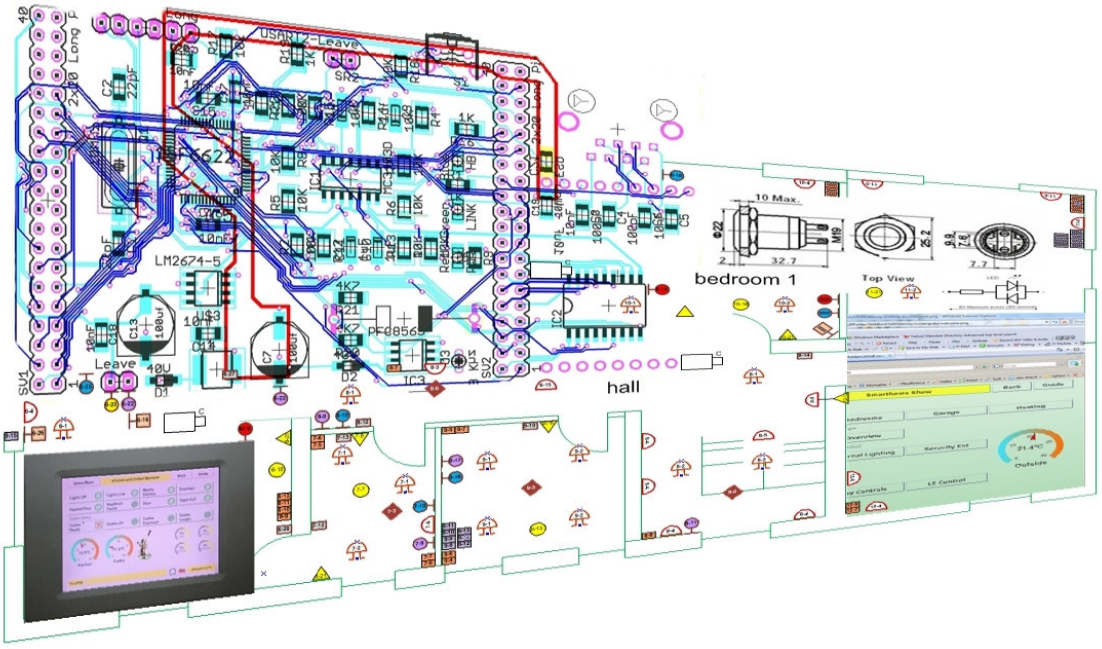
WebBrick URPS™ – Manual

Ultra Reliable Power Supply UC15-15

April 2008



Features

- ✓ Multiple redundant power supply; Two mains power supplies plus one battery
- ✓ Battery charge management to protect against over-discharge, for maintenance of performance, and over-charge, for safety
- ✓ Load shedding output, for extending battery discharge time to essential services
- ✓ Status and alarm communication via serial port to *WebBrick Controller™* or *WebBrick Gateway™*
- ✓ Charge voltage adjustment indication for precision setting of float voltage
- ✓ Visual alarm indication on all power inputs
- ✓ Visual "heart-beat" indication during normal operation
- ✓ Audible alarm when urgent attention is required, battery <11V or mains supplies under-volts
- ✓ Low quiescent current
- ✓ Press button to enable display for power saving and alarm cancelling
- ✓ 105mm wide DIN rail housing with rising clamp connectors

Background

In a home automation system where continuous uninterrupted operation of the local control is a must, to prevent brown-outs and maintain a certain level of service during mains power-outage, a battery back-up system is essential. User information about the power supply condition is available directly from the front panel or by remote monitoring through the *WebBrick Controller™* and WebBrick Gateway*™*. This information allows the user to take appropriate action which may be overlooked in a dumb system. Battery maintenance is also a crucial factor and to this end, the *WebBrick URPS™* will prevent abuse of the battery by switching charge and discharge current to prevent damaging voltage excursions. Ultra reliability is provided by combining the input from two AC mains to DC power supplies and one rechargeable battery. The *WebBrick URPS* is a device custom-designed for use in an environment that requires little maintenance and will give the user confidence and peace of mind.

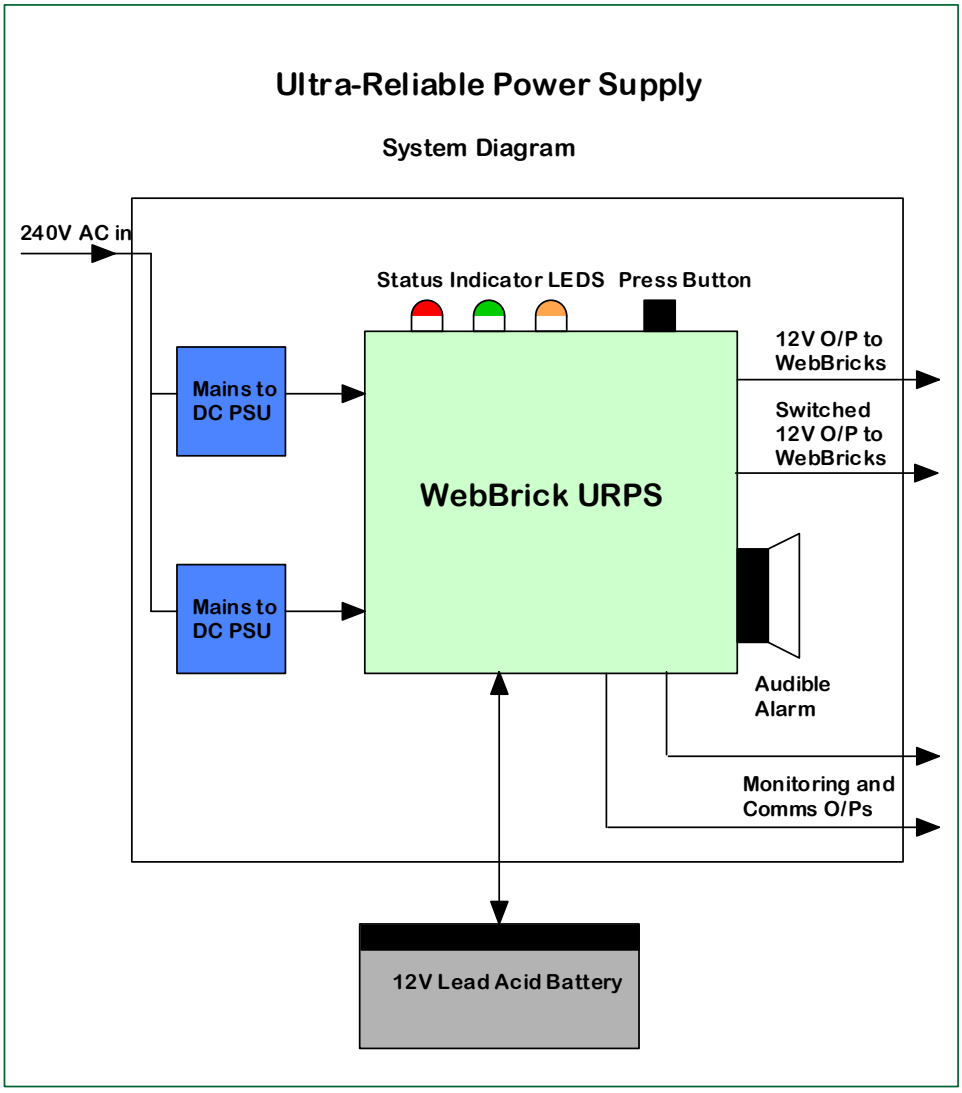


Fig1. Layout of a WebBrick URPS with 2 PSUs & battery

General Description

The *WebBrick URPS* is most often deployed with 3 other components, a 12V lead acid battery and two mains to 12V (nominal) DC power supplies (PSUs), they are laid out as in Fig1.

It is a triple-redundant power source to provide ultra-reliable supply for WebBrick installations.

The specification of the PSUs and 12V lead-acid battery must be determined by the installer. Batteries are to be sourced independently of WebBrick Systems.

Power Supply and Battery Selection

Battery
First of all, the capacity of the battery selected will be dependent on the run time as discussed below. Once the battery capacity is established, suitable power supplies can be selected. Getting a good balance between the power supply and the battery is essential to ensure against excessive charge current to the battery or overloading the power supplies. As a rule of thumb, the total charge current in Amps available from both power supplies added together should not be less than the 1/10 of the battery capacity expressed in Amp.hours and should not be greater than ½ of the battery capacity expressed in Amp.hours. For example when using a 60Ah battery, the combined power supply currents should add up to between 6A and 30A. It is important that the battery selected is capable of taking a full charge current which can be as much as the rating of both the PSUs added together. For example, when using two 15A PSUs, the battery must be capable of charging at 30A otherwise cycle life and more importantly safety will be compromised. Always verify the technical specification of the battery before connecting it to the system. Use only batteries designed for deep-discharge as actual "car batteries" rarely fulfil this criterion.

Warning:
Large capacity lead acid batteries can give extremely high current if short circuited and the correct handling procedures must be observed as per the battery manufacturers guide lines. Be sure to site vented lead acid batteries in appropriate locations.

Run-time
The capacity of the battery will depend on the load normally applied to the *WebBrick URPS* output under mains failure conditions and the length of time required to keep the system live. The load during a power-outage must take into account devices not normally used in day to day operation such as emergency lighting.

E.g. Total load including emergency lighting plus WebBrick overhead etc. = **15A**, using a battery of **150Ah** (assuming it's fully charged and in good condition) it will give…

150/15 = 10 hours

When using the switched, load-dumping output from the WebBrick URPS which closes down at approximately 50% remaining charge, this will need to be factored into any calculation of run-time.

One should bear in mind that batteries degrade over time and it may well be worth over-rating the capacity so a certain amount of reduction is acceptable on the runtime of the system with age.

Charging time is a little more complex to estimate due to the effects of thermal management when charging from fully discharged and the effects of current taper near full charge. A test to determine the charge time should be run if it is critical.

Power supply units (PSUs)
One option is to use the *WebBrick URPS* with the low power 1.25A PSUs commonly supplied by WebBrick Systems, in this case the maximum recommended battery capacity is no greater than 25Ah.

It is important that the power supplies selected can cope with battery charging duty. The worst case is where the battery is at 10V and the power supply is set to 13.8V. A current limit is essential within the power supply that doesn't prevent it operating under such conditions. WebBrick Systems doesn't recommend the use of actual battery chargers to double as power supplies because of the output voltage ripple. Some dedicated chargers are set to change voltage under certain conditions of charge current which could confuse the alarm sensing function of the WebBrick URPS.
Use only high quality power supplies in order to take advantage of the system reliability the *WebBrick URPS* offers.

Installation

The WebBrick URPS and its associated adjustable PSUs should be fitted to a suitable DIN rail and the battery located as close as possible while observing the warnings.
Once the WebBrick URPS is in position between its two mains to DC power supply units (PSUs), an example is shown in Fig2, connect the DC supplies to the *WebBrick URPS*, but do not connect the battery at this stage.

At switch-on, the *WebBrick URPS* will go through its start-up routine to test the LEDs and audible alarm (if enabled). Press the display enable button and the LEDs will give a full status read-out for about 2 minutes before going into power-save mode. Press the button again for more display time. Ignore any audible or flashing LEDs at this stage until the controller has been fully set up. To attain the correct output from the *WebBrick URPS* for float charging the battery, **press and hold the display button for the duration of the adjustment procedure.** Switch on the power supplies in-turn and adjust the outputs of each of the two mains PSUs until the top two LEDS show pure green. The LEDs will show pure red when the voltage is too low and a mix of the two colours to show orange when the voltage is too high. The top LED indicates the voltage of PSU1 and the centre LED indicates the voltage of PSU2. Careful adjustment will bring the voltages into the centre of the acceptable range. The button can be released at this time and the indicator LEDS will now show the normal running status on the PSUs. Once adjusted, the battery float-charge voltage will be close to 13.8V (at the battery) which is the standard for almost all lead acid batteries work to. Checking the actual output voltage of the PSUs will reveal a level of close to 14V, the difference is due to the voltage drop in the diodes in the *WebBrick URPS*.

It is now time to connect the battery. The battery input has a fuse which will blow if a battery is connected with reversed polarity so care is needed at this stage. A healthy battery should be above 11.0V when connected, if it is lower, the bottom LED will show red (in display mode) until the battery has charged to above 11.0V, the PSU1 and PSU2 indicator LEDs may show red, this is normal, it indicates that the mains power supplies are working at their maximum output. Use cable of the appropriate gauge to connect the battery to keep the resistance low and charging time down. Once the battery is near fully charged the top two LEDs will show constantly green (in display mode), indicating the charge current to the battery has dropped significantly.

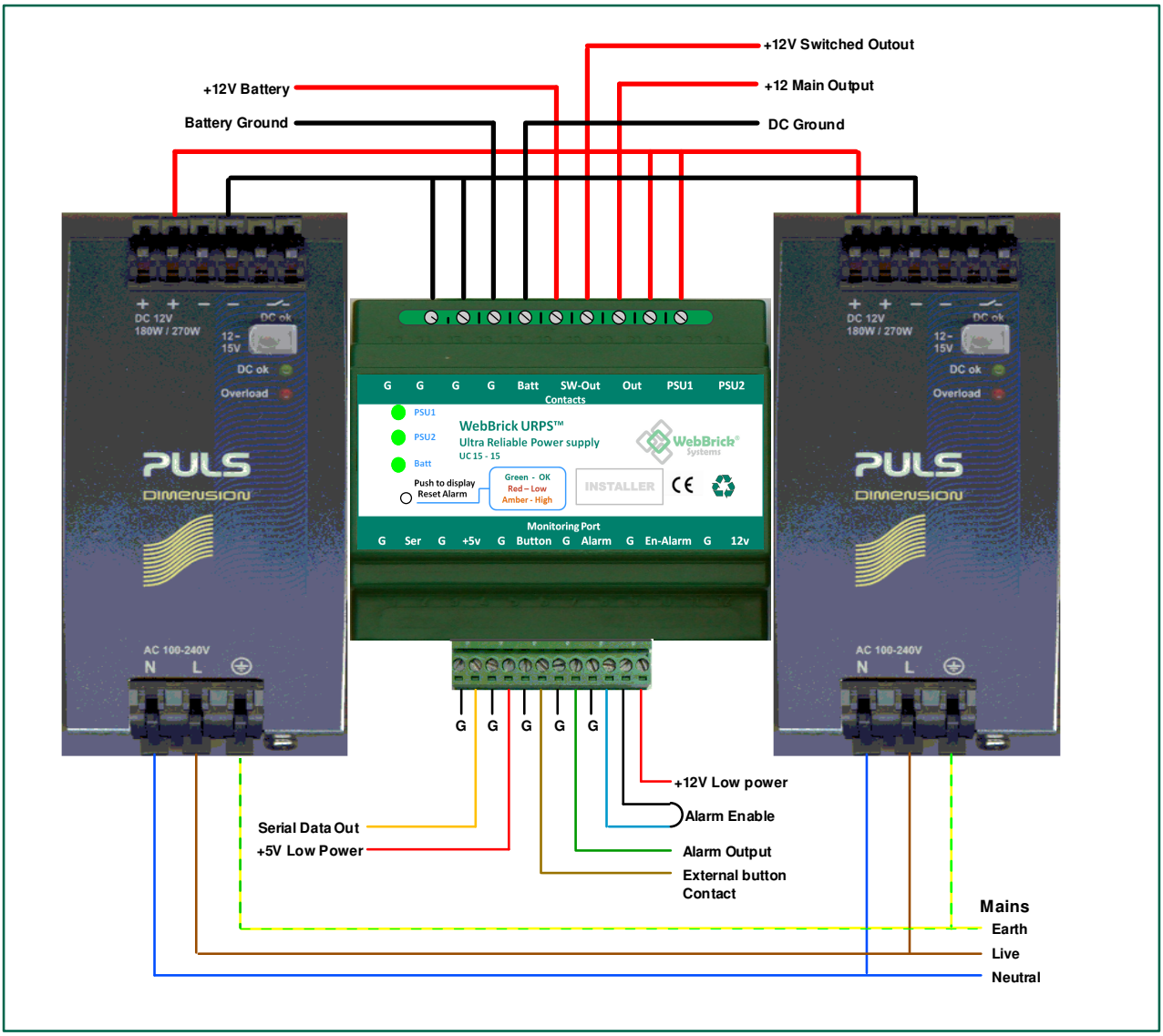


Fig.2

If at any time the a red heart-beat flash is seen, the display button should be pressed to show the full status of the inputs to the *WebBrick URPS*, action should then be taken if necessary to prevent any fault condition from persisting, see the diagnostic chart in table 2

If it is suspected that the mains power supply voltage has drifted outside the normally tight limits required for battery charging it will be necessary to disconnect the battery before readjusting the power supplies. This is necessary because the battery may cause a slight load which effects the voltage measured within the *WebBrick URPS*. The home automation system connected to the *WebBrick URPS* should function quite happily providing at least one power supply stays live and provided it is sufficient to supply the total load, see Operation section.

Monitoring via WebBrick Controller or WebBrick Gateway is optional but recommended as the *WebBrick URPS* will most likely be housed in an area which would normally be out of sight of day to day activities.

Since the battery charging voltage is standardised at 13.8V nominal float-charge voltage, it will increase battery life to ensure the back-up battery chosen for the installation is compatible with this value. Do not attempt to connect any other type or other voltage battery to the system.

Operation

The normal operation mode of the controller is with the display in power-save mode. In this mode only a visual "heart-beat" indication is given where the centre LED flashes at low duty cycle in order to confirm operation. When all the power inputs are within normal operating limits, the flash is green but should there be an abnormal voltage the LED will flash red, this can include when the battery is charging at high current.

If the battery is called upon to supply power in the event of a mains failure, it will do so down to 10V at which point the controller will switch it off the output to prevent damage to the battery by over–discharge. When the battery has discharged to a voltage of 11.8V (approximately 50% charge), the secondary (Switched) power output is switched off to release load for the more essential services which are required to work until the battery is exhausted. At a discharge voltage of 11V, the audible alarm will sound (if enabled) until either the voltage of the battery recovers above the 11V limit or the display enable button is pressed. Pressing the button cancels the audible part of the alarm until such time as the battery voltage has recovered to above 11V at which time the alarm is re-enabled for the next low voltage warning.

As discussed above, during discharge of the battery there are 3 stages of low voltage battery warning. Load dumping is the first is at 11.8V, then at 11 Volts when the audible alarm sounds there is an amount of charge remaining which should be enough to allow an ordered power-down of the live devices. Below 10 Volts the battery is automatically disconnected so it can no longer discharge. There is very little energy left in the battery at this voltage and little point in trying to use it because to do so would damage the battery's ability to store charge in the future. The battery can still be charged below 10 volts but only on the trickle regime, regulated internally by the WebBrick URPS, to prevent overloading the mains power supplies. Once the battery charges to above 10V, full charge current is automatically restored so the battery can charge as fast as the mains power supplies will allow although there is a thermal limitation within the WebBrick URPS that will switch in and out of charge to prevent overheating when at full charge current which can be as high as 30A depending on the battery size, connecting cable and its depth of discharge.

If the battery is below 5V it is considered "dead". It is very unlikely, once a 12V lead acid battery reaches this voltage, that it will be recoverable. In this instance all charge and discharge is inhibited by the *WebBrick URPS*. The audible alarm will sound in power-save mode and can be cancelled when the button is pressed at which time the display will show a red bottom LED to indicate a dead or missing battery.

Once the PSU adjustment procedure has been completed, the normal under-voltage warning point of the mains PSUs is automatically reduced to 13.4V in order to reduce unnecessary alarms due to noise on the PSU lines.

The *WebBrick URPS*'s output is fused at 15A so no attempt should be made draw more than this amount of current as a blown fuse will result, see fuse replacement section below. A maximum allowable current rating for the output is equal to one of the mains PSUs, this is an essential element of redundancy in the system. To be in-line with the philosophy of ultra-reliability, failure of any one of the two mains power supplies should not bring the whole system down, there should be enough available from one to keep the system going indefinitely whilst mains power is available.

WebBrick URPS Technical Specification

Part Number UC15-15

- External connections
  - Two mains derived DC 12 to 15V (adjustable for battery float-charging)
  - 12V lead-acid battery connection (charge output/discharge input)
  - DC output to supply WebBricks and other low voltage utilities including lighting etc.
  - Secondary load–dumping output for non-essential services
  - Serial output for monitoring of critical voltages and alarm flags
    2400 Baud 8N1
  - Low power 5V output 50 mA maximum short-circuit protected
  - Audible alarm output (0/5V, 25mA when internal alarm disabled, 10mA enabled)
  - Internal alarm enable input (0/5V)
  - Alarm reset button input, voltage free contact to ground
  - Low current 12V output <=1A

- Operating parameters
  - 15A maximum current input from each of the mains derived DC inputs
  - 15A maximum output to all 12V service loads
  - 30A maximum battery charge current (actual maximum charge regulated by heatsink temperature limited by the mains derived DC inputs 15A each supply maximum)
  - Battery capacity range: <= 300Ah
  - Battery charge voltage adjustment indication 13.6V to 14.0V (13.8V Nominal)
  - Load shedding output set to 11.8V (approx 50% capacity)
  - Battery under-voltage protection, discharge ends at <10V
  - Battery over-voltage protection, charge prevented >14V
  - Battery trickle-charge function for deeply discharged batteries (prevents brown-outs in the event of low voltage battery being connected during WebBrick controller operation)
  - Battery trickle-charge within voltage >5V,<10V
  - Battery charge lock-out, recognises and disables a dead-battery at a voltage <5V

WebBrick URPS Connections

As with the *WebBrick Controller*, the *WebBrick URPS* uses a plug-in rising clamp connector for the low power and monitoring connections, this can be left in place or removed whilst connecting up, a description of the connections is shown in Fig3 and table 1.

Fig3. Connections to the *WebBrick URPS*

Power Connector (Top)	Description
1	Ground
2	Ground
3	Ground
4	Ground
5	12V Lead Acid Battery Positive Connection
6	12V Positive Switched Output to WebBricks Etc.
7	12V Positive Output to WebBricks Etc.
8	PSU1 Positive input
9	PSU2 Positive Input
Monitoring Connector (Bottom)	
1	Signal Ground, electrically the same connection as power ground
2	Serial Output, monitoring of voltages in serial string, 2400,8 n 1
3	Signal Ground, electrically the same connection as power ground
4	+5V Output, low current, support for low current external equipment,50mA max
5	Signal Ground, electrically the same connection as power ground
6	External Press Button connection (return from button to ground, push to make)
7	Signal Ground, electrically the same connection as power ground
8	External Alarm Positive connection maximum current 10mA at 5V, return to ground
9	Signal Ground, electrically the same connection as power ground
10	Internal Alarm Enable, connect to ground to enable internal audible alarm
11	Signal Ground, electrically the same connection as power ground
12	12V Positive Output to WebBricks Controllers Etc., Electrically connected to pin 8

Table 1.

WebBrick URPS Operational diagnostic chart

Indication	Meaning	Action to be taken
Centre Green LED Flashing	System running Normally No faults	None
Centre Red LED flashing	Possible Battery or PSU fault	Press display button to enable display and observe LEDs
Audible alarm sounding	Possible Battery or PSU fault	Press display button to enable display and observe LEDs
Top LED showing red	PSU1 low volts	If battery has been discharged recently then wait and check again later should symptom persist, disconnect battery and re-adjust PSU1 voltage
Centre LED showing red	PSU2 low volts	If battery has been discharged recently then wait and check again later should symptom persist, disconnect battery and re-adjust PSU2 voltage
Bottom LED showing red	Battery voltage below 11Volts	If battery has not been discharged recently, check battery off-line and replace if necessary
Bottom LED flashing red	Unrecoverable or disconnected battery	Check and re-make battery connections or replace battery
Top LED showing orange	PSU1 high volts	Readjust PSU1 as necessary
Centre LED showing orange	PSU2 high volts	Readjust PSU2 as necessary
Bottom LED showing orange	Battery high volts*	Readjust the PSU(s) as necessary

Table 2.

*This is a situation which is prevented in practice buy the *WebBrick URPS* but it could give this indication if the charging voltage is adjusted too high. This indication shows an attempted over-voltage situation exists. The *WebBrick URPS* will be seen to switch in and out of charge as the battery voltage lags the control from the URPS.
If an alarm condition persists after some corrective action is taken, it will be necessary to check for other faults in the system.

Fuse Replacement

There are two internal fuses inside the controller, should either of them blow during normal operation, the first thing that will happen is a battery warning will sound if the battery fuse has blown or there will be no output from the *WebBrick URPS* if the output fuse blows.

Fuse Function	Rating	Colour	Fuse type
Battery	30A	Green	Farnell 994-3900
Output	15A	Blue	Farnell 308-341

Table 3

If a fuse blows it will first be necessary to find out why it blew before replacing it. Simply replacing it and re-powering the system may cause damage to the devices it is connected to.

Once the source of the overload has been cured and with the *WebBrick URPS* powered-down, remove the controller from the DIN rail and flip off the cover by inserting a thin flat blade under the ends of the case and gently easing them out. With the case off, locate the relevant fuse. The fuses can clearly be seen, the 30A battery fuse is to the left of the circuit board and the 15A output fuse is to the right of the circuit board. The ratings are marked on the PCB. Do not replace the fuses with any other rating as this may cause an over-heat situation. The blown fuse can be pulled out of its holder and a new one pressed home.
Care should be exercised when handling the internals of the controller so as not to bend the heatsink mounted component legs.

If the display circuit board becomes dislodged during this operation, simply plug it back in again before replacing the case. To do this make sure press-button is orientated towards the bottom (the signal connector side) and all the 8 pins are aligned with the sockets and push it home.

Replace the cover by lining-up the LEDs and switch with their respective holes and drop the cover back on to the base. Clip the ends of the case over the catches on the base and press the ends in to check they are secured.

Serial Monitoring, Alarm/Status Interface

The serial interface at pin 2 of the monitoring connector is an RS232 transmit only output which sends the status of the *WebBrick URPS* approximately every 3 seconds. This data can be sent to a WebBrick Gateway for more sophisticated control and readout. The serial port set-up is 2400,8,N,1.

The data set always consists of 10 Bytes as follows...

Start Byte	PSU1 Volts Hi Byte	PSU1 Volts Lo Byte	PSU2 Volts Hi Byte	PSU2 Volts Lo Byte	Batt Volts Hi Byte	Batt Volts Lo Byte	Output Volts Hi Byte	Output Volts Lo Byte	Alarm/Status Bits
11111111	000xxxxx	000xxxxx	000xxxxx	000xxxxx	000xxxxx	000xxxxx	000xxxxx	000xxxxx	0xxxxxxx

Table 4

Voltages are expressed as 0 to 15V over 10 bits, split 5 bits to each pair of bytes, high then low. To reassemble the 10 bits of the original data it is necessary to use an algorithm that takes the high 5 bits and shifts them to the right by 3 places within a 2 byte data word. Splitting the data bytes like this allows a simple unequivocal start byte consisting of all 1s to be used.

Using 0 to 1023 to represent 0 to 15V means that each bit count is equivalent to 68.2mV.

The alarm/status Byte is assembled as follows...

MSB Start	Under Voltage Battery	PSU Failure	Battery Connected	Switched Output	Trickle Charge	Discharge Control	Charge Control
Always 0	0=OK 1=UV	0=OK 1=Fail	0=OK 1=No Batt	0=ON 1=Off	0=ON 1=Off	0=ON 1=Off	0=ON 1=Off

Table 5

Using a WebBrick URPS to power a WebBrick Gateway Appliance.

The voltage requirements for the WebBrick Gateway appliance are somewhat more critical than the rest of the system i.e. 12V+/- 5%. The *WebBrickURPS* output voltage can vary between 10V and 13.8V. It is therefore necessary to use a voltage stabiliser the type of which is supplied to run an LCD TV from a caravan supply these typically take any voltage from 10 to 28V and convert it into a tightly regulated 12V supply.