Lithium-Ion Power Supply, Boost DC/DC Converter, 250W

User Manual

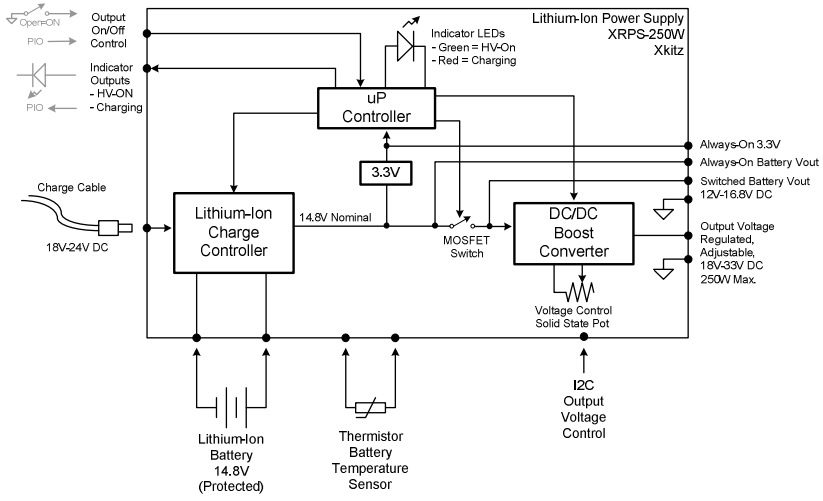
Model XRPS-250W

Rev 3.1

Xkitz Electronics

Features

- Regulated adjustable 250W DC power supply for portable applications
- Combines a programmable 250W DC/DC Boost converter with a Lithium-Ion battery power supply
- Output voltage adjustable 18V–33V DC, up to 8 Amps
- Maintains a constant regulated DC output, even as the battery drains
- Integrated Lithium-Ion charge controller
- Two phase DC/DC converter provides clean, quiet, solid output voltage – optimized for audio applications
- Can be used as a stand-alone power supply or as a DC/DC converter module in a larger system
- Programmable DC/DC converter voltage – output voltage can be controlled by:
  - On-board trim pot
  - External panel pot
  - Programmatically controlled by I2C
- Output voltage On/Off can be controlled by:
  - External switch
  - Programmatically controlled by a PIO pin
- Sleep mode – automatically enters low current sleep mode when output voltage is switched Off
- 'Always On' battery voltage and 3.3V available on modular connector to power other systems or controllers
- Switched battery voltage also available on a modular connector
- Charger voltage input: 18V – 24V DC, 2amps min.
- Multiple levels of thermal and electrical protections to prevent Lithium-Ion battery damage
- Applications
  - Rechargeable power supply for Portable Bluetooth Speaker
  - Portable guitar amplifier supply
  - Power supply for mobile or remote art works or displays
  - Electronic or radio installations – portable or in remote locations
  - Remote or portable lighting
  - Robotics power supply
  - Solar based power supply
- Dimensions: 2.5" x 2.5" x 1" High (64mm x 64mm x 25mm)
- Weight: 1.5oz



Introduction

The XRPS-250W is a general purpose portable, rechargeable power supply board. It's designed to be used either as a fully stand-alone portable power supply, or as a programmable modular power supply that can be integrated into a larger system. It has a powerful two-phase DC/DC converter that steps up the battery voltage to 18V-33V at up to 8 amps.

Basic Stand-Alone Use

In stand-alone configuration the connections and operation are simple:

- Connect a 14.8V Lithium-Ion battery to the terminals marked 'BAT(+)' and 'BAT(-)'
- Connect an 18-24V DC charge power source (when charge is needed) to the 'CHRGV(+)' and 'CHRGV(-)' terminals
- Connect your DC load to the terminals marked 'HV-OUT(+)' and 'HV-OUT(-)'
- Adjust the output voltage with the on-board trim-pot marked 'HV ADJ'
- The green LED indicates when the HV-OUT output voltage is ON
- The red LED will indicate when the battery is charging, and will blink to indicate battery level
- A Power On/Off switch can be connected between J3 pin 1 and J3 pin 2 (ground). Closing the switch will turn off the output voltage and put the XRPS-250W into low power sleep mode. Opening will turn on the output voltage. The battery charge function is still active when the power is off.

Programmable DC/DC Power Supply Module

For use as a modular power supply integrated in a larger system, the XRPS-250W has two modular connector footprints. These connectors are not populated by default and must be soldered in place if you want to use them. These connectors provide signals for control and monitoring of the state of the board, and connections to all of the power rails and ground. Through use of the signals on these connectors, an external micro controller can control the output voltage level and on/off state, and it can monitor the charge status and battery level.

All voltage connections on the terminals posts are also available on the modular connectors, so there is no need for wiring to the terminals when modular configuration is in use.

Voltage Adjustment

There are several methods for controlling the output voltage level. There is a small trim-pot on the board that controls the output voltage level in the absence of any of the other methods. But if you connect an external 10K panel pot to J3, it will take over control of the output voltage level. The third method of controlling the output voltage is through and I2C bus interface driven by an external micro controller which will take over control if the I2C bus connection is detected.

This table specifies the activation and use of the three possible voltage control methods:

Control Source	**Activated When:**	**Use:**
On-Board Trim Pot	The other two sources are not detected	Turn clockwise to increase voltage
External Panel Pot	The external 10K panel pot is auto detected and activated simply by connecting it as follows: - J3 pin 15 connected to upper leg of the pot - J3 pin 13 connected to the wiper - J3 pin 16 connected to lower leg of the pot	Turn clockwise to increase voltage. If the operation is backwards, switch the pot leg connections
I2C Programmable	The I2C is auto detected and activated simply by connecting the I2C signals SCL and SDA. The presence of the SDA and SCL pull-up resistors on the system board is used to detect the I2C bus. The external panel pot must not be connected for I2C operation.	See below for programming info

LED Indicators

There are two indicator LEDs on the board:

- Green LED indicates when the HV-OUT DC/DC converter voltage is ON
- Red LED is a multi-purpose indicator:

Charger is:	Red LED is:	Indicates:
Connected	On	Battery is currently being charged
	Off	Battery is full, Unit is being powered from CHARGV(+)
Not Connected	Off	Battery is > 50% Full
	Blinking at 1Hz	Battery is < 50% Full The duty cycle of the blinking indicates the battery level (i.e. 20% duty cycle = 20% battery life remaining)
N/A	Blinking at 2Hz	Over temperature condition exists, charging and HV-OUT is disabled to protect the battery

Voltage On/Off Control

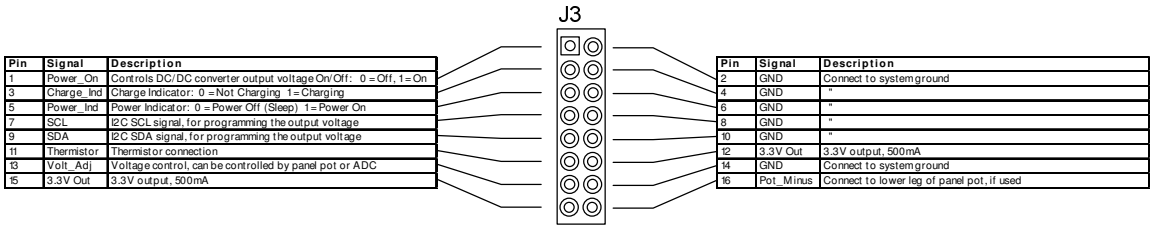
The DC/DC converter can be powered down to put the unit into a low power sleep mode by pulling the 'POWER_ON' pin (J3 pin 1) to ground. This pin has an internal pull-up resistor, so the default power state is ON if no switch is connected. The 'POWER_ON' signal J3-1 can also be controlled by a micro controller PIO pin.

Programming from External Micro-controller

The output voltage level can be programmed through an I2C bus connection to an on-board solid state pot. This pot can be set to one of 127 levels. <More info will be provided in later versions of this manual>

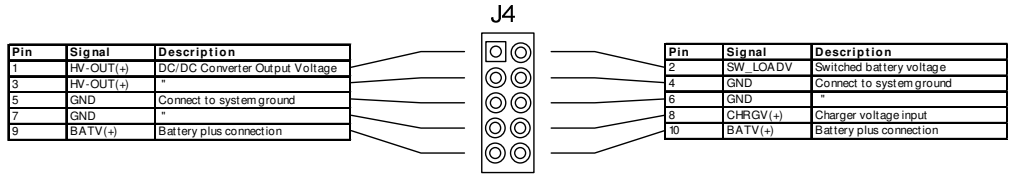
Modular Connector Pin-Outs

When the XRPS-250W is used as a DC/DC converter module integrated into a larger system, two modular connectors are used to connect to the system. One 16 pin connector, J3, and one 10 pin connector, J4. These are standard dual-inline header type connectors, with 0.1" pitch (2.54mm). The square shaped pad is pin 1. See Fig. 2 'Dimensions' diagram below for precise X,Y locations of these connectors for PCB layout footprints.



Pin	Signal	Description
1	Power_On	Controls DC/DC converter output voltage On/Off: 0 = Off, 1 = On
3	Charge_Ind	Charge Indicator: 0 = Not Charging 1 = Charging
5	Power_Ind	Power Indicator: 0 = Power Off (Sleep) 1 = Power On
7	SCL	I2C SCL signal, for programming the output voltage
9	SDA	I2C SDA signal, for programming the output voltage
11	Thermistor	Thermistor connection
13	Volt_Adj	Voltage control, can be controlled by panel pot or ADC
15	3.3V Out	3.3V output, 500mA

Pin	Signal	Description
2	GND	Connect to system ground
4	GND	"
6	GND	"
8	GND	"
10	GND	"
12	3.3V Out	3.3V output, 500mA
14	GND	Connect to system ground
16	Pot_Minus	Connect to lower leg of panel pot, if used



Pin	Signal	Description
1	HV-OUT(+)	DC/DC Converter Output Voltage
3	HV-OUT(+)	"
5	GND	Connect to system ground
7	GND	"
9	BATV(+)	Battery plus connection

Pin	Signal	Description
2	SW_LOADV	Switched battery voltage
4	GND	Connect to system ground
6	GND	"
8	CHRGV(+)	Charger voltage input
10	BATV(+)	Battery plus connection

Supported Batteries and Charging

The XRPS-250W supports ONLY 14.8V Lithium-Ion or LiPo protected battery packs. The term 'protected' means that a cell protection circuit board is integrated inside the pack. This circuit board continuously monitors the charge/discharge state of each cell of the battery pack and instantly disconnects the cells if they experience any charge/discharge current outside of their safe parameters. Protected packs can be identified by the fact that they have only two wires coming from the pack, usually red and black wires. If there are more than two wires, then it's not a protected pack. Packs of any voltage other than 14.8V or un-protected packs are NOT SUPPORTED by the XRPS-250W.

DANGER: USE OF UNSUPPORTED BATTERY PACKS MAY CAUSE FIRE! THEY MUST BE 14.8V PROTECTED PACKS.

The Amp-Hour capacity (rated in mAH, e.g. 4400mAH) is flexible. Packs from 4400mAH through 10,000mAH or larger are supported by the XRPS-250W.

The XRPS-250W has an integrated Lithium-Ion charge controller, which handles the complex charge algorithm required to avoid battery damage. This allows any DC voltage source of 18V-24V to be applied to charge the battery.

Connecting or disconnecting the charge voltage does not cause any disruption or noise on the DC/DC converter output voltage. This is nice feature for audio applications; plugging or unplugging the charger will not cause any click or popping sound on the audio output, it will be completely silent.

While the charge voltage is connected and the battery is fully charged, power input to the DC/DC converter will be supplied by the charge voltage input, not from the battery. So it's safe to leave the charge voltage connected to the XRPS-250W on a full time basis, and only disconnect from the charger when mobile operation is required.

Lithium-Ion batteries exhibit a self discharge over time even with no load. So even when running with the charger plugged in full time, you will see that the XRPS-250W will periodically re-engage the charge circuit to top off the battery when necessary.

Electrical and Thermal Battery Protections

Lithium-Ion batteries, as most know, can be extremely dangerous if not operated within specified parameters. The batteries must be protected from over-charging, over-discharging, over-temperature, and from physical shock. Failure to properly protect the battery can lead to violent and explosive fires.

The XRPS-250W provides several layers of safeguards to protect the Li-Ion battery and sub-systems. The first layer of protection is inside the battery packs themselves. Battery packs that are supported by the XRPS-250W have a small PCB inside that monitors and protects the individual Li-Ion cells. This protection PCB constantly watches for any over-charge or over-discharge conditions and immediately disconnects the cells from the system if any anomalous condition exists. It reconnects when the error condition is removed.

Note: Some lower cost Lithium-Ion packs do not contain the cell protection board. These packs, sometimes seen in the RC or drone markets, will generally have a number of smaller wires coming from inside the pack that are intended to be connected to an external protection circuit. These packs SHOULD NOT BE USED unless you properly connect an external protection circuit.

The second layer of protection is in the charge controller chip. It performs the standard Li-Ion charge algorithm in a way that won't overstress the battery pack. It also has a current limiting feature that prevents over-current conditions on the output load from impacting the battery pack.

The third layer of protection is in the current limiting function of the DC/DC boost converter. This protects on-board circuitry from damage due to over-current or short circuit conditions on the boosted HV-OUT.

To protect the battery from over-temperature operation, which can lead to catastrophic failure, the XRPS-250W can read the temperature of a thermistor attached on or near the battery, and will shut down all functions when the temperature is above 140 degrees F. To enable the thermal protection, simply connect the provided thermistor to the PCB and affix it to the battery pack so that the battery temperature can be picked up by the thermistor. The thermistor wires can be connected between J3 pin 11 and the J3 pin 12. Just the presence of the thermistor wired to these locations will activate the thermal protection mechanism. If you do not connect the thermistor, the board will operate normally, but will not be able to protect from over temperature events.

The final layer of protection is handled by the on-board micro-processor. It constantly monitors several key voltages in the charge controller and the DC/DC boost converter sub-systems, and immediately shuts down all functions and flashes an LED error code when any of these parameters go outside of expected nominal ranges.

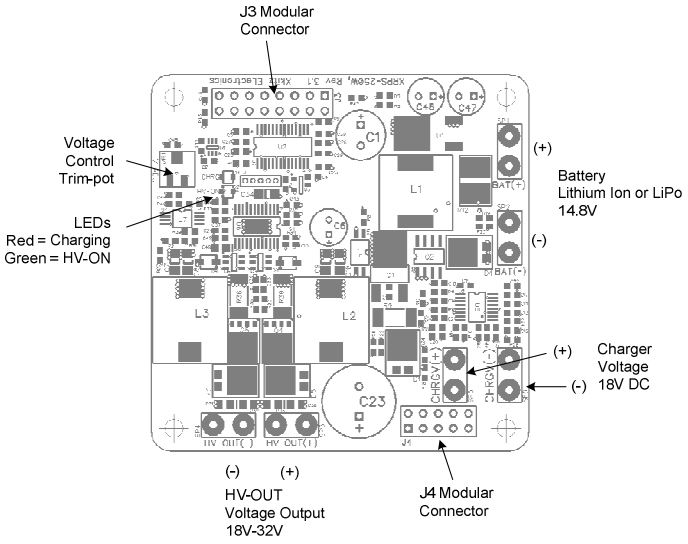
DC/DC Boost Converter Specs

The DC/DC boost converter employs a unique two-phase design, which gives a much cleaner output voltage compared to a standard single phase converter. It also reduces the output capacitance requirement, since the converter can respond very quickly to changes in load current, like those caused by powerful audio transients. For these reasons, this converter is very well suited for audio applications.

- Output Voltage: Adjustable from 18V-32V, voltage remains constant through the life of the battery
- Output Current: 8 Amps Max.
- Output Power 250W Max.
- Operating frequency: 500Khz, far above audible frequencies
- Efficiency: > 95%

The DC/DC boost converter gives the added benefit of keeping the output voltage constant as the battery drains. If you power your system directly from the battery, you'll see that the voltage drops as the battery drains. For example, a 14.8V Li-Ion battery starts out at about 16.8V on a full charge, but it drops to under 13V when fully discharged. But with the XRPS-250W if you set the output to 30V, it will remain rock solid at the 30V until the battery is approximately 95% drained, at which point the output will be gracefully powered down.

Figure 1. Board Connections



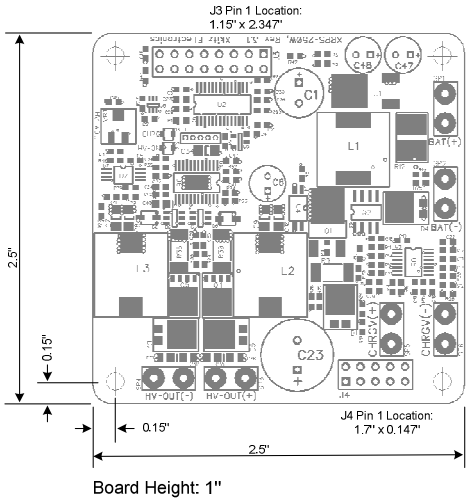


Figure 2. Board Dimensions