# Using a UPS during load-shedding

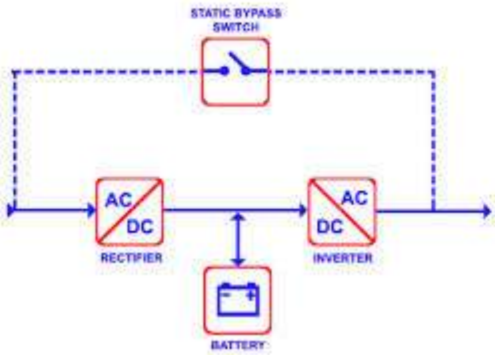


Desktop **Uninterruptible Power Supplies** (UPS) are widely available and cheap. Can these be used to provide power during load shedding? Yes, provided you understand their limitations. This article explains how they work and how they can be used.

When buying a desktop UPS, you will see that they are rated in terms of Volt-Amps (VA). 600VA, 800VA, 1000VA, or 1200VA for example. Unfortunately, this doesn't tell you how long it will hold up the supply for a given load, and bigger is not necessarily better.

A typical desktop UPS rated at 650VA can be bought for less than R1000-. These units are built very much to a price, and technology wise are very basic.


The unit has an input connector for 230V AC mains and several output connectors for 230V AC mains to connect loads such as computers.
It operates off-line when the AC mains power supply is in the normal range. As soon as the supply goes out of the normal range, typically 230V ±10%, the UPS will supply power to the loads using the internal inverter and batteries. An inverter converts the 24V DC from the batteries to 230V AC. The picture at the bottom of the page with the cover off shows the batteries in the bottom compartment on the right.
While the 230V AC input power is in the normal range, the UPS charges the internal batteries so that they are ready to supply power in the event of an interruption.
A UPS rated at 650 VA is rated to supply power to loads up to 650VA, but the real (resistive load) power capability is probably around 400W.
The hold-up time is the time that the UPS is rated to supply power from the batteries to the load. At maximum power this is typically less than 10 minutes. This is really just enough time to finish up what you are doing and shut down your computer.




The basic limitation is the capacity of the internal batteries. The unit shown has two 12V 7Ah lead-acid gel electrolyte batteries. These are sealed batteries that do not leak electrolyte and cause corrosion unlike the old fashioned car batteries you may be familiar with.

The 7 Ampere – hour (Ah) rating of the batteries refers to the capability of the batteries to supply a certain amount of energy. The Ah rating is usually calculated at the 20 hour rate – the current drained to discharge a fully charged battery over a period of 20 hours. In this case, 7Ah ÷ 20 = 0.35 A for 20 hours. Discharging the battery at 0.35 amps for 20 hours gives you 7 Ah. The output voltage is approximately 12 V, so 12V x 7Ah = 84 Watt hours (Wh) of energy.
If we have two of these batteries, then we have 2 x 84Wh = 168 Wh of energy stored. If the unit is called on generate 400 W, then we can expect the hold-up

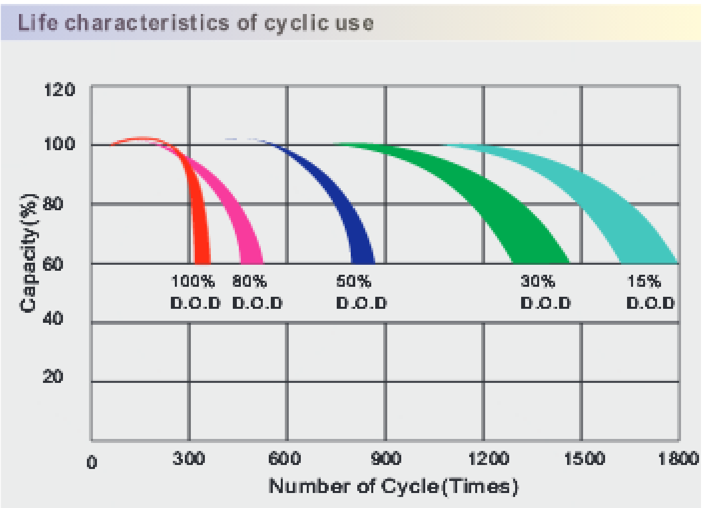
time to be approximately 168Wh ÷ 400W = 0.42 hours or 25 minutes, theoretically.

Unfortunately, there are all sorts of losses that occur. The batteries are much less efficient at high discharge currents (400W ÷ 24V = 17A) because the internal resistance starts to dominate, and the batteries warm up. The inverter is probably only 80% efficient as well, so the UPS may manage 10 minutes hold-up time.
Obviously, if the load is lower than 400W in our example, then the hold-up time will extend proportionally. A typical desktop computer may only load the UPS with 100W, so you could perhaps expect a hold-up time of closer to 168Wh ÷ 100W = 100 minutes, but given all the losses mentioned, 60 minutes is realistic.
As the UPS discharges the battery, it monitors the battery voltage and when the voltage drops below a minimum level, it will shut off to avoid damaging the batteries. Initially, the UPS may beep at a slow rate, and then approximately half-way through the discharge cycle, it will beep more rapidly. Finally, just before it cuts off, it will beep continuously.
Once the batteries are discharged, when the power returns, the batteries must be recharged. Typically this is done at the 10 hour rate, so accounting for losses, you need about 14 hours to get back to full capacity. Fast charging is also bad for batteries as heat is generated and batteries don't last long at high temperatures.

**To get back to the question on UPS sizing**, many suppliers do not state the size of the internal batteries – but you need to know this before you buy one. Most of the typical desktop ranges have the same pair of 12V 7Ah batteries in the example above. This means that the larger ones have larger peak power capacity, but the poor batteries just go flat sooner.

Another factor to bear in mind is that, if you operate the UPS with deep discharges ie running it until it switches off, the batteries will not give you very many cycles. Depending on the minimum voltage setting of the UPS and the quality of the batteries, you should not expect to get many cycles before the battery capacity drops off so much that you only have a minute of breathing space.
Also, even with no discharges, the batteries have similar operating life times to those you find in your car – four to five years before the capacity drops off too much. 12V 7Ah batteries can be found for less than R200- each, so a pair will be less than R400-, every five years or so, provided the batteries are not worked hard. They are also easy to replace, provided you observe basic safety precautions.

So the question may be asked: **How do I make sure my batteries last?**
All rechargeable batteries wear out, losing some capacity with each discharge cycle. The deeper the discharge, the quicker they wear out. Rapid, deep discharges are particularly stressful – such as UPS duty.




In UPS duty, you will be lucky to get 100 cycles of maximum power down to 100% depth of discharge (DoD). If you discharge them at the 10 hour rate (ie 16W over 10 hours in our case) down to 100%, then you may see 300 cycles until the capacity loss exceeds 20%. If you limit the depth of discharge to 50%, then you may be able to achieve 800 cycles before the batteries need replacing. These are for high quality batteries like the one shown in the graph alongside.

The extra-cheap UPS you found at the China-mall may not quite be up to this.
(See http://www.mantech.co.za/Datasheets/Products/RT1270E.pdf and http://www.mantech.co.za/Datasheets/Products/RA12-100AD.pdf for typical battery data sheets if you want to see more.)

If you have load shedding twice a week – say 100 times a year, and then if you treat your UPS batteries gently, then they will probably last five years, before other wear-out mechanisms occur. Typically, when the UPS goes from a slow beep to a fast beep, then you are at about 50% depth of discharge, and you should switch off for decent battery life.
For our example above, the energy draw for a 50 % DoD is 80Wh, so for a four hour load shedding period, you should only draw 20W (80Wh ÷ 4 hours = 20W). This is not much, but is perhaps enough to keep an ADSL modem and WiFi router alive, and charge a couple of cell phones, or power a table lamp with LED bulbs.

Modern lap-top batteries can often make it through a four hour black-out, so a small UPS on the modem/router may be enough to keep you on-line and working in the above example.

As an aside, you may be tempted to replace the standard UPS batteries with external, larger batteries to get extra capacity and hence longer life. This is fine in principle, but there are some issues to address. Safety may be compromised, as the larger batteries will have larger fault currents and the internal wiring and protection (fuses) in the UPS may not be able to cope. The thermal design of the UPS may be inadequate, as it was designed to just make it through the limited discharge time given by the standard batteries without overheating. If there is no protection against thermal overloads, safety may become an issue again.
If you need more capacity, rather buy a purpose designed inverter and battery setup, rated to give you the holdup time you need.