC - 40% (As low as you're happy to take the battery, allowing for something like load shedding at night after the sun has set).
3. Li: Bat Saver Enable - Solar Priority
4. Partial Chg Ena - No (N ot on AC coupled solar , as the inverter will not charge the battery full)
5. Chg Inhibit Enable - Yes
6. Chg Inhibit Limit - 1kW (Ensure the battery gets charged at night)
7. Peak Load Shave Ena - Yes
8. Peak Load Shave Lim - 1kW (Assuming 1kW covers base load at night and allows for some charging)
9. Load Lop Start Time 09:00 (Assuming the sun is shining by 09:00)
10. Load Lop Duration 8 (Assuming 8 hours of usable sunshine per day)
11. Load Lop Limit 0 (This will use only battery in this time, no power from source)

If the batteries are not getting charged fully then this durati on might need to be reduced to allow more grid use, if the solar generation never exceeds the base load then Peak Load Shaving and Load Lopping can be disabled, making the inverter essentially just a backup system with all solar going to self consumption.

9.5 SYSTEM WITH A REASONABLE OR LARGE AMOUNT OF AC COUPLED SOLAR

With a fair amount of solar there should be excess generation to just the load demand. This excess generation will be used to charge the batteries, though we might need to allow some grid charging as well.

9.5.1 Disable Freq Shift - No

9.5.2 Li:Charge Ena SoC - 40% (As low as you're happy to take the battery, allowing for something like load shedding at night after the sun has set).

9.5.3 Li: Bat Saver Enable - Solar Priority
9.5.4 Partial Chg Ena - No (N ot on AC coup led solar)
9.5.5 Chg Inhibit Enable - Yes
9.5.6 Chg Inhibit Limit - 0 5kW (Ensure the battery gets some grid charge. If solar generation is enough for loads and recharging the batteries most days it can be set to 0.2)
9.5.7 Peak Load Shave Ena - Yes
9.5.8 Peak Load Shave Lim - 0 5kW (Allow a constant load of 0.5kW , it can be reduced to 0.2kW if there is enough solar).
9.5.9 Load Lop Duration - 0

9.6 NOTES ON AC COUPLED SOLAR:

With a fair amount of solar there should be excess generation to just the load demand. This excess generation will be used to charge the batteries, though we might need to allow some grid charging as well.

9.6.1 We have found that quite a few AC coupled solar systems (Solar Edge, Enphase...) become unstable if the grid drops to 0kW, kicking out, lights flashing, in worst cases making the PS10 unstable and connect disconnect frequently.
9.6.2 Enabling a small amount of grid power (0,2 0,5Kw) to flow constantly helps to keep the inverter in production and remain stable.
9.6.3 It is also recommended to have charge inhibit enabled, with about a 0.2kW limit, to account for loads being 0 , then a small amount of charging will maintain the demand.
9.6.4 It is often necessary to try variations and various limits to find the best balance for a specific site, but it is important to remember this note if an ac coupled solar system appears unstable.

9.7 THREE PHASE / PARALLEL SETUP

3 phase and parallel systems can be one or multiple machines per phase, the only difference in settings is that for parallel configuration the machines are on the same phase, for multi phase configurations the machines are on different phases. (6 machines in 3 phase / parallel is currently the maximum allowable by Apex).

Inverter 1

1. System Master - YES
2. Phase Assignment - 1
3. Enable PE Relay Check with the installation electrician, if needed the master should be set to yes.
4. Li:Charge Ena SoC Set to desired SoC.
5. 5. Li:Charge Dis SoC If using partial charge set to desired SoC.

Inverter 2

1. System Master - NO
2. Phase Assignment 2 or 3 (1 if parallel with master)
3. Enable PE Relay - NO
4. Li:Charge Ena SoC Set to a lower SoC than the master, ie. 20%. That way the Master setting will override and only one machine needs to be set to make a change.
5. Li:Charge Dis SoC 100%, let master be the lowest.

Inverter 3

1. System Master - NO
2. Phase Assignment 3 or 2 (1, or the phase it's parallel on if configuring parallel).
3. Enable PE Relay - NO
4. Li:Charge Ena SoC Set to a lower SoC than the master, ie. 20%. That way the Master setting will override and only one machine needs to be set to make a change.
5. Li:Charge Dis SoC 100%, let master be the lowest.

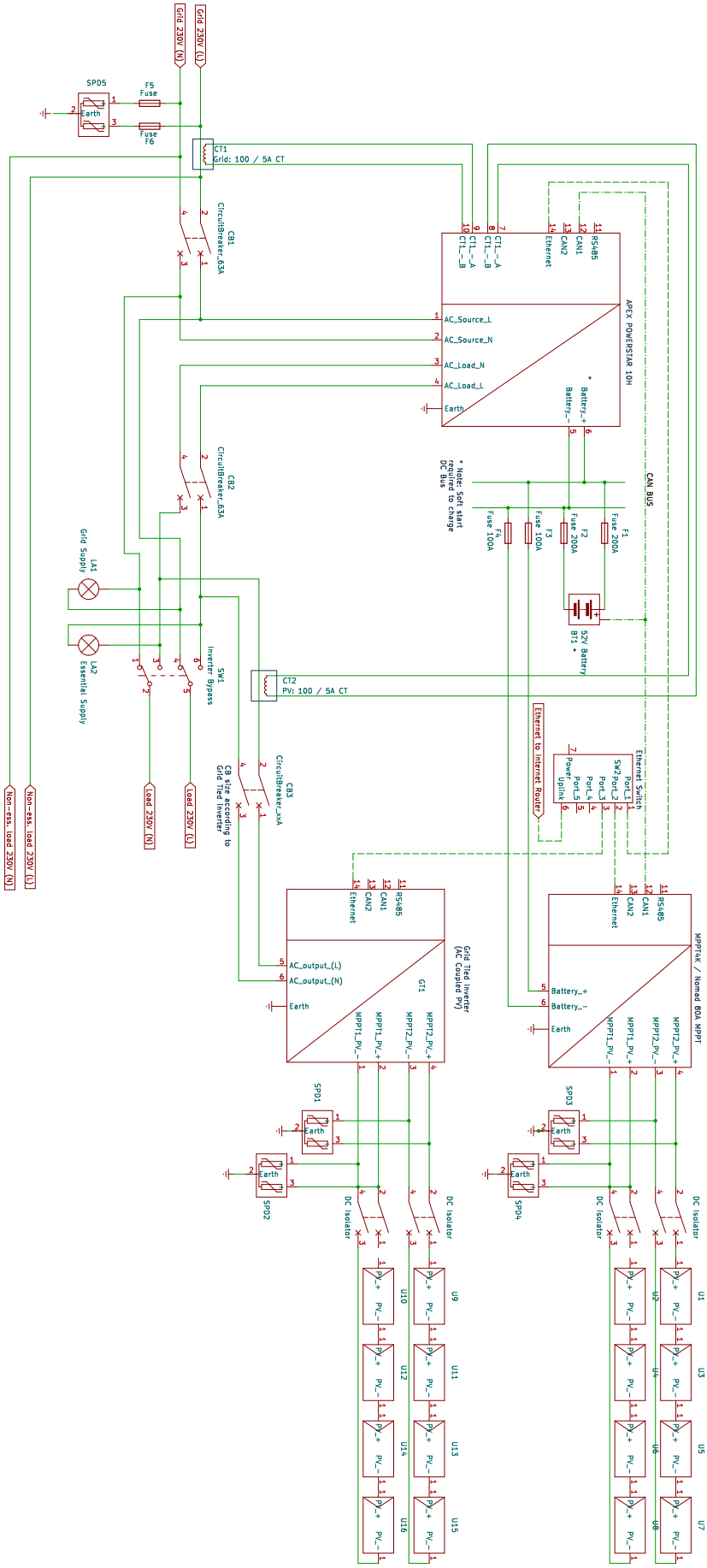
GLOSSARY

AC	Alternating current. The utility, generators, and inverters can supply AC. The AC voltage to homes in South Africa is described as 230V AC 50Hz meaning 230V RMS that is alternating between a positive voltage and a negative voltage 50 times a second.
DC	Direct current. Batteries, solar panels (PV) and some wind turbines provide DC. The Powerstar 10H can take DC from batteries and output 230V AC to supply homes and businesses.
RCD	Risidual Current Device, or earth leakage unit, used to detect current flowing into earth and trip to protect the installation.
Generator	This is a machine that usually runs off diesel or petrol to provide AC power. Generators are usually only run when needed. Generators need to be run periodically to keep their moving parts functional. Generators usually provide most power per litre when they are electrically loaded to 80% of their rating.
Grid/Utility	This is an AC power source that is usually will be present most of the time. The utility is often provided by some power producing company and is not always reliable due to lack of capacity.
PV	Photo voltaic cell. Also known as solar panels. PV cells generate DC electricity when sunlight strikes them.
SRC or SOURCE	A source (abbreviated as SRC) is the general definition for an AC supply such as the Grid or a Generator.
Wind Turbine	This is a modern form of windmill. Wind turbines generate electricity when their blades are rotated by the wind. Wind turbines usually generate DC.
PLS	Peak Load Shaving is a limit on the amount of power drawn from source, the inverter will generate power from the batteries to keep the source power to this limit, if EXT CT is enabled then it will be the point of measurement, otherwise the inverter's own current measurement.
Load Lopping	Load lopping is a time based limit that is lower than PLS. It also limits the source power, but from a starting time for a duration. For instance if one wants to use less grid during the night when there's no sunshine, but more grid in daylight hours when there should be solar production then PLS might be set to 2kW and Load Lopping from 17:00 for 14hrs at 0.2kW.

REVISION NOTES

Variable	Unit	Description
06.03.00	2021-08-31	Update list of settings as per Variable Table version 0.49.
06.03.01	2022-02-22	Update manual, change from APEX to Apex inverters, update for ACDY-04 DSP card.

APPENDIX A: EXAMPLE SCHEMATIC



APEX POWERSTAR 10H EXAMPLE INSTALLATION

APPENDIX A: SINGLE LINE WIRING DIAGRAM

It is recommended to record the parameters of the system at the time of installation, this could be useful if service or support might be needed in future.
It also serves as a convenient check list to confirm that important settings have been made.

Site / Client:			
Client contact number:			
Installer:			
Installer Contact number:			
Installed location:			
Inverter serial number:			
Battery manufacturer and model:			
Installer Contact number:			
Installed battery capacity:			
Setpoint#	Setpoint Name	Value Set	Comments
3	System Master		
4	Phase Assignment		
5	Enable PE Relay		
6	Source Size		
7	Inv Max Imp Amps		
8	Inv Max Exp Amps		
9	Ext CT used		
10	Ext CT Nom Amps		
12	Disable Freq Shift		
36	Ext Solar CT enable		
167	Ext Sol CT Nom A		
91	Bat Type		
93	Bat Capacity (C5)		
148	Li:Default Charge V		
149	Li:Float V		
150	Li:Crit. Low V		
151	Li:Charge Ena V		
152	Li:Recon Load V		
153	Li:Charge Ena SoC		
154	Li:Charge Dis SoC		
155	Li:Bat Empty SoC		
158	Li: Bat Saver Enable		

Setpoint#	Setpoint Name	Value Set	Comments
159	Partial Chg Ena		
160	Chg Inhibit Enable		
161	Chg Inhibit Limit		
162	PLS Ena		
163	Inv Max Imp Amps		
164	Load Lop Start Time		
165	Load Lop Duration		
166	Load Lop Limit		

CONTACT US

For more or updated information, new products and technical support please visit:

www.ApexSolar.Tech