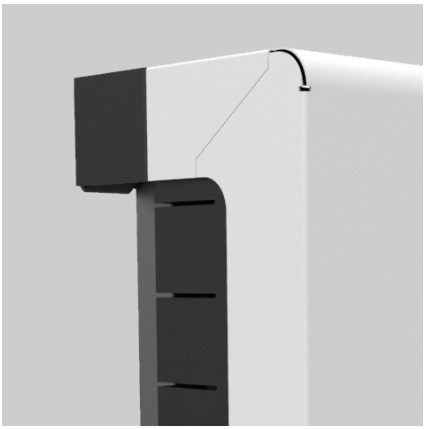
mlt INVERTERS



NOMAD 80

User Manual

Edition: May 2019

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: 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, e.g. bypass boxes and other safety devices and their location are the responsibility of the user and are not provided by MLT Inverters.

CAUTION: Do not cover the device or store 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 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 distribution board and if possible at the batteries.

1.2 Contacting MLT Inverters

1.2.1 Product Support

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

- Charge controller model number
- Serial number
- Battery type
- Battery bank capacity
- Battery bank voltage
- A description of the event

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) 21 201 1335

Email: info@mltinverters.com

Address: 103 Garfield Road
Kenilworth 7708
Cape Town
South Africa

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@mltinverters.com and will be answered at the earliest opportunity. When contacting technical support, please ensure that you have the information listed above available.

1.3 System Specifications

1.3.1 System Ratings

	Nomad 80 Charge Controller
Number of Input Ports	2 (Individual MPPT Control)
Input Vmp Voltage Range	65 - 375 Vdc per port
Maximum Input Voltage	400 Vdc
Nominal Photovoltaic Power (24/36/48V)	1000 W / 1500 W / 2000 W (per port)
Maximum Photovoltaic Power (24/36/48V)	1500 W / 2250 W / 3000 W (per port)
Output Voltage range	20 – 63 Vdc
Max Battery Output Current	80A (2x 40 A per port)
Programmable Aux. Control Output	30Vdc / 277Vac / 5A relay
Protection	Ground-Fault Detector Interrupter (GFDI), Overvoltage (Photovoltaic and Battery), Reverse Polarity (Photovoltaic and Battery)

1.3.2 Battery Input

Nominal Battery Voltages	24, 36 and 48 Vdc (configurable at start-up)
Battery Temperature Compensation	Optional Remote Temperature Sensor (RTS) available

1.3.3 Efficiency

Efficiency	Up to 95 % @ 80Adc in a 48Vdc system (typical)
No Load Power Consumption	Less than 2.5 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	Full colour Touch screen 4.3 inch LCD
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

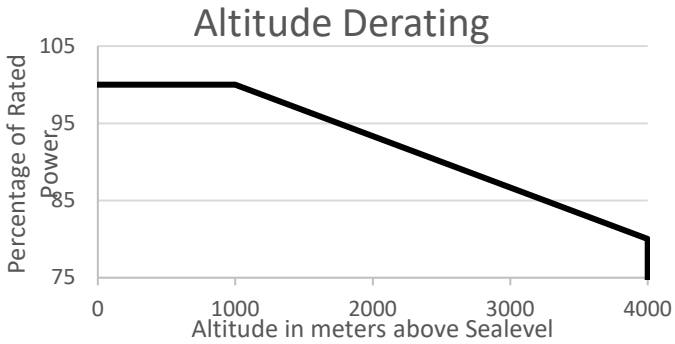


Figure 1: De-rating the Nomad charge controller output power at high altitude

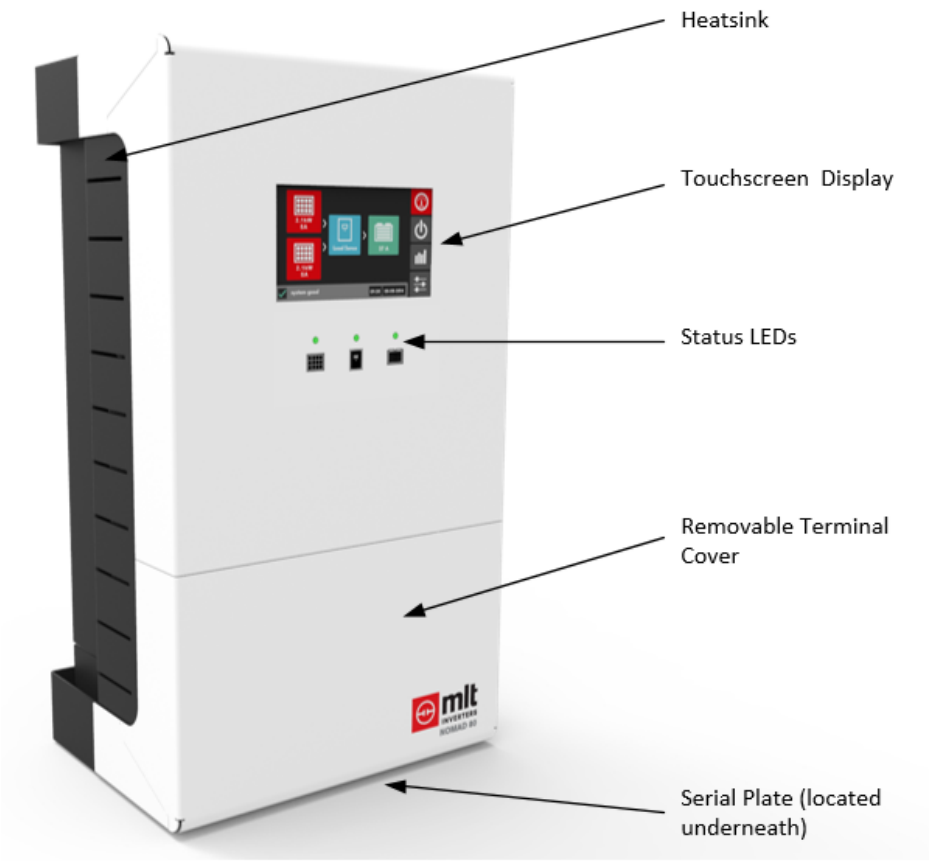


Figure 2: Identifying parts of the Nomad

2. Advanced Features

2.1 Two Independent Maximum Power Point Trackers

The Nomad 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 65 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 junction 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 Nomad physically disconnects the PV-panels to ensure site and operator safety.

The Nomad 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 Nomad is compatible with a variety of battery technologies. For example, in the event of a Li-ion battery trip, the Nomad will immediately disconnect, thereby protecting against rapid battery DC bus rises which typically destroy slower MPPTs and connected inverters. The Nomad's charging voltage and current are fully adjustable, and it can communicate via CAN bus (optional).

2.5 Lead-Acid Battery Equalise

The Nomad 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.

2.6 Auxiliary Relay control

A single, no voltage dry-contact auxiliary relay can be controlled with the user settings menu. This relay can be used to control external load relays, or any other simple binary logical circuit you can think of.

2.7 MLT Bridge Communications (Optional Add-on)

The Bridge external optional add-on enables browser-based internet monitoring and control of the Nomad charge controller. The Bridge must be connected to an internet network.

Visit our website for further details.

3. Solar/Cable Calculations

3.1 Open Circuit Input Calculations

The Nomad PV input ports has an operating range of 65-350Vdc.

When choosing the number of panels in series to connect to each Nomad port, consult the PV panel specifications sheet and use the following formula:

$$\text{Maximum panels per string} \leq 375 / (V_{oc} + (V_{oc} \times (T_{min} - 25) \text{ x } T_c / 100))$$

With:

V_{oc} – Open circuit voltage at STC

T_{min} – Coldest ambient temperature the PV panels will ever be exposed to

T_c – Temperature coefficient of V_{oc} in $\%/°K$

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 Nomad 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.

4. Mounting and Electrical Connections

4.1 Installing the Nomad charge controller

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

4.1.1 Selecting a suitable location

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

1. The Nomad 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 Nomad 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. The wall must be able to take the full weight, otherwise use a mounting frame.
3. The battery leads should be as short as possible, so that the Nomad charge controller will need to be in close proximity to the batteries. (Standard cables length of cable are available as optional accessories).

Note: At high altitudes natural thermal convection (natural thermal cooling) of the all electrical equipment is degraded. This is due a lower air density available to remove heat from the heatsink. The Nomad 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 the maximum continuous load.

4.1.2 Mounting

Once a suitable location for the Nomad 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 Nomad vertically and lift it onto the mounting bracket.

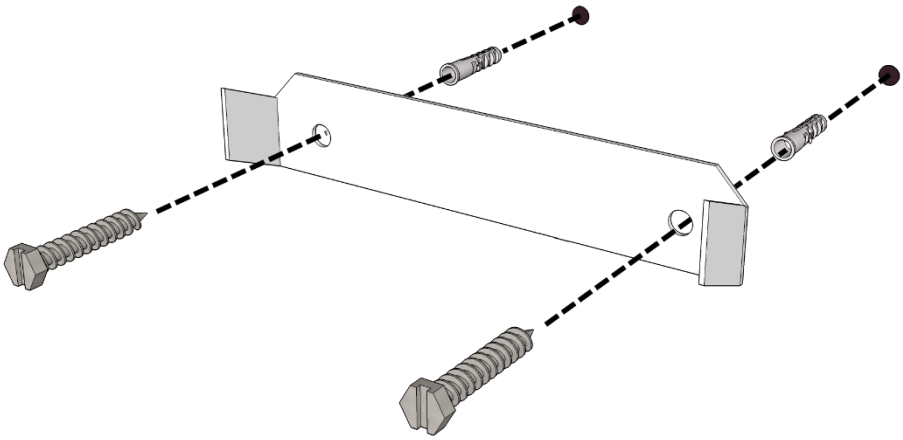


Figure 3: Wall mounting

4.1.3 Making the electrical connections

Once your Nomad 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 carefully could increase the risk of personal injury, death or damage to property or equipment.

Ensure that any electrical connections is dead before touching any potential live wiring. Certain electrical connections must be appropriately trained person. If in doubt about anything, contact MLT Inverters for assistance.

1. Remove the screws that secure the removable bottom cover.
2. The 'Earth' terminal inside the Nomad must be grounded to reduce the risk of electrical shock and to ensure that external earth-leakage protection device can operate correctly.
3. The 'PV' connections inside the Nomad will need to be connected into your solar array. These connections should be made with an 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 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 Nomad.

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 MLT Inverters. MLT 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 MLT Inverters approved installer.

4.1.4 Disconnecting the Inverter

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

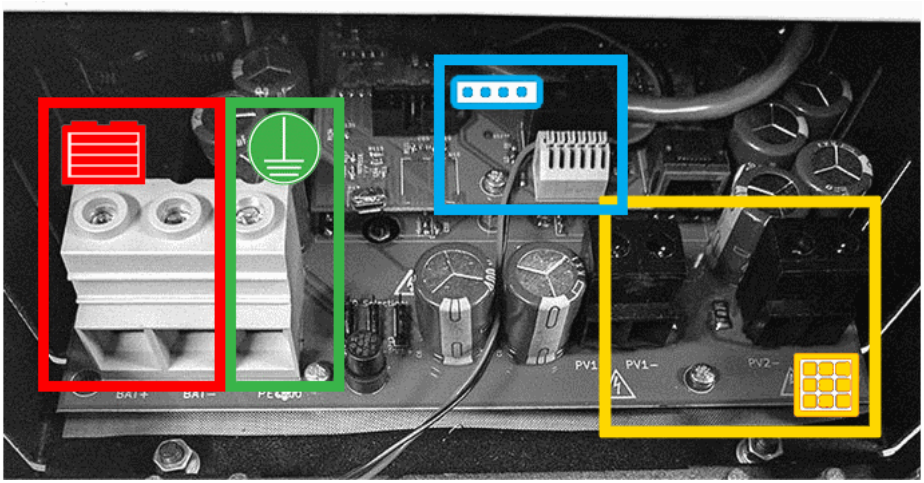


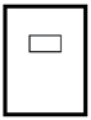
Figure 4: Input/output connections on the Nomad

The above picture illustrates the location of the Battery Connection (red, remember to observe polarity), Earth (green), the External Connections plug (blue), and the Solar (yellow).

5. Charge Controller Operation Indicators

On the front panel of the Nomad charge controller there is three LED status indicators:

Solar status



Charge Controller status

Battery status

5.1 Solar Status

Green – The Nomad charge controller is active and there is sufficient power in order 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 Nomad 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 Nomad is performing an equalise charge.

6. Interface

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

6.1 System Icons

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

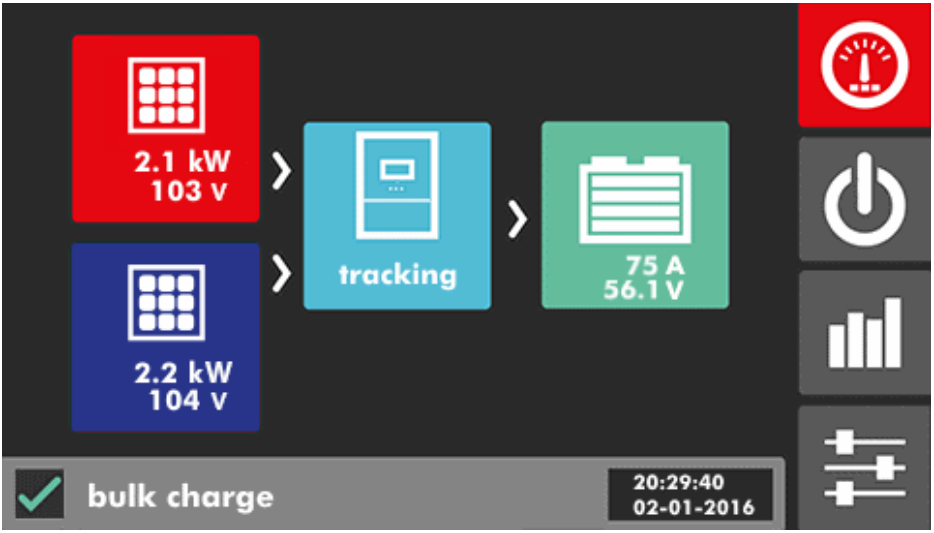
Dashboard

Control Panel

Graphing

Settings

6.2 Dashboard



The Dashboard screen shows an overview of the current charge controller operation. Power coming from the each of the solar arrays, and battery charging current. Clicking on each of the icons takes you to the individual graphing screens.

From the top left, the source power draw and frequency is indicated underneath the **red Source** icon.

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

The **light blue Nomad** 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 an indication of the state charge of the battery bank, with four bars implying a full charge and one bar implying battery critical.

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 button here with the followings functions:

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.

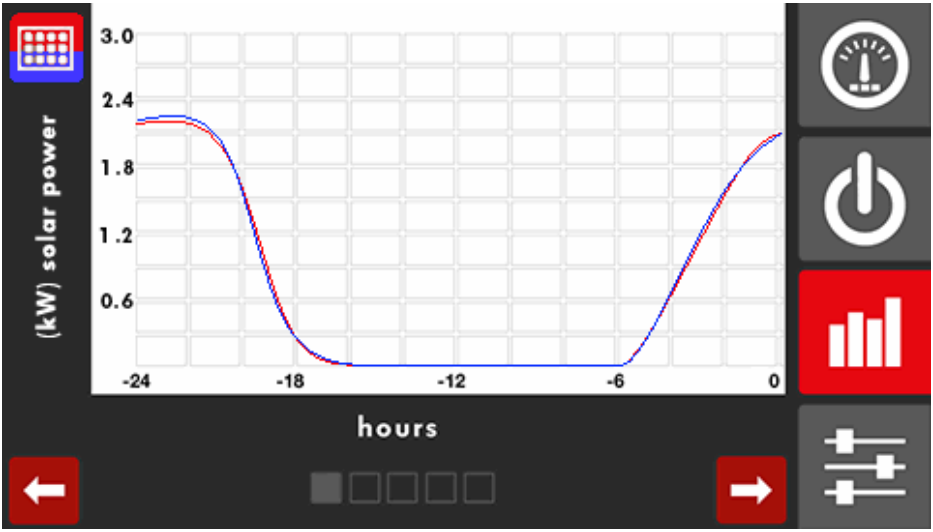
Sweep forces the charge controller to recalculate the maximum power point for both the solar arrays.

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.

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

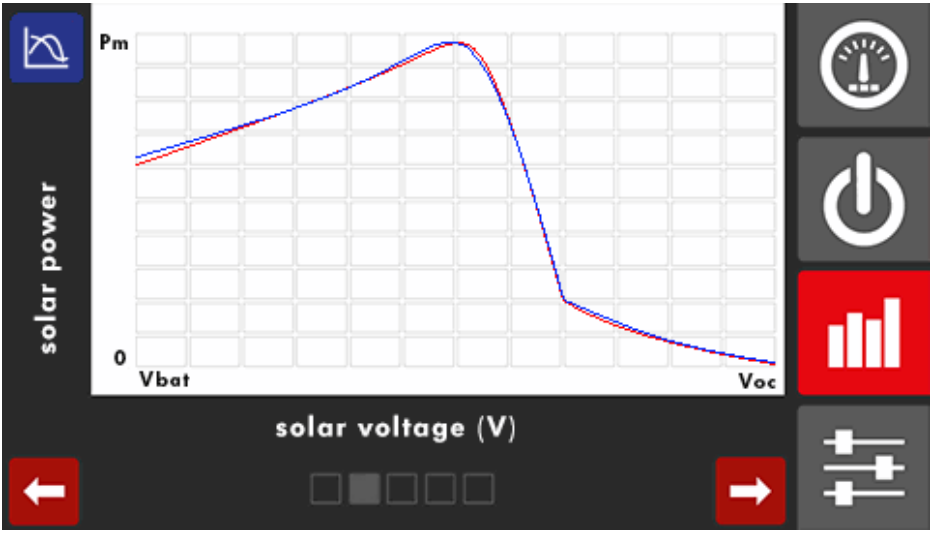
6.4 Graphing and Logs

6.4.1 Solar Output Graphs



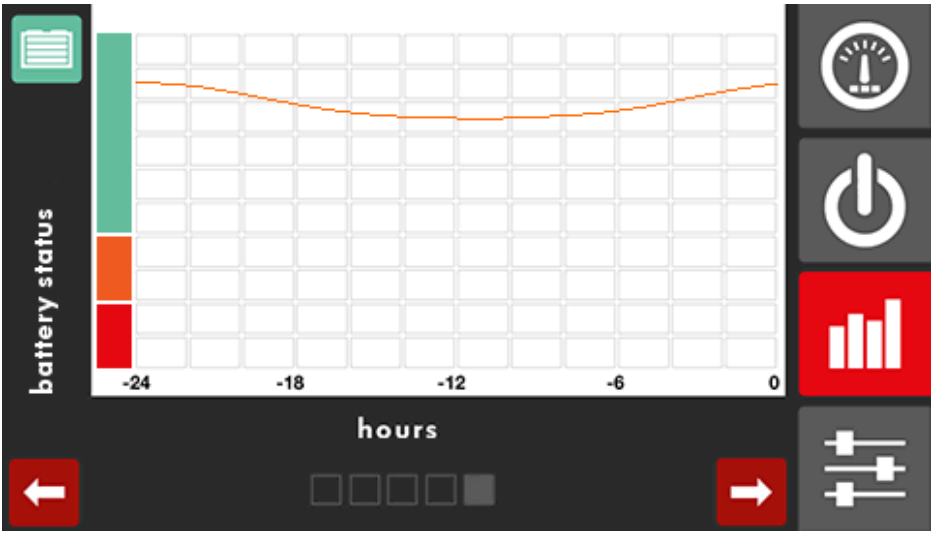
The solar input screen graphically shows the amount of solar power that each of the two inputs delivers. Input one is plotted in red and input two is plotted in blue.

6.4.2 Solar Sweep Graph



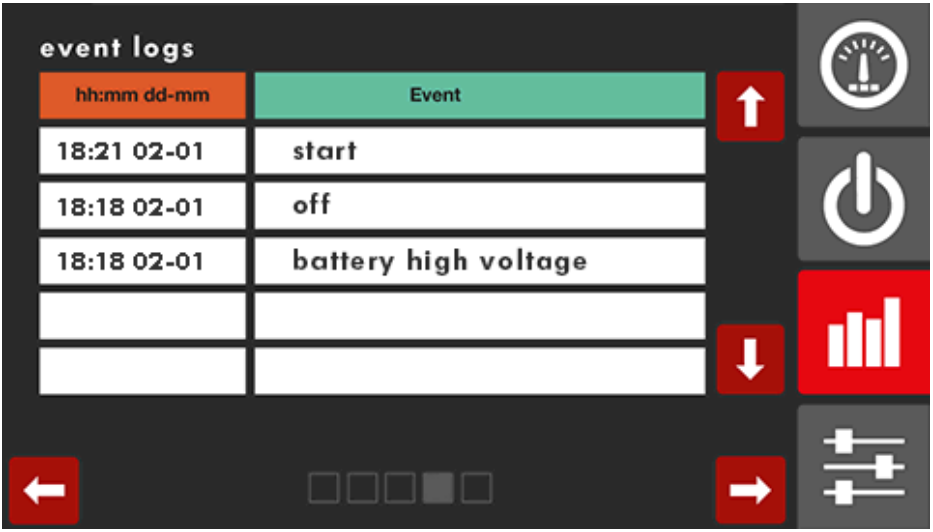
The solar sweep graph plots solar power vs voltage. This can be used by your installer to check if the panels are performing optimally.

6.4.3 Battery Graphs



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

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 the solar output.

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 Battery High 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

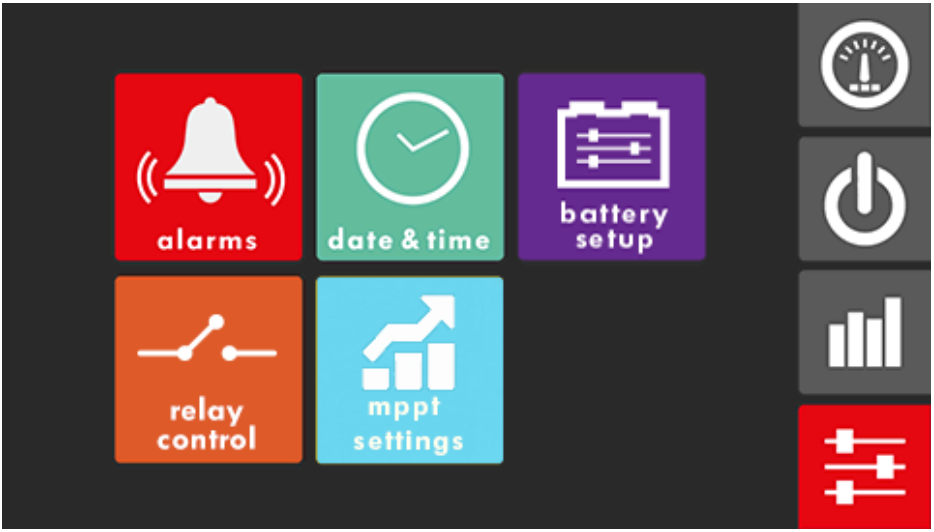
If the solar voltage goes higher than the upper limit of the solar input, this message will be logged and the charge controller will switch off until it is back in specifications.

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.

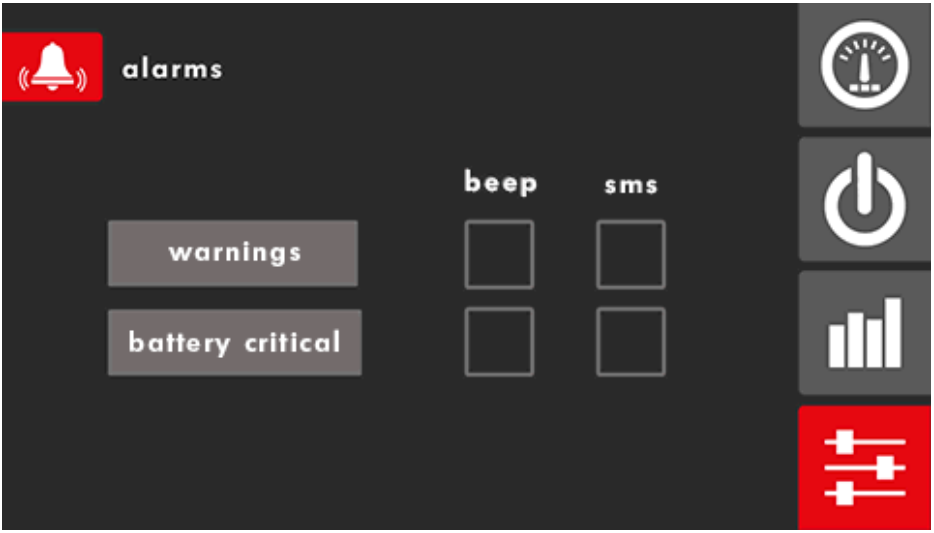
6.5 Settings

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



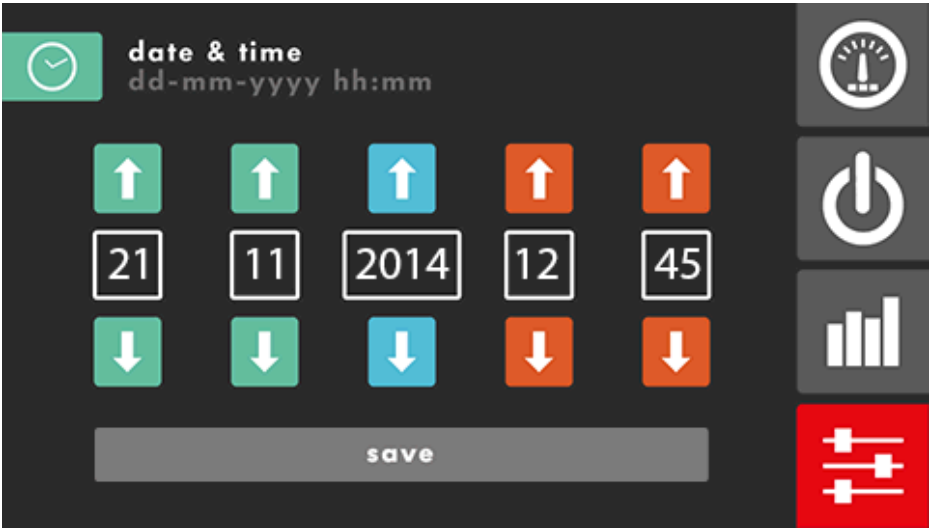
6.5.2.1 Beep

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.

6.5.2.2 SMS

The SMS function is only available if a Bridge communications module is attached to the Nomad.

6.5.3 Date & Time

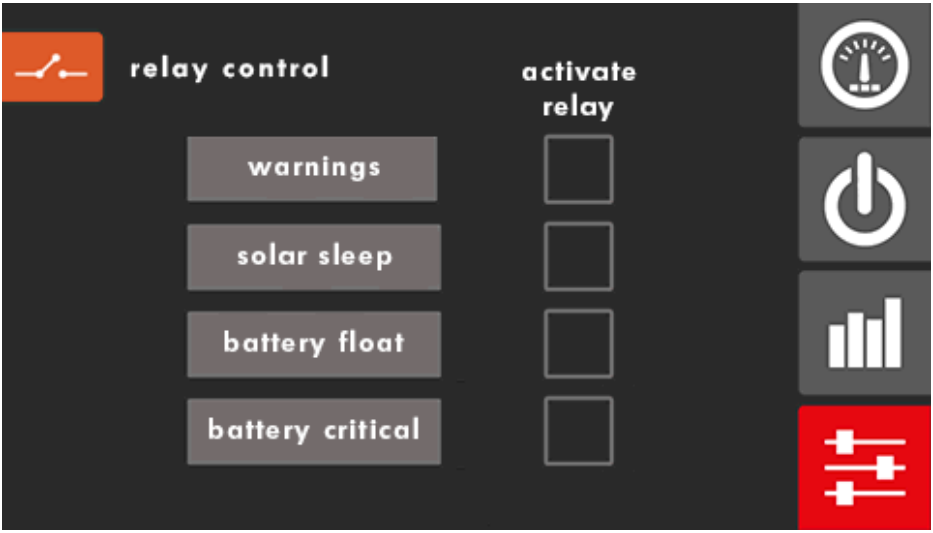


Set the date and time to the current time, using the up and down arrows. In this example the date is the 21st of November 2014, with the time being 12h45 in the afternoon.

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 make the changes permanent.

6.5.4 Relay Control



A single, no voltage auxiliary relay can be controlled with the above three user settings. Please see section 2 for more details on how to use this relay settings.

Since there is only one relay, setting more than one option will perform action for all three states. The typical use for the setting all three is to start a generator when the battery reaches a low state of charge.

6.5.4.1 Warnings

The relay will close on any of the reasons as discussed in chapter *7. Faults and Warnings.*

6.5.4.2 Solar Sleep

When the current into the batteries reaches less than 1A for an extended period of time, the Nomad will go to sleep and close the relay.

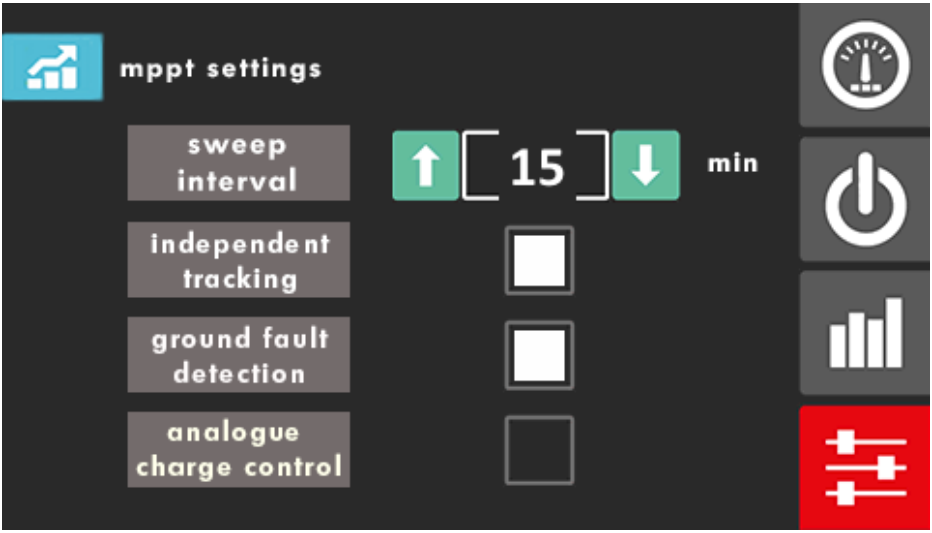
6.5.4.3 Battery Float

Once the battery is fully charged the relay will be closed. See *6.5.6 Battery Setup*.

6.5.4.4 Battery Critical

When a battery critical value is reached, the auxiliary relay will be engaged. See *6.5.6 Battery Setup*.

6.5.5 MPPT Settings



6.5.5.1 Sweep Interval

When the battery cycle is activated in the settings menu, the following system operation will be applicable (Please ensure that the Date & Time is set correctly.):

6.5.5.2 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.

6.5.5.3 Ground Fault Detection

The Nomad 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)* section for more information.

6.5.5.4 Analogue Charge Control

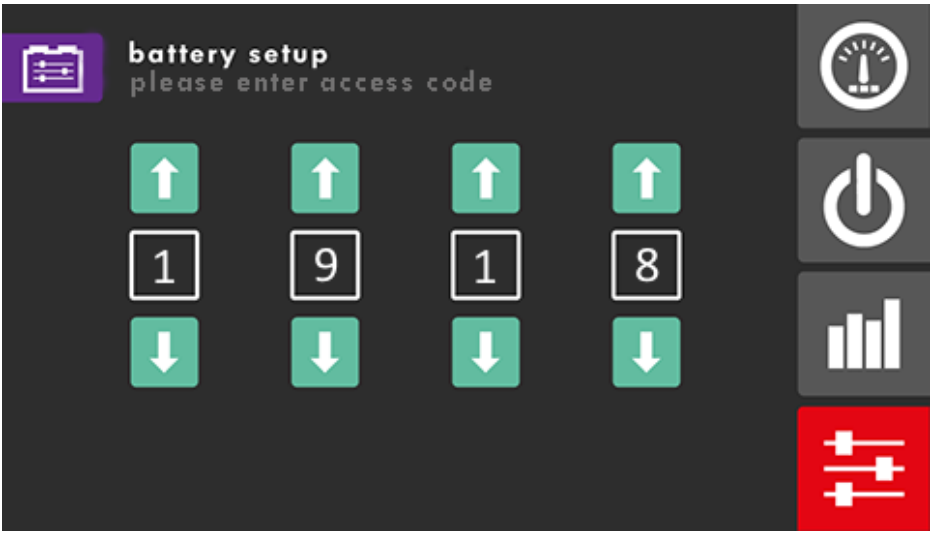
This setting enables temperature sensing and adaptive battery charging by connecting the required cable to the External Connections plug (see *Figure 4: Input/output connections on the Nomad* for the location of the plug). Selecting this option with **no cable connected disables battery charging.**

This feature is used by certain *freedomWON*[1] Lithium batteries.

[1] http://www.freedomwon.co.za/

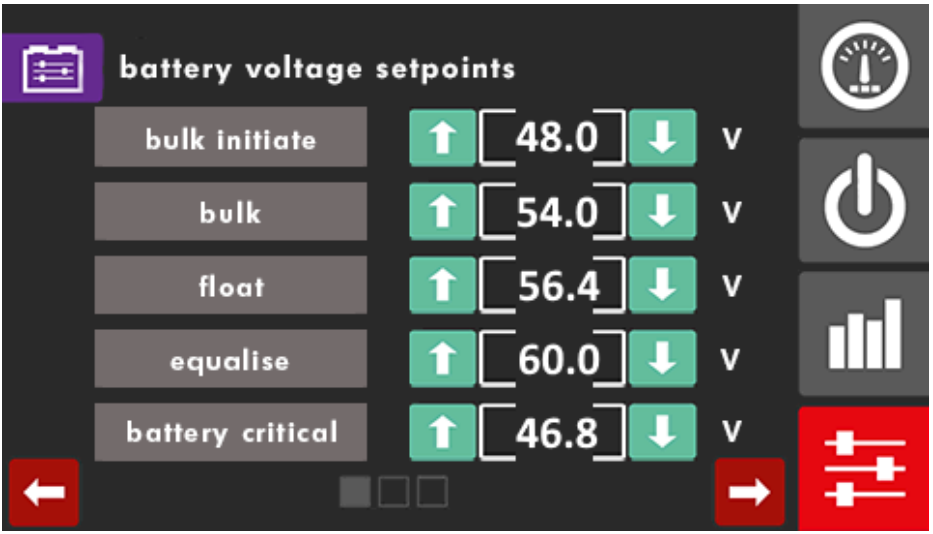
6.5.6 Battery Setup

6.5.6.1 Battery Setup – Access Code



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

6.5.6.2 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.

6.5.6.2.1 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.

6.5.6.2.2 Bulk

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

6.5.6.2.3 Float

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

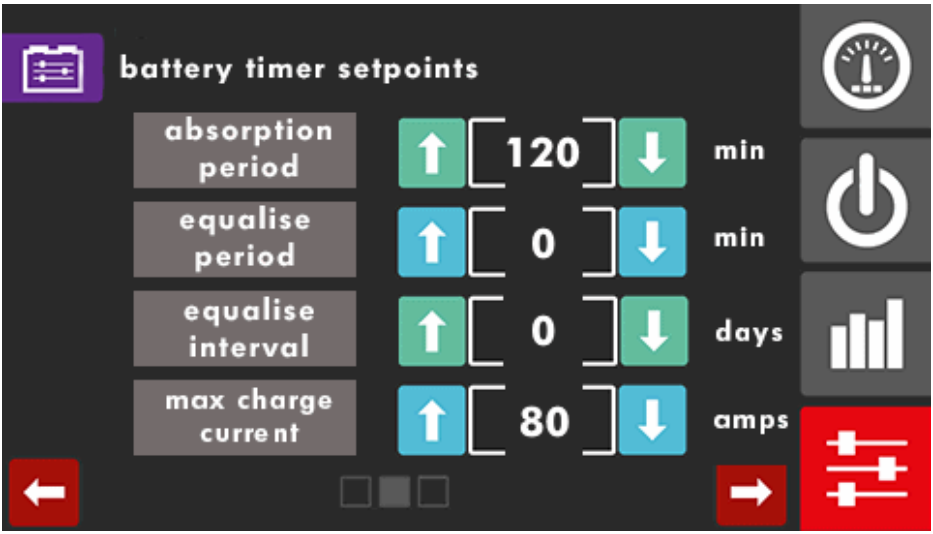
6.5.6.2.4 Equalise

Some types of batteries require a periodical equalise charge.

6.5.6.2.5 Battery Critical

This setting is used for the relay option, see *6.5.4 Relay Control*.

6.5.6.3 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.

6.5.6.3.1 Absorption period

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

6.5.6.3.2 Equalise period

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

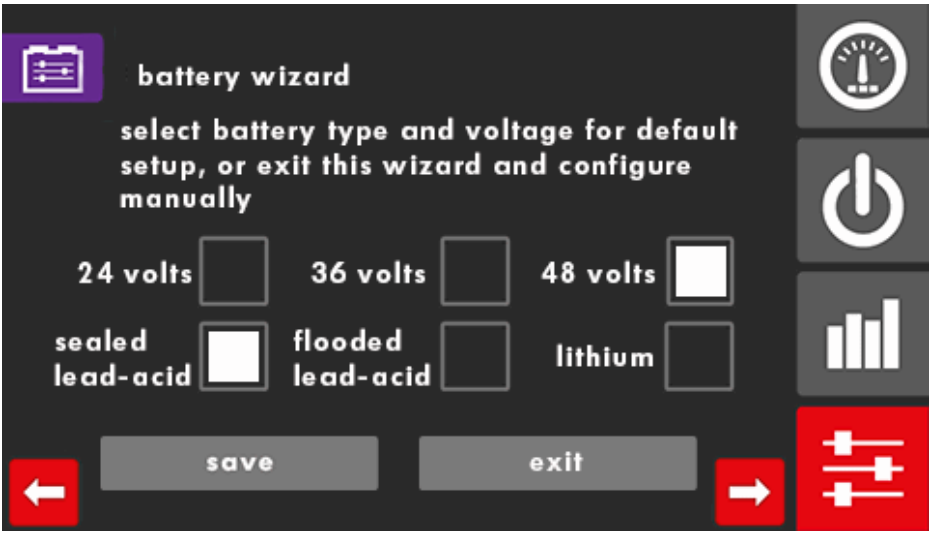
6.5.6.3.3 Equalise interval

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

6.5.6.3.4 Max charge current

The maximum current that the batteries will ever be charged at.

6.5.6.4 Battery Wizard



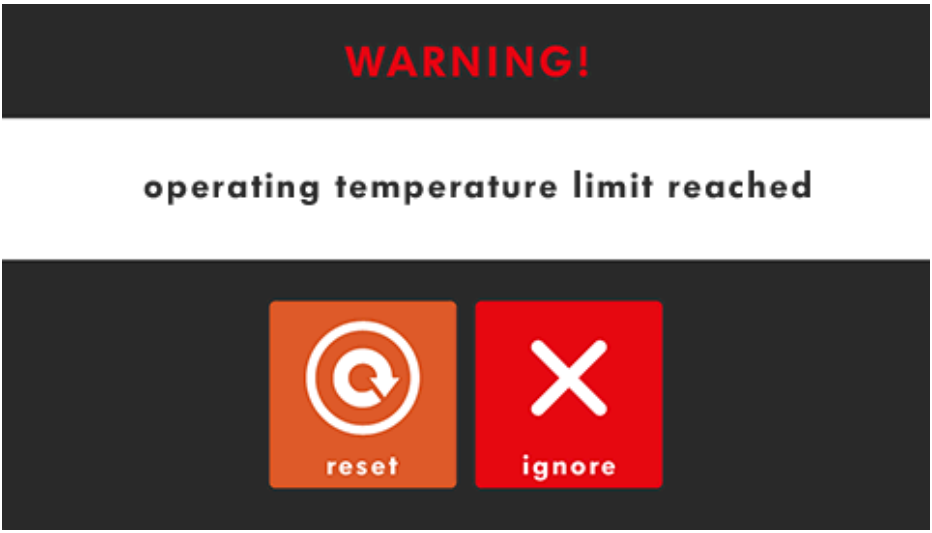
The Battery Wizard screen allows the user to quickly select some pre-configured options. Depending on the selection it will pre-set the battery options as below:

(24 / 36 / 48V)	Sealed Lead-Acid	Flooded Lead-Acid	Lithium
Bulk Initiate	24 / 36 / 48 V	24 / 36 / 48 V	24 / 36 / 48 V
Bulk	27.6 / 41.4 / 55.2 V	29.4 / 44.1 / 58.8 V	28.2 / 42.3 / 56.4 V
Float	26.4 / 39.6 / 52.8 V	26.4 / 39.6 / 52.8 V	28.0 / 42.0 / 56.0 V
Equalise	-	30 / 45 / 60 V	-
Absorption period	120 min	120 min	60 min
Equalise period	-	60 min	-
Equalise interval	-	60 days	-
Max Charge Current	85 A	85 A	85 A

Sweep Interval	30 min	30 min	30 min

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. This will re-enable the charge controller and it will start to export power 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 by selecting the appropriate option from the control menu.

7.2 Description of Warning and Faults

7.2.1 Operating Temperature Limit Reached

If the internal temperatures exceed a certain level, the charge controller will start to reduce the output power in an attempt to regulate the internal temperature to an acceptable level.

7.2.2 High Battery Voltage

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

7.2.3 High Solar Voltage

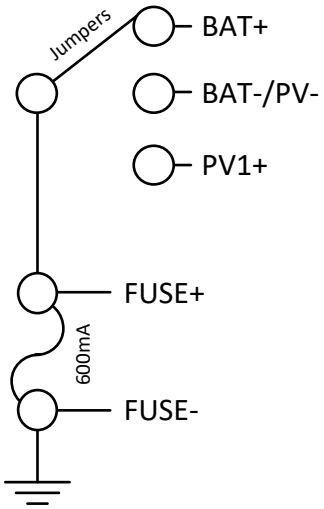
One or both of the two solar ports has a too input voltage. Once the input voltage returns to an acceptable level, the charge controller will resume battery charging.

7.2.4 Incorrect Nominal Voltage

If the battery voltage is far outside the acceptable nominal range, the charge controller will suspect operation until the correct nominal voltage is selected.

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 equipment grounding conductor.



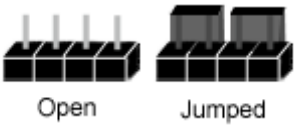
This can create a number of hazards since the normally grounded current-carrying conductor may no longer be at ground potential. The Nomad physically disconnects the PV-panels to ensure site and operator safety.

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

The Nomad 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 blow the voltage difference is detected and the Nomad 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 Nomad, 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 26).

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

8.1.1 Battery Positive

Select this option if your battery bank needs to be positively 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 panel needs to be 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 panel needs to be 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 6.5.5 MPPT Settings on page 26.

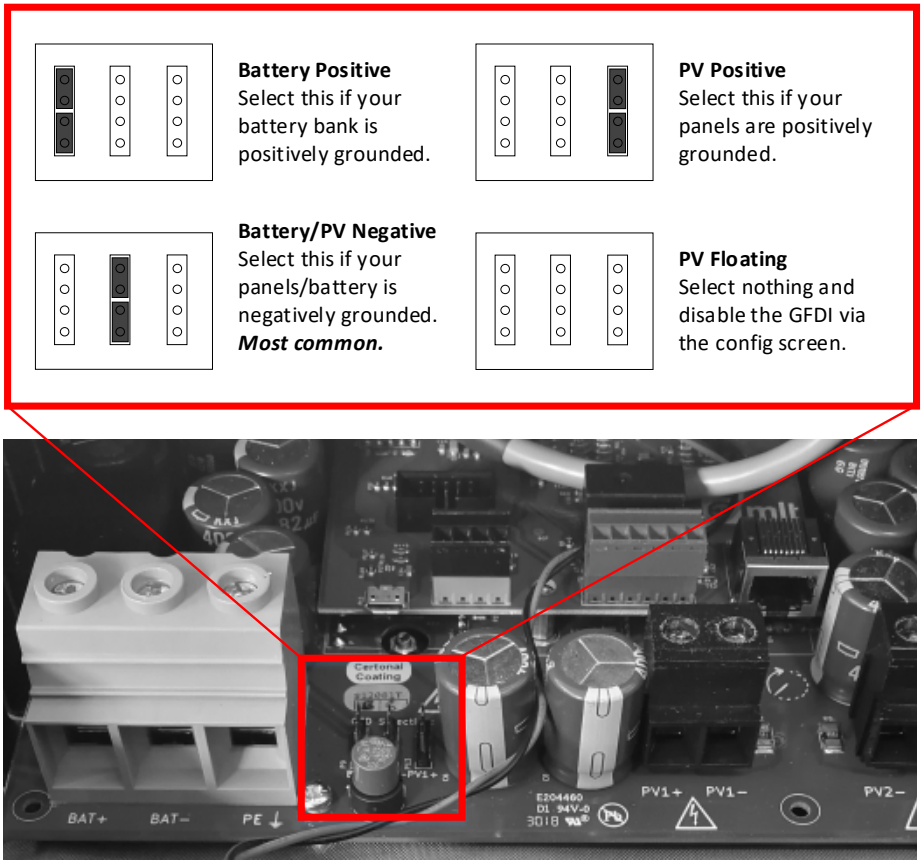
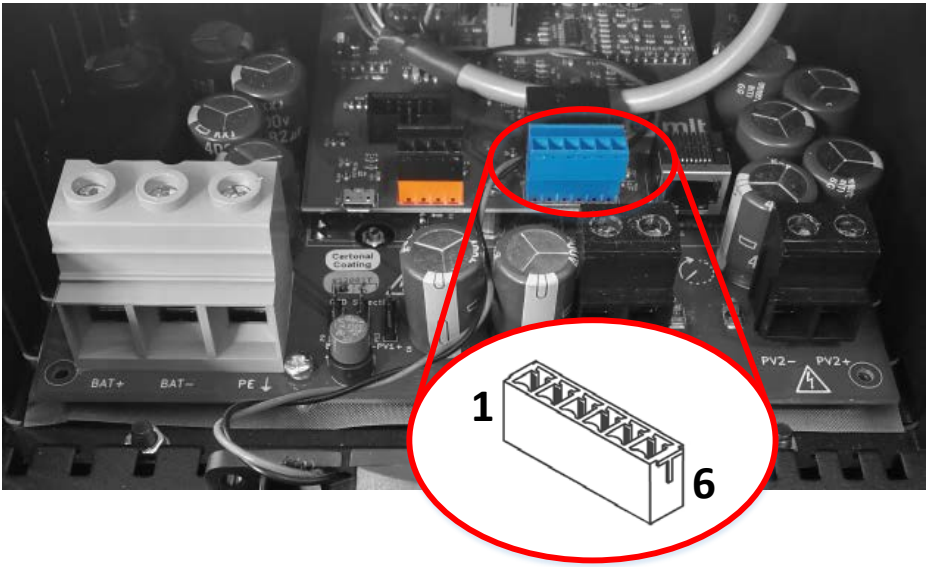


Figure 5: GFDI Jumper Selection (Bottom Cover Removed)

9. External Connections

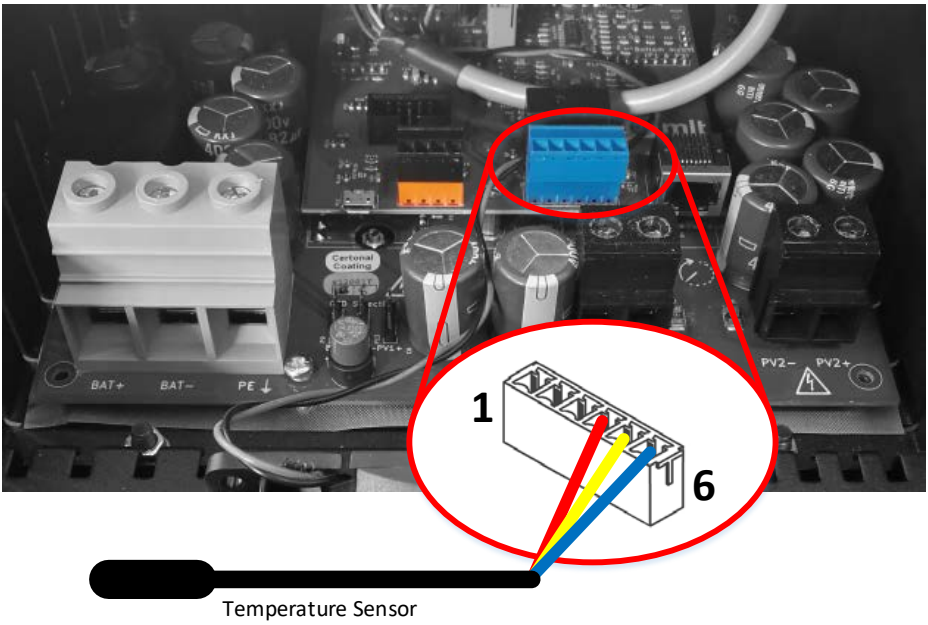
9.1 External Connections Header



	Name	Description
Pin 1	Normally Open Relay	The output of the on-board relay is tied to Normally Open/Normally Closed pin respectively. The relay will toggle depending the Relay Settings. See *6.5.4 Relay Control* for options.
Pin 2	Normally Closed Relay	
Pin 3	Relay Common	
Pin 4	+5V	A temperature sensor with a 10mV/°C (0V at 0°C) scale can be connected and the Nomad will automatically throttle back at high temperatures. Alternatively, pull the Output Throttle pin to +5V to throttle all output of the charge controller to zero.
Pin 5	Temperature Sensor/Output Throttle	
Pin 6	Ground	The Ground/Throttle for current limiting when using a Freedom Won battery with analogue control.

9.2 Temperature Sensor

An external (optional) temperature sensor is available. This will automatically reduce the float and charging voltages depending on temperature. The voltage reduction is approximately 60mV/°C per cell for every degree above 20°C.



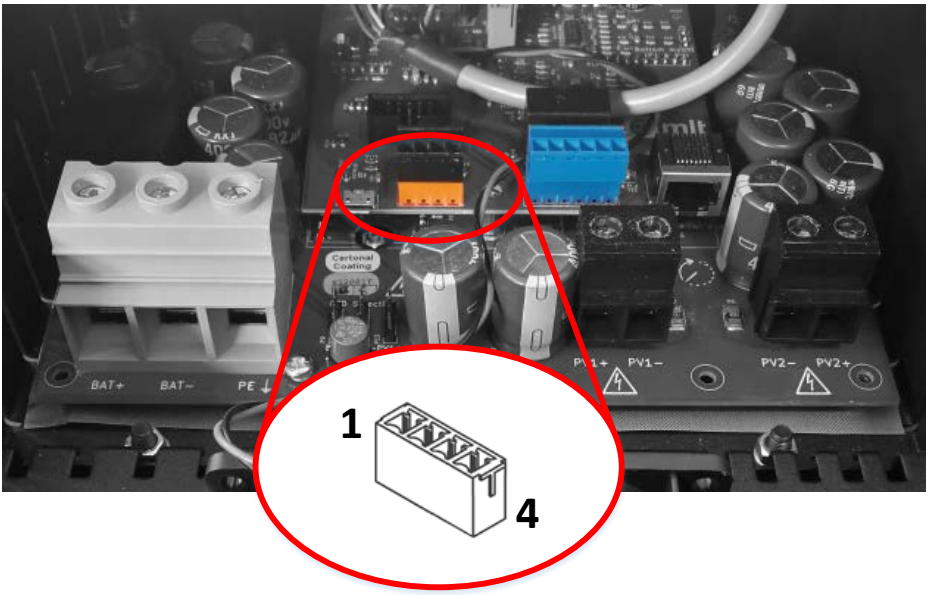
Installation procedure:

1. Isolate solar and battery.
2. Remove cover of Nomad.
3. Wire the Temperature sensor into the connector on the far right, with red (+5V, pin 4), yellow (Sense, pin 5) and blue (GND, pin 6).
4. Turn on the Nomad.

If the Nomad is configured as a Lead-Acid battery, ensure that the Analogue Charge Control setting is disabled. Temperature based throttling will enabled and use the temperature sensor.

9.3 CAN-bus connector

Nomad charge controllers with a newer hardware revision comes with a CAN-bus connector included for communication to a Lithium battery. Contact MLT 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 side signal for the CAN bus.
Pin 3	CANH	CAN-HIGH side signal for the CAN bus.
Pin 4	RES	This is a 120Ω termination resistor if the Nomad is placed at the end of the CAN-bus. Bridge this pin with pin 3 to complete the termination.

10. Batteries

10.1 General

A number of batteries can be used together with the Nomad charger. There are two types of batteries that can be used, Lithium and Lead-Acid.

10.1.1 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 suitable for backup applications.

10.1.2 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.

10.1.3 Lithium Batteries

Lithium based batteries is currently manufactured using various technologies and chemistries. The most commonly available Lithium batteries are lithium polymer batteries (LiPo) and Lithium Iron Phosphate ($LiFePO_4$). Some Lithium batteries can be used with the Nomad charge controller please contact MLT Inverters for details of recommended Lithium packs.

10.2 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.
- Appropriate protection ***must always*** be installed!

10.3 Maintenance

The battery maintenance required will be detailed in the documentation supplied with the battery. Flooded batteries generally includes 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.

10.4 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.

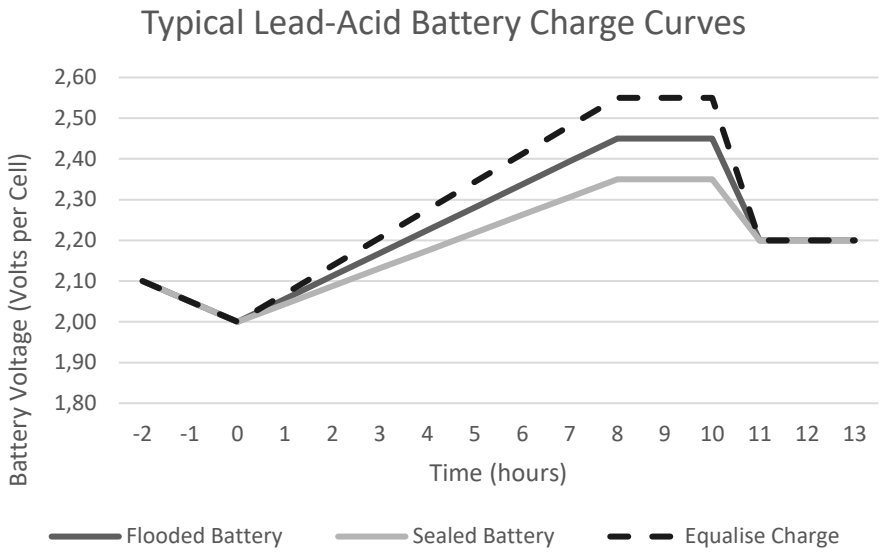
If you are not sure about the type and capacity of the batteries installed, please contact your installer. Always following the instructions of the battery manufacturer.

ELECTRICAL SHOCK: 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 connection must be made a qualified person.

10.5 Lead-Acid Battery Charging

10.5.1 Charging Stages



The Nomad 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.

10.5.1.1 Stage 1: Bulk Constant Current Charge Period (Hours 0-8)

This is the first stage of charge using a constant current until the either 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.

10.5.1.2 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.

10.5.1.3 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.

10.5.1.4 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.

10.5.2 Battery charger settings

It is important to select the correct charging current and voltage for your batteries during the installation of your Nomad. 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:

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

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

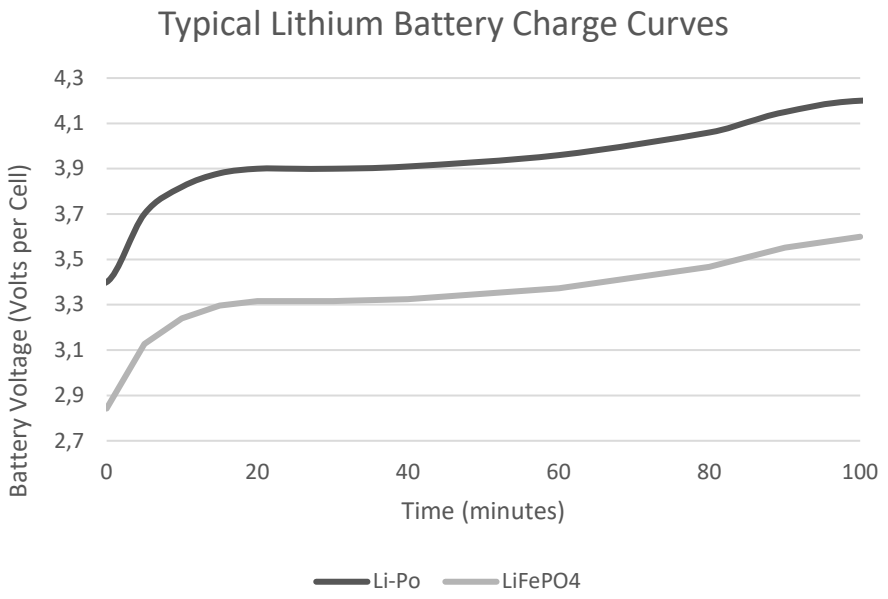
$$\frac{205\ Ah}{10\ h} = 20.5A$$

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 was correct at time of publication, but manufacturers may change the limits.

	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

10.6 Lithium Battery Charging



The Nomad can charge certain Lithium-based battery banks. Lithium batteries are typically charged much faster than Lead-Acid based batteries, and at higher currents. Please see the MLT Inverters website for full information regarding compatible battery banks.

10.6.1 Battery charger settings

It is important to select the correct charging current and voltage for your batteries during the installation of your Nomad.

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.

11. Trouble Shooting

11.1 Faults

If there is a fault with the Nomad 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 Nomad or MLT Inverters product support. See 'Contacting MLT Inverters' on Page 8.

11.2 Typical Problems

11.2.1 The Nomad 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 Nomad 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 Nomad 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.

11.2.2 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.

12. 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 No can take DC from batteries and output 230V AC to supply homes and businesses.
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