Repairing a broken PC power supply is a lot simpler than you might think. Nine times out of ten you can do it yourself for under $10.00.

It’s 8:00 a.m., the neighbor’s dog barked all night, your coffee tastes like weak tea, and the phone message light blinks frantically. Full of resolve, you flip on your PC’s power switch, and ... presto — nothing! No lights, no beep, no fan, nada. Suddenly you realize, it’s gonna be a really bad hair day.

While there’s nothing I can do about the early hour or the coffee, I can probably help you get your PC back on its feet. The most common case of “Sudden PC Death Syndrome” is a defective power supply. The problem can come from many sources, like heat, power surges, and old age. While it’s easy enough to replace a power supply by swapping the old for new, it’s not always practical.

A case in point: I have an AST 486SX that died when a truck plowed into the corner power pole and caused a two-hour black out. When the power came back on, my PC didn’t. A quick check showed the cause was a fried power supply. Unfortunately, a call to AST revealed, to my horror, that a replacement power supply costs $150.00. Moreover, because of its unique case design, there’s no generic substitute.

Fortunately, it’s not difficult to fix PC power supplies. While they may look different on the outside, most PC power supplies use the same electronics on the inside. In this article, I’ll show you how easy it is to fix a dead power supply.

The Basics

The power supply is a large metal box, mounted inside the PC that provides power to the motherboard and various peripherals. It’s easily identified by a warning sticker on the case that reads “CAUTION! Hazardous Area” (or a similar high-voltage warning).

On the back of the power supply is an AC connector that plugs the PC into the wall. Often there’s another AC connector that’s used by some monitors. Most power supplies also have a voltage selector switch that lets it work with 110V or 220V power sources.

A typical PC power supply provides four DC output voltages: +5, +12, -5, and -12 volts. These voltages are available through four different types of connectors (Figure 1; 1-4). The color of the wire identifies the voltage and its use (Table 1).

Getting Started

A lot of power supply failures are actually simple problems that are easy to fix. Obviously, the place to start is at the beginning — in other words, are you getting power from the wall to the PC? As stupid as it sounds, the first thing to do is look under your desk and see if the PC is plugged into the wall. If it is, move the plug to a different socket (they go bad, too, you know).

That done, pull the power cord from the back of your PC and see if the power is getting that far. You can do this using a VOM or a simple neon lamp circuit tester, like part number 22-102 from Radio Shack.

If there’s no power, and you’re plugged into a power strip or surge protector, the strip is probably the culprit. To test it, simply remove the PC’s plug from the strip and plug it into a wall socket. If the PC starts working, the problem is in the strip. Generally, the problem is a blown fuse or a tripped circuit breaker. You’ll find both at the cord end of the strip. The last item you should test before popping the hood is the power cord itself; replacing it with another cord is the fastest and safest method.

Under The Hood

Still nothing? Now it’s time to remove the cover. Most covers are attached by five or six screws on the back. Before going any further, carefully read the instructions in the section called “Safety First.”

The next logical place to look is at the power switch. Unfortunately, this may not be possible at this stage of the game. Many power supplies have a built-in power switch which isn’t accessible until you dis-

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The switcher section is the most common to fail. The power transistors have to have a breakdown voltage of 600 volts or more, and the damper diodes have to be fast recovery (a 1N4005 won’t work). You can generally identify the semiconductors by their shapes. From left to right, the first three are diodes, +12V rectifier, +5V rectifier, and switching transistor.

**Table 1. Power Supply Color Codes**

<table>
<thead>
<tr>
<th>Wire Color</th>
<th>Voltage</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>+5V</td>
<td>Motherboard, adapter cards, disk drives</td>
</tr>
<tr>
<td>White</td>
<td>-5V</td>
<td>Logic circuits (rarely used in modern PCs)</td>
</tr>
<tr>
<td>Yellow</td>
<td>+12V</td>
<td>Disk drive motors, RS-232 serial port, fans, adapter cards</td>
</tr>
<tr>
<td>Blue</td>
<td>-12V</td>
<td>RS-232 serial port, fans</td>
</tr>
<tr>
<td>Orange</td>
<td>0V</td>
<td>Power OK signal</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td>Ground (GND)</td>
</tr>
</tbody>
</table>

**Figure 4.** The switcher section is the most common to fail. The power transistors have to have a breakdown voltage of 600 volts or more, and the damper diodes have to be fast recovery (a 1N4005 won’t work).

**Resistance Checks**

Refer to Table 2, perform a resistance measurement test. Keep the VOM’s polarity correct, that is red to ground when testing a negative source, and wait for the filter capacitors to charge before taking a reading. The resistance values listed in Table 2 are only representative (the figures were gathered from actual measurements of several power supplies using a cheap VOM), so don’t worry if your values are different from those listed.

However, if a resistance value is abnormally high or low, you have a problem. As a rule of thumb, a reading of 50 ohms or less indicates a short, generally in the rectifier diodes. The five-volt line is the most prone to failure because it carries the heaviest load (typically 20 amps). An extraordinarily high resistance reading indicates an open, probably a zapped board trace or a burned resistor. Both conditions are often harbingers of problems in the high-voltage section, but not necessarily. It depends on how fast the shutdown circuit reacted. But before we face that possibility, we first need to find the extent of the low-voltage damage.

**Low-Voltage Repair**

The low-voltage section of the power supply is a very simple rectifier, L-section filter design (Figure 3). Key to the success of this design is a multiple secondary power transformer. There is a 5-volt winding and a 12-volt winding. In high-power supplies (250 watts and larger), there are usually two five-volt windings that are paralleled for higher output current — yet treated as a single winding.

**Safety First!**

Would you put a hairpin in an AC outlet socket? Not hardly! So why would you consider putting your finger in a power supply that is clearly labeled CAUTION! Always unplug your PC before going under the hood. Once there, pay attention to my WARNING signs. I’ve done my best to make the troubleshooting processing as shock free as possible, but power has to be provided at various stages of the game. Be alert, don’t be stupid, and if you don’t know what to do next, stop now!
The high-voltage supply is a simple voltage doubler circuit.

![Figure 6. The high-voltage supply is a simple voltage doubler circuit.](image)

The output of the rectifiers is filtered first by an inductor, called a choke, then by a heavy-duty electrolytic capacitor. In some designs, the five-volt line is double-filtered to reduce ripple by cascading two L-section filters on the output. Invariably, a bleeder resistor is placed across the output to discharge the capacitors after power off.

The most common cause of low-voltage failure is a shorted rectifier. If one blows, so does its companion, which forces you to replace them as a package, because no two supplies are alike. Use your imagination, and be careful not to damage other components in the process. For example, twisting and turning the board too many times can cause attached wires to break loose.

Table 2. Output Voltage and Resistance

<table>
<thead>
<tr>
<th>Nominal Voltage</th>
<th>Voltage Range</th>
<th>Resistance</th>
<th>Wire Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5V</td>
<td>+4.75V to +5.25V</td>
<td>&gt;100 ohms</td>
<td>Red</td>
</tr>
<tr>
<td>+5V</td>
<td>+4.75V to +5.25V</td>
<td>&gt;250 ohms</td>
<td>White</td>
</tr>
<tr>
<td>-12V</td>
<td>+9V to +15V</td>
<td>&gt;1000 ohms</td>
<td>Yellow</td>
</tr>
<tr>
<td>n/a</td>
<td>0V or +5V</td>
<td>0 ohms</td>
<td>Blue</td>
</tr>
<tr>
<td>0V</td>
<td>0V</td>
<td>0 ohms</td>
<td>Blue</td>
</tr>
</tbody>
</table>

Each winding has a grounded center tap to permit fullwave rectification using just two diodes (fullwave bridge rectifiers need four diodes). The direction of the rectifiers determines the polarity of the output voltage. Common cathodes are positive, and common anodes are negative.

Because of its high-current requirements, the +5-volt rectifier is usually an array of parallel Schottky diodes in a single package (Figure 4) that mounts on a heat sink. The -5-volt output is often derived from the -12-volt rectifier via an IC regulator (typically an LM7905 equivalent) rather than from the five-volt transformer winding. However, I’ve seen it done both ways.

The output of the rectifiers is filtered first by an inductor, called a choke, then by a heavy-duty electrolytic capacitor. In some designs, the five-volt line is double-filtered to reduce ripple by cascading two L-section filters on the output. Invariably, a bleeder resistor is placed across the output to discharge the capacitors after power off.

The most common cause of low-voltage failure is a shorted rectifier. If one blows, so does its companion, which forces you to replace them as a package, because no two supplies are alike. Use your imagination, and be careful not to damage other components in the process. For example, twisting and turning the board too many times can cause attached wires to break loose.

Now comes the tricky part, because you have to first locate the affected parts on the circuit board. Use the road map, “How To Find Waldo,” to help you in your quest. An ohmmeter is a good way to probe suspected areas for shorted devices. Once the area is located, the real work begins because it’s virtually impossible to tell the difference between a shorted diode and a shorted capacitor without removing one or the other. Since the rectifier is the most likely culprit and the easier to remove (the electrolytics are glued in place), I’d start there.

The +5-volt and +12-volt diodes are most likely nestled inside a transistor case mounted on a heat sink. The bigger one (Figure 4e) is the +5-volt rectifier, and the smaller one (Figure 4d) is the +12-volt rectifier. The negative-voltage rectifiers are individual diodes typically in a DO-41 case.

With the suspect rectifier or diodes in hand, do a resistance check of the defective voltage output line again. If the reading is within the normal range, trash the old part or parts and replace with new. (Helpful Hint: If the new diodes come in an axial-lead pack-
High-Voltage Repair

If only the input pin is shorted, the rectifiers are bad. If both are shorted, the chance is both the diodes and the IC are shorted. To verify this theory, remove the IC and check the resistance again. If it reads okay, because failure of the -12-volt line can cause cascading damage that goes all the way back to the shutdown circuit that reacts a lot faster than the fuse. That's why you should replace both the transistor and the damper diode that's across its emitter-collector. I normally use a Motorola MJE13009 for the power transistor and a 1N4937 for the damper diode.

You should also replace the low-value resistor that's in series with the transistor's base. This resistor is often used as a fusible link that goes puff when the switcher fails. Its purpose is to protect other components in the chain from harm. If the resistor is burned beyond recognition, you can replace it with any 1/4-watt resistor with a value of 1 to 10 ohms (the exact value isn't important). Sometimes, though, even the fusible isn't fast enough to prevent damage. So before installing the new parts, it's wise to check out the pulse shaper network (typically a resistor-diode-capacitor combination) associated with the base circuit, too. A quick way to test all three components at once is to treat the network like a single diode, checking it as a whole for shorts and opens (Figure 7). Now repeat the procedure for the second switching transistor.

The high-voltage supply is a simple voltage doubler with an output of about 300 volts (Figure 6). While this section rarely fails on its own, a shorted switching transistor can wipe out the bridge rectifier in an instant. Check the AC input for shorts, and replace the entire bridge if a short is found. Bridges can be either discrete diodes or a large, rectangular module, and you can find suitable replacements from Radio Shack. There's probably a one-ohm resistor in line with the AC input that needs to be checked, too. On the outside chance that one of the doubler capacitors is shorted, do a resistance check of each. When powered from a 220-volt AC power source, the capacitors serve as voltage dividers to provide an artificial ground. Consequently, the capacitance and ESR (equivalent series resistance) values of the capacitors are critical when operating from a 220-volt line and have to be evenly matched, otherwise the switching voltages will be uneven. As electrolytics age, both the capacitance and ESR changes. If the mismatch is too great, one voltage could exceed the limits of the switching transistor, which can start parts a-poppin'. You can check the voltage balance with a VOM. Always replace both capacitors, not just one, and use a good grade capacitor, like the Panasonic TSM series.

It's Showtime

If you've made it this far, you probably have a working power supply. But before you apply power, let's make sure we've covered everything.

- You did a final resistance check on the output voltage lines, and all are within the specifications of Table 2, right?
- You checked the resistance across the AC input (with the power switch on) and it measures 1 megohm or better, check?
- You checked the fuse.
- Any broken wires or burned parts?

Good! Then it's showtime. Re-assemble the power supply. Plug the dummy load into one of the disk drive connectors. Apply power.

If both lights light, congratulations! You've got yourself a working power supply, because the power supply itself needs the -5- and -12-volt lines to operate. Consequently, you don't have to test them, unless you're as curious as I would be. Now all you have to do is put everything back together and enjoy a more peaceful day — except for the coffee. Here I suggest NV.