Low cost independent or remote power supply using a UPS

by Jonathon Thwaites 13th Nov 2005

I had been thinking about using an Uninterruptible Power Supply (UPS) for some time to build an independent power supply system. The UPS would supply the most expensive component of the system – the sine wave inverter- free of charge, these are usually about $1.20 per watt of rated output. So a 1500 Watt continuous rated sine wave inverter would typically cost around $2000. UPS systems are often thrown away when their batteries go flat and yet are in perfect working order otherwise.

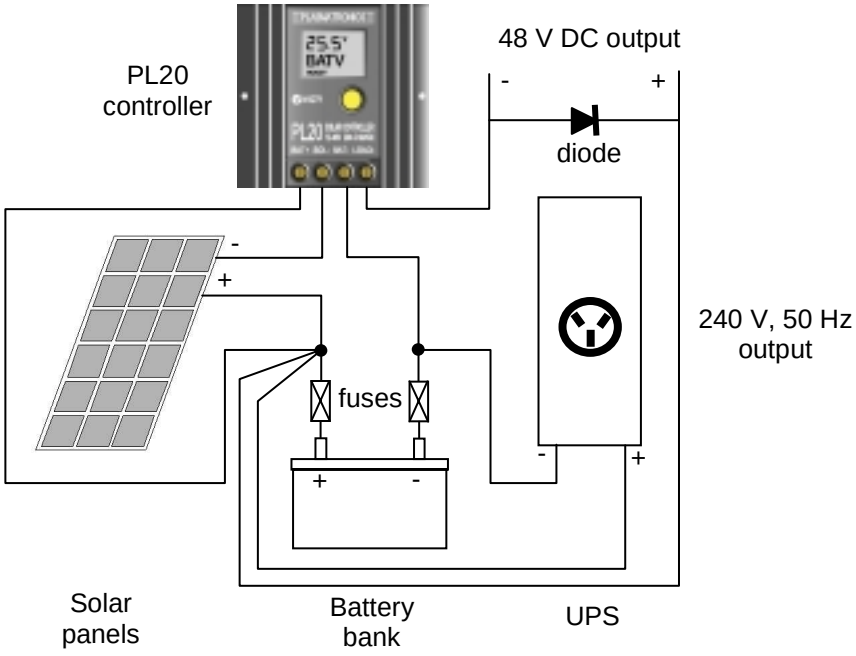
UPS systems are used to supply electricity for essential equipment or in offices where unplanned shut down of computers would be costly. They generally have a small bank of batteries built into them, often lead acid gel cells but sometimes NiCads. The batteries store energy and on mains shut down supply power to the UPS's inverter which keeps the essential supply on at 240 Volts 50 Hz AC for anything from 10 minutes to hours for any piece of equipment plugged into it. They occasionally have battery extender terminals so the UPS supply time can be extended by adding external battery banks.

The lead acid batteries have a limited life time, usually less than 10 years and it is often the case that the UPS system is thrown away when the batteries finally fail because either, the operator isn't aware of the batteries at all or because to replace the batteries is expensive and the new UPS technology makes the old system obsolete. The UPS inverter is often of high quality and sine wave and in no way damaged. The systems also usually come with battery chargers of varying sophistication to keep the batteries in a good state of charge. Many of UPS systems are rated for only 10 minutes or so but sometimes they are rated at usefully higher power output under continuous conditions.

A UPS system is built to be connected to the mains to keep the batteries charged and to supply power to its output plugs. When the mains go down the UPS kicks in and supplies power from the batteries to the output plugs, if the mains comes on again the supply to the output plugs is automatically switch back to the mains input of the UPS.

The system I have built uses a battery bank and UPS to create an independent mains power supply system. It also uses a typical PV charging set up, with voltage regulator (PL20) to maintain the battery charge from a number of solar panels. This allows me to do away with the need for a mains connection to the UPS and it become independent. It is really two very simple systems one charging the batteries and the other using the batteries through the UPS.

The system is shown below and tried and tested it and it seems to work seamlessly.



The diode is supplied with the PL20 and is used to protect the PL20. I used 15 Amp fuses on the battery, both positive and negative terminals, this would allow a maximum load of approximately 750 Watts. Its a bit conservative as the inverter is rated at 1500 Watts and they could be 25 amp. It means the load should not exceed 750 Watts if you don't want the fuses to blow.

The UPS is a Holec and contains a good quality sine wave inverter continuously rated at 1500 Watts, with a peak transient rating of 2500 Watts. I picked it up in from a company in Perth that services, installs and supplies UPS systems from their rubbish pile after asking the manager if I could have it. It includes:

- Battery charger and inbuilt logic controls the gas point charge setting coming on for short times periodically and a float charge setting for normal charge.
- Settings on a dip switch panel on the back to adjust the gas point and float charge voltages, adjustment for typical mains voltage in the area and a number of other functions.
- Automatic low battery shut down.
- An RS232 connecter for logging and to use as a signal to shut down equipment in an orderly fashion
- Alarms for low battery etc.
- Two UPS standard power point plugs.
- Two filtered non-UPS standard power point plugs.
- A number of fuses to protect the UPS, battery and attached equipment

A number of features on the UPS are not used in this systeem. I do not have it connected to the mains so it will not charge batteries from the mains (although the charging electronics are excellent and can be used). I have not used the 48 Volt load terminals of the system. These are the usual power outputs from a system without an inverter controlled by a PL20. The PL20 is simply controlling the charge state of the batteries independently of the UPS. This is a relatively basic use for the PL20 and many of its other control and data logging facilities can easily be implemented. Use of a PLS2 shunt adaptor

would allow logging of the whole system's energy use and charging from PV through the PL20 to the battery bank giving a full picture of the battery charge state.

It is important that the manual for the UPS be read carefully and that you understand it. Another good reason for asking the owner of the UPS business is to get the UPS operations manual and circuit diagrams. The Holec requires the large capacitors in the UPS to be charged relatively slowly (through a high power resistor of something like 50 Ohms) when connecting to the battery bank, otherwise the batteries will dump a massive current on the capacitors for a very short time, creating massive voltage spikes in the UPS and capable of destroying its internal components. Similarly the capacitors should be discharged slowly when disconnecting or shorting the output.

Shown below is a picture of the system, the fan is a test load. The white box is the UPS, PL20 is sitting on top of it and needs to be mounted vertically for cooling. The battery bank is shown behind with the lid of the battery box removed. It has big holes in the sides to prevent hydrogen gas build up in the box.

Components of UPS independent power supply

Panels	8 x 60 Watt Solarex polycrystalline panels. Second hand. Configured as two strings of 4 panels in series. Nominal power 480 Watts. Nominal output voltage 48 Volts, unloaded 68 Volts
Bypass and string diodes	From bring out your rubbish. From old computer power supplies.
Panel mounting system	Unistrut, but could use anything sensible, Steel bed frames are good
Inverter	Holec UPS. From the rubbish heap. Sine wave inverter 1500 Watt continuous rating, 2500 Watt peak transient load. 2 x UPS power outputs, 2 x filtered outputs RS232 connector for logging and system control

	Alarm, low battery shut off 48 Volt battery bank configuration (internal batteries dead and removed)
Batteries	8 x Lead acid deep cycle 130 Amp.hour, 6 Volt. Second hand Usable energy approx. 33 % of 6.240 kWatt.hour or 2.080 kWatt.hour. Configured in series as 130 Amp.hour, 48 Volt or 6.240 kWatt.hour
Voltage regulator	Plasmatronics PL20
Wiring and terminal block	From the bring out your rubbish
Battery box, paint	From bring out your rubbish

The cost of the system excluding my time and the PLS2 shunt adaptor is given in the table below. A typical equivalent system using purchased components would be of the order of $7,000, with the main saving here being for the panels ($2,000), inverter ($2,000) and wiring ($500).

Panels: second hand (and very good price at that) 8 x $200	$ 1,600
Panel mounting system: (Unistrut) could make it yourself with old bed frame angle iron etc	$ 300
Inverter: Holec UPS. From the rubbish heap.	$ 0
Batteries: second hand 8 x $20 (probably a very good price – I had reliable information that they were in good shape)	$ 320
Voltage regulator: Plasmatronics PL20	$ 330
Wiring and terminal block: From the rubbish heap.	$ 0
Battery box, paint: From the rubbish heap.	$ 0
Total	$ 2,520

The system would be capable of running the lighting circuit in a modest hobby farm house and maybe even the refrigerator depending on the owners care.

The PL20

The PL20 is a complete battery system controller capable of handling battery, PV, Wind, microhydro or other inputs. It is completely programmable, has data logging and can be connected to a PC through an RS232. This little box is expensive but a very nice piece of gear and worth the dollars. It is designed and manufactured in Melbourne. See http://www.plasmatronics.com.au/

PLS2 shunt adaptor

The PLS2 shunt adaptor is designed for use with PL series solar charge controllers. It allows the controller to measure charge or load currents which do not go though the controller. This allows inverter or generator currents to be included in the controller's display. (price approx. $230). The PLS2 shunt adaptor measures the current in a current shunt and converts that measurement into a digital form.This data is then sent to the PL controller.

http://www.plasmatronics.com.au/