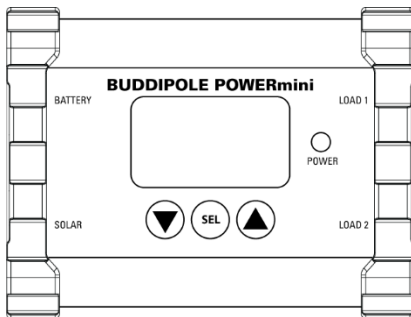


# BUDDIPOLE

## POWERmini USB

COMPACT PORTABLE DC POWER MANAGEMENT SYSTEM  
WITH BUILT IN SOLAR CONTROLLER

### USER GUIDE



The Buddipole POWER mini is a unique, 12 VDC pocket sized 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 35A and solar panels up to 150W output.

Built in monitoring provides you an instant view of how well your battery is keeping up with the demands of your radio.

For additional convenience a USB charger port is provided to charge devices such as cell phones or tablets.

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# GETTING STARTED

## Product Overview

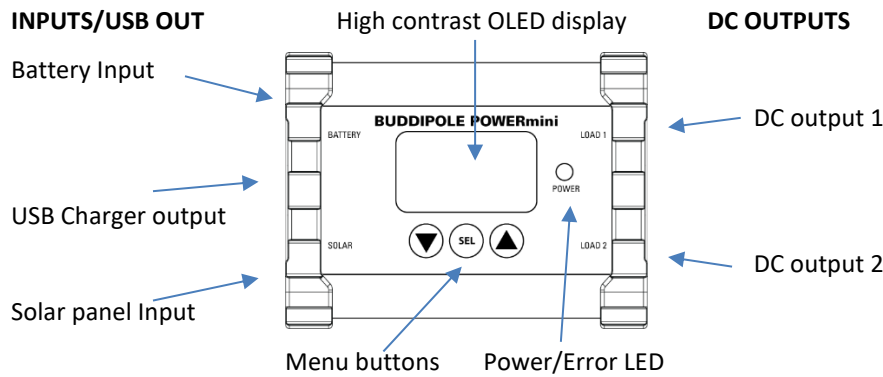


Figure 1 POWERmini USB controls and power connections

Power inputs are located on the left side of the unit together with the USB charger output. The DC power outputs are on the right side of the unit. 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 (EMCOMM).

The front panel contains an OLED graphical display providing 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 (SEL) is the center button and the UP/DOWN buttons on either side of the SEL button are used to change user settings.

## Choice of Battery Type

POWERmini USB can be set up to work with different types of battery chemistry. It has presets configured for two popular preset battery types, Lithium Iron Phosphate (LiFePO4), and Lead Acid (PbSO4).

Each of these setups can be customized to suit other battery types. Refer to (Battery Type page 12) for more information.

You should set the battery type before using POWERmini USB.

## Solar Panel Input

POWERmini USB can be used with a 12V solar panel with power output up to 130W.

It may also be used without solar input but note however that the solar input should only be used with a solar panel and should never 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 USB.

## Power Connections

POWERmini USB can be used with a solar panel, deliver power to two output loads and provide USB charging capability as shown in the Figure 2 below.

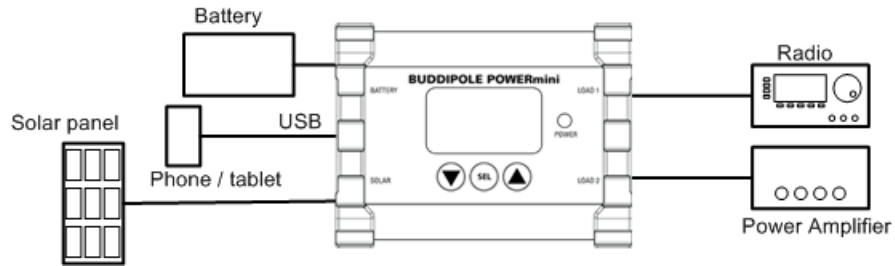


Figure 2 POWERmini USB power connections

The input and output connectors are color coded as shown in the following table.

From	To	Connector Colors
Radio	POWERmini LOAD1	Red/Black
Accessory	POWERmini LOAD2	Red/Black
Battery	POWERmini BATTERY	Blue/Black
Solar Panel	POWERmini SOLAR	Yellow/Black
POWERmini	Phone or tablet	USB Type A

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

## Powering Up

POWERmini USB will start working as soon as the battery is connected.

The startup screen is displayed briefly at power up and POWERmini USB checks the battery to see if it is ready for use. If the battery voltage is within the normal range the outputs will be automatically connected.

Note that the unit will not turn on if the input voltage has reverse polarity. Additionally, if the battery voltage is less than 10V, after showing the startup screen the unit will automatically shutdown.

## FUNCTIONS

This section provides a description of the many functions that POWERmini USB performs for you.

### ***Battery Settings***

The POWERmini USB can be setup to charge Lead Acid or LiFeEPO4 battery types. You can also set it to work with other battery types by adjusting the maximum charge voltage (see Figure 7). The battery settings are stored by type so you can quickly switch between two different types of battery.

### ***Output Control***

The POWERmini USB controls the output to protect the battery and your radio equipment from out of range voltages and current.

#### *Low voltage warning*

When the battery voltage falls below the preset Low Voltage Limit (see page 13) 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. The output load will not be reconnected until the battery voltage falls below the HV reset limit. For information about changing the settings of both of these limits refer to High Voltage Limit on page 13

#### *Auto shutdown (under voltage condition)*

Auto-Shutdown automatically disconnects the battery from the load when the voltage falls below the Low Voltage Disconnect threshold (LVD) The Auto-shutdown may be enabled or disabled by the user.

If the Auto-shutdown is enabled, when the battery voltage falls below the LVD, the Shutoff warning is indicated at the bottom of the Status screen. Both the POWER LED (red to show alarm condition), and the audible alarm (if enabled) will flash (sound) for a period of approximately 10 seconds. After this warning period the POWERmini will disable the output and the audible alarm will stop.

The output will be automatically reconnected when the battery voltage rises above the Low Voltage Reset threshold (LVR). See Threshold Voltages (page 10) for information on how to change this value.

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

**IMPORTANT:** Regardless of whether the auto-shutdown mode is enabled or not, if the battery voltage falls below 10.1V POWERmini USB will automatically shut down and will not restart until it is reset.

To reset the unit, disconnect and then reconnect the battery from the unit.

## Functional Description

### *Auto shutdown (over voltage condition)*

The battery will be automatically disconnected from the load when the voltage exceeds the High Voltage Disconnect threshold (HVD). The ability to disable this function is not provided. The output will be automatically reconnected when the battery voltage falls below the High Voltage Reset threshold.(HVR).

### *Output Overload*

POWERmini USB 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 an 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 USB (both ports) by removing the Powerpole load connectors at the POWERmini USB end of the cable.
2. Disconnect the battery from the POWERmini USB
3. Reconnect the battery from the POWERmini USB 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 USB.

### *Audible alarm cancel*

If the audible alarm is enabled, you can silence the audible alarm from the Main Menu page by pushing the SEL button and releasing after about 1 second. The audible alarm will remain disabled until you manually re-enable it (see Figure 7). 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).

## **Solar Control**

### *Solar Charge Controller*

The solar charger is a constant current / PWM style of charger which has very low levels of RFI.

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. POWERmini USB 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 USB 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.

Note that if the POWERmini USB detects a solar panel output greater than 11A 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 USB solar input, disconnect the solar panel from POWERmini and then reconnect it.

## **USB Charger**

### *USB Dedicated Charger Port (DCP)*

The 5V USB charge port is compatible with the requirements of the USB Battery Charging Specification 1.2. This supports different charge current limits for a wide variety of devices including most popular cell phones and tablets. The maximum charge current is set by the device connected to the USB charger port. This requires a standard 4 conductor USB cable. Note that if you do not use the standard cable the charger will default to a maximum charge current of 500mA (900 mA USB3.0).

The maximum output is current limited by specification to 1.5A.

## **System Monitoring**

### *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.

### *Battery Charge Monitoring*

POWERmini USB keeps track of the total amount of charge taken from the battery and displays the result on the System Report screen (see Figure 4).

In addition to the total charge provided by the battery, the net amount of charge remaining is indicated by the Battery Use measurement (see Figure 6). Battery Use is the difference between the total amount of energy used by the load and the amount that has been replaced by the Solar panel.

For example, if the Battery capacity on the status page indicates that 12Ah has been used, but the solar panel has delivered 8.5Ah during this time, the net amount used is only  $12 - 8.5 = 3.5$  Ah. This would be displayed as Battery Use on the System Report page.

### *Solar Power Monitoring*

The POWERmini USB measures the solar panel output current and reports both the current and charge delivered to the battery on the Status page (see Figure 5).

POWERmini also reports the solar panel instantaneous 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 USB will keep track of the maximum (peak) power output of the panel and display the result on the System Report page (see Figure 6).

### *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 briefly press any of the front panel buttons. You can tell that the unit is continuing to function from the front panel LED (see below).

### *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. Examples of fault condition are over-voltage and under voltage battery voltage.

## Functional Description

### *Operating Time*

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

## ***Restore Factory Defaults***

Use the following procedure to reset the unit back to the setup provided with each new unit.

- Disconnect the POWERmini USB from the battery and solar input
- Press and hold the SEL button and connect the battery to the battery input port
- When the splash screen has displayed, and you hear a brief beep, release the SEL button
- Reconnect the solar panel (if in use).

The default values will have been restored to the system. Before using the device please check that you have settings that are suited to your system. It is particularly important to check that the correct battery type has been selected.



# OPERATIONS

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.

POWERmini USB is a programmable device allowing you to configure it to use with different types of battery.

User settings include

- Low battery voltage trip point, reset point and early warning of low battery
- Automatic disconnect – provides protection from deep discharge
- Max charge voltage -customize to suit specific battery
- Over voltage trip point and reset point

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 Status 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.

in addition to the Status page there is a System Report page and two settings pages. Briefly press the SEL to sequence between the four display pages as shown in Figure 3 below. The SEL button is the center button in the row of three buttons.

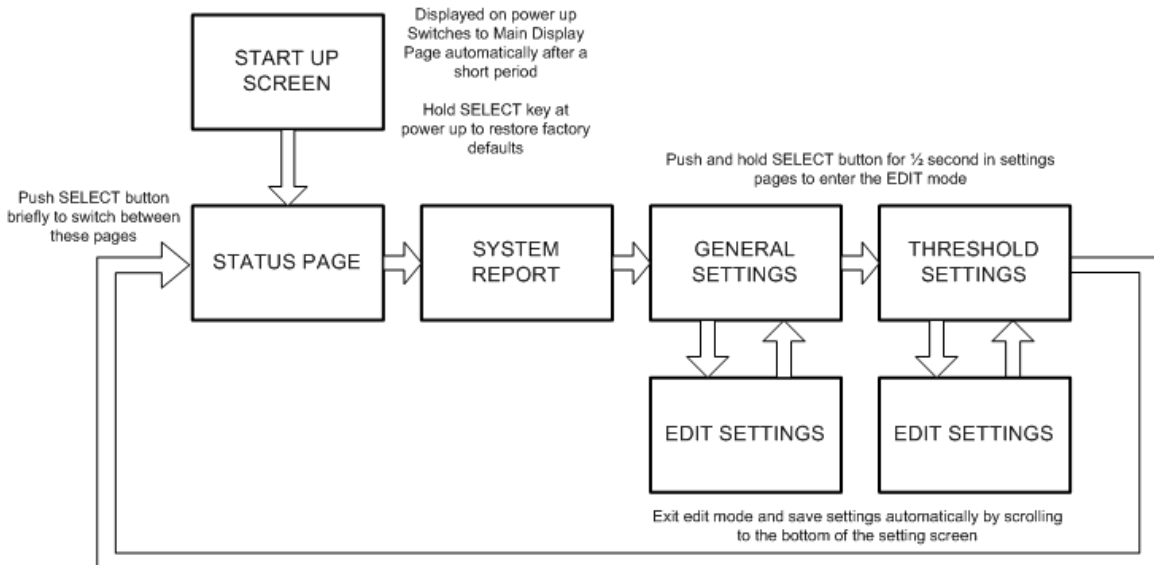


Figure 3 Menu Selection

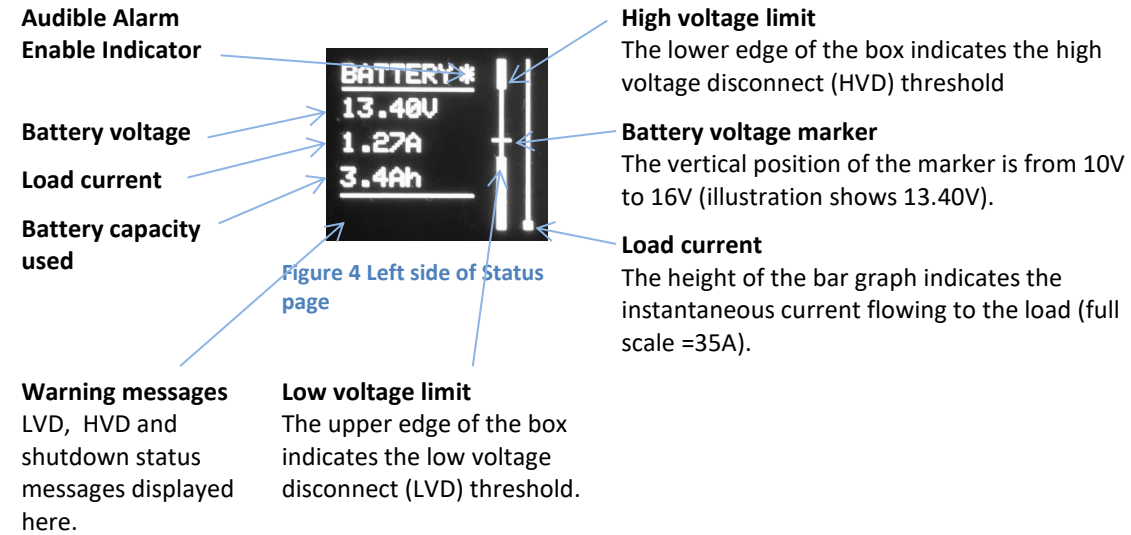
The User Settings pages are different from the two other pages because the user settings can be edited. To change the user settings first select the required Settings page and then press and then hold the SEL button for about 1/2 second to enter the Edit mode. See Changing User Settings on page 11 for details on editing user settings.

## Status Page

The Status page is where important information about the system is shown.

The left side of the Status 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 threshold disconnect 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 indicates the instantaneous battery voltage.

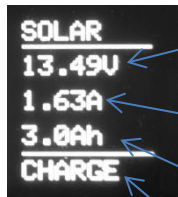
As the battery voltage decreases the battery voltage marker will move down the scale towards the white box representing the low voltage disconnect limit (LVD). When the marker is about 0.5V above the LVD a Low Voltage Warning message is displayed in the space at the bottom left of the display, the front panel POWER LED will flash red and the audible alarm (if enabled) will sound.

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. The solar charger will continue to work if the battery voltage is above 10.0V. The output will be reconnected when the battery voltage rises above the low voltage reconnect limit. This is a user defined value. See Threshold Voltages on page 10 for information on how to set the Low Voltage Reconnect threshold voltage.

If the battery voltage increases above the lower edge of the high 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 user defined reconnect threshold. See Threshold Voltages on page 10 for information on how to set the High Voltage Reconnect threshold.

## Operations

The right side of the Status page provides information about the solar panel performance. See Figure 5 below for a brief description of the various fields.



```
SOLAR
13.49V
1.63A
3.0Ah
CHARGE
```

Figure 5 Right Side of Status page

### 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

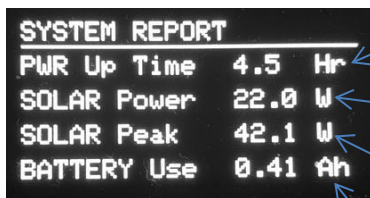
The total charge delivered by the panel to the battery.

### Solar Charge indicator

Indicates if the charger is in charge, float mode or off.

## System Report

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



```
SYSTEM REPORT
PWR Up Time 4.5 Hr
SOLAR Power 22.0 W
SOLAR Peak 42.1 W
BATTERY Use 0.41 Ah
```

Figure 6 System Report page

### Power Up Time

The operating time since the unit was powered on.

### Solar Power

The instantaneous solar panel power output.

### Solar Peak

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

### Battery Use

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

## User Settings

There are eight parameters that you can set to configure the POWERmini USB to better suit your needs. These settings will be saved in non-volatile memory so they will be automatically recalled the next time you power up the unit.

The eight parameters are contained on the GENERAL SETTINGS and THRESHOLD VOLTAGES setup pages.

### General Settings

The General Settings page contains settings for the battery type, maximum battery charge voltage, the Auto-Off setting and the audible alarm enable setting. See Figure 7 below.

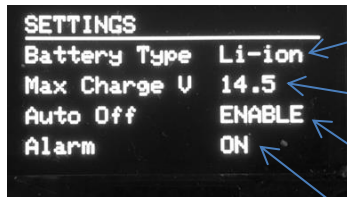


Figure 7 General Settings page

**Battery Type** (LiFePO4/PbSO4)

Select the battery chemistry

**Max Charge Voltage** (13-15V)

Sets the 100% charge limit.

**Auto off** (Enable/Disable)

Select whether auto-shutdown is enabled or not.

**Alarm** (Enable/Disable)

Enable or disable the audible alarm that indicates when an over voltage or under voltage condition has occurred.

### Threshold Voltages

This page contains the trip and reset voltage settings for the over-voltage and under-voltage conditions

Under voltage settings control the point at which PoWERmini USB will disconnect or reconnect the battery and the load. The Low Voltage Disconnect point (LVD) is set by the LV Trip parameter. When the battery falls below this voltage and AUTO OFF is enabled the output will be automatically disconnected.

LV Reset is the voltage at which the disconnected output is reconnected. For information on how to choose the values see the TECHNICAL REFERENCE section beginning on page 12.

You should set the trip voltage first before setting the reset voltage.

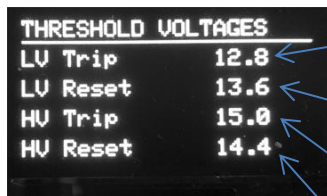


Figure 8 Threshold Settings page

**LV Trip** (10.5 – 13.0V)

Output disconnected when voltage falls below this limit.

**LV reset** (0.5 – 1.5 above the LV trip setting)

The output is reconnected after a LV trip when the battery voltage is at or above this voltage limit

**HV trip** (15- 16V)

The output is automatically disconnected when it exceeds this trip voltage

**HV reset** (0.5 – 1.5 below the HV trip setting)

The output is reconnected after a HV trip when the voltage is at or below this voltage limit

## Changing User Settings

If you would like to change the settings of any of the user parameters you need to enter the Edit mode in the appropriate Settings Display page. To accomplish this select the User Settings page (see Figure 3 Menu Selection on page 7 ) and then press and hold the SEL button for about ½ second.

The figure below shows the edit page for the Threshold Voltages.

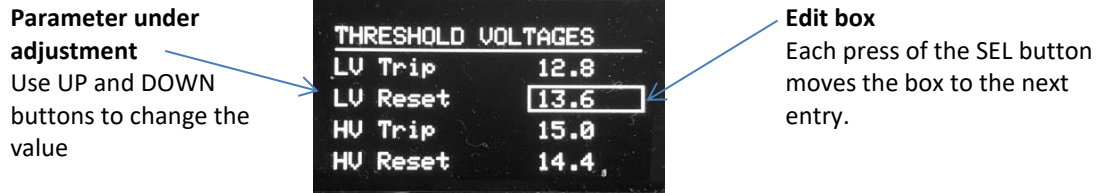


Figure 9 Edit Threshold Voltage Edit page

When the edit mode is active a white edit box is drawn around the parameter selected for adjustment beginning at the first line.

To skip to another line briefly press the SEL button to move down the list and repeat until you have reached the parameter you want to change.

Use the UP / DOWN buttons located either side of the SEL 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 the SEL button to advance to the next parameter.

To exit the edit mode and save your changes press of the SEL button until the edit box scrolls off the bottom of the list. A beep will sound to indicate that the changes have been saved.

## TECHNICAL REFERENCE

### Battery Types

For best results you should be sure to set the charge and cut-off parameters to suit the battery chemistry that you are going to use. 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.

Different types of battery chemistry have different voltage vs capacity characteristics. The characteristic Capacity (Ah) vs voltage curves of three popular battery types are shown in Figure 10 below.

### Battery Comparison (Ah vs Battery Voltage)

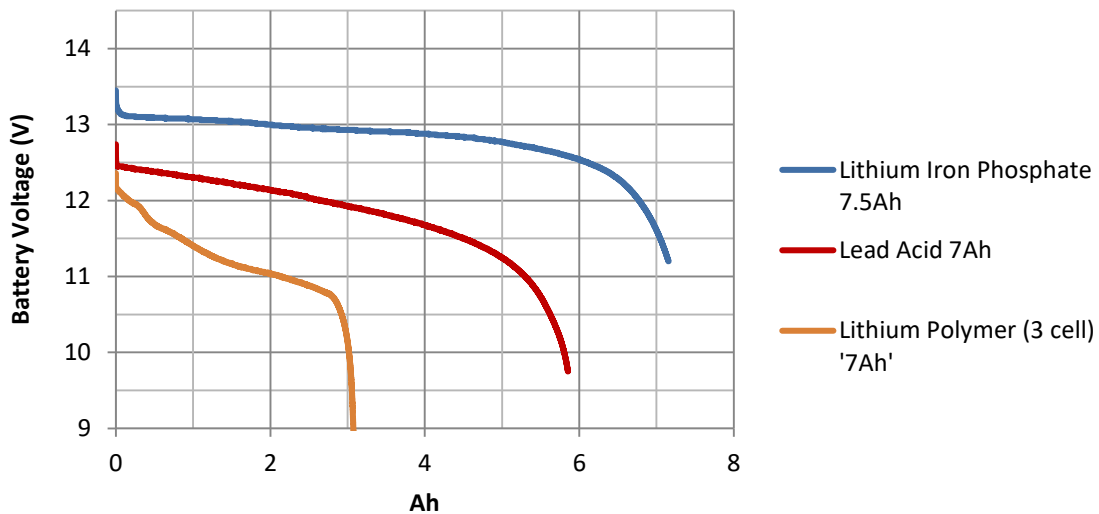


Figure 10 Comparison of battery characteristics for different battery chemistry

The three types of batteries are Lithium Iron Phosphate (4 cell), Lead Acid (6 cell) and Lithium Polymer (3 cell). Notice that the curves are similar in shape but have very different values for the fully charged and depleted states.

The Lithium Iron Phosphate battery has a higher maximum voltage (100% charge level) and a relatively flat discharge curve.

The Lead Acid battery has a lower maximum voltage, more slope to the discharge curve and a lower cut-off voltage.

The Lithium Polymer (3 cell) battery has an even lower maximum voltage and a lower cut-off voltage. It should be noted that this type of battery is frequently used as a car jump start battery and cell phone charger. The low terminal voltage of this battery is problematic for radios, many of which require a battery voltage of over 12V to function normally.

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

## Technical Reference

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.

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 Trip*

The low voltage trip point must be set to suit the type of battery that you are using. A “12 V” Lithium Iron Phosphate (LiFePO<sub>4</sub>) battery pack is considered to be discharged when the terminal voltage is about 11.2V (on load). The State of Charge (SOC) is technically defined under a no load condition and so you may see a number closer to 13V. 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 (PbSO<sub>4</sub>) battery type and then setting the Low Voltage Limit. When you switch between battery types the appropriate setting will be automatically recalled.

### *Low Voltage Reset*

The low voltage trip condition will be automatically reset when the voltage rises above the Low Voltage Reset threshold. The threshold can be set in Threshold Voltages page. Setting the threshold too low may cause cycling of the shutdown and reset states, whereas too high a setting means you may have to wait longer before the battery reconnects.

### *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 USB to shutoff the load and the USB charger when the battery voltage has fallen to the Low Voltage Limit.

## Technical Reference

Battery life is degraded by allowing a battery to fall below the 100% discharged state. For optimum life a fully discharged 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.

### ***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
Battery Type	Lithium ion (LiFePO4)
Max Charge Voltage	14.2V
Auto Off	Disabled
Audible alarm	Enabled
Low voltage limit	12.9V
Low voltage reset	13.4V
High voltage limit	15 V
High voltage reset	14.5V



## SPECIFICATIONS

Battery Type	Lithium ion or Lead Acid
Maximum Battery Input Voltage <sup>1</sup>	24 V DC
Minimum Battery Input Voltage	10V DC
Maximum Solar Input Voltage	24 V DC
Minimum Solar Input Voltage	N/A
Maximum Load Current (total)	35 A (continuous)
Maximum Solar Charge Current	11 A
Number of 12V DC output ports	2
DC power connectors	Anderson Powerpole® 45A
USB charger output connector	USB type A connector
USB charger output voltage	5V
USB charge maximum output current	1.5A
Reverse Polarity Protection	Battery and Solar Panel inputs
Over voltage disconnect range	14 – 16 V (user adjustable)
Low voltage disconnect range	10.5 – 13 V (user adjustable)
Maximum Charge Voltage	12-15 V (user adjustable)
Audible alarm	User settable enable, disable
Overall Size	4.5 (W) x 3.2 (D) x 1.3 (H) inches 115 (W) x 82 (D) x 33 (H) mm
Weight	6.2 oz (176g).
Operating Temperature Range	0 – 40 degrees Celsius

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<sup>1</sup> 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.