Powerline Transient Suppressor

All it takes is a single glitch, transient, or surge on a power line to wipe out hours of work on a personal computer. Here's a simple yet effective device that helps eliminate those three serious power-line-related problems.

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THERE ARE THREE DIFFERENT TYPES OF power-line disturbances that can affect the operation of small computers: RF interference, line transients, and power-line surges. Each can affect different computers in different ways. Also, some computers are more easily affected than others. For example, short of a direct lightning hit, no power-line disturbance will disrupt a Heathkit/Zenith *H8* or *Z/19* computer. One *H8* we know of was running when the opposite wire of a 120/120 (240 volt) power line took a direct lightning hit only 100 feet away; the *H8* just kept on working. On the other hand, simply turning on one of the most popular printers will cause an equally popular personal computer to re-boot—and wipe the program you've been writing for three hours right out of memory.

Let's look at the three types of disturbances and some of their causes. Turning first to RF interference, we were asked to cure such a problem plaguing a *TRS-80 Model III* used for demonstrations in a Radio Shack store. It turned out that the source of the interference was a *Color Computer* that was also being used for demonstrations. All that was needed for a quick and inexpensive fix was a $12 RF filter that Radio Shack itself sold.

Line transients are another simple-to-cure but nevertheless bothersome problem. They are generated by power transformers and inductors when the current through them is turned on or off (although it's most severe when turned off.) Consider this case involving an Epson Printer and a *TRS-80 Model I* computer. If *scripsit* text-editing software was running, simply turning the printer on caused a line transient that scrambled the memory but not the video display. Everything looked just fine on the video screen, but what was saved to disk or sent to the printer came from memory, and that was pure garbage.

Transient "ride-through" was the reason for the scrambled memory. It's not unusual for line transients caused by inductors and even lightning discharges in the neighborhood to range as high as 1000 volts; and those transients can ride right through the power-supply regulators and into the five-volt computer power supply. The result can be scrambled memory or "blown" ICs. The cure for the problem is a General Electric MOV (*M*etal *O*xide *V*aristor) that more or less clips instantaneous line-transients at about 180 volts, a safe value that is generally handled (as far as we can tell) by all personal computers.

Finally, we can come to the third disturbance, one that causes the "silent death" of software, and sometimes of hardware: power-line surges caused by the local electric company's trying to maintain service after a power interruption. As a general rule, if a power line fails, the utility company will attempt to maintain service; often, the line may surge several times before failing completely, or the line may "hold," and power will be restored. The first interruption will probably wipe out or scramble whatever is in the computer's memory. The transients caused by the surges that follow as the utility tries to maintain power are quite capable of zapping your IC's and disks. If the first failure takes your disk drives out of service, you want to keep them out of service until things are safe for them once more. Applying power again and again—particularly in the case of start-up transients—to a disk drive with the door closed is an odds-on bet to wipe out a disk. For software protection, a good rule of thumb for personal computers is that when the power takes the computer down even for an instant, keep the computer and all its peripheral equipment out of service until you are absolutely certain that steady, reliable power has been restored.

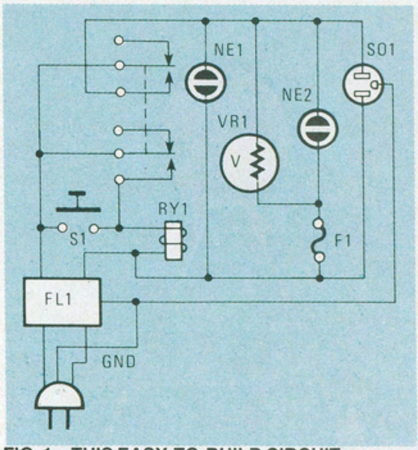

FIG. 1—THIS EASY-TO-BUILD CIRCUIT can provide better power-line protection for a personal computer than many commercial devices costing as much as $150.

TRANSIENT SUPPRESSOR

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The relay specified handles 10 amps, and all circuit wiring should, similarly, be capable of handling 10 amps. This means No. 14 wiring for all circuits associated with receptacle SO1. (The wires to the relay coil and the lamps can be No. 20, or No. 18.) Solid wire is recommended. You can obtain No.14 solid wire by purchasing a few feet of No. 14 Romex electrical-wire at your local hardware store and stripping off the outer skin. Under the skin will be two (or three) insulated No. 14 solid wires and a bare ground-wire. Save the bare wire for some future project.

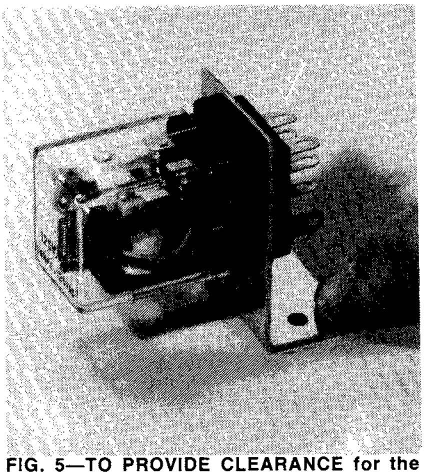

FIG. 5—TO PROVIDE CLEARANCE for the power-drop-out relay, mount it on an L-bracket made from scrap aluminum.

Receptacle SO1 must be of the three-pronged, grounded type. The particular unit you get may have screw or solder terminals, or may be prewired. If there are screw or solder terminals use your No. 14 wire. If the receptacle is prewired the wire is probably No. 12 stranded. Simply twist the free strands together tightly and tin them with solder. Take care to be sure you locate the correct "ground" terminal on SO1. If SO1 is prewired the wires will be color-coded red, black, and green. The green one is the ground wire, and is soldered to the ground lug on FL1. The power-line ground, also green, must be soldered to the filter's ground terminal, as well.

Neatness doesn't count

Insulated No. 14 wire is not the easiest material to work with. Usually, forming "square corner" bends will put undue strain on the associated components. Don't try to be extremely neat; bend the power wires in gentle arcs. There's plenty of room on the panel, so don't crowd the wiring. Bending No. 14 wire around a relay socket's solder lug is a sure way to break the lug, so lay the wire on the lug (use a clamp if necessary) and make a

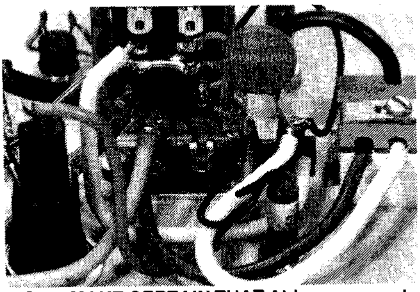

FIG 6—MAKE CERTAIN THAT ALL components and wires are securely soldered to a terminal. No components should "float," and no wires should have in-line splices. Such construction will help ensure glitch-free operation for your computer.

secure tack-solder connection.

Use a 3AG fuse rated at 12 amps (*not* the "Slo-Blo" type) for F1. If you can't get a 12-amp one, a 10-amp fuse will do. We have never run across a varistor's protection fuse that opened, or a "shorted" varistor, but since the possibility exists that it can happen, don't eliminate F1.

Checkout

Measure the resistance across the line cord's terminals with an ohmmeter. It should be "infinite," even though the RF filter's schematic, printed on the filter's case, shows a resistance across the input terminals.

Check the resistance across SO1's output connections; it should also be "infinite." If not, check the connections to the varistor.

Check the resistance from both sides of the line-cord plug's prongs, and SO1 to ground. It too should be "infinite;" if not, there is a wiring error.

If everything checks out up to this point, connect the unit to the power line. Nothing should happen. Next, press RESET switch S1. You should hear RY1 switch in and both NE1 and NE2 should light. If NE1 does not turn on, check RY1 for a wiring error. If NE1 turns on but NE2 does not, check the wiring of F1 and the varistor.

If both lamps turn on, the device should be OK. As a final check of the device's latching function, simply remove then restore power. To do that, simply plug a load such as a table lamp into SO1 and then cut power either by throwing a circuit breaker or pulling the device's plug. Restore power and if the lamp will not light the device is ready for use. Connect your computer system's main power-cord to SO1, or better yet, connect a power strip to the socket, and the computer and the disk drives to the strip. Your printer should then be plugged into the same socket that's used by the protection device. That ensures that any RF or glitch generated by turning the printer on must feed through the RF filter before reaching the varistor. That provides double protection, and you can never be too safe. **R-E**

Three in one

One way to eliminate, or at least sharply reduce, the problems caused by the unusual power-line conditions we've discussed is with the simple yet effective device described by this article. A schematic diagram of that device is shown in Fig. 1.

Although relatively unsophisticated, it does protect your computer against the three most common forms of power-line disturbances. First, there's FL1, an RF filter that keeps RF from entering into your computer through the power line, and RF from your own computer from getting into the power line (see Fig. 2).

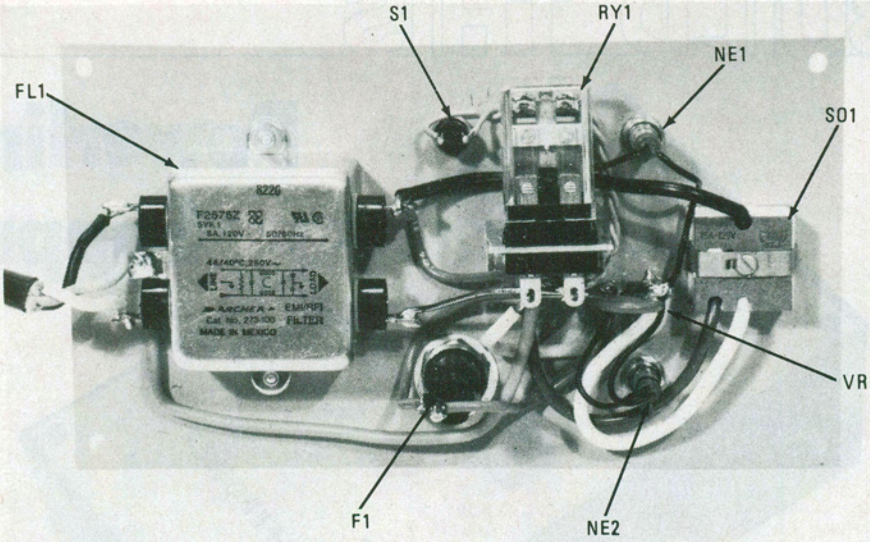

FIG. 4—ALL OF THE COMPONENTS mount on the metal front panel of a plastic utility cabinet.

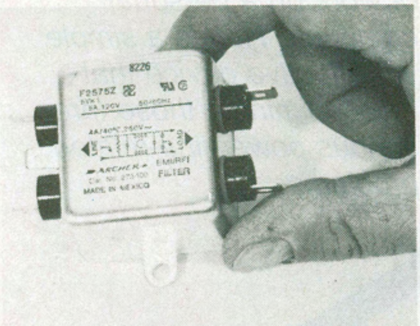

FIG. 2—THIS RF FILTER keeps RF power-line interference from leaking into your computer, and keeps your computer from interfering with other devices. It is particularly good at keeping two computers on the same power line from interfering with each other.

Second, it has a General Electric MOV, VR1, across the outlet receptacle to reduce the effects of line transients (see Fig. 3). Finally, relay RY1 is wired so that it drops out and *stays out* after the first power-line interruption until deliberately reset by the user. If the power fails at night, and in the darkness you forget to turn off your computer system, hours later—when the utility restores power—your disk drives won't start by themselves. Also, if the utility creates surges on the line while trying to maintain power, your computer will be safely disconnected from any consequences of that surging.

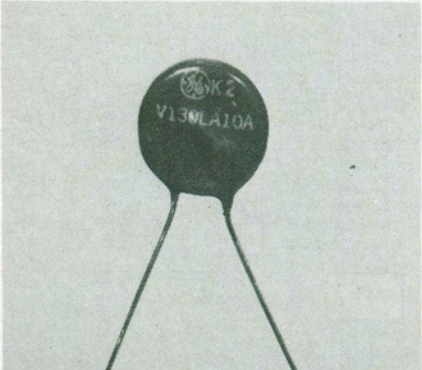

FIG. 3.—IT LOOKS LIKE A DISC CAPACITOR, but it's really a metal oxide varistor that limits transient line-voltage surges to about 180 volts.

Two neon indicator lamps show the condition of the power line and of VR1. Lamp NE1, an amber-colored POWER indicator, will always be lit if there was no interruption of the power source. If NE1 is out it means there was a power-line interruption and the power to receptacle SO1 is locked out (RY1 dropped out). Power is restored by pressing RESET switch S1, which causes RY1 to pull in and latch, and apply power to SO1.

Lamp NE2, a green LIMIT indicator, shows that the safety fuse in series with VR1 is intact and the power line is protected against transients. Lamp NE2 must always be on when NE1 is on. If NE2 is out it means there was an excessive transient that caused fuse F1 to blow, or—more seriously—that VR1 is damaged. Replace fuse F1. If it blows again (as indicated by failure of NE2 to light), simply replace the varistor. It is rare for a varistor to be damaged by a transient, but it can happen.

No provision is made for an on-off switch because the unit is intended always to be on; it is simply a safety device. If you want to use the device as a master power-control for your computer system, you can install an on-off switch in series with either power-line connection to the RF-filter input. Keep in mind, however, the fact that S1 must still be depressed to turn the power on.

Construction

The unit described was built on the metal panel supplied with a $7\frac{5}{8} \times 2\frac{3}{8} \times 4\frac{5}{16}$ plastic utility-cabinet. There are two versions of that cabinet around: the U.S.-made Bakelite cabinet with a sturdy metal panel, and the "imported" model made of soft plastic with a relatively thin metal panel. If the thin panel is all you can get and you want something more sturdy, you can cut a duplicate from a sheet of a heavier grade aircraft-quality aluminum.

PARTS LIST

FL1—EMI/RF filter (Radio Shack 273-100 or equivalent)
VR1— V130LA10A metal-oxide varistor (General Electric)
RY1—DPDT plug-in relay, 125-volts AC (Radio Shack 275-217 or equivalent)
S1—pushbutton switch, normally open
NE1—neon lamp assembly with built in resistor, 120 volts, amber
NE2—neon lamp assembly with built in resistor, 120 volts, green
F1—fuse, 3AG, 10 or 12 amps (see text)
SO1—AC receptacle, three-pronged, grounded type
Miscellaneous—cabinet, fuseholder, 3-wire line cord, relay socket (Radio Shack 275-220 or equivalent), No. 14 solid wire, etc.

As shown in Fig. 4, all components except RY1 mount directly on the metal panel. Relay RY1 is mounted on a small L-bracket fashioned from scrap aluminum. (See Fig. 5.) Form the bracket to the shape required to mount the particular relay you use. The relay specified in the Parts List is easy to obtain, and mounts in a socket that is similarly easy to obtain and install. Its use is recommended.

When you form the L-bracket, make certain there will be clearance for the small terminal-strip used to mount the VR1—that terminal strip is secured by one of the rivets or screws used to mount the bracket on the panel; alternatively, you can leave room for the terminal strip next to the bracket. Take note that the power line for a computer must be 100% free of interruptions. Make sure that all components are tied down and expertly soldered; leave no connections hanging in space even if they are soldered and taped (see Fig. 6).

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