

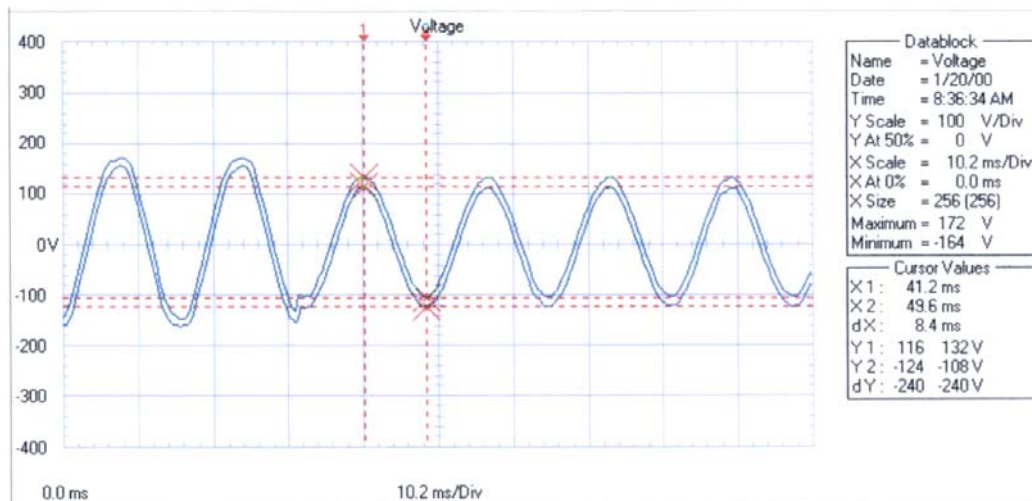


## Power Protection For Your Computer

November 2004

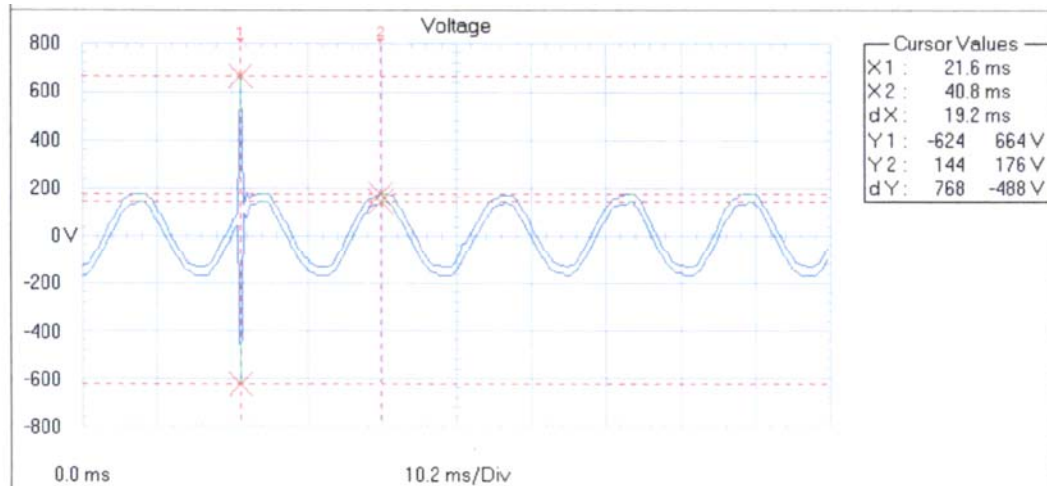
Michael McCord, P.E.

Electrical power is used so casually that few of us ever give a second thought to the quality of power that may be coming from standard wall outlets. Shoot, as long as the power cord plugs in and our device(s) turn on we don't give it a second thought, right? It's a credit to the commercial power suppliers that equipment damage caused by line power problems is quite rare. However, even the best commercial line power can suffer from brown-outs, black-outs, and surges (spikes). If your line power comes from a small generator, battery inverter, shipboard power, etc. or if there are industrial loads on a nearby power feed, then the risk is even greater that there will be line fluctuations that could be serious enough to wreak havoc with your electronic equipment.



This is a "brown-out" where the line voltage dropped to 85 Volts. Normal is 120 Volts.

Most users are unaware of the disturbances that affect their power lines because it takes special equipment to view and record them. On a given day in a typical Washington, DC office, I've measured 5 to 10 spikes per day that exceed 100 Volts. It's not unusual to measure a dozen or more spikes that exceed 200 Volts in the course of a week. In fact, once or twice a week, I've measured spikes well over 500 Volts! In addition to the disturbances that are typical in a power distribution system, Mother Nature adds her effects which can be far more destructive.



This spike measured 1288 Volts but lightning-induced spikes can be significantly worse.

Most of us are aware of lightning surges and line power transients because the marketing people tell us to buy products that protect electronic equipment. They tell us that not only can these disturbances damage your computer but they can also affect your telephone and cable modem lines as well. Minor transients may result in degraded performance while major spikes can result in immediate failure. Line voltage running high or low can damage your computer and rapid fluctuations (on-off-on-off-etc.) can be particularly destructive.

This tech note will describe the hardware you need to protect your computer. Of course, the price goes up with degree of protection but even the most basic and inexpensive surge protection will help prevent damage to your computer system.

These power protection tips also apply to your entertainment system and other sensitive electronics such as fax machines, cordless telephones, and entertainment systems.

#### Levels of Protection:

**Basic.** At the bare minimum, you should use a good surge-protected multiple-outlet power strip for each computer. There are a number of products on the market that provide excellent protection and at a cost of less than \$50. Power strips simply plug into your wall receptacle and provide multiple outlets for devices such as your computer, monitor, speakers, printer, etc. However, they will not provide back-up power or protect against line voltage that's running high or low, or rapid fluctuations. For power outages longer than about 0.05 seconds, or 50 milliseconds (ms), your computer will reboot and any unsaved data will be lost.

When selecting a surge-protected power strip, check the product's description to ensure it will protect all three wires: hot (black), neutral (white), and ground (green). Often marketed as 3-line protection, this is your best protection against transients. Another desirable feature is radio frequency and electromagnetic interference (RFI/EMI) noise filtering. Protection for your modem's phone line, cable, or DSL modem is also recommended and is available in many product lines.

Line power voltage protection is provided by an uninterruptible power supply (UPS). There are three topologies in today's market: Standby, line-interactive, and on-line. Standby UPS's simply monitor the line voltage and cut in the inverter within 50 milliseconds of a power loss. Line-interactive UPS's perform the functions of the standby UPS and add voltage regulation. True on-line UPS's perform a dual conversion – that is, all incoming line power is converted to the battery's DC voltage and then inverted to provide stable computer line power.

Functionally, when power is lost the UPS generates 120 Vac line power from an internal battery and transfers your computer to this back-up power in less than 50 ms. For outages up to a few minutes or so in duration, the UPS will allow you to continue using your computer. However, for longer outages you'll want to save your data and shut down your computer. Remember, the purpose of the UPS is to allow you time to shut down in an orderly manner and save your data.

### Standby UPS

At the inexpensive end of the UPS line-up is the standby UPS. For comparison, a 420 V-A standby UPS from PowerWare's 3115 series can be purchased for about \$77 but it has limited features and its output waveform is a "stepped" sine wave. I would not recommend UPS models that generate a stepped or triangle wave because the high harmonic content generates heat. Sine wave output will usually be stated in the specifications and, if missing indicates the UPS likely has a stepped type of output.

### Line-Interactive UPS

I usually specify the PowerWare 5115 series because their inverters produce a pure sine wave and they provide excellent surge protection. Cost for their 500 Volt-Amp (V-A) model is about \$160 from online e-tailers such as Page Computers.

### On-Line UPS

When power quality is critical, you'll want to use the on-line UPS primarily because the inverter is always in operation, which means the switch-over time is zero. Therefore, the risk that the computer will reset is minimized. Another important feature is good isolation between the line power input and the load power output. This is very important for reducing ground loops in systems used for low-level signal acquisition. (See topic below on ground.) Also, the output waveform is a well-regulated sine wave. For cost comparison, a 700 V-A on-line UPS from PowerWare's 9120 series is about \$335.

### Our Recommended UPS Topology

Most home and small office users will find that a line-interactive UPS provides the most cost-effective solution. There are a number of brand names on the market that will do a good job for you. Just shop the specifications and search for product reviews. Many models feature communications with your computer (via the USB, com port, etc.) and include software that will tell you the state of the battery and load on the UPS. You don't need to use a surge-protected power strip after the UPS, but to protect against long-term aging of the surge devices, I consider the small additional cost a form of cheap insurance.



A PowerWare UPS is shown on the left and a Leviton surge-protected power strip in the middle.

### Selecting a UPS

The most important specification for a UPS is its Volt-Amp (V-A\*) rating, that is, the maximum power that can be delivered to your computer system. You can quickly estimate your V-A requirement by using 75 watts for the computer, 50 watts for an LCD monitor, 125 watts for a CRT monitor, and 50 watts for miscellaneous small loads. Devices such as printers and scanners can be left out of your calculation if you don't plan to protect them with the UPS. Take the sum and multiply by three factors, which together will give you an estimate of your UPS power requirements. First, use the factor 1.25 to allow for future power needs and UPS battery aging; second use the factor 1.4 to convert watts to V-A; and third use the factor 1.4 to ensure the UPS operates at less than 70% of its rated load – this prevents nuisance tripping.

For this example, a 200-watt system will require a UPS rated at 490 V-A (that is,  $200 \times 1.25 \times 1.4 \times 1.4 = 490$ ). Large CRT monitors, external drives, dual processors, printers, etc. will add to your V-A requirement. For this reason 500-600 V-A UPS's are very popular because they meet the requirements for most computer systems.

If you add the power ratings stated on your computer device labels, the resulting power calculation will be significantly higher than your actual requirement. This is because the manufacturer is required to state the maximum power that can be drawn under all operating conditions. The above estimate will put you in the ballpark, but if you have any doubt then you should have a technician measure the actual power drawn by your computer system. Most consumers find it easier to simply pay a few more dollars and purchase a UPS with a higher V-A rating. Just remember, the more devices plugged into the UPS, the more power you'll need, and the more expensive the UPS will get.

Note: V-A rating is typically higher than the watt rating and is due to the way the device power supplies load the UPS. (For our technical readers, this is the power factor or phase angle relationship between the voltage and current.)

Before you go out and purchase your UPS, check with the power company for the voltage and frequency in your locality. In the USA, power is distributed at 120 Vac at 60 Hz (cycles per second). In Europe,

220 Vac at 50 Hz is common. UPS's must be purchased specifically for the voltage and frequency of your locality.

### Ground.

If your computer system has a third (ground) prong, never operate it ungrounded! Properly grounded, your computer will be safe to operate, quiet, and meet the manufacturer's design specifications. If it is intentionally ungrounded, you will have potential shock and fire hazards. In addition, EMI/RFI noise may affect other electronic systems. Systems used to process high fidelity sound may pick up 60-cycle hum if the computer and associated equipment are not properly grounded. If you suspect your line power ground is contributing to a noise problem then try using a power isolation transformer or online UPS. When 60-cycle hum persists, use signal isolation transformers between multimedia components. MGE Topaz<sup>1</sup> is a good source for power isolation transformers and Jensen<sup>2</sup> offers an excellent line of audio/video signal isolation transformers. Properly grounded systems provide the best protection against EMI/RFI noise, 60-cycle noise, and protection against electrical shock and fire.

1 <http://www.mgeups.com/products/pdt120/powerc/tpz100/t100.htm> (sold at Page Computers)

2 [http://www.jensentransformers.com/iso\\_aud.html](http://www.jensentransformers.com/iso_aud.html) (sold direct)

### Whole-House And Whole-Office Surge Protection

If you live in a region with a high incidence of lightning storms then you should also install a surge protector at your line power breaker box. If you have a telephone line, cable modem, DSL modem, etc., protect these items as well. With lightning, there is never 100% protection but you can improve your odds of survival by installing several layers of surge protection (e.g. protection at your breaker box, UPS, and outlet strip). For more information on home and business power protection, you may want to read an article posted on Leviton's web site entitled "Whole-House Protection"<sup>3</sup>. End users can easily install consumer protection devices but the services of an electrician will be required for installation of devices at your breaker box.

3 <http://www.leviton.com/pdfs/wholehousesurge/wholehouse.pdf>

### Conclusion

This article is intended to be used as a guide for protecting your computer system. There are a number of power protection devices on the market and you are encouraged to research product literature and discuss with application specialists before making any purchases. Power strips and UPS's are easy to install but you will need to turn off power to your computer system for their installation. If the hardware or software installation is confusing, your local computer store guru should be able to provide advice and may also assist with the installation.