Power Supplies

Chapter 10
Overview

• In this chapter, you will learn how to

  – Explain the basics of electricity
  
  – Describe the details about powering the PC
  
  – Install and maintain power supplies
  
  – Understand power-supply troubleshooting and fire safety
Understanding Electricity

Figure 1: Typical power supply mounted inside the PC system unit
• **Voltage**—pressure of electrons in a wire
  – Unit of measurement: volts (V)

• **Current**—flow (or amount) of electrons in a wire
  – Unit of measurement: ampere (A)
  – When voltage is applied to a wire, electrons flow, producing current

• **Wattage**—measure of power consumed or needed
  – Unit of measurement: watt (W) \( W = V \times A \)

• **Resistance**—impedance or opposition to the flow
  – Unit of measurement: ohm (\( \Omega \))
• **Wire** has amperage rating
  - Defines how much amperage it can handle
    - i.e., 20 amp, 30 amp
  - If you exceed amperage
    - Wires heat up—may break

• **Circuit breakers** are heat sensitive
  - Sense when amperage exceeds threshold
  - Breaks the circuit to stop the flow of electricity
Two Types of Current

- **Alternating current (AC)**—electrical current flows in both directions
  - Electricity provided at wall socket
  - Frequency of alternations measured in cycles per second, or hertz (Hz)

- **Direct current (DC)**—electrical current flows in one direction
  - Electricity provided by batteries
Two Types of Current (continued)

Figure 2: Diagrams showing DC and AC flow of electrons

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- **DC**: Constant voltage in one direction
- **AC**: Voltage in both directions, constantly switching back and forth
Powering the PC
Types of Power

- PCs use DC voltage.

- Power companies supply AC voltage.

- The power supply in a computer converts high-voltage AC to low-voltage DC.
Supplying AC

• In the U.S., 115 volts AC (VAC) is standard.

• Other countries use 230 VAC.
  – Most power supplies are dual-voltage and compatible with both. They may have a switch on the back to accommodate multiple countries.
  – Pay attention to this switch, especially when traveling overseas.
Figure 3: Back of fixed-input power supply, showing typical switches and power connection
Outlet Voltages

- **Hot and neutral provide path for AC**
  - Hot has 115 V
  - Neutral carries no voltage

- **Ground used for safety**
  - Returns excess electricity to ground

![Figure 4: Outlet voltages](image-url)
Multimeter Basics

• A multimeter (or Volt-Ohm meter, VOM) measures
  – Voltage
  – Resistance
  – Continuity

• Warning
  – Set it properly before measuring
  – If not, damage can occur

Figure 5: Digital multimeter
Testing AC Voltage

- **Verifies wiring of outlet**
  - Hot should be 115 VAC
  - Neutral completes the circuit
  - Ground should go to ground

Figure 6: Multimeter featuring DC and AC symbols
Testing AC Voltage
(continued)

Figure 7: Circuit tester
1. Set a multimeter to test AC  
   - (That's the wavy symbol)
2. Put the leads into a handy electrical outlet to test the power  
   - What's the voltage between hot and neutral?  
   - What's the voltage between hot and ground?
   - What's the voltage between neutral and ground?
   - Does the outlet have the proper polarity?
3. Test the voltage on the computer power cord too
Imperfect Electricity

• Power companies supply imperfect power
  – Voltage varies a bit
  – Sags because of high demand
  – Surges or spikes

• Requires two devices to compensate
  – Surge suppressor
  – Uninterruptible power supply
Surge Suppressors

- **Surge suppressors** provide protection against power surges
- Insert between the power supply and the outlet
- **Joule** is a unit of electrical energy
  - Surge suppressor rated by joules
  - Higher joules = better protection
- **Some protect more than AC surges**
  - Phone lines for traditional modems and DSL
  - Cable connections for cable modems
Surge Suppressors (continued)

Figure 8: Surge suppressor

Figure 9: Surge suppressor with telephone line protection
• An **uninterruptible power supply (UPS)** provides protection against a power dip or power outage
  - Contains a battery that provides continuous AC power
  - Provides surge protection and power conditioning
    • Constantly charges battery—provides protection against power sags (brownouts) and total loss of power (blackout)
  - All UPSs measured in watts and volts-amps
    • Watts are what your system uses
    • Volt-amps are what UPS can deliver in a perfect world
    • Try manufacturers’ Web sites for matching wattage with a specific system

  - Look for smart UPS with USB connector
Uninterruptible Power Supply (continued)

Figure 10: Uninterruptible power supply
Figure 11: APC PowerChute software
### Table 1: Typical UPS Devices

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Outlets Protected</th>
<th>Backup Time</th>
<th>Price</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>BE350G</td>
<td>3 @ 120 V</td>
<td>3 min @ 200 W, 10 min @ 100 W</td>
<td>$33.99</td>
<td>Standby</td>
</tr>
<tr>
<td>APC</td>
<td>Pro 1000</td>
<td>4 @ 120 V</td>
<td>4 min @ 600 W, 64 min @ 100 W</td>
<td>$129.99</td>
<td>Standby</td>
</tr>
<tr>
<td>CyberPower</td>
<td>CPS1500AVR</td>
<td>6 @ 120 V</td>
<td>18 min @ 950 W, 6 min @ 475 W</td>
<td>$279.99</td>
<td>Line-interactive</td>
</tr>
</tbody>
</table>
The power supply acts as a step-down transformer

- Converting AC into 5-, 12-, and 3.3-V DC

- PCs use a 12-V current to power motors on devices such as hard drives and optical drives

- PCs use a 5-V/3.3-V current to support onboard electronics
Supplying DC (continued)

Figure 12: Desktop PSU
Power Connectors

• **Motherboard**
  - 20- or 24-pin P1 (ATX)
  - 4-pin (P4), 6-pin, 8-pin

• **Peripherals**
  - Molex
  - Mini
  - SATA
  - PCIe

Figure 13: Motherboard power connectors
Power Connectors (continued)

Figure 14: Molex connector

Figure 15: Mini connector
Power Connectors (continued)

- Connectors are keyed
  - Can plug in only one way

- Splitters and adapters
  - Can create two power connectors from one
  - Can convert Molex to SATA

Figure 16: Correct orientation of a mini connector
Power Connectors (continued)

Figure 17: SATA power connector

Figure 18: Molex splitter
1. Set the multimeter to DC
   - (That’s the dotted line)
2. Place the black lead into a ground
   - (That’s a black wire)
3. Place the red lead into various hot circuits
   - Molex
     • Yellow wire
     • Red wire
   - P1
     • Various wires: red, yellow, purple, etc.
   - What voltages did you find?
• **ATX power supplies first to use**
  - P1 power connector

• **Always on when plugged in**
  - 5 V supplied to motherboard when plugged in

• **Configured in CMOS**

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Figure 19: Soft power setting in CMOS
Power Supply Versions

• **ATX 12 V 1.3**
  - First widespread update to ATX PS

• **EPS 12 V**
  - Introduced for server motherboards

• **ATX 12 V 2.0**
  - Overcame problem overloading 12-V rail
  - Provides multiple 12-V rails
  - Ideally, rails should be independent and not draw power from each other (some cheaper power supplies do not obey this rule).
Power Supply Versions (continued)

Figure 20: Auxiliary power connector

Figure 21: Molex power on motherboard
Power Supply Versions (continued)

Figure 22: 20- and 24-pin connectors

Figure 23: Convertible motherboard power connector
Figure 24: PCI Express 6-pin power connector
Form Factors

• **Niche market power supply form factors**
  - TFX12V, SFX12V, CFX12V, LFX12V

• **Active PFC**
  - Power Factor Correction
  - Common in quality power supplies
  - Eliminates harmonics

Figure 25: SFX power supply
Figure 26: Power supply advertising active PFC
Wattage Requirements

• Every device requires some wattage
  - Often starting requirements are higher than running requirements

• Power supplies don’t run at 100 percent efficiency
  - ATX 12 V requires power supplies to be at least 70 percent efficient

• General recommendation
  - Use at least a 500 W power supply
  - Enough extra for starting and future growth
Installing and Maintaining Power Supplies
Installing

• Removing
  – Disconnect wires
  – Remove four standard screws
  – Remove PSU

• To install
  – Place PSU in case
  – Replace screws
  – Connect wires
Installing (continued)

Figure 27: Mounting screws for power supply

Figure 28: Removing power supply from system unit
Installing (continued)

Figure 29: On/off switch for an ATX system

Figure 30: Shorting the soft on/off jumpers
Cooling

- The **power supply fan** provides basic cooling for the PC
  - Fan keeps the voltage regulators cool and provides a constant flow of cool air through the computer
  - If power supply fan stops, replace power supply
  - Many fans have sensors to detect when they should run faster

Figure 31: Power supply fan
Cooling (continued)

- **Case fan** provides extra cooling for PC
  
  - Most modern computers have case fans
  
  - Often plug into Molex connector
  
  - Connector adapters can be used
Cooling (continued)

Figure 32: 3-wire fan sensor connector

Figure 33: Case fan
Maintaining Airflow

- Keep case closed.

  - Keep covers on case.
  
    - If an expansion card is removed from the PC, be sure to cover the hole with a **slot cover**.

  - Without proper airflow, the CPU can overheat and destroy itself.

Figure 34: Slot covers
Reducing Fan Noise

• Some fans can be adjusted
  – Manually adjustable with knob
  – Software adjustable by sensing heat

• Larger fans that spin more slowly are quieter

• Higher-end fans are quieter
  – Use better bearings

Figure 35: Manual fan adjustment device
CMOS Fan Options

- Can monitor PC’s health by showing temperatures
  - Doesn’t control fans
  - Can set fan thresholds for alarms

Figure 36: CMOS fan options
Freeware Tool

- **SpeedFan**
  - Allows monitoring of fan speeds
  - Can set fan speeds
  - Hundreds of chipsets supported
  - www.almico.com/speedfan.php

Figure 37: SpeedFan
Troubleshooting Power Supplies

- Power supplies fail in two ways
  - Sudden death
    - When the fan doesn’t turn and no voltage is present
    - Computer simply stops working
  - Slowly over time
    - Intermittent errors
    - Output voltages may exceed specs (± 10%)
1. Set the multimeter to test DC.
2. Turn on the PC.
3. Put the black lead onto any black wire connection.
4. Put the red lead onto colored wire.

- 12 V ± 10 percent
  - 10.8 to 13.2 V
  - If readings are outside tolerance and symptoms exist, replace power supply.
- 5V ± 10 percent
  - 4.5 to 5.5 V
- 3.3 V ± 10 percent
  - 2.97 to 3.63 V
Power Supply Test

• Power supplies need a load
  – Plug into motherboard
  – Plug into tester

• Check power switches
  – If faulty, can turn on with motherboard jumper

Figure 39: ATX power supply tester
When Power Supplies Die Slowly

• Intermittent problems
  – Sometimes occur, sometimes don’t
  – You could measure voltage now and it’s good; 10 minutes later, system crashes

• A dying power supply can cause
  – Random lockups and reboots
  – Sporadic boot-up difficulties

• When you encounter intermittent symptoms, consider replacing the power supply
Fuses and Fire

- **Circuit breakers** are heat-sensitive
  - Sense when amperage exceeds threshold
  - Breaks the circuit to stop flow of electricity

- **Fuses** blow for a reason
  - Power supply is malfunctioning
  - As a designed safety precaution, fuses blow (break) to stop circuit

- **Alternative is a possible fire**
Fire Extinguishers

• **Class A**
  - Ordinary combustibles such as paper and wood

• **Class B**
  - Flammable liquids such as gasoline

• **Class C**
  - Live electrical equipment

• **Use only Class C extinguishers on electrical fires**
Beyond A+

• It glows
  – Fancy colors, light up, and have extra fans

• Modular power supplies
  – Reduced cables

• Temperature efficiency
  – Power supplies provide less power in warmer temperatures—pay attention to operating temps
Beyond A+ (continued)

Figure 40: See-through power supply that glows blue

Figure 41: Modular-cable power supply