Chapter 2
Form Factors, Power Supplies, and Working Inside a Computer
Objectives

- Learn about different form factors used for computer cases, motherboards, and power supplies
- Learn how electricity is measured and about electrical components
- Learn how to select a power supply
- Learn how to protect yourself and your equipment against the dangers of electricity
- Learn how to work inside a computer case
- Learn how to troubleshoot electrical problems
Acronyms

1. AC: Alternating Current
2. DC: Direct Current
3. ATX: Advanced Technology Extended
4. BTX: Balanced Technology Extended
5. CRT: Cathode Ray Tube
6. DIP: Dual Inline Package
7. EMI: Electromagnetic Interference
8. ESD: Electrostatic Discharge
9. LPX: Low Profile Extended
10. NLX: New Low-profile Extended
11. POST: Power-On Self Test
12. PSU: Power Supply Unit
13. RFI: radio frequency interference
14. UPS: Uninterruptable Power Supply
Form Factors

- Computer case, motherboard, power supply
  - Interconnected system
  - Must be compatible

Figure 2-1 Computer power supply with connectors Courtesy: Cengage Learning
Form Factors (cont’d.)

• Form factors
  – **Standards** that specify size, shape, and features of components

• Using the same form factor assures
  – Motherboard fits the case
  – Powers supply cords provide proper voltage
  – Motherboard and case holes align properly
  – Case and motherboard ports align
  – Wires on case match connections on motherboard
  – Power supply holes align with case
Types of Form Factors

• Intended use
  – Influences computer case, motherboard, power supply selection (form factor)

<table>
<thead>
<tr>
<th>Form Factor</th>
<th>Motherboard Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATX, full size</td>
<td>Up to 12&quot; x 9.6&quot;</td>
<td>Most popular form factor, which has had many revisions</td>
</tr>
<tr>
<td>MicroATX</td>
<td>Up to 9.6&quot; x 9.6&quot;</td>
<td>Smaller version of ATX</td>
</tr>
<tr>
<td>FlexATX</td>
<td>Up to 9&quot; x 7.5&quot;</td>
<td>Smaller version of MicroATX</td>
</tr>
<tr>
<td>BTX</td>
<td>Up to 12.8&quot; wide</td>
<td>Has improvements over ATX and can have up to seven expansion slots</td>
</tr>
<tr>
<td>MicroBTX</td>
<td>Up to 10.4&quot; wide</td>
<td>Has up to four expansion slots</td>
</tr>
<tr>
<td>PicoBTX</td>
<td>Up to 8&quot; wide</td>
<td>None or one expansion slot</td>
</tr>
<tr>
<td>NLX</td>
<td>Up to 9&quot; x 13.6&quot;</td>
<td>Used in low-end systems with a riser card</td>
</tr>
</tbody>
</table>
Types of Form Factors (cont’d.)

• ATX form factor
  – Most common
  – Motherboard dimensions: up to 12” x 9.6”
  – Versions
    • Original ATX form factor used P1 connector
    • ATX Version 2.1 specifications added 2-pin auxiliary connector
    • ATX Version 2.2 allowed for 22-pin P1 connector
    • Version 2.2 provides +12 volts, +5 volts, and +3.3 volts pins
  – Motherboard offers “soft switch” feature
Figure 2-2 The CPU on an ATX motherboard sits opposite the expansion slots and does not block the room needed for long expansion cards.

Courtesy: Course Technology/Cengage Learning
Types of Form Factors (cont’d.)

• MicroATX form factor
  – Reduces total cost of a system
• FlexATX
  – Variation of MicroATX with maximum flexibility
• BTX (Balanced Technology Extended) form factor
  – Reduces heat with better airflow
• NLX (New Low-profile Extended) form factor
  – Developed to improve older and similar LPX form factor
**Figure 2-7** This MicroATX motherboard by Biostar is designed to support an AMD processor
Courtesy: Course Technology/Cengage Learning

**Figure 2-8** Improved airflow in a BTX case and motherboard makes it unnecessary to have a fan on top of the processor
Courtesy: Course Technology/Cengage Learning
Types of Computer Cases

• Computer case (chassis)
  – Houses power supply, motherboard, cards, drives
  – Panel switches/lights to control/monitor PC
  – Ports connecting cables to motherboard
    • Mounted on front, top, side, rear
  – Match power supply to system electrical needs

• Desktop cases: Motherboard on bottom; power supply to the rear

• Tower cases: Up to 2 feet high; can contain several drives

• Notebook cases: Used for all portables; includes desktop components
Types of Computer Cases (cont’d.)

Figure 2-11 Tower and desktop cases
Courtesy: Course Technology/Cengage Learning
Measures and Properties of Electricity

• Successful PC technicians:
  – Understand electricity
  – Know how to use electricity
  – Know how to measure electricity
  – Can protect computer equipment from electricity

• Units used to measure characteristics of electricity
  – Volt (pressure)
  – Amp (current)
  – Ohm (resistance)
  – Watt (power)
  – Joule (work)
<table>
<thead>
<tr>
<th>Unit</th>
<th>Definition</th>
<th>Computer Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volt (for example, 115 V)</td>
<td>A measure of electrical “pressure” differential. Volts are measured by finding the potential difference between the pressures on either side of an electrical device in a circuit. The symbol for volts is V.</td>
<td>An ATX or BTX power supply provides these separate voltages: +12 V, -12 V, +5 V, and +3.3 V. (-5 V is included in the specs for these power supplies but is almost never used.)</td>
</tr>
<tr>
<td>Amp or ampere (for example, 1.5 A)</td>
<td>A measure of electrical current. Amps are measured by placing an ammeter in the flow of current. The symbol for Amps is A.</td>
<td>A 17-inch monitor requires less than 4 A to operate. A small laser printer uses about 2 A. A CD-ROM drive uses about 1 A.</td>
</tr>
<tr>
<td>Ohm (for example, 20 Ω)</td>
<td>A measure of resistance to electricity. Devices are rated according to how much resistance they offer to electrical current. The ohm rating of a resistor or other electrical device is often written somewhere on the device. The symbol for ohm is Ω.</td>
<td>Current can flow in typical computer cables and wires with a resistance of near zero Ω (ohm).</td>
</tr>
<tr>
<td>Watt (for example, 20 W)</td>
<td>A measure of electrical power. Whereas volts and amps are measured to determine their value, watts are calculated by multiplying volts by amps. Watts measure the total electrical power needed to operate a device. The symbol for watts is W.</td>
<td>A computer power supply is rated at 200 to 800 W.</td>
</tr>
</tbody>
</table>
AC and DC

- **Alternating current (AC)**
  - Oscillatory current driven by an alternating voltage
  - Example: house current oscillates at 60 Hz

- **Direct current (DC)**
  - Single direction current driven by constant voltage
  - Required by computer in small amounts, such as 5 V

- **Power supply acts as a transformer and rectifier**
  - Rectifier(Inverter): converts AC to DC
  - Transformer: changes ratio of current to voltage
Watts = Volts * Amps

Figure 2-14 A transformer keeps power constant but changes the ratio of current to voltage
Courtesy: Course Technology/Cengage Learning
Hot, Neutral, and Ground

• Completing a circuit:
  – AC travels from power station to house on a hot line
  – AC travels from panel to device using black (hot) wire
  – AC flows out of device circuit in a white (neutral) wire
  – AC returns to power station on a neutral line

• Short circuit: failure due to excess flow of electricity
  – Fuses protect circuits by melting wire (breaking circuit)
  – Grounded neutral lines pass detoured AC to earth

• Lines in three-prong plugs: hot, neutral, ground
  – Receptacle tester verifies outlet wiring
Figure 2-15 Normally, electricity flows from hot to neutral to make a closed circuit in the controlled environment of an electrical device such as a lamp. Courtesy: Course Technology/Cengage Learning
Figure 2-16 A polarized plug showing hot and neutral, and a three-prong plug showing hot, neutral, and ground. Courtesy: Course Technology/Cengage Learning

Figure 2-17 Use a receptacle tester to verify that hot, neutral, and ground are wired correctly. Courtesy: Course Technology/Cengage Learning
Some Common Electronic Components (cont’d.)

• Materials to make components:
  – Conductors: weakly resist current flow (copper)
  – Insulators: highly resist current flow (ceramics)
  – Semiconductors: allow flow if charged (silicon)

• Transistor
  – Switches current on (1) and off (0)
  – Amplifies current
  – Contains three layers of semiconductor material
  – Charge applied to center layer
    • Controls switching
Some Common Electronic Components (cont’d.)

• Capacitor
  – Holds electrical charge for a period of time
  – Creates even flow of current in a PC

• Diode
  – Allows electricity to flow in one direction only
  – Rectifies current (convert AC to DC)

• Resistor
  – Controls amount of current flowing through device
  – Degree of resistance is measured in ohms
Some Common Electronic Components

Figure 2-18 Symbols for some electronic components and for ground
Courtesy: Course Technology/Cengage Learning
Figure 2-19 Capacitors on a motherboard or other circuit board often have embedded crossed lines on top
Courtesy: Course Technology/Cengage Learning
Selecting a Power Supply

• Power supply or power supply unit (PSU)
  – Box inside a computer case supplying power to motherboard and other installed devices
  – Both a rectifier and transformer
    • Converts AC house current to DC
    • Steps down voltage from 110 V or 220 V to 3.5, 5, and 12 V
Types and Characteristics of Power Supplies

• Important power supply feature considerations:
  – Form factor determines power supply size
  – Type and number of power cables, and connectors
  – Voltage selector switch
  – Fans
  – On/off switch
  – Wattage ratings
  – Warranty and overall quality
How to Select a Power Supply

• Considerations
  – Match form factor to case, motherboard
  – Make sure it provides necessary connectors
  – Match wattage capacity to system requirements
  – Consider warranty, price, and additional features

• Determining wattage capacity
  – Consider all components inside case
  – Consider USB and FireWire devices
    • Get power from ports connected to motherboard
How to Select a Power Supply (cont’d.)

• Points to keep in mind
  – It may have two ratings
    • Room temperature (peak rating)
    • Continuous operation (actual rating)
  – Video cards draw the most power
  – Use power supply rated 30 percent higher than expected
  – Web sites have wattage calculators
  – Never use Dell power supply with non-Dell motherboard
    • Pinout verification or pinout converter
<table>
<thead>
<tr>
<th>Devices</th>
<th>Approximate Wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderately priced motherboard, processor, RAM, keyboard, and mouse</td>
<td>100 watts</td>
</tr>
<tr>
<td>High-end motherboard, processor, RAM, keyboard, and mouse</td>
<td>100 to 150 watts</td>
</tr>
<tr>
<td>Fan</td>
<td>5 watts</td>
</tr>
<tr>
<td>IDE hard drive</td>
<td>25 watts</td>
</tr>
<tr>
<td>SATA or SCSI hard drive</td>
<td>35 watts</td>
</tr>
<tr>
<td>CD-RW drive</td>
<td>25 watts</td>
</tr>
<tr>
<td>DVD-RW or Blu-ray drive</td>
<td>35 watts</td>
</tr>
<tr>
<td>Tape drive</td>
<td>25 watts</td>
</tr>
<tr>
<td>Low-end AGP or PCI video card</td>
<td>40 watts</td>
</tr>
<tr>
<td>Moderately priced video card</td>
<td>100 watts</td>
</tr>
<tr>
<td>High-end PCIe x16 video card</td>
<td>150–300 watts</td>
</tr>
<tr>
<td>PCI card</td>
<td>20 watts</td>
</tr>
<tr>
<td>PCI e x16 card</td>
<td>100 watts</td>
</tr>
<tr>
<td>Liquid cooling system</td>
<td>50–150 watts</td>
</tr>
</tbody>
</table>

**Table 2-5** To calculate power supply rating, add up total wattage
Protect Yourself and the Equipment Against Electrical Dangers

- PC support activities present physical dangers
  - PC technicians must protect themselves and others
  - PC technicians must protect the equipment
Protect Yourself Against Electrical Shock and Burns

• Protection from electrical shock
  – Disconnect power
    • Pull plug at AC outlet
  – Protect power cord
    • Do not pull on cord itself
  – Remove jewelry
  – Power supplies and CRT monitors contain capacitors
    • Technician must not be grounded
    • Both considered field replaceable unit (FRU)
Protect the Equipment Against Static Electricity or ESD

- Static electricity (electrostatic discharge or ESD)
  - Touching device causes discharge, damaging device
  - Particularly severe in dry and cold climates

- Protecting system from ESD
  - Use ground bracelet, static mat, static shielding bags, ESD gloves
  - Touch computer case before touching components
  - Touch person when passing components
  - Remove jewelry, work on hard floors
  - Unplugged power cord before working inside case
Protect Against Electromagnetic Interference

• Caused by magnetic fields generated by current flow
• RFI (radio frequency interference)
  – EMI in radio frequency range affecting reception
• Crosstalk problem
  – Data in cables crossing EM fields gets corrupted
  – Control crosstalk by shielding cables, power supply
• Detect EMI using tuned-down AM radio
• Other ways to protect device:
  – Use line conditioners; shield cables, power supply
  – Move PC to a new location
Surge Protection and Battery Backup

• Storms and uneven AC flow cause power surges
  – Prevented by installing an AC filter
• Devices between AC outlet and computer equipment:
  – Power Strips
  – Surge suppressors
  – Power conditioners
  – Uninterruptible power supplies (UPSs)
• Use devices with UL (Underwriters Laboratory) logo
  – UL 1449
Surge Protection and Battery Backup

• Surge protector
  – Protects equipment from sudden power changes
  – Absorbs and/or blocks surge
• Recommended features:
  – Joules rating greater than 600 joules
  – Protection activation time (2 nanoseconds or less)
  – Warranty for connected equipment and UL seal
  – Light indicating surge protection working
  – Data line protector for telephone line to modem
  – Let-through voltage rating and line noise filtering
Figure 2-28 Both surge suppressors alert you when protection is not working. The small surge suppressor is designed to travel with a laptop.

Courtesy: Course Technology/Cengage Learning
Surge Protection and Battery Backup

• Line conditioners (power conditioners)
  – Protect against spikes or swells (voltage surges)
  – Raise voltage during brownouts (voltage sags)
  – Filter EMI/RFI interference from the electrical line
• Power conditions are measured in watts, volt-amperes (VA), kilovolt-amperes (kVA)
• Determining VA needed
  – Multiply amperage of each component by 120 V
  – Add up the VA for each component
• Provide no protection against a total blackout
Surge Protection and Battery Backup

• Uninterruptible power supply (UPS) benefits
  – Conditions line to account for brownouts, spikes
  – Provides backup power during a blackout
  – Provides protection against very high spikes

• Designs: standby, inline, line-interactive

• Smart (intelligent) UPS: controlled with software

• Considerations when buying
  – VA rating and watts
  – Degree of line conditioning
  – Warranties, guarantees, and service policies
How to Work Inside a Computer Case

• Skills needed to:
  – Replace computer parts inside the case
  – Build a system from scratch

• Requires tools and safety precautions

• Taking a PC apart and putting it back together
  – Should follow step-by-step procedures
PC Support Technician Tools

• Essential tools
  – Ground bracelet, ground mat, ground gloves
  – Flat-head screwdriver
  – Phillips-head or cross-head screwdriver
  – Torx screwdriver set (size T15)
  – Insulated tweezers
  – Extractor
  – OS recovery CD or DVD

• Many other non-essential tools exists

• Use a toolbox
Figure 2-31 PC support technician tools
Courtesy: Course Technology/Cengage Learning
PC Support Technician Tools (cont’d.)

- Post Diagnostic Cards
  - Helps discover, report computer errors and conflicts at power-on self test (POST)
  - Tests performed by startup BIOS

**Figure 2-32** Post Code Master diagnostic card by Microsystems Developments, Inc. Courtesy: Course Technology/Cengage Learning
PC Support Technician Tools (cont’d.)

• Power Supply Tester
  – Measures output of each power supply connector

**Figure 2-33** Use a power supply tester to test the output of each power connector on a power supply
Courtesy: Course Technology/Cengage Learning
PC Support Technician Tools (cont’d.)

• Multimeter
  – Measure several characteristics of electricity in a variety of devices

Figure 2-34 This digital multimeter can be set to measure voltage, resistance, or continuity
Courtesy: Course Technology/Cengage Learning

A+ Guide to Hardware
Safety Precautions

• Make notes for backtracking
• Stay organized, do not stack boards
• Do not touch board chips
  – With hands, magnetized screwdriver
• Do not change dual inline package (DIP) switch settings with a graphite pencil
• Protect yourself and the equipment
  – Never ever touch inside of a turned on computer
  – Consider monitor, power supply as “black boxes”
  – Protect against static electricity
Steps to Take Apart a Computer

• Tools needed
  – Ground bracelet, a Phillips-head screwdriver, a flat-head screwdriver, paper, pen

• Guidelines
  – Back up data
  – Power down system, unplug it, press power button
  – Put computer on a table with plenty of room
  – Open computer case
  – Diagram all cable connections
Steps to Take Apart a Computer (cont’d.)

• Guidelines (cont’d.)
  – Before removing ribbon cables, look for red color or stripe down one side of each cable
  – Remove cables to all drives
  – Remove expansion cards
  – Remove motherboard
  – Remove power supply
  – Remove drives
Steps to Put a Computer Back Together

- Reverse disassembly process
- Component installation order
  - Power supply, drives, motherboard, cards
  - Connect all data and power cables
  - Plug in keyboard, monitor, mouse
  - Turn on power
  - Verify PC working properly
Troubleshooting the Electrical System

• Electrical problems can occur before or after boot
  – May be consistent or inconsistent
• Possible electrical problem symptoms:
  – PC appears “dead”
  – PC sometimes halts during booting
  – Error codes or beeps occur during booting
  – Smell burnt parts or odors exists
  – PC powers down at unexpected times
  – Hear a whine coming from the power supply
• Most PC problems have simple solutions
Problems with External Power

• Brownout (reduced current) may create issues
  – Check out other devices using same circuit
  – Remove other devices
    • See if voltage increases

• Resolution
  – Install line conditioner
    •Conditions voltage to the PC
Problems with Loose Internal Connections

- Can cause a system to appear dead or reboot itself
- Troubleshooting tasks:
  - ATX and BTX power supplies
    - Verify power switch wire connected properly to motherboard and turned on before power comes up
  - Remove case cover
    - Check all power connections
    - Check cables linking power supply to motherboard
    - Check cables linking power supply to drives
  - Verify case front panel in place before power-on
Problems that Come and Go

• Intermittent symptoms indicating a post-boot problem
  – Computer stops, hangs, reboots for no reason
  – Memory errors appear intermittently
  – Data written incorrectly to the hard drive
  – Keyboard stops working at odd times
  – Motherboard fails or is damaged
  – Power supply overheats, becomes hot to the touch
  – Power supply fan becomes very noisy or stops
• Intermittent problems are more difficult to solve
Problems with an Inadequate Power Supply

• Power supply may not meet needs of new devices
• Testing for an adequate power supply
  – Make all devices in the system work at the same time
    • Example: copy files from new drive to old drive
• Simple solution: upgrade to a higher power supply
• Calculate total wattage needed by system
Problems with a Faulty Power Supply

• Test with a power supply tester or multimeter
• Power supply with correct voltages
  – May still be problem source
• ATX power supply monitors motherboard voltage range
  – Halts motherboard if voltages inadequate
• If power supply appears “dead”, replace it
Problems with the Power Supply Fans

• Fans usually hum, whine before failing
  – Replace fan or entire power supply
  – Suspect another short if failure continues
  – Do not operate PC if fan not working

• Troubleshooting nonfunctional fan
  – Turn off power; remove all power cord connections to all components except motherboard; turn on power
  – Turn off power; reconnect one card or drive at a time
  – Motherboard power supply problem
    • Fan does not work when all devices except motherboard disconnected
Problems with Overheating

• Computer powers down after operating for a few minutes or a few hours

• Troubleshooting
  – Leave system turned off for about 30 minutes, try again
  – Check computer’s internal temperature
  – Install additional fans
Power Problems with the Motherboard

• Bad contact between board component and chassis
  – Short can seriously damage motherboard
  – Check for missing or extra standoffs (spacers)
• Shorts in the circuit on motherboard
  – Look for damage to the bottom of the motherboard
  – Look for burned-out capacitors
Replacing the Power Supply

• Criteria for replacement power supply
  – Uses correct form factor
  – Adequately rated for power in watts
  – Has necessary power connectors

• Determining power supply problem
  – Turn off PC, open computer case, set new power supply on top of the old one
  – Disconnect old power supply’s cords, plug PC devices into the new power supply
  – Turn on PC, verify new power supply solves problem
Summary

• Form factor specifies size, shape, features of device
  – Motherboard, power supply, and case share the same form factor
• Types of cases: desktop, tower, notebook
• Quantities characterizing electricity
  – Voltage, current, resistance, power
• Current flows from hot wires to neutral wires
  – Excess current escapes through grounds
Summary (cont’d.)

- AC supplied by power station
  - Transformed, rectified before flowing into PC
- Major components in a circuit board
  - Transistor, capacitor, diode, resistor
- Electrical threats
  - ESD, EMI, uneven current flow, sudden power surges (or spikes)