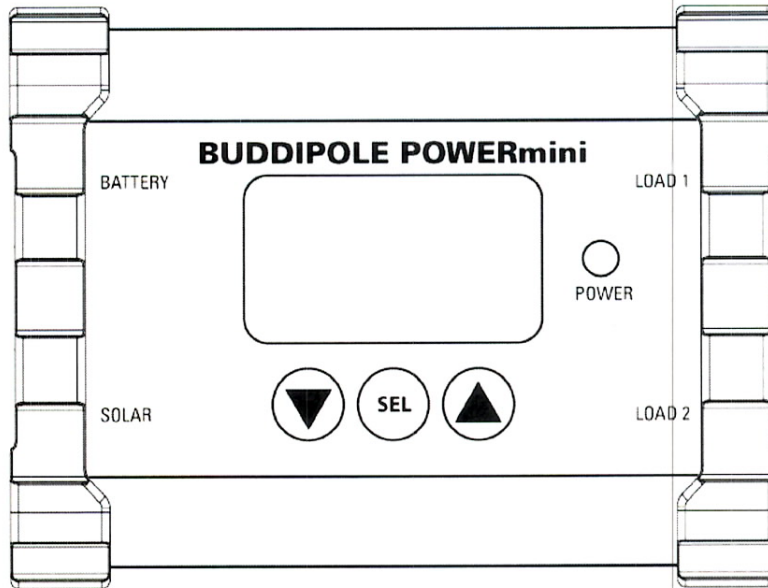


BUDDIPOLE

COMPACT PORTABLE DC POWER MANAGEMENT SYSTEM
WITH BUILT IN SOLAR CONTROLLER

POWER_{mini} USER GUIDE



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Introduction

The Buddipole POWERmini is a unique, 12 VDC power control system particularly suited for portable operations. This highly integrated device incorporates the functions of a solar charge controller, battery management system, power monitoring device and power distribution in a small, robust and weather resistant package. Despite its small size the unit handles a load current of up to 25A. Be sure that you use the appropriate gauge of cable for the application that you are using. For a load current of 25A you should use at least 12 AWG insulated wire.

BASIC FEATURES

POWERmini optimizes the life of the battery by protecting the battery from overcharging or excessive discharge. It accomplishes this by constantly monitoring the battery voltage and solar panel voltage and determining the state of charge of the battery.

The unit provides warning of low battery voltage and can be configured to disconnect the battery automatically to protect from damage due to deep discharge.

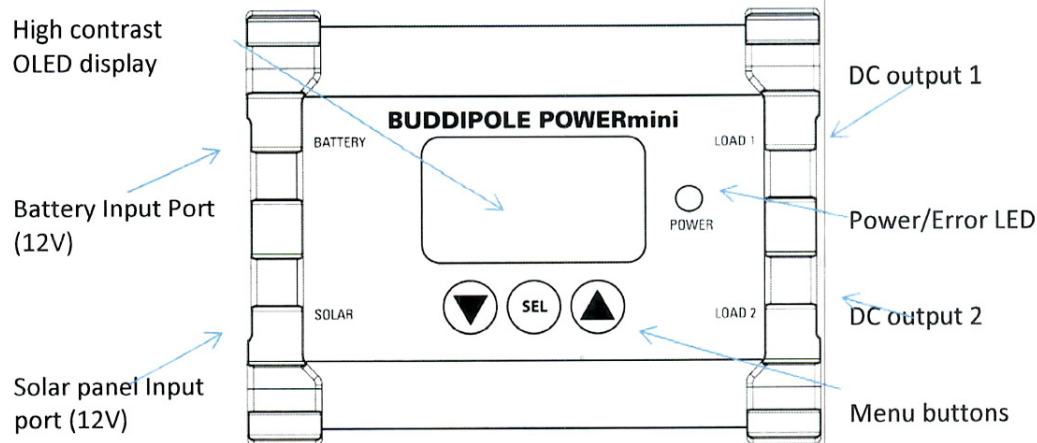


Figure 1 POWERmini controls and power connections

All power connections use the popular Anderson Powerpole® family of low voltage high current connectors which are popular in amateur radio particularly with Emergency communications.

The right side of the unit contains two Powerpole output ports enabling connection of power to a radio as well as some auxiliary device such as an LED work light, SWR bridge or small Power Amplifier.

The front panel contains an OLED graphical display which provides a comprehensive view of the 12 VDC power system. The navigation buttons located below the display switch between display pages and edit user settings. The SELECT button is the center button and the UP/DOWN buttons on either side of the SELECT button are used to change user settings.

QUICK START

The POWERmini can be setup to work with either Lead Acid or Lithium ion batteries. The initial configuration (default) is for Lithium – ion. If you are going to use a Lead-Acid battery see the section Changing User Settings (page 9) for details.

Connecting

To get started with POWERmini connect as shown in Figure 2 below:

From	To	Connectors
Radio	POWERmini LOAD1	Red/Black
Accessory	POWERmini LOAD2	Red/Black
Solar Panel	POWERmini SOLAR	Yellow/Black
Battery	POWERmini BATTERY	Blue/Black

In all cases the BLACK terminal is the negative terminal and the colored terminal is the positive terminal.

The unit will work with or without a solar panel connected. If you are not using a solar panel then you may leave the solar port unconnected and the unit will function normally. Note however that the solar input should only be used with a solar panel and should not be connected to any other type of power source (for example DC power supply or car battery) as this may cause damage to the battery and/or POWERmini.

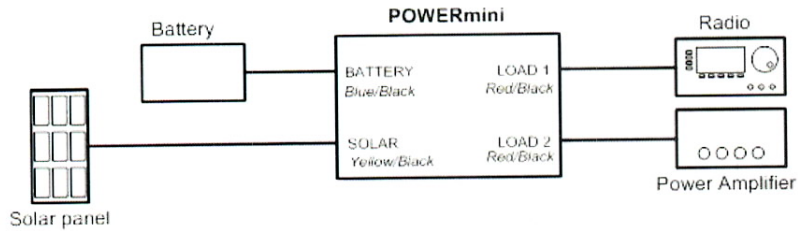


Figure 2 POWERmini power connections

OPERATIONS

This section provides information about how to get the most out of your POWERmini.

Menu Selection

Immediately after battery power is connected to the unit the Startup Page is briefly displayed followed by the Main Display Page. The display screen will be blanked after displaying the screen for about 5 minutes after the last button push. Press any front panel button to wake up the display.

There are two other display pages in addition to the Main Display Page. Briefly press the SELECT to switch between the three display pages as shown in Figure 3 below. The SELECT button is the center button in the row of three buttons

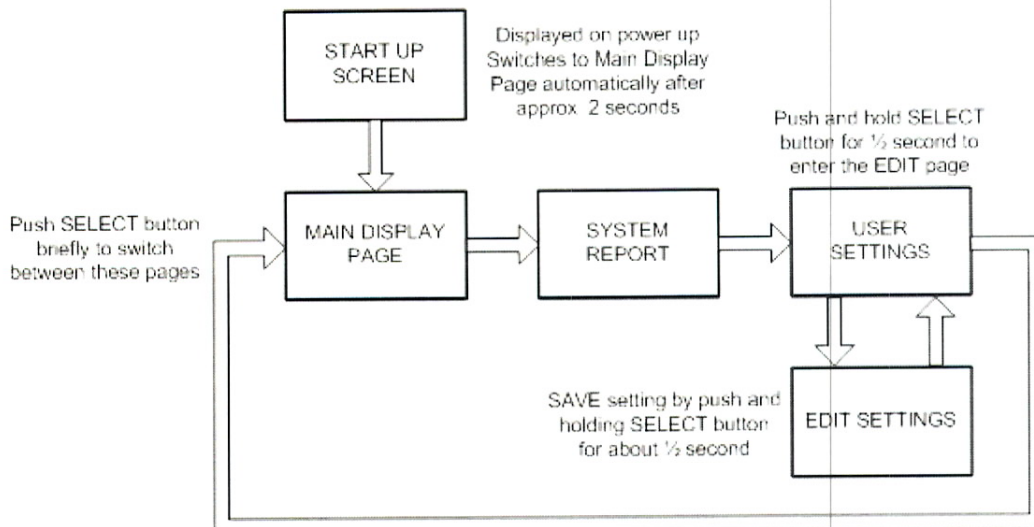


Figure 3 Menu Selection

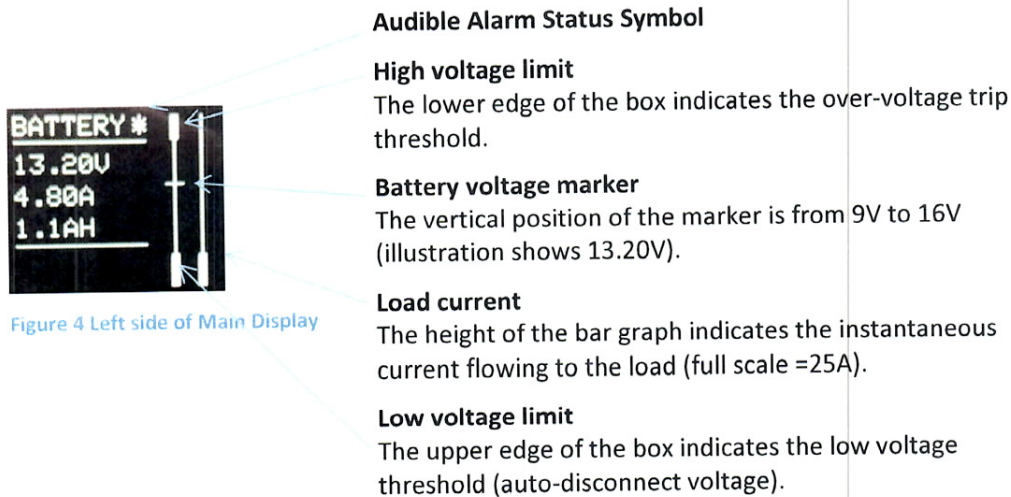
The User Settings page is different from the two other pages because it includes user settings that can be changed. To change the user settings first select the User Settings Page and then press and then hold the SELECT button for about 1/2 second to enter the Edit Settings Page. Details about how to make changes are provided in the Changing User Settings section found on page 9.

Main Display Page

The Main Display Page is where important information about the system is shown.

The left side of the Main Display Page provides digital information about the battery including battery voltage, load current and the amount of charge that has been provided by the battery to the load since power has been applied. The status of the audible alarm is also indicated here. When the alarm is enabled an asterisk is displayed to the right of the "BATTERY" title line. The asterisk is not shown when the audible alarm is disabled.

Two vertical bars to the right of the digital information provide a graphical view of the state of the battery and the user defined settings (see Figure 4).



The upper and lower limits are shown on the left vertical bar as the thick bars at the top and bottom of the graph. The thin vertical line between them shows the useful region of battery voltage. The thin horizontal marker is the battery voltage marker.

As the battery voltage decreases the battery voltage marker will move down the scale towards the white box representing the lower voltage limit. When the marker is about 0.5V above the top of the lower voltage limit a Low Voltage Warning message is displayed in the space at the bottom left of the display and front panel POWER LED will flash red.

As the battery discharges further the battery voltage marker will reach the lower voltage limit and the Shutdown Warning message will be displayed at the bottom of the display. If the automatic shutoff feature is enabled, power will be disconnected 10 seconds after this point has been reached.

If the battery voltage increases above the lower edge of the voltage limit box the unit will automatically disconnect the load to protect your radio equipment. Power will not be restored until the voltage falls below the lower edge of the upper voltage limit box. For more information on settings associated with alarms and disconnect and Low voltage warning see F on page 10.

The right side of the display provides information about the solar panel performance.

Operations

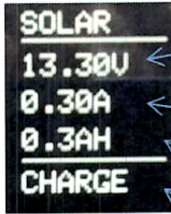


Figure 5 Right Side of Main Display

Solar panel output voltage

The solar panel voltage will be different from the battery voltage when the panel is not charging the battery.

Solar panel output current

The current being delivered from the solar panel to the battery.

Solar panel contribution to battery

The total charge delivered by the panel to the battery.

Solar Charge indicator

System Report

The System Report page shows information about the system since the POWERmini was powered up. See Figure 6 for more details.

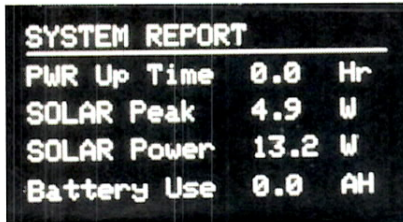


Figure 6 System Report Page

Power Up Time

The operating time since the unit was powered on.

Solar Peak

The maximum output of the solar panel since the unit was powered on.

Solar Power

The current solar panel power output

Battery Use

Actual battery charge used. The difference between charge used and charge replaced by the solar panel.

User Settings

The Main Display Page provides a graphical view of the voltage limits but does not indicate the actual numerical value. This is user defined and displayed on the User Settings Page (Figure 7) shown below.

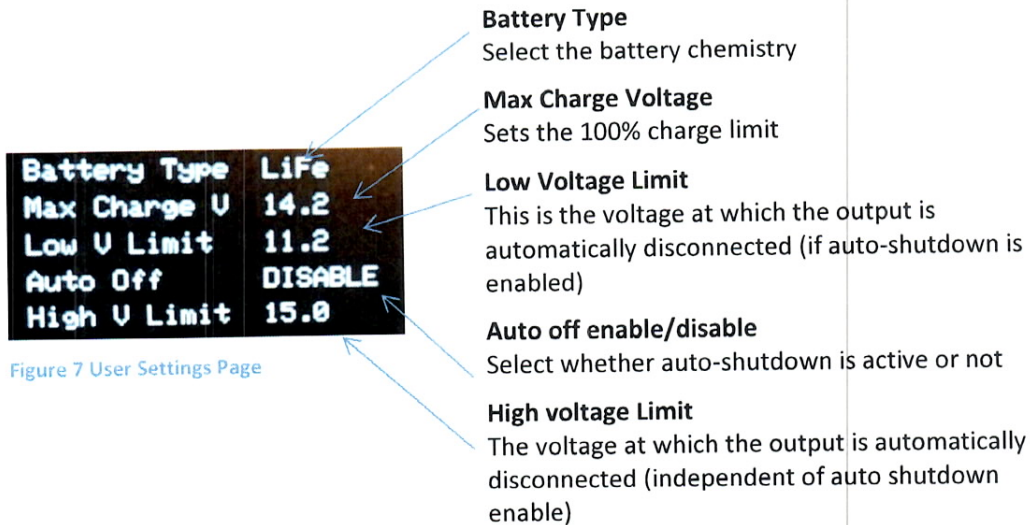


Figure 7 User Settings Page

Battery Type

Different types of battery chemistry have different charge and discharge cycles characteristics. POWERmini allows you to save settings for the maximum and minimum battery voltages separately for two different types of batteries, Lithium ion and Lead Acid.

Lead Acid batteries tend to have a greater difference between the fully charged state and the fully discharged state than Lithium ion batteries. This means that the low cut off voltage point for Lead Acid is usually lower than the Lithium ion battery.

The Battery Type setting shows the POWERmini which type of battery you are using. The Maximum Charge Voltage and Low Voltage Limit (minimum battery voltage) are saved separately for Lead Acid and Lithium ion batteries. First choose the battery type you want to use and then set the Maximum Charge Voltage and Low Voltage Limit voltage for that type of battery. Then if you plan to use a different type of battery chemistry repeat the process selecting the new battery type and storing values for Max Charge Voltage and Low Voltage Limit. Now when you recall either Battery Type the settings you stored will be automatically recalled for the selected type of battery.

Careful setting of these parameters will help ensure that the either type of battery is not overcharged or allowed to operate below the fully discharged state.

Max Charge Voltage

As a battery charges the terminal voltage rises. The voltage should not be allowed to rise significantly above the voltage corresponding to the 100% charge state or the battery will be overcharged. This may damage the battery, and in the case of Lithium ion batteries can be dangerous.

Operations

CAUTION: Unless you are sure that the battery manufacturer supports a maximum charge voltage other than the factory default (14.2V) it is recommended that you do not change the maximum charge voltage setting.

The maximum charge voltage of a specific type may even vary from brand to brand so if in doubt you should check with the manufacturer of the battery for the maximum recommended charge voltage.

IMPORTANT NOTE: Some batteries with internal intelligent battery management systems (BMS) have a strict maximum limit which should not be exceeded. Take this into account when setting the maximum charge voltage.

Low Voltage Limit

The low voltage limit must be set to suit the type of battery that you are using. A “12 V” Lithium Iron Phosphate (LiFePO₄) battery pack is considered to be discharged when the terminal voltage is about 11.2V. A lead acid battery typically has a lower operating voltage and the low voltage limit would be about 10.2V. These settings are stored individually so when you select the battery type the correct value for the battery you are using will be automatically loaded.

To store the setting for a Lithium ion battery (for example Lithium Iron Phosphate) battery, first select the LiFe battery type and then set the Low Voltage limit. Repeat for the Lead Acid battery by first setting the Pb (PbSO₄) battery type and then setting the Low Voltage Limit. When you switch between battery types the appropriate setting will be automatically recalled.

High Voltage Limit

The high voltage limit is intended to prevent damage to your radio equipment. Most amateur radio equipment is designed to operate from a power source of 13.8 V +/- 15% which is a range from 11.7V to 15.8V. Check the specification for your specific radio as some have an upper limit of 15V and some operate well at 11 V. Operating at higher voltage than the maximum may cause damage to the equipment and operating below the minimum voltage may result in below normal performance (especially on transmit).

Auto Off

The Auto-Off feature allows the POWERmini to shut off the system power when the battery voltage has fallen to the Low Voltage Limit. The system will then enter a low power state with the load disconnected. Power will be reconnected when the input voltage has been restored above the Low Voltage Limit. Battery life is degraded by allowing a battery to fall below the 100% discharged state. For optimum life a fully discharge battery should be recharged as soon as possible. Leaving a battery in a fully discharged state may dramatically reduce the capacity and cause permanent damage to the battery.

To avoid having the power disconnected unexpectedly at an inconvenient time you can disable the auto shut off feature, but be aware that you may adversely affect the life of the battery if you continue to operate below the Low Voltage Limit setting.

Changing User Settings

If you would like to change the settings of any of the user parameters you need to enter the Edit Settings Display Page. To accomplish this select the User Settings page (see Figure 3 Menu Selection on page 4) and then press and hold the SELECT button for about ½ second.

Battery Type	LiFe	Battery type	LiFePO4 or PbSO4
Max Charge V	14.2	Adjustment range	13V to 15V
Low V Limit	11.2	Adjustment range	9 V to 12 V.
Auto Off	DISABLE	Auto off enable/disable	Enable or disable
High V Limit	15.0	Adjustment range	13V to 16V

Figure 8 Edit Settings Display Page

An edit box is drawn around the parameter that is selected for adjustment. Use the UP / DOWN buttons located either side of the SELECT button to change the value. The value will change by one increment for each push of the button. When you have selected the value that you want, press and hold the SELECT button for just over ½ second. If the audible annunciator chirps when you release the button you have successfully saved the new value. If the value is not saved the parameter will return to its previous value.

If you decide that you want to return to the previous value, then briefly press the SELECT button and the old value will be restored and the edit box will move to the next parameter.

If you do not want to change a parameter you can skip to the next value by pressing the SELECT button briefly.

Exit the page by repetitively pressing the SELECT button until you reach the end of the page.

FUNCTIONS

Periodic Monitoring

The unit continuously monitors the battery voltage and current and solar input voltage and current. Monitoring is performed automatically whether the display is active or blanked.

The battery current is continuously monitored and the amount of charge removed from the battery is tracked and reported on the Main screen.

Display Timeout

The display is active as soon as the unit is powered on. After a period of about 5 minutes of inactivity the display is automatically blanked. To turn the display back on press any of the front panel buttons.

Front panel LED normal operation

The POWER LED serves dual functions. When the unit is working normally the LED is green indicating normal operation. When the display is active the LED is steady. When the display has timed out the green LED flashes to indicate that the unit is operating normally.

A fault condition is indicated by the front panel POWER LED changing color to flashing red to alert a fault condition as described below.

Low voltage warning

When the battery voltage falls below the preset Low Voltage Limit (see page 8) the Power LED will flash red periodically. The audible alarm will also sound if it is enabled. The alarm is active as long as the battery voltage is below this level. The Low Voltage Warning threshold is 0.5V above the Low Voltage Limit (user setting). For example if the Low Voltage Limit is set at 11.2V, the Low Voltage Warning Alarm will activate at 11.7V.

High voltage warning

If the battery voltage exceeds the High Voltage Limit setting the power is automatically disconnected from the load. An overvoltage warning message is displayed on the front panel and the alarm LED will glow red continuously.

Audible alarm cancel

If the audible alarm is enabled you can silence the audible alarm from the Main Menu page by pushing the SELECT button and releasing after about 1 second. The audible alarm will remain disabled until you manually enable it. To enable the alarm repeat the process by pushing the SELECT button and releasing after about 1 second. The audible alarm is enabled when the asterisk is shown to the right of the BATTERY label at the top of the Main Menu (see Figure 4).

Auto shutdown

Auto-Shutdown automatically shuts down the system, disconnecting the battery from the load when the voltage falls below the Low Voltage Limit. The Auto-shutdown may be enabled or disabled by the user.

Functional Description

Auto Shutdown will also automatically disconnect the battery from the load when the voltage exceeds the High Voltage Limit but the ability to disable this function is not provided (see Auto-reset page 11 for more details).

If the battery voltage falls below the Low Voltage Limit (11.2V in this case) the Shutoff warning is indicated on the Main screen. Both the POWER LED (red to show alarm condition), and the audible alarm (if enabled) will flash for a period of approximately 10 seconds. At this point in time if the Auto-Off shutdown mode is enabled the POWERmini will disable the output and then shut down.

If the Auto-shutdown mode is disabled the POWERmini will not disconnect the battery after the warning period and the alarm will cease to sound. The shutdown message will be displayed on the bottom of the main page regardless of whether Auto Off is enabled or not.

Auto-reset

If the Auto Off mode is selected POWERmini will shut down and power will have to be disconnected and reconnected before the unit will return to normal operation.

If Auto-shutdown is disabled then the unit will continue operating even when the battery voltage is below the low voltage point. If the voltage subsequently recovers, the Power LED (red) and warning messages will be automatically canceled.

If the output was disconnected because of an overvoltage condition then it will be automatically reconnected when the voltage has fallen 0.5V below the Upper Voltage limit.

Output Overload

POWERmini protects the system from overload by automatically disconnecting the load if excessive load current is detected. This is indicated by the Power LED flashing RED and audible warning if the audible alarm is enabled. The source of overload should be investigated and rectified before using the system. The following procedure should be used to remedy the fault condition.

1. Disconnect the load from POWERmini (both ports) by removing the Powerpole load connectors at the POWERmini end of the cable.
2. Disconnect the battery from the POWERmini
3. Reconnect the battery from the POWERmini and confirm that the unit powered up normally.
4. Visually inspect the output cables for damaged insulation or strands of wire shorting at either end of the cable.
5. Check with an ohmmeter for a short circuit between conductors of the output cable.
6. Resolve any issues found in steps 4 and 5 above and reconnect the output cables to the POWERmini.

NOTE: If the load is short circuited this may cause the internal fuse to blow. This will result in the POWERmini display going blank. For information on replacing the fuse see page 15.

Solar Charge Control

The solar charger is a constant current / PWM style of charger and does not support MPPT style of operation (MPPT is a technique to optimize the performance of solar panels which is sometimes used in installations where power is > 200W).

Functional Description

The solar input voltage and battery voltages are continuously monitored. The solar panel voltage is related to the amount of solar radiation on the panel and so when the panel is not fully illuminated it may not provide enough voltage to charge the battery. If the POWERmini determines that the solar panel is not sufficient then the solar panel input is disconnected from the battery.

The POWERmini enables charging only when the battery is in the safe area. This area is defined by the Low Voltage Limit (low voltage disconnect) and the fully charged voltage which is defined by the Max Charge Voltage setting. POWERmini tests the battery to be sure that is above 10V and will not attempt to charge a battery at or below that voltage. This prevents charging of a possibly defective battery.

If the POWERmini determines that the battery voltage has reached the full charge limit the solar panel will change to a charge maintenance mode to keep the battery fully charged without overcharging. The full charge voltage is different between different battery chemistries. The user may adjust the full charge voltage to suit the battery in use. Both the Low Voltage Disconnect voltage and the Maximum Charge Voltage can be stored by battery type. This allows you to store values for Lithium ion and Lead Acid batteries separately. Do not change the Maximum charge voltage from the 14.2 default value unless you are sure the battery is designed to charge to a higher voltage.

The POWERmini measures the solar panel output current and reports both the current and charge delivered to the battery on the Main Display Page (page 5).

Note that if the POWERmini detects a solar panel output greater than 10A the POWERmini solar input will be automatically disconnected and the warning message "FAULT" will be displayed in the bottom of the solar panel window. To reset the POWERmini solar input, disconnect the solar panel from POWERmini and then reconnect it.

POWERmini monitors the solar panel output current and reports the panel output power to the System Report screen. Because the output of the panel changes with changes in sunlight power, the output of the panel will not be constant. POWERmini will keep track of the maximum (peak) power output of the panel and display the result on the System Report Page (page 6).

Operating Time

POWERmini keeps track of the amount of time that has passed from power up time and displays the information on the System Report Page.

Battery Use

POWERmini keeps track of the total amount of charge taken from the battery and displays on the System Report screen.

Battery use is the difference between the amount of energy used by the load and the amount that has been replaced by the Solar panel.

Specifications

SPECIFICATIONS

Battery Type	Lithium ion or Lead Acid
Maximum Battery Input Voltage ¹	24 V DC
Minimum Battery Input Voltage	9 V DC
Maximum Solar Input Voltage	24 V DC
Minimum Solar Input Voltage	N/A
Maximum Load Current (total)	25 A (continuous)
Maximum Solar Charge Current	10 A
Number of output ports	2
DC power connectors	Anderson Powerpole® 35A
Reverse Polarity Protection	Battery and Solar Panel inputs
Electrical Safety	Internal 30A Fuse
Fuse Type	LittleFuse mini ATC, 30A PN 297030
Over voltage disconnect range	13 – 16 V (user adjustable)
Low voltage disconnect range	9 – 12 V (user adjustable)
Maximum Charge Voltage	13-15 V (user adjustable)
Audible alarm	User settable enable, disable
Overall Size	4.5" (W) x 3.2" (D) x 1.3" (H) 115 (W) x 82 (D) x 33 (H) mm
Weight	6.2 oz (176g).
Operating Temperature Range	0 – 40 degrees Celsius

¹ The maximum battery input voltage is the maximum that the POWERmini will accept. The voltage will not be applied to the radio unless it is below the High Voltage Limit set in the user settings.

Specifications

Default Settings

The following table shows the values that are set at the factory, but if these can be changed to better suit your needs if required. See the following section for details.

PARAMETER	DEFAULT VALUE	ALTERNATIVE
Battery Type	Lithium ion (LiFePO4)	Lead Acid (PbSO4)
Max Charge Voltage	14.2V	Adjustable 13-15V.
Low voltage limit	11.2 V	Adjustable 9 – 12V.
Auto Off	Disabled	Enabled
High voltage limit	14.5 V	Adjustable 13 – 16V.

MAINTENANCE

The POWERmini does not have any user serviceable items with the exception of an internal fuse. Instructions on replacing the fuse are provided in the following section.

IMPORTANT: Do not attempt to remove the printed circuit board from the unit or damage may occur to the front panel switch board which will void the warranty. If there is a need to replace the fuse inside the unit closely follow the instructions below.

Fuse Replacement

The POWERmini does not require routine maintenance, and includes internal current limiting so that failure of the internal fuse is rare. However if the internal fuse has failed replacement will be necessary. Replacement fuses can be readily obtained from most Auto Part stores (see page 13 for fuse part number). Fuse replacement requires disassembly of the unit so ensure that the fuse has failed before proceeding further.

If you have POWERmini plugged into a known good 12V power source and there are no outputs connected the POWERmini front panel POWER LED should be flashing (green). If the LED is flashing then the fuse does NOT require replacement.

The fuse is accessed by removing the end cap at the left hand end of the enclosure. Do NOT remove the cap at the right hand end of the enclosure.

Use the following procedure to replace the fuse.

1. Remove the four Torx T10 head screws in the left side end cap (see Figure 1) and carefully remove the end cap.
2. Place your fingers on the board to prevent it from sliding forward and use pliers to grasp the fuse and pull straight out towards you. The fuse is a tight fit in the fuse-holder so considerable force is required for removal.

IMPORTANT NOTE: Do not attempt to slide the printed circuit board out of the enclosure or you may damage the switch connector at the other end of the board.

3. Replace the fuse by inserting the replacement into the fuse clips mounted on the printed circuit board. Ensure that the fuse is securely pushed into position.
4. Reinstall the end cap on the end of the enclosure. Note that because the Powerpole connectors are not exactly in the center of the opening you will have to make sure that the end cap is oriented correctly to fit over the connectors. If the cap is not installed correctly you may find after installation that you are unable to insert the mating connectors.
5. Secure the end cap with the Torx screws taking care not to overtighten.