Power Supplies

Chapter 7

Overview

• In this chapter, you will learn to
  – Explain the basics of electricity
  – Provide proper power and cooling to the PC
  – Troubleshoot electrical problems

Understanding Electricity

• Voltage—force or pressure caused by the separation of electrons and protons
  – Unit of measurement: Volts (V)
• Current—the free flow of electrons in an electrical circuit
  – Unit of measurement: Ampere (amp)
    – When voltage (electrical pressure) is applied and there is a path, electrons flow producing current
• Resistance—impedance or opposition to the flow of electrons: conductor=low resistance
  – Unit of measurement: ohms (Ω)
    insulators=high resistance

Measuring Electricity

• Alternating Current (AC)—electrical current flows in both directions; positive and negative terminals continuously trade places (polarity)
  – Example: Electricity provided by AmerenUE
    – Frequency at which AC electricity alternates is measured in cycles per second, or hertz (Hz)
• Direct Current (DC)—electrical current flows in one direction; negative to positive
  – Example: Electricity provided by batteries

Two Types of Current

Powering the PC
Type of Power

- PCs use DC voltage but power companies supply AC voltage
- The power supply in a computer converts high-voltage AC power to low-voltage DC power

Safety Ground Wire

- Safety Ground Wire prevents electrons from energizing metal parts of the computer
- Without grounding, severe shock and fires can occur
- Safety grounds are connected to the exposed metal parts of the computer’s chassis
- Do not use ungrounded plugs in PCs

AC Power

- In the U.S. 115 V and 60 Hz
  - PCs may have a small switch on the back to choose 115 or 230 V (used in other countries)
- Hot and neutral provide the path for AC
- Four wires to the fuse box:
  - Bare wire that goes to ground and not the pole
  - Two 115-volt hot wires (black) from the pole to the fuse box
  - Neutral wire from the pole (black or striped)
- House gets 230 V AC from the pole

Multimeter Basics

- A multimeter (or Volt-Ohm meter: VOM) is used to measure:
  - Voltage
  - Resistance
  - Continuity (level of resistance)
- When using a multimeter, you must properly set it to either AC or DC, depending on the voltage you’re trying to measure

Testing AC Voltage

- Test all of the wall outlets that the PC uses
  - Include any peripheral devices plugged into a wall outlet
  - Include the PC and the monitor plugs
  - Circuit testers are available
  - The ‘hot’ should output approximately 115 V, the ‘neutral’ should output approximately 0 V, and the ‘ground’ should connect to ground (also approximately 0 V)

Uninterruptible Power Supply

- An uninterruptible power supply (UPS) provides protection against a power dip or power outage
  - Contains a battery that provides AC power to the computer
  - Online is true protection and power conditioning – battery is constantly being charged and system is running off the battery at all times
  - Stand-by uses AC until the voltage drops enough to switch over to the battery – no power conditioning and a fail-over time required
  - All uninterrupted power supplies are measured in watts
Uninterruptible Power Supply (continued)

Surge Suppressors

- Surge suppressors provide protection against power fluctuations
- Insert between the power supply and the outlet
- Joule is a unit of electrical energy, and the joule rating of a surge suppressor needs to be checked before purchasing one
- Surge suppressors with modem protection are also available

The Power Supply

- The power supply acts as a step-down transformer converting high voltage AC into 5, 12, and 3.3 V DC
  - PCs use a 12V current to power motors on devices such as the hard drives, and CD-ROM drives
  - PCs use a 5-volt/3.3-volt current to support onboard electronics

The Power Supply

- AT and ATX are the two types of power supplies that can be installed in any PC
- The ATX form factor motherboard, with its unique ATX power supply, dominates today’s systems
- All power supplies share a number of common features such as the power connection, motherboard power, power switch, peripheral connections, and the fan

Power Supply

Power Connections

- The power supply connects to the power cord through a standard IEC-320 connector
- Each power supply must have standard AC power from the company
**DC Power**

- DC power comes out of the computer’s power supply, and provides electricity to all the components in the PC
  - Flows in one direction, from negative to positive
  - All PC power supplies provide both positive and negative voltages

**AT Power Connectors**

- P8 and P9 are a pair of connectors that link the AT power supply to the AT motherboard
  - As they are ‘faced’, they cannot be installed backwards

**ATX Power Connector**

- Uses a single P1 power connector
- The P1 has a notched connector to ensure proper installation

**P4 Connector**

- Many motherboards require a second, four-wire connector to push more 12-volt power into the board

**P1 and P4 Voltages**
Power to Peripherals

- Motherboards require power from the power supply as we've already seen.
- Peripherals like hard drives, floppy drives, CD-ROM drives, and fans also require power from the power supply.
  - Different types of connectors are used.

Molex Connectors

- Primarily used for devices that require 12V and 5V of power.
- A Molex connector uses 'chamfers' (notches) for easy installation.
- Installing a Molex backwards can destroy the device into which the Molex is connected.

Mini Connectors

- Primarily for 3.5-inch floppy drives.
- Care should be taken when installing mini connectors.

SATA power connector

Splitters and Adapters

- Occasionally, there are not enough connectors to power all the devices inside a PC.
- Splitters are used to create more connections.

Wattage

- Power supplies are rated in watts.
  - A PC requires sufficient wattage to run properly.
  - An average desktop with two hard drives and a CD-ROM drive requires about 115-130 watts while running, and up to 200 watts when booting up.
  - Buy 230 to 250-watt power supplies.
  - Power requirements may be calculated by adding up the power required by each peripheral and the motherboard and CPU.
Sizes

- Power supplies are available in a variety of shapes and sizes depending on the form factor.
- Most desktop and mini-tower PCs use the standard ATX power supply.
- Take the defective power supply with you when getting a replacement.

Other Power Supply Specifications

- MTBF or MTTF
- Input Range
- Peak Inrush Current
- Hold-up Time
- Transient Response
- Overvoltage Protection
- ...

Power Supply Issues

- A bad power supply causes intermittent lockups and reboots, as well as intermittent bootup difficulties.
- Bad power supplies erase CMOS information and sometimes even erase data on mass storage devices.

Power Supply Test

- Put the black lead onto any black wire connection.
- Put the red lead onto a yellow +12V connection.
  - 11-13 V is good.
  - 10.5-11 V indicates a new power supply is needed.
  - Less than 10.5 V and your PC won’t boot.

- The computer must be turned on.
- Do not touch any chips or circuit boards to prevent damage.
- Do not touch a probe to the hot circuit and to ground at the same time.
- Do not allow both probes to touch each other while one is touching hot and one is touching ground.
- Make sure a probe only touches one metal object or pin at a time.

Power Supply Notes

- If you don’t detect any power:
  - disconnect all devices except the motherboard – check for power to the motherboard by itself.
- If the motherboard gets power:
  - one of the devices is causing the problem.
- If the motherboard still does not have power:
  - check the power coming from the power supply without the motherboard plugged in – if you get power then the motherboard has an issue.
- Most PCs today come with a 230-watt or higher power supply:
  - if you add too many devices the power supply may stop working due to too much wattage being required.
AT Power Switches

- Rocker and plunger types
- Used to turn the system on and off
- Each of these switches has four tab connectors that attach to four color-coded wires leading from the power supply
- Black and brown wires are 115V – make sure the power supply is unplugged!

Problems with AT Power Management

- Power management involves going into power-saving modes, where devices are put to sleep
- Power management also involves bringing devices back to an active state
- The AT form factor and the AT power supply do not mix well with any type of power management

ATX Soft Power and CMOS

- The soft power feature on ATX motherboards handle all power management issues
- ATX power supplies put a 5-volt charge on the motherboard at all times
- The important settings for ATX soft power reside in the CMOS setup

ATX Soft Power and CMOS

- An ATX power supply never turns off: it continues to supply a 5 V to the motherboard as long as it is connected to the power outlet
- Always unplug an ATX system before working on it

Cooling

- The power supply fan provides basic cooling for the PC
  - The fan keeps the voltage regulators cool and provides a constant flow of cool air through the computer’s interior
  - If an expansion card is removed from the PC, be sure to cover the hole with a slot cover
  - Without the airflow the CPU can overheat and destroy itself
  - The CPU usually has its own fan and sits very near to the power supply so that it will not overheat from a disruption

Removing the Power Supply Fan

- Replacement fans are easy to find and inexpensive
Troubleshooting Power

- A failure of the internal electronics of the power supply can cause some of the most difficult to diagnose problems
- The secret to discovering that a power supply is dying lies in one word: *intermittent*
- A voltmeter can be used to verify if the power supply is working or not
- A failed power supply should be replaced rather than attempting to repair it
- Power supplies break more often than many other parts in a PC

Diagnosing a Dead Power Supply

- **Power Supply Switches**
  - Broken power switches are also a common source of problems
  - On an AT system, a multimeter can be used to check the switch
  - On an ATX system, try shorting the soft power jumpers – if that works, then you need a new switch

- **When Power Supplies Die Slowly**
  - A power supply may be dying if you are getting intermittent problems such as
    - PC fails locks up as it is booting several times but finally boots up okay
    - Error codes show up on boot up but go away
    - PC runs fine for an hour or so and then locks up

- **Fire Extinguishers**
  - Do not open power supplies
    - The inside of a power supply contains high-voltage capacitors
  - Every PC workbench needs the right kind of fire extinguisher
  - A Class C fire extinguisher should be used for live electrical equipment
    - Class A fire extinguishers are for wood and paper
    - Class B fire extinguishers are for flammable liquids

- **More**
  - Some power supplies come in fancy colors, light up, and have extra fans
  - EPS12V power supplies provide more power for servers
  - Converting AC to DC causes a 30-50% loss in power, so the power factor number is used on power supplies to define the amount of loss
    - 0.7 means a 30% loss
    - An Active Power Correction (APC) power supply is more efficient with a power factor closer to 0.95