Solar-recharged UPS as a low cost AC power supply for Electronics and Environmental Education

J. Diz-Bugarín[1], M. Rodríguez-Paz[2]
[1] *IES Escolas Proval, Avda Portugal 171, E36350 Nigrán (Spain)*
[2] *IES Tomiño, Solleiro s/n, E36740 Tomiño (Spain)*
javier.diz@edu.xunta.es, montserpaz@edu.xunta.es

Abstract. *This article describes the transformation of an Uninterruptible Power Supply (UPS), commonly used as power backup for desktop computers, into a solar rechargeable portable mains supply. Almost any commercially available UPS can be used and the conversion can be made without having detailed knowledge about electronic circuits inside. A few external elements must be added: solar panel, charge regulator (commercial or self-made), a protection diode, cables and connectors. The system has many applications as a solar educational kit, as a small power source for car or camping, or for lighting and powering small isolated buildings.*

Keywords. Solar Power Supply, Electronics, Environmental education.

1. Introduction

Uninterruptible Power Supplies (UPS) are a simple and inexpensive protection against mains failures for computers and many other electronic systems. These devices contain almost all the elements required (battery, charger and inverter) to make a portable mains supply that can be recharged by many sources like solar photovoltaic energy, wind energy or hydro-electric power. If any of these sources is not available, it could be removed and recharged with a car battery or an ordinary ac socket.

Some external elements must be added, like a solar photovoltaic panel, a charge regulator and protection elements. The battery capacity can be increased adding a second element connected in parallel.

This article describes all the changes that must be made and elements that have to be added.

Fig. 1 shows the system with external elements, cables and AC socket ready to use.

Figure 1. Complete solar kit with panel and ac socket

This system was projected to light an old flour mill where we are planning to make an educational exhibition about traditional uses of renewable energies.Fig. 2 shows the mill and surroundings with water channel or *levada*. In this application the system could be recharged by solar or hydraulic energy.

Figure 2. Mill and water channel (*levada)*

2. UPS description

A common UPS (Fig. 3) contains the following elements:
1) Power supply and battery charger that are connected to external ac mains and keep the 12V battery completely charged.
2) Battery (Figs. 4 and 5) of lead-acid type, 7-12 Ah. This capacity is enough to light one or two low consumption lamps for several hours.
3) Power inverter that receives 12V DC from the battery and provides an output of 230V AC.

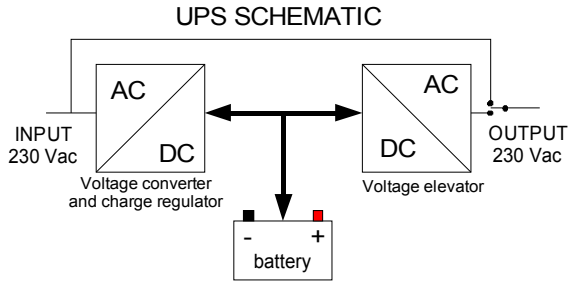

Figure 3. UPS internal schematic

These devices are typically connected to the mains all the time, and battery is always full. When there is a power failure UPS inverter starts generating power from the battery.

In our application UPS is simply disconnected from the mains, and will continue generating power until battery is empty. If we can recharge the battery without reconnecting it to the mains we will get an independent power source that can be used anywhere.

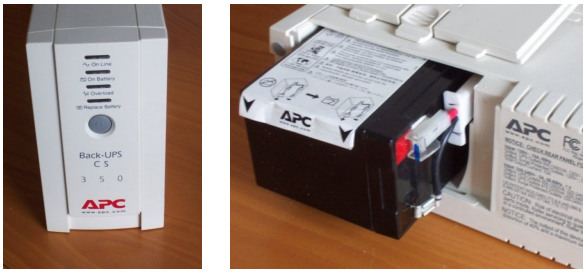

Figure 4. UPS and battery housing

Figure 5. Lead-acid battery

3. UPS modifications

The following changes have been applied to allow solar recharging, as can be seen in schematic (Fig. 6):
- An external connector must be installed and connected to the battery to allow access and recharging (Fig 7 and 8).
- A solar panel and external regulator must be connected directly to the battery. The solar panel should provide at least 14V and 10-20W of peak power [1]. The regulator can be a commercial type or a self-made one (see next section).
- A protection diode must be inserted between the battery and external regulator. This diode allows simultaneous working of external and internal recharging and avoids discharge of the battery through the solar panel.

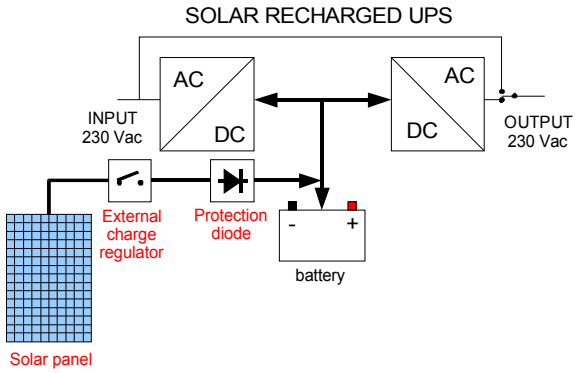

Figure 6. UPS modifications to allow solar recharging (external elements in red)

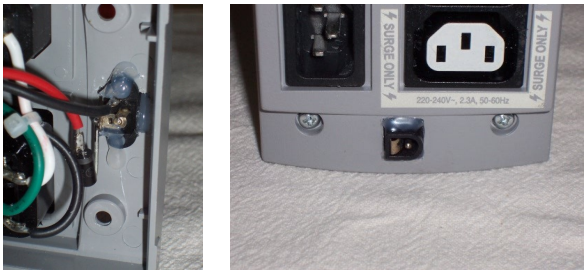

Figure 7. External recharge connector

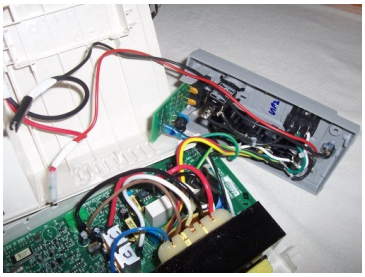

Figure 8. Detail of internal connections

4. External regulator

UPS's have an internal charge regulator to avoid damage to battery. This regulator could be incorporated into the solar recharging system, but unfortunately manufacturers [3] do not provide enough information about internal circuits, so this option must be discarded. That's the reason we decided to develop our own regulator based in an integrated circuit of common use in electronics, the voltage regulator LM317 [2]. The circuit is adjusted to obtain an output of 14,5V. Fig. 9 shows the schematic of this circuit, that can easily be assembled by electronics students in a typical school workshop. Fig. 10 shows a prototype of regulator inside an outdoor box.

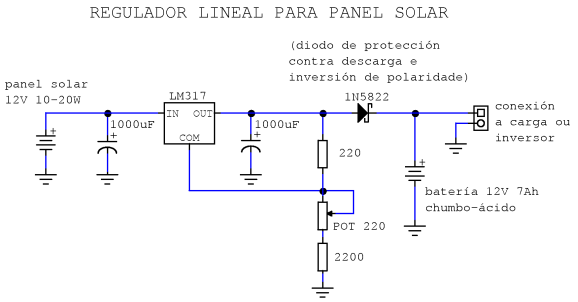

Figure 9. Charge regulator schematic

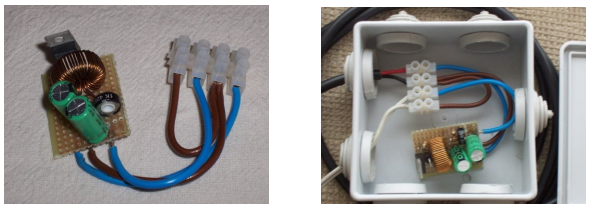

Figure 10. Charge regulator fully assembled

5. Final assembly

To make the final assembly of the system the following steps must be followed:

1) Solar panel must be connected to the charge regulator input. It can be checked with a multimeter (under direct sunlight).

2) Regulator output must be connected to external battery connector in the UPS (see Fig. 9).

3) UPS output must be connected to an electric appliance (like a low consumption light). A mains socket (schuko or similar) can be mounted at the UPS output to allow different charges to be easily connected and disconnected.

If everything is right the power supply will start generating electric power. If there is enough solar energy to partially recharge the battery every day the system will work indefinitely without any external contribution.

6. Applications

The system can be used wherever there is need for ac power with low consumption, like lighting in small isolated houses, camping, powering of small electronic devices like tv or radio transmitters, etc.

An important field of application is electronics students training, since these students can both make the system elements (like the regulator or connectors), and use them as a solar energy practice.

Students of other fields can also take advantage of this system due to its low cost, like in subjects related to environmental themes.

It can be used in exhibitions or science fairs about renewable energies, specially if other power sources are used for recharging instead of solar power (like a small wind generator, hydraulic generator, etc). As an example of this applications, the kit was shown at "Encuentro Solar 2007" meeting in Granada, Spain.

Another interesting application is as a backup power source for laptops when used outdoors. A fully charged battery can provide 2-4 hours of use of computer.

7. References

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