APEX

MPPT-4K

User Manual

APEX Inverter's MPPT-4K is designed for high power charging of lithium or lead batteries. Dual MPPT trackers take care of 2 PV arrays independently, optimising your installation and ensuring the maximum yield. Black start functionality ensures that you are never stuck without the ability to restart an over-discharged battery. The colour user interface is attractive, intuitive and user-friendly and provides all the information you need to monitor, manage and control your system.

Key Features:

- Blackstart functionality.
- Dual independent trackers.
- High voltage – no precombining required.
- Wide battery compatibility.
- Ground Fault detection.
- Colour touch screen user interface.
- CAN bus for battery integration.

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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: Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results.

GENERAL WARNINGS

DANGER OF ELECTRIC SHOCK. There are no user serviceable parts inside the charge controller.
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.

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, 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 operate it in a small space - always keep it well ventilated and well 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 lead-acid batteries and can become a hazard in poorly ventilated spaces.
CAUTION: For indoor use only and MUST be installed in a dry area free from conductive liquids or conductive debris. If part of the charge controller becomes submerged in water, look for a safe way to isolate it at the PV combiner and the batteries.

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 bottom of the machine inside the cover.

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 SYSTEM RATINGS

	MPPT-4K 80 Charge Controller
Number of Input Ports	2 (Individual MPPT Control)
Input Vmp Voltage Range	8 kW
Maximum Input Voltage	35 A / 45 A/ 80 A
Nominal Photovoltaic Power	63 A
Maximum Photovoltaic Power	63 A
Output Voltage range	+1 to -1
Max Battery Output Current	< 5 %
Protection	Ground-Fault Detector Interrupter (GFDI), Overvoltage (Photovoltaic and Battery), Reverse Polarity (Photovoltaic and Battery)

1.3.2 BATTERY INPUT

Nominal Battery Voltage	48 Vdc

1.3.3 EFFICIENCY

Efficiency	Up to 95 % @ 80Adc (typical)
No Load Power Consumption	Less than 5 W

1.3.4 GENERAL SPECIFICATIONS

Mounting Method	Wall Mounted (Bracket and fasteners included)
Dimensions (W x H x D)	210 x 380 x 147 mm (Shipping: 275 x 440 x 215)
IP/NEMA Rating	IP20 / NEMA1
Colour	RAL9002 / RAL9011
Weight	6 kg / Shipping: 6.2 kg
Architecture	Forced Air Cooling
Compliance	IEC62109-1

1.3.5 CLIMATIC CONDITIONS

Ambient Temperature	-10 to 60 °C (derated above 40°C)
Ambient Transport Temperature	-25 ... 70 °C
Maximum Ambient for Rated Power	40 °C
Relative Humidity (Non-Condensing)	5 ... 85 %
Maximum Altitude for Rated Power	1000 m above sea level (Power derated for High Altitude)

1.3.6 OPERATOR PANEL

Display Type	4.3 inch LCD Colour Touch screen
Graphs	24 hour history display of solar power production (both ports), battery and most recent sweep graph (both ports)
Data and Event Logs	Daily solar production (kWh) and peak power (kW). Logging of system events.

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

1.3.7 ALTITUDE DERATING

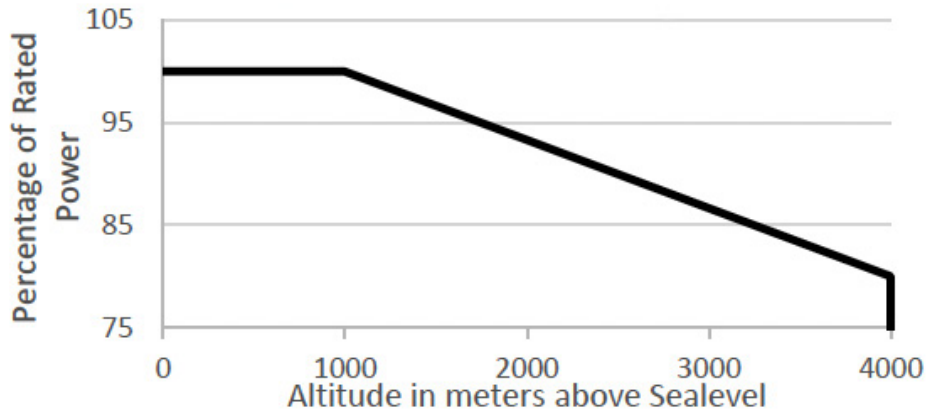


Figure 1: De-rating the MPPT-4K charge controller output power at high altitude

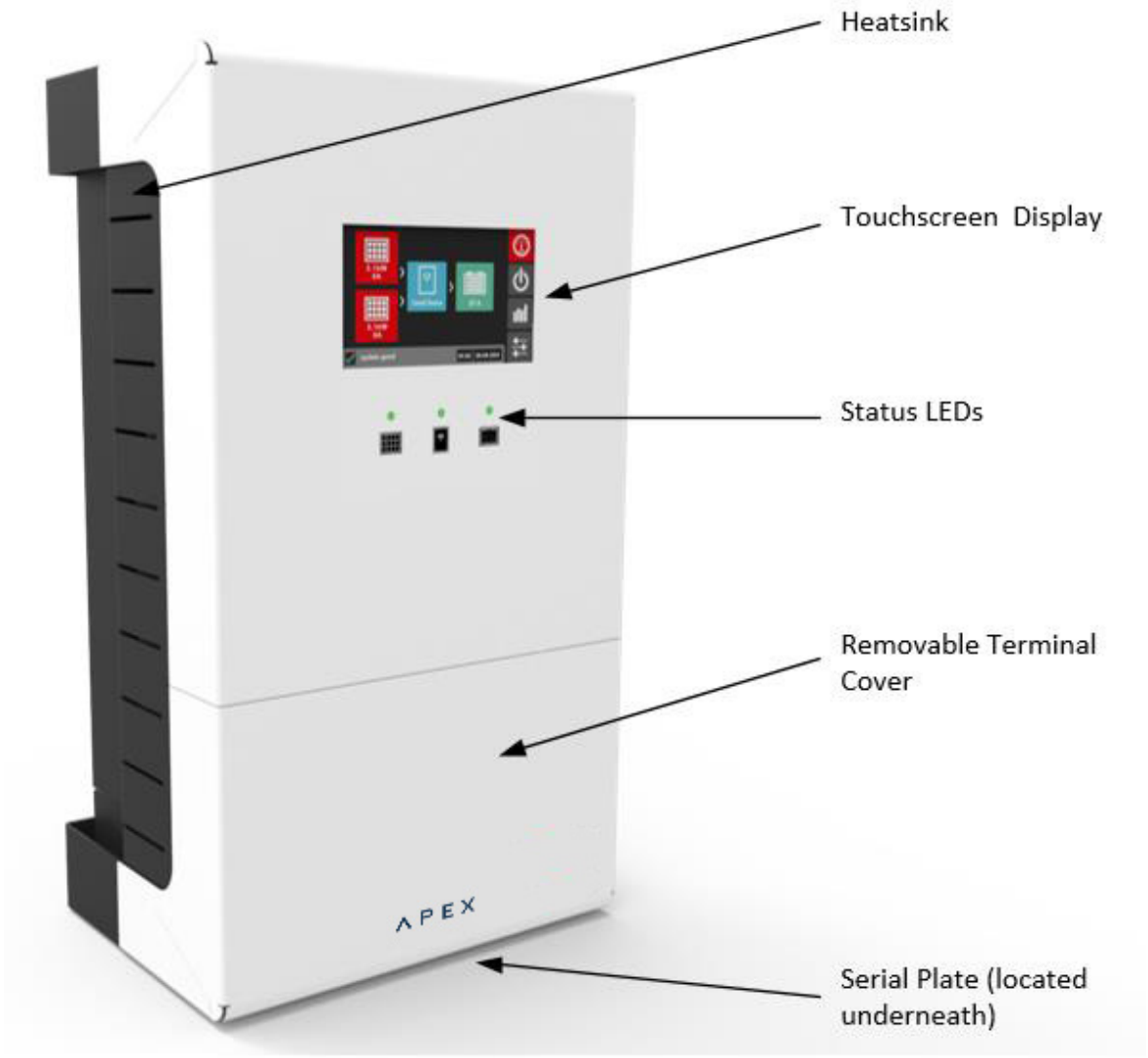
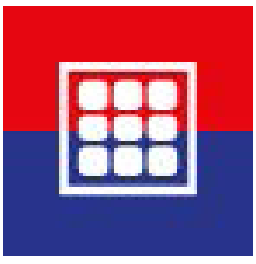


Figure 2. Identifying parts of the MPPT-4K

2. ADVANCED FEATURES

2.1 TWO INDEPENDENT MAXIMUM POWER POINT TRACKERS

The MPPT-4K contains two fully independent MPPTs, perfect for residential applications where PV arrays often face in a variety of directions. Connecting such PV strings to separate MPPTs can increase energy yields significantly compared to combining all strings into one MPPT.



2.2 WIDE PV STRING VOLTAGE RANGE

Each of the two MPPTs can accept PV string DC voltages between 100 and 350V. This wide range means a single PV string per MPPT is possible, instead of being forced to parallel PV strings. This allows for thinner DC cables, no string combiner boxes and easier & lower cost installations.

2.3 GROUND-FAULT DETECTOR INTERRUPTER

A ground fault is the undesirable condition of current flowing through the grounding conductor. The cause of this undesirable current flow is an unintentional electrical connection between a current-carrying conductor in the PV system and the equipment grounding conductor.
This can create a number of hazards since the normally grounded current-carrying conductor may no longer be at ground potential. The MPPT-4K physically disconnects the PV-panels to ensure site and operator safety. The MPPT-4K can be configured to detect ground faults on both positively and negatively grounded photovoltaic arrays as well as negatively grounded battery banks.

2.4 COMPATIBLE WITH VARIOUS BATTERY TECHNOLOGIES

Unlike many MPPTs, the MPPT-4K is compatible with a variety of battery technologies. For example, in the event of a Li-ion battery trip, the MPPT-4K will immediately disconnect, thereby protecting against rapid battery DC bus rises which typically destroy slower MPPTs and connected inverters.
The MPPT-4K's charging voltage and current are fully adjustable, and it can communicate via CAN bus.
The MPPT-4K also has blackstart functionality that allows it to start from PV only and wake up a battery that has tripped on under-voltage. (Blackstart is not possible on all makes of batteries. If unsure, consult your installer.)

2.5 BLACKSTART FUNCTIONALITY

Some lithium batteries, when tripped due to a low voltage, can be woken up by attempting to charge them slowly. If you try to start the MPPT-4K and it doesn't detect a battery, it will display the following warning:

Figure 3 - Blackstart warning

If you are certain that your battery is connected and turned on and is capable of being woken up in this way then selecting "Black start" will attempt to wake up your battery. If you are not sure, then select "cancel". Before attempting to blackstart, make sure that any loads such as inverters are disconnected from the battery, the battery is correctly connected to the MPPT-4K and is turned on.

2.6 LEAD-ACID BATTERY EQUALISE

The MPPT-4K charge controller has an equalise charge option available. This is used on flooded lead-acid batteries to prevent battery sulfation by dissolving sulphur crystals. An equalising charge also reverses acid stratification, a condition where acid concentration is greater at the bottom of the battery than at the top. Lastly, it also helps with cell balancing.

2.7 MONITORING

The ethernet port enables browser-based internet monitoring of the MPPT-4K charge controller.
The MPPT-4K must be connected to an internet network for this functionality to work.
Visit our website for further details.

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3. SOLAR / CABLE CALCULATIONS

3.1 OPEN CIRCUIT INPUT CALCULATIONS

The MPPT-4K PV input ports have an operating range of 100-350Vdc.
When choosing the number of panels in series to connect to each MPPT-4K port, consult the PV panel specifications sheet
and use the following formula:
Maximum panels per string $\leq 350 / (Voc + (Voc \times (Tmin - 25) \times Tc / 100))$
With:
Voc – Open circuit voltage at STC
$Tmin$ – Coldest ambient temperature the PV panels will ever be exposed to
Tc – Temperature coefficient of Voc in $\%^{\circ}K$

Warning: PV input voltages above 400Vdc will cause system damage and void the product warranty.

3.2 BATTERY DC CABLE CALCULATIONS

In order to size the cables correctly, we need to know that the MPPT-4K automatically limits the current into the batteries to 85A.

SANS 10142-1 (South African National Standard for Wiring, your local legislation may differ) specify a minimum conduit size of 25mm² if using a PVC insulated copper cable, installed in a conduit on a wall.

Always use a registered electrician who will calculate the correct number of cables and apply the appropriate corrective factors for conduit and multiple cables.

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4. MOUNTING AND ELECTRICAL CONNECTIONS

4.1 INSTALLING THE MPPT-4K CHARGE CONTROLLER

For optimal performance, please refer to the following instructions regarding the installation and setup of your newly purchased MPPT-4K.

4.1.1 SELECTING A SUITABLE LOCATION

When selecting a location to mount your charge controller, take note of the following:

1. The MPPT-4K charge controller should be mounted indoors, in a well-ventilated area out of direct sunlight, where the ambient temperature does not exceed 45°C (derating applies).
2. The MPPT-4K is designed to be wall-mounted and must therefore be installed upright in a vertical position, with a clearance of 200mm above and below, to allow sufficient cooling and airflow.
3. The battery leads should be as short as possible, the MPPT-4K charge controller will need to be close to the batteries.

Note: At high altitudes natural thermal cooling of all electrical equipment is degraded. This is due to lower air density available to remove heat from the heatsink. The MPPT-4K is rated for altitudes up to 1000m above sea level. If it is going to be installed in an area where the altitude is greater than 1000m above sea level, refer to the power derating graph (Figure 1) to establish maximum continuous load.

4.1.2 MOUNTING

Once a suitable location for the MPPT-4K has been chosen, use the following information as a guide to make the mounting process easier using an M5x35 wall anchor:

1. Using an appropriate bit masonry drill bit (typically 7mm), drill 2 holes 45mm deep and 135mm apart.
   It is recommended to use the bracket as a template.
2. Insert the wall anchor bolts through the bracket into the holes, and tighten with a screwdriver, fixing the bracket to the wall.
3. Hold the MPPT-4K vertically and lift it onto the mounting bracket.

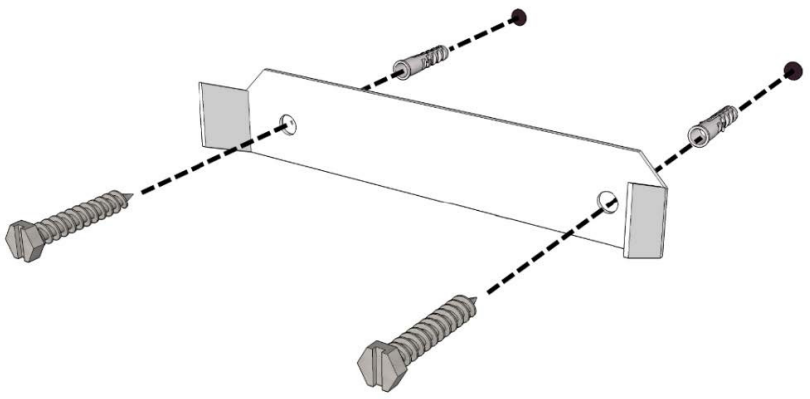


Figure 4: Wall mounting

4.1.3 MAKING THE ELECTRICAL CONNECTIONS

Once your MPPT-4K has been mounted on the wall, you can begin making the electrical connections. Follow these steps to make the task as simple as possible.

Caution: Failure to follow these instructions could increase the risk of personal injury, death or damage to property or equipment. Ensure that electrical connections are dead before touching any potential live wiring.
Certain electrical connections must be made by an appropriately trained person. If in doubt about anything, contact APEX Inverters for assistance.

1. Remove the screws that secure the removable bottom cover.
2. The 'Earth' terminal inside the MPPT-4K must be grounded to reduce the risk of electrical shock and to ensure that the earth-leakage protection device can operate correctly.
3. The 'PV' connections inside the MPPT-4K will need to be connected into your solar array.
   These connections should be made with appropriately rated solar wire. Take care to connect the Positive wire to the '+' terminal and the Negative wire to the '-terminal. Ensure that the cables are rated appropriately for the environment, voltage and current.
4. Insert and tighten the battery cables to the DC battery terminal connections, taking care to observe the polarity.
   Make sure to use cables rated to carry the full current output of the MPPT-4K.
5. Once all the electrical connections have been made, double-check that they are secure, as a loose connection could get hot enough to cause a fire.

Note: External protection devices such as fuses, DC-circuit breakers and earth-leakage protection 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 must be made by a qualified electrician or an APEX Inverters approved installer.

4.1.4 DISCONNECTING THE MPPT-4K

1. Turn off the MPPT-4K on the control panel.
2. Disconnect the solar panels.
3. Disconnect the batteries.
4. Disconnect the earth and remove the MPPT-4K from the mounting bracket.

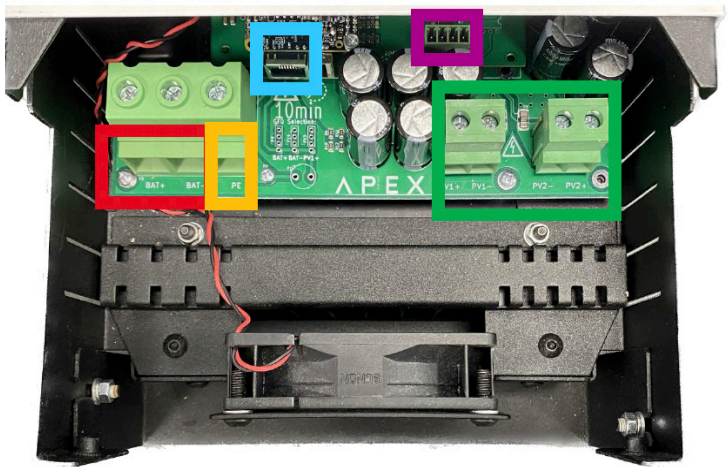
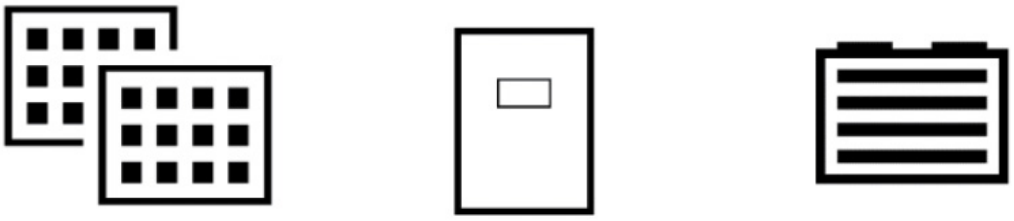


Figure 5: Input/output connections on the MPPT-4K

The above picture illustrates the location of the Battery Connection (red, remember to observe polarity), Earth (yellow), CAN (purple), Ethernet Connection (blue), and the 2 Solar inputs (green).

5. CHARGE CONTROLLER OPERATION INDICATORS

On the front panel of the MPPT-4K charge controller there are three LED status indicators:



Solar status | Charge Controller status | Battery status

5.1 SOLAR STATUS

Green – The MPPT-4K charge controller is active and there is sufficient power to charge the batteries.
Orange – The charge controller is in sleep state. Either there is no solar irradiation, or the battery is full.
Red – A solar fault exists, typically an overvoltage condition. Consult the screen for more information.

5.2 CHARGE CONTROLLER STATUS

Green – The MPPT-4K is operation is normal with no faults.
Orange – The charge controller is throttling the solar power output due to temperature.
Red – A fault condition exists. Consult the screen for more information.
Off – Charge controller is turned off.

5.3 BATTERY STATUS

Green – The battery is fully charged.
Orange – The battery state of charge is low.
Red – The battery state of charge has reached a critically low level.
Blinking Orange – The MPPT-4K is performing an equalise charge.

6. INTERFACE

The MPPT-4K HMI (Human Machine Interface) is a colour 4.5" touchscreen interface. This chapter covers using the interface to set up the MPPT-4K charge controller.

6.1 SYSTEM ICONS

There are four system icons on the right-hand column. Tapping on the icon select the current screen.

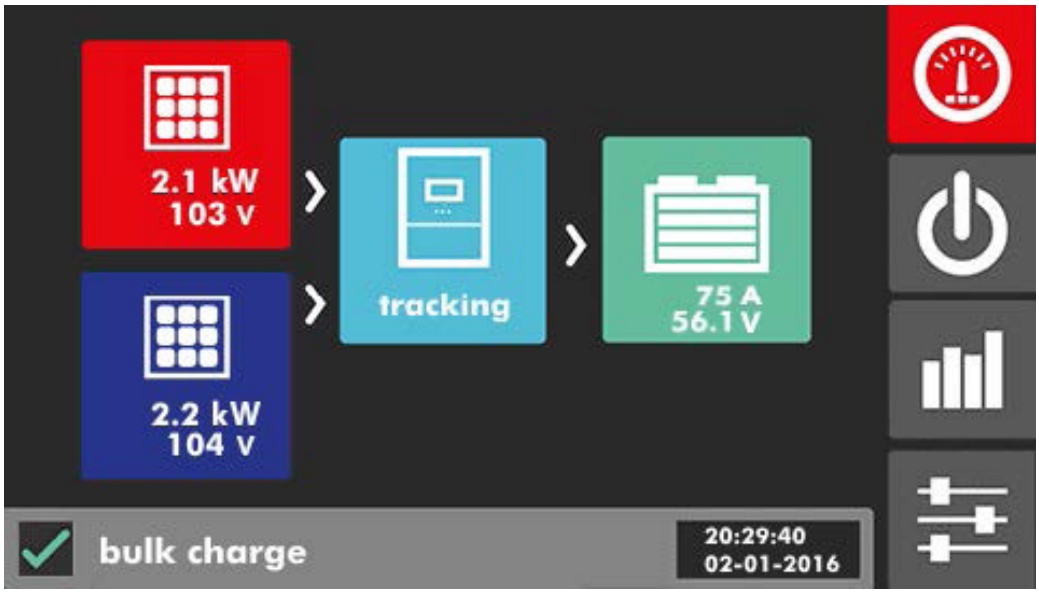
Dashboard

Control Panel

Graphs

Settings

6.2 DASHBOARD



The Dashboard screen shows an overview of the current charge controller operation. Power and voltage from the each of the solar arrays, and battery charging current. Touching on each of the icons takes you to the individual item's graph.

The **red and dark blue Solar Panel** icon indicates the current panel voltage and the amount of power flowing from the panels.

The **light blue MPPT-4K** icon indicates the mode that the charge controller is in.

The **green Battery** icon shows the battery voltage and the current that is charging the battery.
The bars within the icon are not an indication of the state charge of the battery bank.

The **directional arrow** indicates which direction the power is flowing. The arrows from the solar arrays indicate that power is flowing into the charge controller. The arrow pointing towards the battery, indicates that the battery is getting charged.

The bottom part of the screen contains a bar, showing system status and indicates any known issues. Next to it is the current date and time.

6.3 CONTROL PANEL

There are four buttons here with the following functions:

On will turn on the charge controller. When on, the icon will change to Off, which will turn off the charge controller.

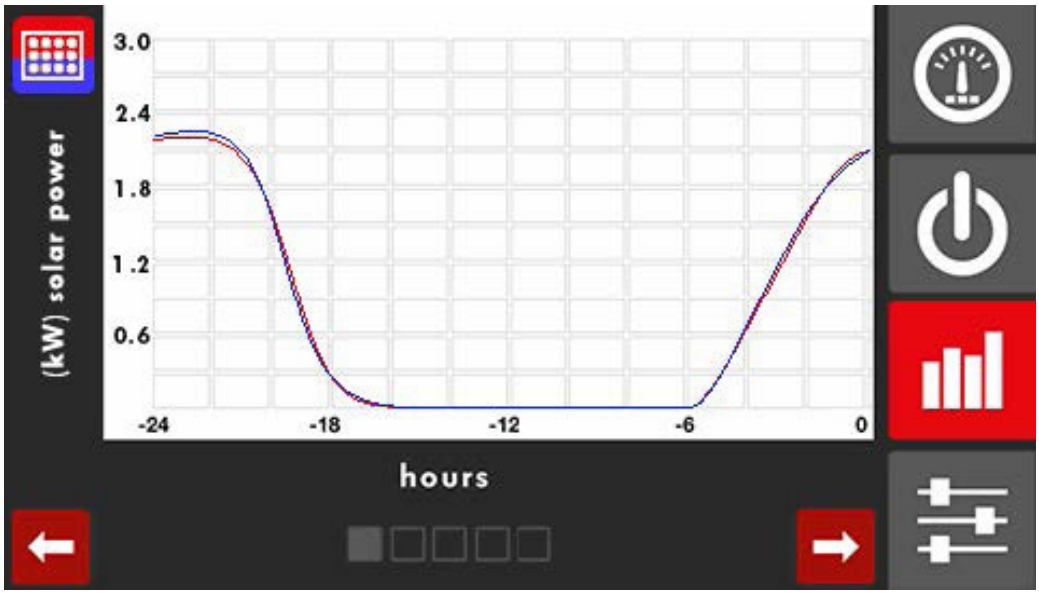
Reset will clear any active event messages and turn the charge controller on. If the event message is still present, it will not turn on.

Sweep forces the charge controller to recalculate the maximum power point for both the solar arrays.

Equalise turns on and off the equalise charge. If the equalise charge is selected, the next bulk charge will be done at the equalise voltage.

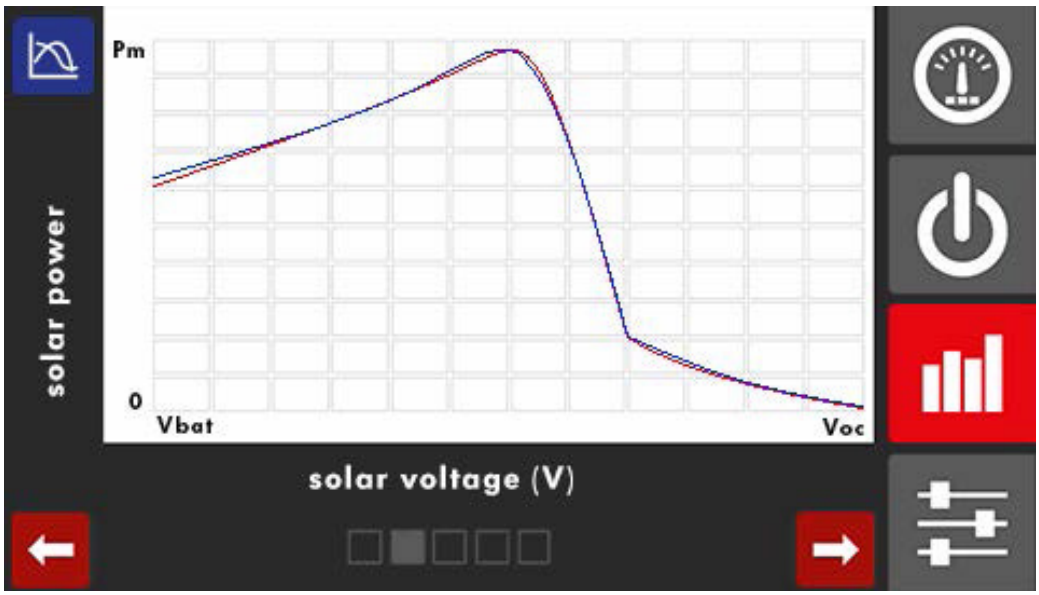
6.4 GRAPHING AND LOGS

6.4.1 SOLAR OUTPUT GRAPHS



The solar input screen graphically shows the amount of solar power that each of the two inputs delivers. Input one is plotted in red and input two is plotted in blue.

6.4.2 SOLAR SWEEP GRAPH



The solar sweep graph plots solar power vs voltage.
This can be used by your installer to check if the panels are performing optimally.

6.4.3 POWER PRODUCTION LOGS

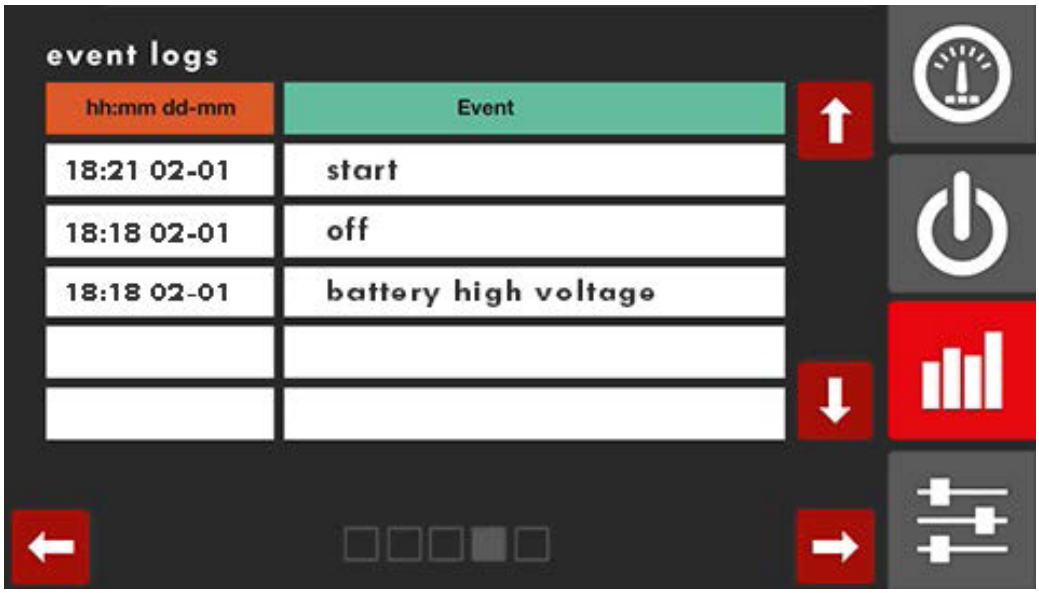
The total energy in kWh that the MPPT-4K has produced is summarised at the bottom.
The reset button will clear this log.

Daily energy (kWh) and peak production (kW) is also shown.

This screen can be useful for figuring out if your system is performing adequately.
Please note that various things can influence energy production, for example:

1. Once the battery is full, then production could be limited to instantaneous use of solar only, depending on how the system is set up and which inverter is installed on site.
2. Weather influences the production of solar, with high irradiance and low temperatures giving the highest yield.
   Disconnect the earth and remove the MPPT-4K from the mounting bracket.

6.4.4 EVENT LOGS



Event logs are viewable on this interface screen. It is sorted in a descending list by time and date. General events are marked in black and critical events, typically causing charge controller shutdown, are marked in red.
The following events are logged:

6.4.4.1 START

The charge controller has been turned on and the system started. It then goes through the safety checks and once completed, will perform a sweep and start tracking.

6.4.4.2 OFF

The system was turned off by the user.

6.4.4.3 GROUND FAULT DETECTED

A ground fault was detected, and the system has been shut down in order to protect the user.

6.4.4.4 HIGH BATTERY VOLTAGE

The charge controller has been shut down due to a high battery voltage.

6.4.4.5 LOW BATTERY VOLTAGE

The charge controller has detected a low battery and if the appropriate relay settings has been set, will close the relay.

6.4.4.6 SOLAR HIGH VOLTAGE

If the solar voltage goes higher than the upper limit of the solar input, this message will be logged and the charge controller will switch off until it is back in the specified range.

6.4.4.7 TEMPERATURE DERATING

If the charge controller reaches a certain internal temperature, it will start throttling the controller output in order to attempt to regulate the temperature rise of the heatsink.

6.4.5 BATTERY GRAPHS

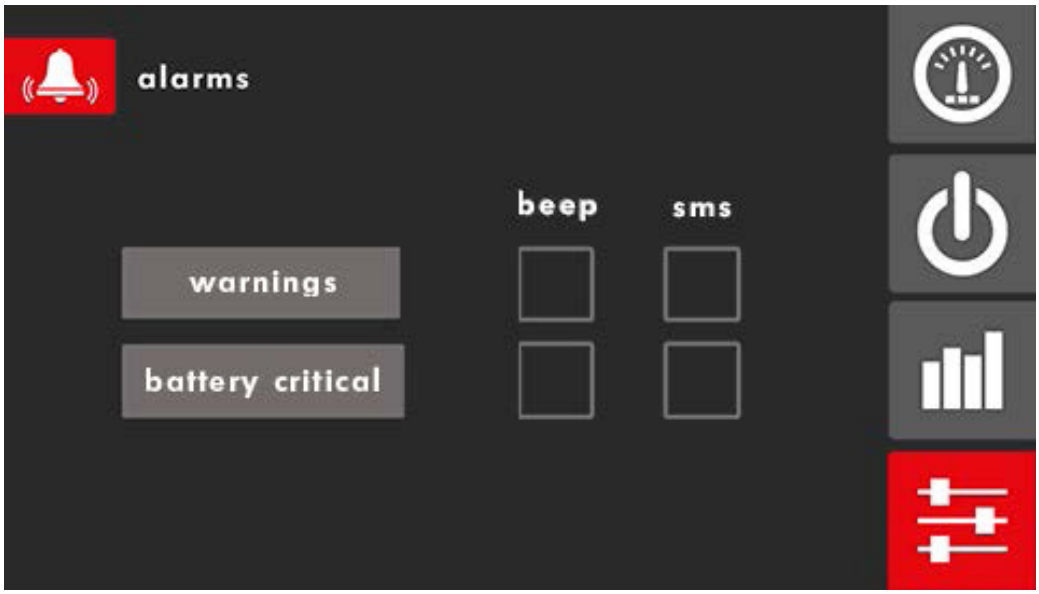
The battery graph screen graphically illustrates the charging and discharging of the battery bank. The green, orange and red bar on the left is a rough indication of charge left.

6.5 SETTINGS

6.5.1 SETTINGS MENU

Selecting Alarms, Date & Time, Relay Control, MPPT Settings and Battery Setup will take you to their respective setting screen.

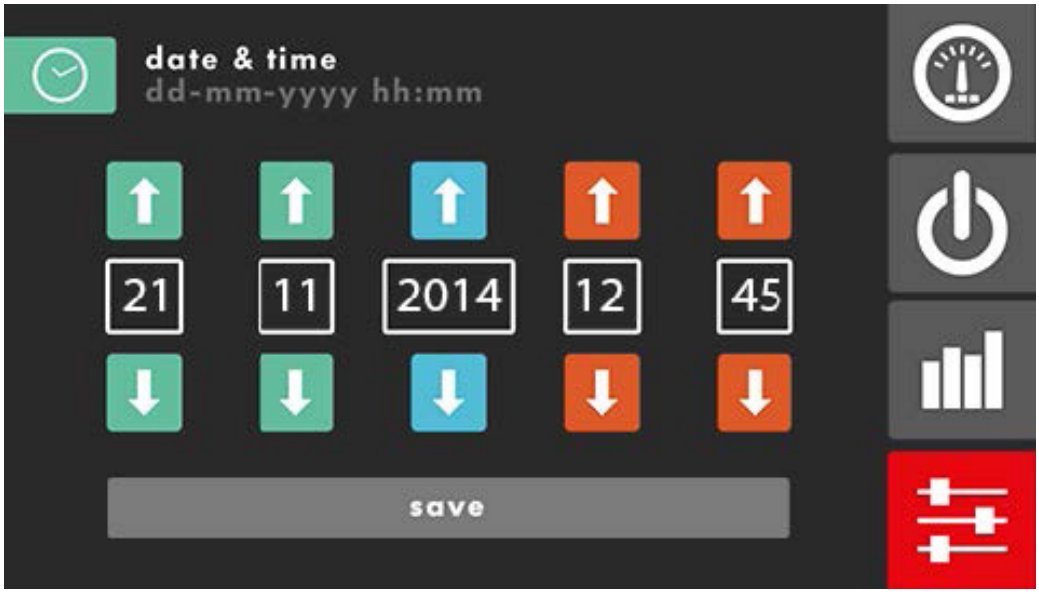
6.5.2 SETUP ALARMS



6.5.2.1 BEEP

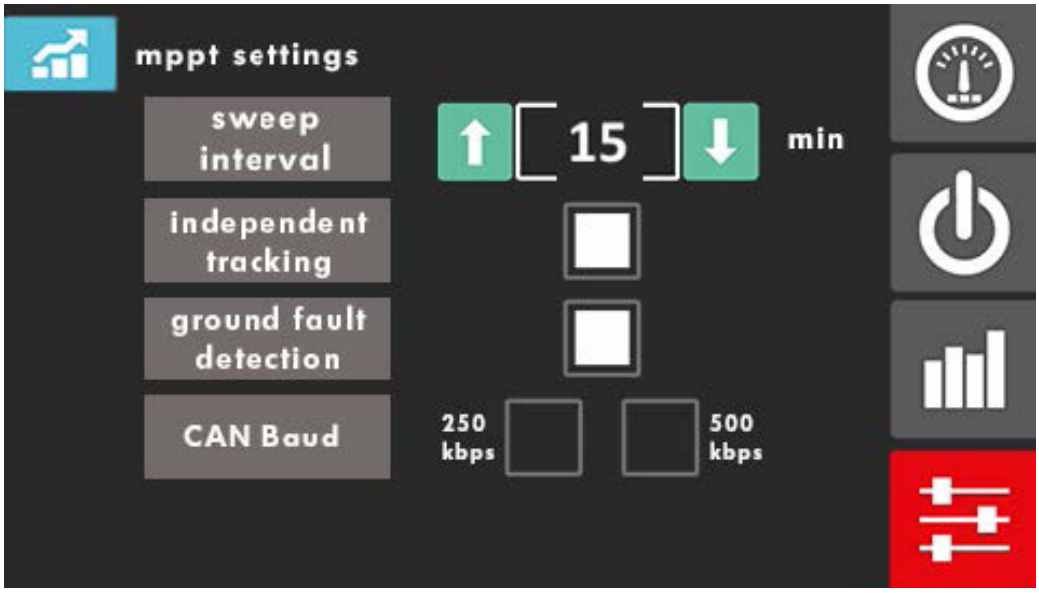
Click on the beep square to toggle on and off. Beep implies that the charge controller will sound an audible noise, at a once per second interval.

6.5.3 DATE & TIME



Set the date and time to the current time, using the up and down arrows. In this example the date is the 21st of November 2014, with the time being 12h45 in the afternoon.
Green and blue is for setting the date in the day-month-year format, and the orange buttons are for setting the time in the 24-hour time format.
Use up and down arrows to change the time/date and the save button to set.

6.5.4 MPPT SETTINGS



6.5.4.1 SWEEP INTERVAL

At certain intervals, set by this parameter, the system will "sweep", which is where it determines the Maximum Power Point (MPPT) of the panels at that time.

6.5.4.2 INDEPENDENT TRACKING

If selected (selected by default), each of the two solar input ports will be independently controlled. Deselecting the independent tracking option, links the port together and they will track the maximum power point together. You must also physically link the input ports together with a cable or wire.

6.5.4.3 GROUND FAULT DETECTION

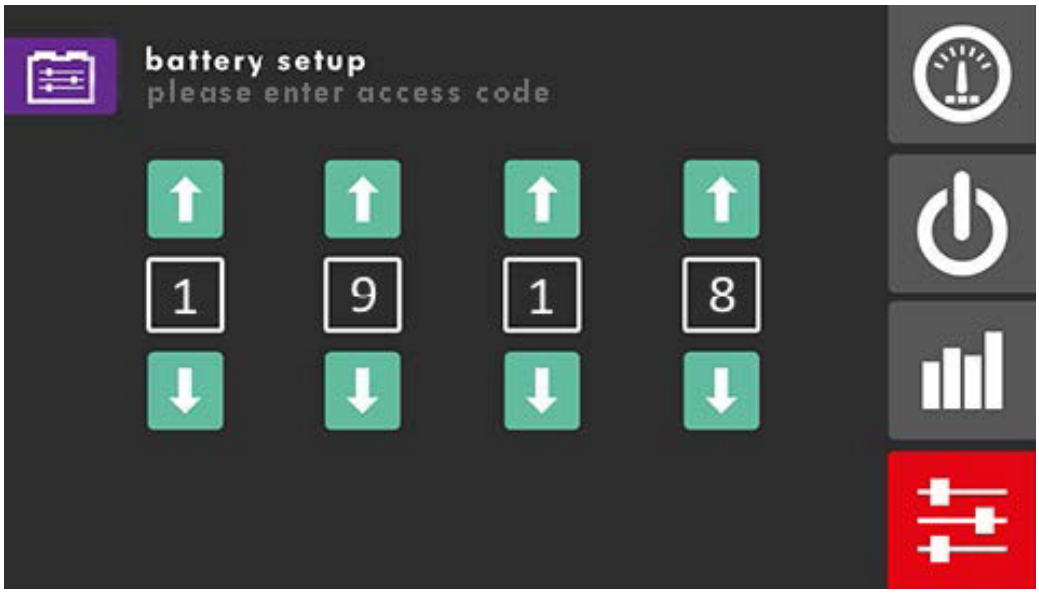
The MPPT-4K can be configured to detect ground faults on both positively and negatively grounded photovoltaic arrays as well as negatively grounded battery banks. See the Chapter 8. Ground Fault Detector Interrupter (GFDI) for more information.

6.5.4.4 CAN BAUD

Select between 250 and 500kbps for the CAN bus. Some batteries use 250kbps, but 500kbps is more common and should be used in most cases.

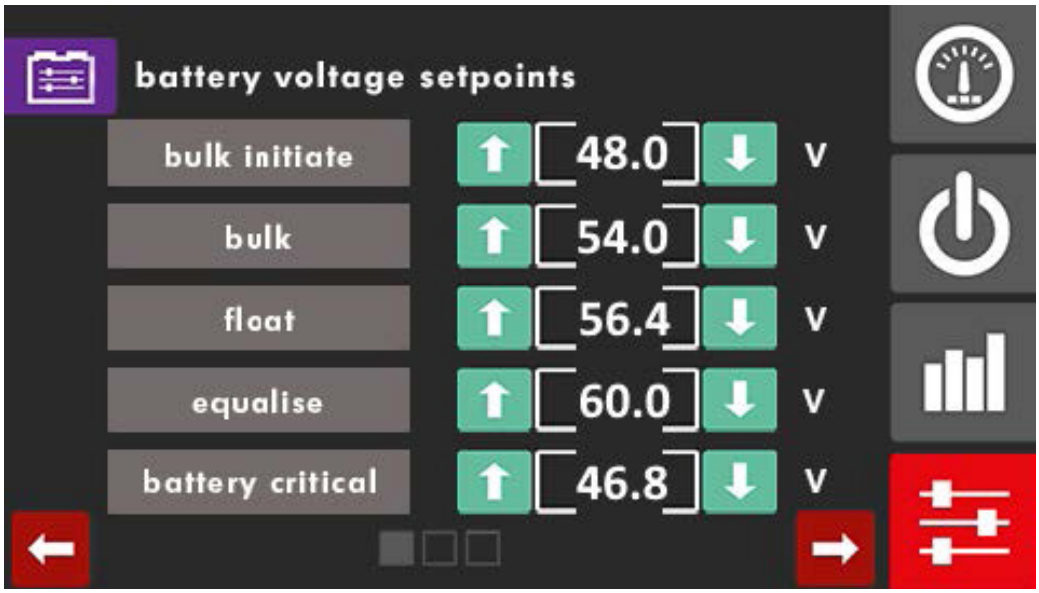
6.5.5 BATTERY SETUP

6.5.5.1 BATTERY SETUP – ACCESS CODE



Before entering the Battery Setup screen, a password will be requested. The password is 1918.

6.5.5.2 BATTERY VOLTAGE SETPOINTS



Under the Battery Voltage Setpoints page it is possible to fine-tune and adjust the various battery charging options.
Please see the Battery chapter and set according to the battery manufacturer's specifications.

6.5.5.2.1 BULK INITIATE

The battery will be kept at a float voltage, until the battery voltage falls below the bulk initiate value. Thereafter a bulk charge will be initiated.

6.5.5.2.2 BULK

The bulk or boost is the voltage that the charge controller keeps the battery at after the initial current charge is done.

6.5.5.2.3 FLOAT

The battery is kept at float after the charging is complete.

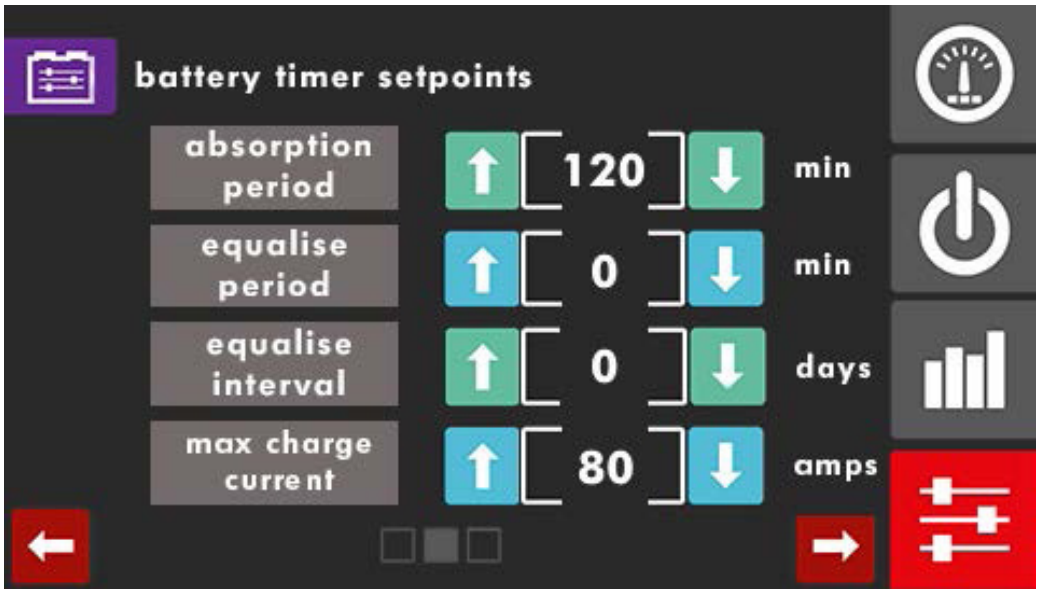
6.5.5.2.4 EQUALISE

Some types of batteries require a periodical equalise charge.

6.5.5.2.5 BATTERY CRITICAL

This setting is used for the relay option, see **Error! Reference source not found. Error! Reference source not found.**.

6.5.5.3 BATTERY TIMER SETPOINTS



Under the Battery Voltage Setpoints page it is possible to fine-tune and adjust the various battery charging options. Please see the Battery chapter and set according to the battery manufacturer's specifications.

6.5.5.3.1 ABSORPTION PERIOD

The bulk charge will be held for this period of time before returning to the float voltage state.

6.5.5.3.2 EQUALISE PERIOD

The equalise charge will be held for this period of time before returning to the float voltage state.

6.5.5.3.3 EQUALISE INTERVAL

The charge controller will automatically do an equalise charge once this timer has elapsed.

6.5.5.3.4 MAX CHARGE CURRENT

The maximum current that the batteries will be charged at.

7. FAULTS AND WARNINGS

7.1 FAULT / WARNING SCREEN

Above is a typical warning message. There are two options:

1. Reset – Clears the error and resets the system. If the error condition no-longer exists, this will re-enable the charge controller and it will start again.
2. Ignore – This removes the warning message and allows the user control of the HMI interface. After making the needed corrections, the charge controller must be manually reset from the control menu.

7.2 DESCRIPTION OF WARNINGS AND FAULTS

7.2.1 OPERATING TEMPERATURE LIMIT REACHED

If the internal temperature exceeds a certain level the charge controller will start to reduce the output power to regulate the internal temperature.

7.2.2 HIGH BATTERY VOLTAGE

A high battery voltage has been detected and all charging has been suspended until the battery voltage returns to an acceptable level.

7.2.3 HIGH SOLAR VOLTAGE

One or both solar input ports have a critically high input voltage. Once the input voltage returns to an acceptable level, the charge controller will resume battery charging.

7.2.4 INCORRECT NOMINAL VOLTAGE

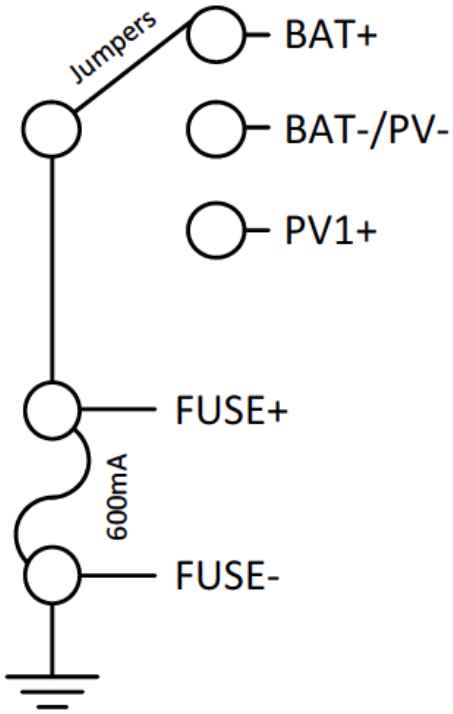
8. GROUND FAULT DETECTOR INTERRUPTER (GFDI)

A ground fault is the undesirable condition of current flowing through the grounding conductor. The cause of this undesirable current flow is an unintentional electrical connection between a current-carrying conductor in the PV system and the MPPT-4K's grounding conductor.

This can create a number of hazards, as the normally grounded, non-current-carrying conductor may no longer
be at ground potential. The MPPT-4K physically disconnects the PV-panels to ensure site and operator safety.

The MPPT-4K can be configured to detect ground faults on both positively and negatively grounded photovoltaic arrays as well as negatively grounded battery banks.

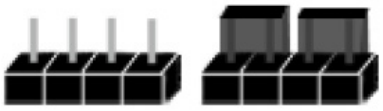
The MPPT-4K GFDI works by checking if there is a voltage difference between the Fuse + and Fuse - points. If a ground fault exists, a current will flow through the ground fuse causing the fuse to blow (at 600mA). Once the fuse blows the voltage difference is detected and the MPPT-4K will stop operation and display a warning message indicating that a ground fault was detected.



8.1 SELECTING GROUND FAULT REFERENCE

After removing the cover from the MPPT-4K, use the enclosed two jumpers to select the relevant four pins as shown below.

Only bridge one of the selection strips.



Ensure that the GFDI option is enabled on the MPPT Settings configuration screen (see page 21).

Caution: Only select one of the following configurations for the Ground Fault Detector Interrupter. Selecting more than one configuration will result in equipment damage and is a safety risk.

8.1.1 BATTERY POSITIVE

Select this option if your battery bank positive is grounded.

8.1.2 PHOTOVOLTAIC / BATTERY NEGATIVE

The most common type of solar panel is a negatively grounded panel. Select this option if your solar panels are negatively grounded.

8.1.3 PHOTOVOLTAIC POSITIVE

Some solar panels need to be positively grounded in order to stop ionisation on the panels. This ionisation can cause a reversible loss of performance. Select this option if your solar panels are positively grounded.

8.1.4 PV FLOATING

If you wish to leave the photovoltaic panels floating, do not select any jumpers. Then disable the GFDI by deselecting the option on configuration screen. See 6.5.4 MPPT Settings on page 21.

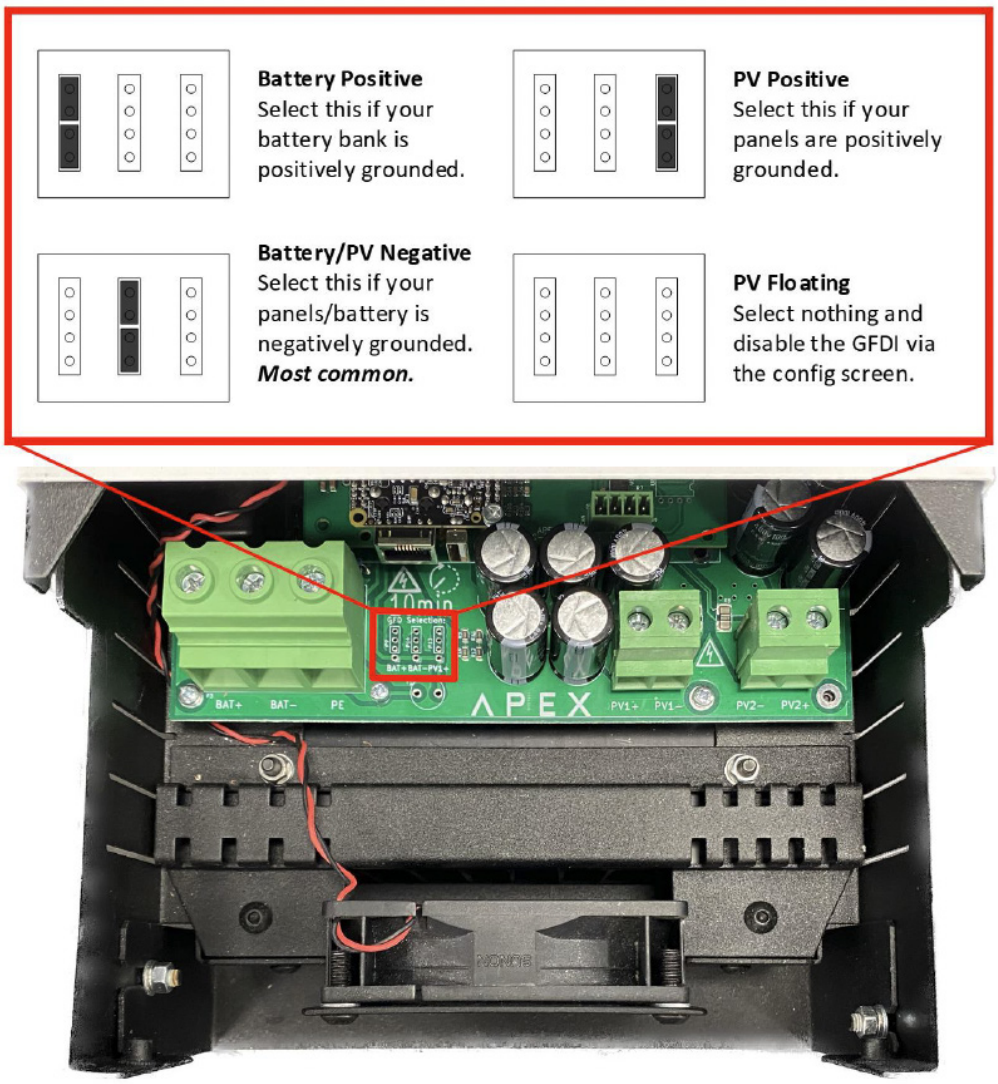
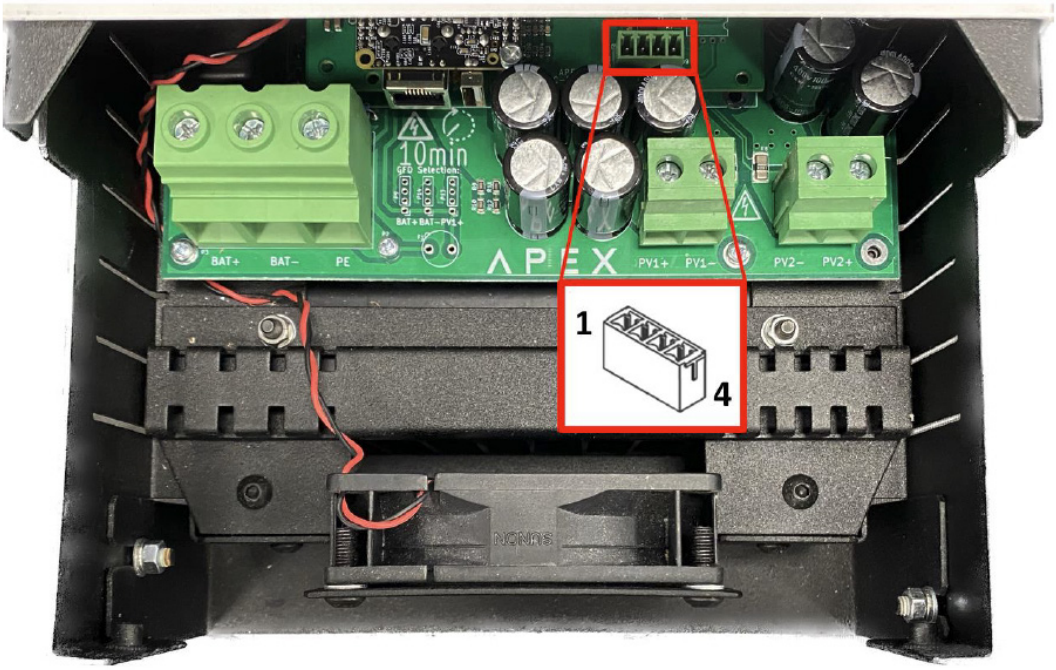


Figure 6: GFDI Jumper Selection (Bottom Cover Removed)

8.2 CAN BUS CONNECTOR

MPPT-4K charge controllers with a newer hardware revision comes with a CAN-bus connector included for communication to a Lithium battery. Contact APEX for a list of approved compatible Lithium Battery packs.



	Name	Description
Pin 1	GND	This is tied to the ground of the internal PCB.
Pin 2	CANL	CAN-LOW signal for the CAN bus.
Pin 3	CANH	CAN-HIGH signal for the CAN bus.
Pin 4	TERM	This is a 120Ω termination resistor. If the MPPT-4K is placed at the end of the CAN-bus, bridge this pin with pin 3 to complete the termination.

9. BATTERIES

9.1 GENERAL

There are two types of batteries that can be used with the MPPT-4K, Lithium and Lead-Acid.

9.1.1 SEALED LEAD-ACID BATTERIES

Standard, Gel, Sealed or Low Maintenance battery which is another name for a normal car battery.
This type of battery is designed to provide a large current for a very short period of time. They are not designed to be regularly discharged by more than 25% of their capacity. This battery is only suitable for backup applications.

9.1.2 DEEP CYCLE LEAD-ACID BATTERIES

Deep cycle lead acid batteries are designed to be repeatedly discharged to at least 50% of their capacity, which makes them suitable for homes using solar power or off-grid power use.
Thus, if in your application you are repeatedly charging and discharging your batteries you should be using deep cycle batteries. If, however, you are using your system as a UPS, low maintenance batteries may be sufficient. Standard batteries can be flooded batteries which require regular maintenance or sealed which are maintenance free. Deep cycle batteries are available only in the flooded variety. If standard batteries are suitable, maintenance free type should be selected as they do not require topping up of their electrolyte during their life.

9.1.3 LITHIUM BATTERIES

Lithium based batteries are currently manufactured using various technologies and chemistries.
The most commonly available Lithium batteries for home storage are Lithium Iron Phosphate (LiFePO4).
Most Lithium batteries can be used with the MPPT-4K charge controller, if you are unsure about a specific battery, please contact APEX Inverters for support.

9.2 BATTERY BANK LOCATION

When selecting a suitable location for your battery bank, take the following into consideration:

- Some batteries packs must be installed in a well-ventilated environment.
- Install batteries away from direct sunlight.
- Ensure that the battery leads are as short as possible for maximum efficiency.
- Always use cables that are thick enough to carry the expected current.
- Appropriate protection must always be installed!

9.3 MAINTENANCE

The battery maintenance required will be detailed in the documentation supplied with the battery.
Flooded batteries generally include checking of the electrolyte levels on a regular basis and topping up with distilled water when necessary.

Providing the site is maintained correctly, a good quality battery bank should last for the full number of rated cycles before needing replacement.

9.4 REPLACING A BATTERY

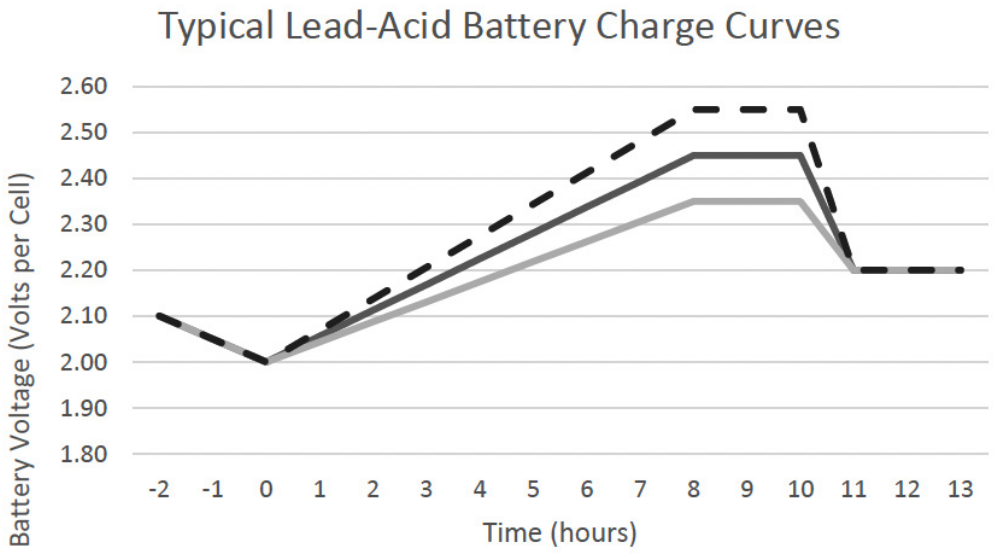
Always replace a battery with a battery of the same type and capacity. Never replace a flooded lead-acid battery with a maintenance free battery or vice-versa.

If you are not sure about the type and capacity of the batteries installed, please contact your installer. Always follow the instructions of the battery manufacturer.

ELECTRICAL SHOCK OR BURN HAZARD: To prevent short circuits it is recommended that you always use an insulated spanner when connecting or disconnecting individual batteries or battery banks. All electrical connections must be made by a qualified person.

9.5 LEAD-ACID BATTERY CHARGING

9.5.1 CHARGING STAGES



The MPPT-4K includes a four-stage battery charger. Please configure the charge controller for use with your batteries as per your battery manufacturers' specifications.

Above is a typical battery charge curve for a lead acid battery. It consists of four stages, a bulk constant current stage, absorption stage, taper-to-float stage and last the float stage.

The total charging period is approximately 10 hours in this example, but can be much shorter depending on depth of discharge, charging current and load.

9.5.1.1 STAGE 1: BULK CONSTANT CURRENT CHARGE PERIOD (HOURS 0-8)

This is the first stage of charge using a constant current until the bulk voltage is reached. At the end of this stage, the battery is around 80% full. This charge period will typically last 7-10 hours.

9.5.1.2 STAGE 2: ABSORPTION CHARGE PERIOD (HOURS 8-10)

This stage maintains the cells, and hence the batteries, at a constant voltage.
This will complete the battery charge.
This charge period is 2 hours or until the charge current is reduced to zero amps.
This is sometimes referred to as a boost or bulk charge.

9.5.1.3 STAGE 3: TAPER-TO-FLOAT PERIOD (END OF BULK)

The voltage per cell will be lowered to the float voltage per cell by lowering the current into the battery cells, and letting the battery discharge into the load, or self-discharging. This typically should only last a few minutes.

9.5.1.4 STAGE 4: FLOAT TAPER CHARGE PERIOD (HOURS 10+)

The current into the battery cells is reduced at a rate that allows the voltage on the cells to remain constant at the float voltage level. If an auto-start generator was used, it will turn off when this stage is reached.

9.5.2 BATTERY CHARGER SETTINGS

It is important to select the correct charging current and voltage for your batteries during the installation of your MPPT-4K. If you increase or decrease your battery capacity or replace the battery bank with a different type of battery it may be necessary to change the battery charger settings.

The maximum battery charging current can be set by the changing the appropriate settings. Note that the actual charging current will depend on the amount of solar available.

As a general rule of thumb, a flooded cell type battery bank should be charged over a maximum period of 7 hours, and a sealed cell bank should be charged over a 10 hour period.
This means that the charge current can easily be calculated by using this formula:

$$\frac{battery\ capacity\ (Ah)}{charge\ time\ (h)} = \frac{Ah}{h} = charge\ current\ (A)$$

For example with a battery bank of 205Ah for a sealed battery:

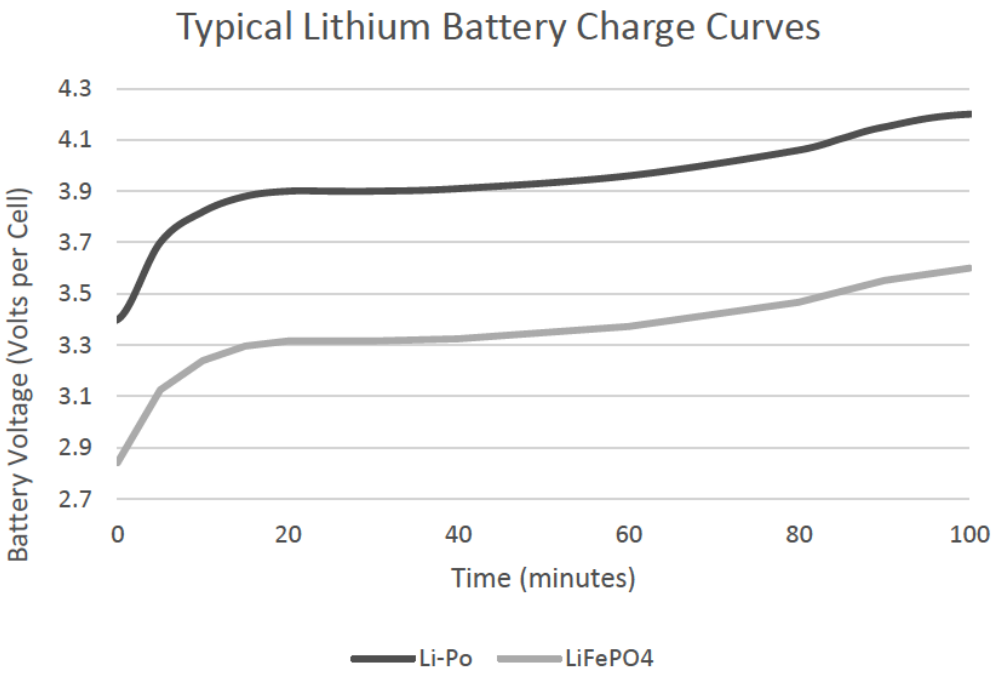
$$\frac{205Ah}{10h} = 20.5A$$

This is the absolute maximum current that the sealed battery bank should be charged with.

Caution: Always configure battery charging currents according to manufacturer limits. These limits may differ from the above formula. The limits in the table below were correct at time of publication, but manufacturers may change the limits.described in the CAUTION may, if not avoided, lead to serious results.

	Capacity	Maximum Charge Current
Royal 95E41R	100 Ah (C20)	10 A
Trojan T105/T105RE	225 Ah (C20)	29.25 A
FNB MIL15P	490 Ah (C100)	140 A
FNB MIL17P	560 Ah (C100)	160 A
FNB MIL21P	700 Ah (C100)	200 A
FNB MIL25P	840 Ah (C100)	240 A
FNB MTL25P	1010 Ah (C100)	288 A
FNB MTE21P	1330 Ah (C100)	380 A

9.6 LITHIUM BATTERY CHARGING



The MPPT-4K can charge most Lithium-based battery banks. Lithium batteries are typically charged much faster than Lead-Acid based batteries, and at higher currents. Please see the APEX Inverters website for full information regarding compatible battery banks. When charging a Lithium battery it is always recommended to connect the battery CAN communication, which would allow the battery to control the charge parameters actively depending on the state of charge.
When connected, the CAN bus will override the charge settings.

9.6.1 BATTERY CHARGER SETTINGS

It is important to select the correct charging current and voltage for your batteries during the installation of your MPPT-4K.
If you increase or decrease your battery capacity or replace the battery bank with a different type of battery it may be necessary to change the battery charger settings.

Please note: Always configure battery charging currents according to manufacturer limits.

10. TROUBLESHOOTING

10.1 FAULTS

If there is a fault with the MPPT-4K charge controller, the HMI will indicate which fault has occurred, and an audible alarm, if enabled via the HMI control panel, will sound. If you have a fault that is not addressed in this manual, then you should contact the person who installed your MPPT-4K or APEX Inverters product support. See 'Contacting APEX Inverters' on Page 05.

10.2 TYPICAL PROBLEMS

10.2.1 THE MPPT-4K IS NOT CHARGING THE BATTERIES

Is there enough sunlight to charge the batteries? Ensure that the solar panels are working and that any fuses in-line with the panels are good. Check that the open circuit voltage is displayed on the screen of the MPPT-4K is close to the expected voltage from the panels.

Is the battery already charged? If there are multiple sources charging the batteries, for example an inverter charging the batteries, the MPPT-4K charge controller might stop charging if the battery is close to full.

Is **Analogue Charge Control** selected? If it is selected (under MPPT settings) and the appropriate cable is not connected, charging is disabled.

10.2.2 WHY DIDN'T I GET THE USUAL CAPACITY FROM MY STORAGE BATTERIES?

Were the batteries fully charged to start with? To ensure a consistent performance from the batteries it is important that they are charged correctly. Each battery type (flooded deep cycle, sealed, gel etc.) has different charging requirements. Incorrect adjustment of battery settings is the most common cause of reduced backup time from your batteries.

For Flooded Lead Acid Batteries it is important to check the battery electrolyte level periodically. Never leave the battery cells with the electrolyte below the required level.

One or more of the batteries in the battery bank could be faulty. Check the batteries in accordance with the manufacturer's documentation and replace as necessary.

Flooded lead-acid batteries can be checked with a hydrometer. All batteries should measure the same specific gravity ±10%.

Sealed batteries can be tested with a multi-meter. All batteries should measure close to the same voltage after they have been standing disconnected for at least 30 minutes.

11. GLOSSARY

AC	Alternating current. The utility, generators, and inverters 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.
GFDI	A ground fault is the undesirable condition of current flowing through the grounding conductor. The cause of this undesirable current flow is an unintentional electrical connection between a current-carrying conductor in the PV system and the equipment grounding conductor.
MPPT	Maximum Power Point Tracking. Maximum power point tracking is a technique used commonly with charge controllers for wind turbines and photovoltaic (PV) solar systems to maximize power extraction under all the varying conditions that the PV or wind turbine is subjected to.

APPENDIX A: SAMPLE SINGLE LINE WIRING DIAGRAM