You can't just plug your computer into the wall!

James V. Dinkey

If you think a dedicated line is the end of your computer problems, read this...

In much of their sales literature, the various computer manufacturers state that all you have to do to get their computers operating is to merely plug them into the wall.

Not true! What the manufacturers really mean is that if the power available at the wall is manufactured by Snow White and the Seven Dwarfs, you stand a pretty good chance of not having power supply problems.

But in reality, with the advent of distributed data processing, and more recently with the advent of the personal home or office system, the computer has been attached to whatever is handy, rather than to a properly selected power source. We're all guilty of the choice; we just don't want to pay the money for a proper power supply. So we hope all will go well and despair when it does not.

In reality, the dedicated line is not nearly sufficient protection.

Most manufacturers state in the material delivered with the computer that the voltage is to be 117 V ± 15% or 20%. On the surface of it that looks fine, except that there are factors that virtually all personnel tend to conveniently forget—like spikes. Inductive components generate spikes. Copiers and plant air conditioning units are the most common spike generators. Even high current loads, such as heaters, generate spikes in association with the inductance of the distribution wiring and service transformer.

For the moment, let's look at the specification of the computer. That statement of 117 volts ± 20% means 117 volts ± 23.4 volts (or not less than 93.6 volts or more than 140.4 volts, all RMS).

But it is a demonstrable fact that an office copier will often generate spikes in excess of 100 volts when turned off for the day and spikes of about 110 volts while running. These voltages ride the normal sine wave voltage and add to, or subtract from, it. Admittedly, the duration of the spike is extremely short, but nevertheless real.

So we can conclude beyond all doubt that even a spike as short as 2 msec at 110 volts is sufficient to go through most power supplies, and is therefore sufficient to adversely affect a computer.

There are three distinct types of power problems which must be handled by computer power supplies:

- impulses (spikes or transients);
- sags and surges; and
- voltage swings.

For purposes of our discussion, the definitions of each of the above are as follows: An impulse is a short-duration voltage excursion; short-duration means 2 msec or less. A sag, or surge, is a one- or two-cycle voltage excursion. A swing is a gradual change in voltage lasting more than 10 seconds and taking at least 10 seconds to move at least three volts. The last two items, sags (surges) and swings, are usually handled quite effect-fully by the computer manufacturer's power supply. But the first, impulses, are usually a very different story.

The only proper way to find out what is affecting your equipment is to get a power line disturbance analyzer. You can rent one for a week for about $150.

The place not to go to get the power line disturbance analyzer is your local power company. Basically, the power company is not geared to handle your specific needs and their equipment is not designed to monitor spikes. Even if it were designed to measure the parameters you would like to have measured, the power company would usually attach it to the outside of the building at the service entrance. This is in line with the power company's policy of monitoring only the delivery of power, thereby divorcing themselves from any problems caused within the customer's building. Such a policy is correct from the power company's viewpoint, but it doesn't do a user much good if the customer is causing his own problems inside his building.

The chances are excellent that the problem you've been having, or will have, is a result of impulses going into your computer. If the specifications are 117 volts ± 20% volts, then a spike of not much more than 40 volts will exceed the manufacturer's specifications.

What can cause this phenomena? Inductive devices! (See how many you have in your own environment!)

- refrigerators,
- air conditioning units (permanent roof and window),
- office copiers,
- typewriters,
- computer printers and terminals, and
- mechanical adding machines.

Even stoves, heaters, and coffee pots can be a source of trouble as a result of the mechanism of line inductance in the local power system.

If any of these appliances sound familiar to you, the chances are excellent that your computer has been acting in strange ways for reasons that are no fault but your own: you have been operating your computer in environments that are outside of its stated design limitations.

I recently placed a power line disturbance analyzer on a machine that was having a significant number of operating system "hangups." With the aid of the analyzer, we were able to establish that our office copier was generating spikes of sufficient strength to send an impulse down the copier's dedicated line. This impulse arrived at our computer as a spike of 112 volts. And if the peak of the sine wave had received the "hit," then...
the instantaneous voltage would have been well over 250 volts, far exceeding the design criterion stated by the manufacturer. In addition, our air conditioning units were putting out 80-volt spikes for a peak total of over 190 volts. Furthermore, these impulses had a fast rise time, creating an electromagnetic interference problem similar to CB radio or radar, but within the computer mainframe!

Therefore, a dedicated line is of little value! Why? Because it is only a partial solution, regardless of what a computer salesman might tell you. If one does put in a dedicated line to a computer, it eliminates the problem of spike sources directly adjacent to the computer, but does nothing about associated devices. Ergo: What most people don’t appreciate about the so-called “solution” of a dedicated line is that the energy impulse initiated by some inductive sources (see again the list above) is propagated down to the power distribution box and split up among the various circuits according to the inverse ratio of the circuits’ impedances.

For discussion’s sake, let’s assume that there are 20 circuits into the distribution box, but only four are active—i.e., an appliance is turned on in only four of them. The others are off and accordingly present infinite impedance. As a result, the energy released from one circuit is going to be spread among the remaining three.

One circuit, of course, the feeder from the street, a feeder transformer. It has a lower impedance than the other circuits, but its value is not zero, particularly at high frequencies. The salesman may have told you that the impulse energy is going to be totally soaked up by the transformer. Not true! Some of the energy undoubtedly is going to go into the transformer and be lost, but a fair part of it is going to be distributed to each of the active circuits in the system. The amount going to each will be inversely proportional to its impedance. The largest proportion of the energy will therefore go into the street transformer or panel box feed, but a significant remainder will go down the dedicated line to your computer.

Obviously, the answer to the spike problem is some sort of filtering. When discussing the type of filter, a distinction must be made between an active and a passive filter. An active filter in effect “follows the sine wave around,” clamping any voltage spikes it may encounter. A passive filter is usually intended to operate when the frequency is incorrect or the excursion of the voltage lies outside of the “envelope” or range of acceptable values. An “envelope can be shown diagrammatically as follows:

\[ \begin{array}{c}
\text{VOLTAGE} \\
\uparrow \\
\text{VOLTAGE} \\
\downarrow \\
\end{array} \]

The envelope method does not protect the computer from a 100-volt spike appearing at the bottom (or top) of a cycle. Hence, a power cycle of

\[ \begin{array}{c}
\text{VOLTAGE} \\
\uparrow \\
\text{VOLTAGE} \\
\downarrow \\
\end{array} \]

will go undetected by the envelope filter, and the effect may be to ask the power supply to filter out a 100-volt spike. The short impulse will almost certainly find its way into the computer itself.

Putting a transformer into the computer line, although usually helpful, doesn’t solve the problem either. It doesn’t make much difference whether

**Spike-control system manufacturers**

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<tr>
<th>Company</th>
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<tr>
<td>Atlas Energy Systems</td>
<td>9457 Rush Street, South El Monte, CA 91733</td>
<td>(213) 575-0755</td>
</tr>
<tr>
<td>Calex</td>
<td>3355 Vincent Road, Pleasant Hill, CA 94523</td>
<td>(415) 932-3911</td>
</tr>
<tr>
<td>Control Concepts Corp.</td>
<td>333 Front Street, Binghamton, NY 13905</td>
<td>(607) 724-2484</td>
</tr>
<tr>
<td>Elgar Corp.</td>
<td>8225 Mercury Court, San Diego, CA 92111</td>
<td>(714) 565-1155</td>
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<tr>
<td>Pacific Power Source Corp.</td>
<td>5291 Systems Drive, Huntington Beach, CA 92649</td>
<td>(714) 898-2691</td>
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<tr>
<td>Topaz Electronics</td>
<td>3855 Ruffin Road, San Diego, CA 92123</td>
<td>(714) 279-0831</td>
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all those high-falootin’ terms like “differential mode” or “common mode” apply. Snow White doesn’t really care—she just wants her computer to work without problems. It is true that Snow White should probably gather together all of her seven dwarfs and pound a rod about eight feet into the ground. Then she should attach the ground (green wire) of the computer to the rod (or a water pipe of the dwarfs are recalcitrant about physical labor). But it’s amazing how full of spikes even those so-called “grounded boxes” are!

In general, the only proper way to handle the spike problem is to either “remanufacture” the power by use of an M-G set (very expensive), or use an “active” filter. An active filter for 30 amps costs only about $250 vs. about $600 for a transformer and $3000 for an M-G set. A filter for 6 amps is about $100.

So whether you are dealing with a minicomputer in a small business or your own home computer, losses of information, or the computer’s “acting queer” can be stopped by careful control of the power, with the “active” filter probably the best and most cost-effective solution for the small-system user.

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Power line problems—a note from the editor . . .

Jim Dinkey’s article prompts me to tell an old war story. Several years back I was in the Air Force and was trying to repair a very broken minicomputer. I worked on it for many days. It was full of bad transistors. It seemed that I would spend all day finding and replacing the bad ones. By the end of the day the machine would be almost working; then, just about quitting time, it would suddenly go downhill. The next day I would start all over again with a very broken machine. Pretty soon I found I was replacing some of the same transistors I had replaced a few days earlier.

The sergeant in charge of the shop was a good military man who liked to keep things looking sharp. In time I noticed that almost every afternoon about quitting time he would have his men run a big floor polisher over the floor. This thing was plugged into an ordinary wall outlet, as was the minicomputer. Whenever the polisher was turned on it drew such a heavy starting current that the line voltage would drop drastically for a fraction of a second. The computer had a power supply using a magnetic amplifier for regulation. This seemed like a nice idea—no transistors to burn out and that sort of thing. But it didn’t have a very fast transient response; when the power line voltage dropped the regulator would open up wide. Then when the voltage returned to normal it couldn’t shut down fast enough, so the voltage on the computer would overshoot by about 50 percent! In those days (and now my age is showing) transistors were very intolerant of overvoltage; they were those funny Philco types like surface-barrier and MADT that were quite fast but terribly delicate (and expensive). I made a decision to stop working on the computer about half an hour before quitting time every day, and in just a few days it was working again.

— J. H.