COMPLETE

CompTIA A+ Guide to PCs

SIXTH EDITION

PEARSON IT CERTIFICATION

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CHERYL A. SCHMIDT

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COMPLETE CompTIA® A+ Guide to PCs

SIXTH EDITION

CHERYL A. SCHMIDT
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Complete CompTIA® A+ Guide to PCs, Sixth Edition

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About the Author

Cheryl Schmidt is a professor of Network Engineering Technology at Florida State College at Jacksonville. Prior to joining the faculty ranks, she oversaw the LAN and PC support for the college and other organizations. She started her career as an electronics technician in the U.S. Navy. She teaches computer repair and various networking topics, including CCNA, CCNP, VoIP, QoS, and wireless technologies. She has published other works with Pearson, including *IP Telephony Using CallManager Express* and *Routing and Switching in the Enterprise Lab Guide*.

Cheryl has won awards for teaching and technology, including Outstanding Faculty of the Year, Innovative Teacher of the Year, and Cisco Networking Academy Stand Out Instructor. She has presented at U.S. and international conferences. Cheryl keeps busy maintaining her technical certifications and teaching, but also loves to travel, hike, do all types of puzzles, and read.

Dedication

A Note to Instructors

I was a teacher long before I had the title professor. Sharing what I know has always been as natural as walking to me, but sitting still to write what I know is not as natural, so composing this text has always been one of my greatest challenges. Thank you so much for choosing this text. I thank you for sharing your knowledge and experience with your students. Your dedication to education is what makes the student experience so valuable.

A Note to Students

Writing a textbook is really different from teaching class. I have said for years that my students are like my children, except that I don't have to pay to send them through college. I am happy to claim any of you who have this text. I wish that I could be in each classroom with you as you start your IT career. How exciting!

Another thing that I tell my students is that I am not an expert. Computer repair is an ever-changing field and I have been in it since PCs started being used. You have to be excited about the never-ending changes to be good in this field. You can never stop learning or you will not be very good any more. I offer one important piece of advice:

> Consistent, high-quality service boils down to two equally important things: caring and competence.
>
> —Chip R. Bell and Ron Zemke

I dedicate this book to you. I can help you with the competence piece, but you are going to have to work on the caring part. Do not ever forget that there are people behind those machines that you love to repair. Taking care of people is as important as taking care of the computers.

Acknowledgments

I am so thankful for the support of my family during the production of this book. My husband Karl and daughters Raina and Karalina were such a source of inspiration and encouragement. Thanks to my colleagues, adjuncts, and students at my college who offered numerous valuable suggestions for improvement and testing the new material. I am especially grateful for the help and edits provided by Kathy A. Himle from Salt Lake Community College.

Many thanks are also due the folks at Pearson. The professionalism and support given during this edition was stellar. Thank you so much Pearson team and especially Drew Cupp, Mary Beth Ray, and two of the toughest technical reviewers I have had since my first and second editions, Chris Crayton and Jeff McDowell. You two kept me up late at night trying to figure out a way to make things better. I thank you so much for your conscientious efforts.

Finally, thank you to the students who have taken the time to share their recommendations for improvement. You are the reason I write this book each time. Please send me any ideas and comments you may have. I love hearing from you and of your successes. I may be reached at cheryl.schmidt@fscj.edu.

We Want to Hear from You!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

We welcome your comments. You can email or write to let us know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that we cannot help you with technical problems related to the topic of this book.

When you write, please be sure to include this book's title and author as well as your name and email address. We will carefully review your comments and share them with the author and editors who worked on the book.

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- Improved career advancement
- More insightful problem solving

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Review Exam Objectives	Review the certification objectives to make sure you know what is covered in the exam. http://www.comptia.org/certifications/testprep/examobjectives.aspx
Practice for the Exam	After you have studied for the certification, take a free assessment and sample test to get an idea what type of questions might be on the exam. http://www.comptia.org/certifications/testprep/practicetests.aspx
Purchase an Exam Voucher	Purchase your exam voucher on the CompTIA Marketplace, which is located at: www.comptiastore.com.
Take the Test!	Select a certification exam provider and schedule a time to take your exam. You can find exam providers at the following link: http://www.comptia.org/certifications/testprep/testingcenters.aspx

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Access to various industry resource links and articles related to IT and IT careers

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- **Global Recognition**—CompTIA is recognized globally as the leading IT non-profit trade association and has enormous credibility. Plus, CompTIA's certifications are vendor-neutral and offer proof of foundational knowledge that translates across technologies.
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Introduction

Complete CompTIA A+ Guide to PCs, Sixth Edition, is intended for one or more courses geared toward CompTIA A+ Certification and Computer Repair. It covers all the material needed for the CompTIA A+ 220-801 and 220-802 exams. The book is written so that it is easy to read and understand, with concepts presented in building-block fashion. The book focuses on hardware, software, mobile devices, virtualization, basic networking, and security.

Some of the best features of the book include the coverage of difficult subjects in a step-by-step manner, carefully developed graphics that illustrate concepts, photographs that demonstrate various technologies, reinforcement questions, critical thinking skills, soft skills, and hands-on exercises at the end of each chapter. Also, this book is written by a teacher who understands the value of a textbook from someone who has been in IT their entire career.

What's New in the Sixth Edition?

This update has been revised to include coverage of mobile devices such as smartphones and tablets, virtualization, and design. This edition differs from the Fifth Edition Update book in the following ways:

- Conformity with the latest CompTIA A+ Exam requirements, including the CompTIA A+ 220-801 exam, as well as the CompTIA A+ 220-802 exam.
- A new chapter on computer design was added after the hardware chapters. The chapter includes design activities with various scenarios.
- Mobile devices and virtualization technologies have been added to relevant hardware and software chapters. Labs have also been included.
- Chapters 1 through 10 focus on hardware and design. Chapters 11 and 12 are the operating system chapters. Chapter 13 and 14 cover Internet/networking concepts. Chapter 15 handles security concepts.
- The Internet Connectivity chapter was moved after the Windows chapters and before the Introduction to Networking chapter. The chapter was revamped to be a better introduction to Internet technologies, before the book dives into the details of supporting devices that connect to a wired or wireless network.
- Chapters 1 through 3 were reorganized to better flow through the basic concepts.
- The book has always been filled with graphics and photos, but even more have been added to target those naturally drawn to the IT field.
- The number of questions at the end of each chapter was reduced, but more questions are available in the test bank available from the Pearson Instructor Resource Center.

Organization of the Text

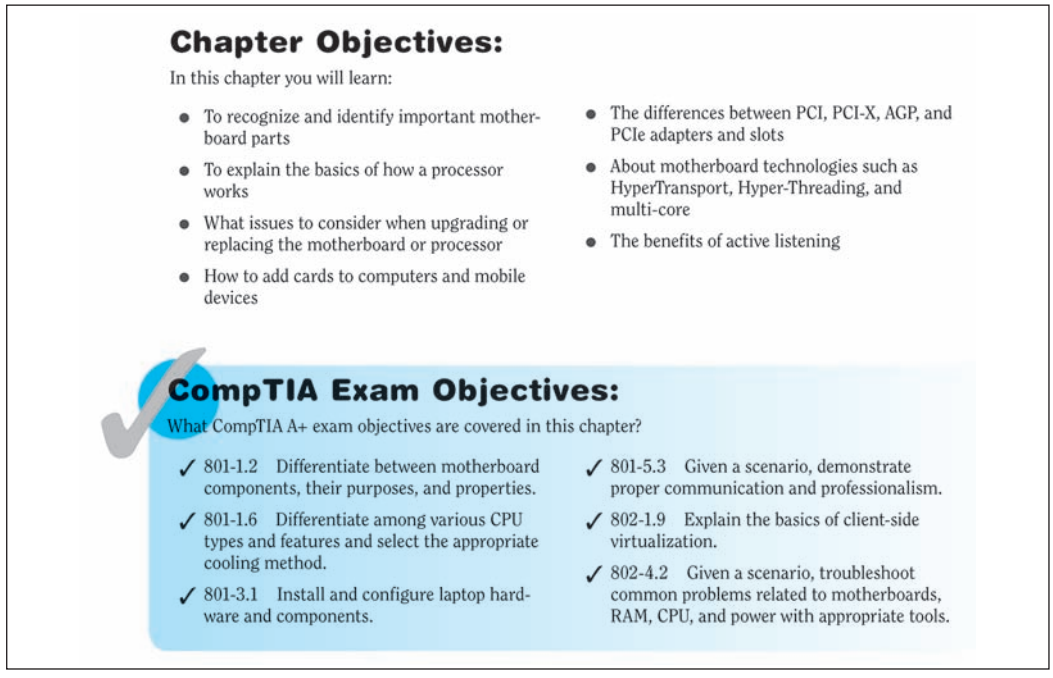
The text is organized to allow thorough coverage of all topics and also to be a flexible teaching tool. It is not necessary to cover all the chapters, nor do the chapters have to be covered in order.

- Chapter 1 covers beginning terminology and computer part and port identification. Chapter 1 does not have a specific soft skills section as do the other chapters. Instead, it focuses on common technician qualities that are explored in greater detail in the soft skills sections of later chapters.
- Chapter 2 details components, features, and concepts related to motherboards, including processors, cache, expansion slots, and chipsets. Active listening skills are described in the soft skills section in this chapter.

- Chapter 3 deals with system configuration basics. BIOS options, UEFI BIOS, and system resources are key topics. The soft skills section covers how one thing at a time should be done when replacing components.
- Chapter 4 steps the student through how to disassemble and reassemble a computer. Laptop disassembly is also covered. Tools, ESD, EMI, and preventive maintenance are discussed. Subsequent chapters also include preventive maintenance topics. Basic electronics and computer power concepts are also included in this chapter. Written communication tips are provided for the soft skills training.
- Chapter 5 covers troubleshooting skills and error codes. Good communication skills are stressed in the soft skills section.
- Chapter 6 covers memory installation, preparation, and troubleshooting. The importance of teamwork is emphasized as the soft skill.
- Chapter 7 deals with storage devices including the floppy drive and IDE PATA/SATA and SCSI (parallel and SAS) hard drive installation, preparation, and troubleshooting. SSDs are also covered. Phone communication skills is the target area for soft skills in this chapter.
- Chapter 8 covers multimedia devices, including optical drives, sound cards, cameras, scanners, and speakers. The chapter ends with a section on having a positive, proactive attitude.
- Chapter 9 deals with peripheral devices, including printers and video output devices. A discussion of work ethics finishes the chapter.
- Chapter 10 is the new computer design chapter. Not only are the specialized computers and components needed within those types of systems covered, but computer subsystem design is also included. The soft skills section targets recommendations for dealing with irate customers.
- Chapter 11 introduces operating systems, including Windows, Android, and iOS. The chapter also includes common desktop or home icons, how to manage files and folders, the registry, and how to function from a command prompt. The soft skills section includes tips on how to stay current in this fast-paced field.
- Chapter 12 covers Windows XP, Vista, and 7. Details include how to install, configure, and troubleshoot the environment. Avoiding burnout is the soft skill discussed in this chapter.
- Chapter 13 handles Internet connectivity. Analog and digital modems, cable modems, DSL modems, and mobile connectivity including wireless, WiMax, and broadband cellular are all discussed. Internet browser configuration is covered along with the soft skill of mentoring.
- Chapter 14 introduces networking. Basic concepts, terminology, and exercises make this chapter a favorite. An introduction to subnetting has been added. The focus of the soft skills section is being proactive instead of reactive.
- Chapter 15 describes computer, mobile device, and network security. The exercises include file and folder security, event monitoring, and local policy creation. The soft skills section is on building customer trust.

Features of This Book

The following key features of the book are designed to enable a better learning experience.



Chapter Objectives:

In this chapter you will learn:

- To recognize and identify important motherboard parts
- To explain the basics of how a processor works
- What issues to consider when upgrading or replacing the motherboard or processor
- How to add cards to computers and mobile devices
- The differences between PCI, PCI-X, AGP, and PCIe adapters and slots
- About motherboard technologies such as HyperTransport, Hyper-Threading, and multi-core
- The benefits of active listening

CompTIA Exam Objectives:

What CompTIA A+ exam objectives are covered in this chapter?

- ✓ 801-1.2 Differentiate between motherboard components, their purposes, and properties.
- ✓ 801-1.6 Differentiate among various CPU types and features and select the appropriate cooling method.
- ✓ 801-3.1 Install and configure laptop hardware and components.
- ✓ 801-5.3 Given a scenario, demonstrate proper communication and professionalism.
- ✓ 802-1.9 Explain the basics of client-side virtualization.
- ✓ 802-4.2 Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU, and power with appropriate tools.

OBJECTIVES **Each chapter begins with BOTH chapter objectives and the CompTIA A+ exam objectives**

GRAPHICS AND PHOTOGRAPHS **Many more have been added to better illustrate the concepts**

ter and remove the computer
pen expansion slot. Some adapters
ptions include 16- and 32-bit PCI

Enable SATA port

Many manufacturers require that you enable the motherboard port through the system BIOS before any device connected to the port is recognized.

TECH TIPS The chapters are filled with Tech Tips that highlight technical issues and certification exam topics

RAM is divided into two major types: **DRAM** (dynamic RAM) and **SRAM** (static RAM). DRAM is less expensive but slower than SRAM. With DRAM, the 1s and 0s inside the chip must be refreshed. Over time, the charge, which represents information inside a DRAM chip, leaks out. The information, stored in 1s and 0s, is periodically rewritten to the memory chip through the **refreshing** process. The refreshing is accomplished inside the DRAM while other

KEY TERMS IN CONTEXT As you read the chapter, terms that appear in blue are considered key terms and are defined in the glossary

Key Terms

KEY TERMS LIST At the end of the chapter, all key terms are listed with page references to which to refer for context

Soft Skills—Active Listening

Active listening is participating in a conversation where you focus on what the customer is saying—in other words, listening more than talking. For a technician, active listening has the following benefits:

- Allows you to gather data and symptoms quickly
- Allows you to build customer rapport
- Improves your understanding of the problem
- Allows you to solve the problem more quickly because you understand the problem better
- Provides mutual understanding between you and the customer
- Provides a means of having a positive, engaged conversation rather than having a negative, confrontational encounter
- Focuses on the customer rather than the technician
- Provides an environment where the customer might be more forthcoming with information related to the problem

Frequently, when a technician arrives onsite or contacts a customer who has a technical problem, the technician is (1) rushed; (2) thinking of other things, including the problems that need to be solved; (3) assuming that he or she knows exactly what the problem is, even though the user has not finished explaining the problem; or (4) more interested in the technical problem than in the customer and the issues. Active listening changes the focus from the technician's problems to the customer's problems.

A common but ineffective service call involves a technician doing most of the talking and questioning, using technical jargon and acronyms and a flat or condescending tone. The customer, who feels vulnerable, experiences a heightened anxiety level. Active listening changes this scenario by helping you build a professional relationship with your customers. The following list outlines some measures that help you implement active listening.

Have a positive, engaged professional attitude when talking and listening to customers:

- Leave your prejudices behind; be polite and aware of other cultures and customs; be open-minded and nonjudgmental.
- Have a warm and caring attitude.
- Do not fold your arms in front of your chest because doing so distances you from the problem and the customer.

SOFT SKILLS **Technology is not the only thing you must learn and practice; each chapter offers advice, activities, and examples of how to be a good tech, an ethical tech, a good work mate, a good communicator, and so on**

Chapter Summary

- Memory on a motherboard is SDRAM, a type of RAM that is cheaper and slower than SRAM, the type of memory inside the CPU and processor housing.
- A DDR module fits in a DDR slot. A DDR2 module requires a DDR2 slot; a DDR3 module requires a DDR3 slot.
- RIMMs use RDRAM and were developed by Rambus, Inc. C-RIMMs are inserted into empty memory slots.
- Unbuffered memory is the memory normally installed in computers.
- ECC is used for error checking and is commonly found in high-end computers and servers. An older method of error checking was called parity.
- The CL rating or the timing sequence first number shows how fast the processor can access data in sequential memory locations. The lower the first number, the faster the access.
- SPD is a technology used so the memory module can communicate specifications to the BIOS.

CHAPTER SUMMARY **Recap the key concepts of the chapter, and use this for review to ensure you've mastered the chapter's learning objectives**

Review Questions

1. Which expansion slot would most likely be used to add an internal adapter to a new laptop?
   [ExpressCard/34 | ExpressCard/54 | mini PCIe | PC Card | USB port | PCI-X | mini PCI]
2. Which expansion slot would be *best* for a video card in a desktop computer?
   [PCI-X | PCIe | PCI | ExpressCard/54 | AGP]
3. A motherboard has a PCIe x16 expansion slot. Which PCIe adapter(s) will fit in this slot? (Select any that apply.) [x1 | x2 | x4 | x8 | x16 | x32]
4. Match the capacity to the description.

____ bit	a. 8 bits
____ kilobyte	b. a 1 or a 0
____ megabyte	c. approximately 1,000 bytes
____ byte	d. approximately 1 million bytes
____ gigabyte	e. approximately 1 trillion bytes
____ terabyte	f. approximately 1 billion bytes

5. What is the front side bus?
   a. the internal data bus that connects the processor core to the L1 cache
   b. the internal data bus that connects the processor core to the L2 cache
   c. the external data bus that connects the processor to the motherboard components
   d. the external data bus that connects the processor to the L2 cache
6. A customer wants to upgrade the L2 cache. What will this definitely require?
   a. a motherboard purchase

REVIEW QUESTIONS Hundreds of review questions, including true/false, multiple choice, matching, fill-in-the-blank, and open-ended questions, assess your knowledge of the learning

Lab 1.3 Identification of Video Ports

Objective: To identify various video ports correctly

Procedure: Identify each video port in Figure 1.55.

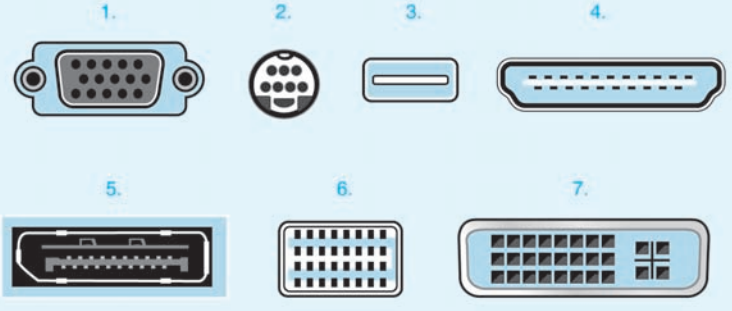
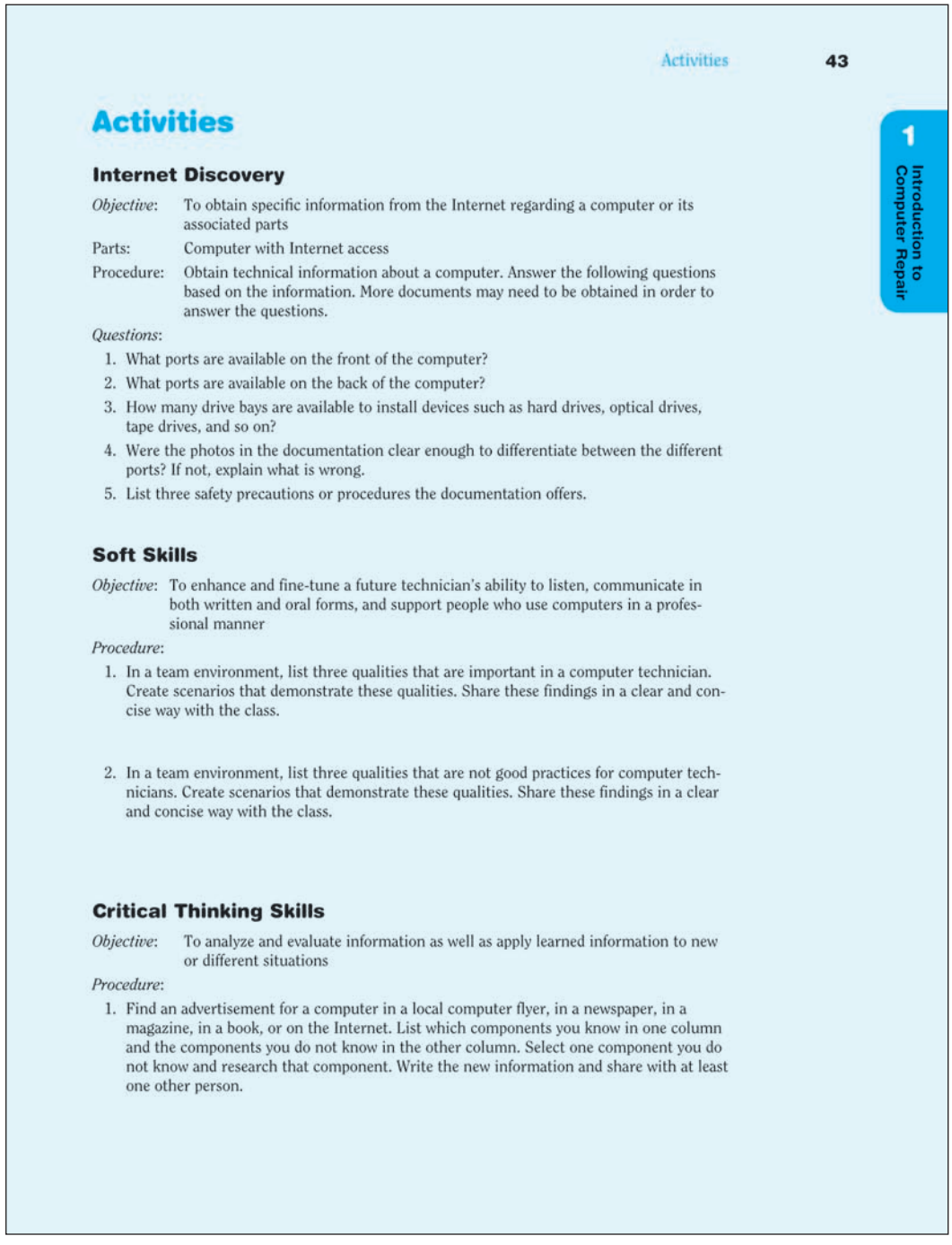


Figure 1.55 Video ports

1.
2.
3.
4.

LAB EXERCISES More than 125 labs enable you to link theory to practical experience



Activities

Internet Discovery

Objective: To obtain specific information from the Internet regarding a computer or its associated parts

Parts: Computer with Internet access

Procedure: Obtain technical information about a computer. Answer the following questions based on the information. More documents may need to be obtained in order to answer the questions.

Questions:

1. What ports are available on the front of the computer?
2. What ports are available on the back of the computer?
3. How many drive bays are available to install devices such as hard drives, optical drives, tape drives, and so on?
4. Were the photos in the documentation clear enough to differentiate between the different ports? If not, explain what is wrong.
5. List three safety precautions or procedures the documentation offers.

Soft Skills

Objective: To enhance and fine-tune a future technician's ability to listen, communicate in both written and oral forms, and support people who use computers in a professional manner

Procedure:

1. In a team environment, list three qualities that are important in a computer technician. Create scenarios that demonstrate these qualities. Share these findings in a clear and concise way with the class.

2. In a team environment, list three qualities that are not good practices for computer technicians. Create scenarios that demonstrate these qualities. Share these findings in a clear and concise way with the class.

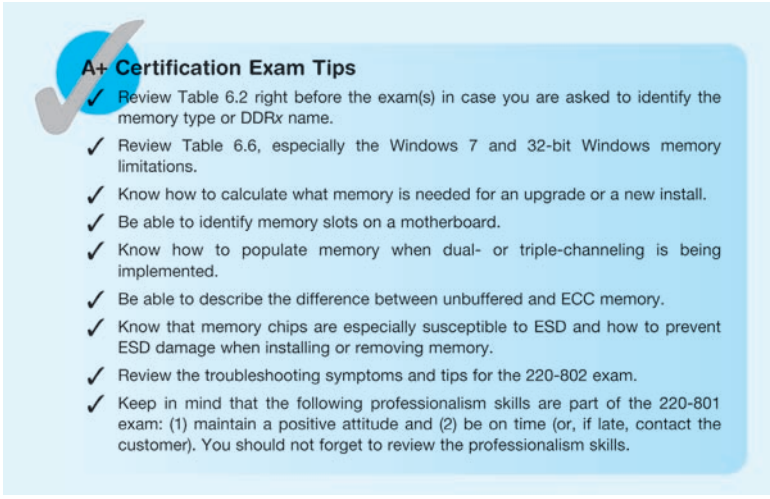
Critical Thinking Skills

Objective: To analyze and evaluate information as well as apply learned information to new or different situations

Procedure:

1. Find an advertisement for a computer in a local computer flyer, in a newspaper, in a magazine, in a book, or on the Internet. List which components you know in one column and the components you do not know in the other column. Select one component you do not know and research that component. Write the new information and share with at least one other person.

ACTIVITIES **Extensive practice with Internet Discovery, Soft Skills, and Critical Thinking Skills round out your technical knowledge so that you can be prepared for IT work**



EXAM TIPS **Read through these tips on the CompTIA A+ exams so you aren't caught off guard when you sit for the exam**

CompTIA A+ Exam Objectives

Tables I-1 and I-2 summarize where you can find all the CompTIA A+ exam objectives covered in the book.

Table I-1 CompTIA A+ 220-801 exam objectives

Objective	Chapters
220-801	
1.0 PC Hardware	
1.1 Configure and apply BIOS settings.	3, 7, 8, 15
1.2 Differentiate between motherboard components, their purposes, and properties.	1, 2, 3, 4, 6, 14
1.3 Compare and contrast RAM types and features.	6
1.4 Install and configure expansion cards.	3, 8, 9, 13
1.5 Install and configure storage devices and use appropriate media.	1, 6, 7, 8
1.6 Differentiate among various CPU types and features and select the appropriate cooling method.	2
1.7 Compare and contrast various connection interfaces and explain their purpose.	1, 13, 14
1.8 Install an appropriate power supply based on a given scenario	4
1.9 Evaluate and select appropriate components for a custom configuration, to meet customer specifications or needs.	10
1.10 Given a scenario, evaluate types and features of display devices.	1, 9
1.11 Identify connector types and associated cables.	1, 7, 9, 13
1.12 Install and configure various peripheral devices.	1, 8, 9

Objective	Chapters
220-801	
2.0 Networking	
2.1 Identify types of network cables and connectors.	14
2.2 Categorize characteristics of connectors and cabling.	14
2.3 Explain properties and characteristics of TCP/IP.	14
2.4 Explain common TCP and UDP ports, protocols, and their purpose.	14
2.5 Compare and contrast wireless networking standards and encryption types.	14, 15
2.6 Install, configure, and deploy a SOHO wireless/wired router using appropriate settings.	14, 15
2.7 Compare and contrast Internet connection types and features.	13, 14
2.8 Identify various types of networks.	14
2.9 Compare and contrast network devices their functions and features.	13, 14, 15
2.10 Given a scenario, use appropriate networking tools.	14
3.0 Laptops	
3.1 Install and configure laptop hardware and components.	1, 2, 4, 6, 7, 8, 9, 14
3.2 Compare and contrast the components within the display of a laptop.	9, 14
3.3 Compare and contrast laptop features.	1, 8, 14, 15
4.0 Printers	
4.1 Explain the differences between the various printer types and summarize the associated imaging process.	9
4.2 Given a scenario, install, and configure printers.	3, 9, 14
4.3 Given a scenario, perform printer maintenance.	9
5.0 Operational Procedures	
5.1 Given a scenario, use appropriate safety procedures.	4, 14
5.2 Explain environmental impacts and the purpose of environmental controls.	4, 10
5.3 Given a scenario, demonstrate proper communication and professionalism.	1, 2, 4, 5, 7, 10, 15
5.4 Explain the fundamentals of dealing with prohibited content/activity.	15

Table I-2 CompTIA A+ 220-802 Exam Objectives

Objective	Chapters
220-802	
1.0 Operating Systems	
1.1 Compare and contrast the features and requirements of various Microsoft operating systems.	6, 11, 12, 15
1.2 Given a scenario, install and configure the operating system using the most appropriate method.	7, 11, 12, 14
1.3 Given a scenario, use appropriate command line tools.	11, 12, 14
1.4 Given a scenario, use appropriate operating system features and tools.	4, 6, 7, 8, 11, 12, 14, 15
1.5 Given a scenario, use Control Panel utilities (the items are organized by "classic view/large icons" in Windows).	4, 6, 8, 11, 12, 14, 15
1.6 Setup and configure Windows networking on a client/desktop.	13, 14, 15
1.7 Perform preventive maintenance procedures using appropriate tools.	7, 11, 12
1.8 Explain the differences among basic OS security settings.	14, 15
1.9 Explain the basics of client-side virtualization.	2, 11, 12, 14, 15
2.0 Security	
2.1 Apply and use common prevention methods.	12, 15
2.2 Compare and contrast common security threats.	12, 15
2.3 Implement security best practices to secure a workstation.	15
2.4 Given a scenario, use the appropriate data destruction/ disposal method.	7, 15
2.5 Given a scenario, secure a SOHO wireless network.	15
2.6 Given a scenario, secure a SOHO wired network.	15
3.0 Mobile Devices	
3.1 Explain the basic features of mobile operating systems.	6, 11
3.2 Establish basic network connectivity and configure email.	1, 14
3.3 Compare and contrast methods for securing mobile devices.	15
3.4 Compare and contrast hardware differences in regards to tablets and laptops.	1
3.5 Execute and configure mobile device synchronization.	14
4.0 Troubleshooting	
4.1 Given a scenario, explain the troubleshooting theory.	5
4.2 Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU, and power with appropriate tools.	2, 4, 5, 6, 14

Objective	Chapters
220-802	
4.3 Given a scenario, troubleshoot hard drives and RAID arrays with appropriate tools.	7
4.4 Given a scenario, troubleshoot common video and display issues.	9
4.5 Given a scenario, troubleshoot wired and wireless networks with appropriate tools.	13, 14
4.6 Given a scenario, troubleshoot operating system problems with appropriate tools.	6, 7, 11, 12
4.7 Given a scenario, troubleshoot common security issues with appropriate tools and best practices.	12, 15
4.8 Given a scenario, troubleshoot, and repair common laptop issues while adhering to the appropriate procedures.	1, 4, 9, 14
4.9 Given a scenario, troubleshoot printers with appropriate tools	9

Summary of Exam Domains by Chapter

Schmidt Table of Contents	220-801 Domains	220-802 Domains
Chapter 1: Introduction to Computer Repair	1, 5	3, 4
Chapter 2: On the Motherboard	1, 3, 5	1, 4
Chapter 3: System Configuration	1, 4	
Chapter 4: Disassembly and Power	1, 3, 5	1, 4
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chapter 4

Disassembly and Power

Chapter Objectives:

In this chapter you will learn:

- How to prevent static electricity, RFI, and EMI from harming or interfering with a computer
- The tools needed to work on computers
- How to take apart a computer and put it back together
- How to perform basic voltage and continuity checks
- How to upgrade or replace a power supply
- Different power-saving techniques
- What type of power devices can be used to protect computers
- Tips for good written communication

CompTIA Exam Objectives:

What CompTIA A+ exam objectives are covered in this chapter?

- ✓ 801-1.2 Differentiate between motherboard components, their purposes, and properties.
- ✓ 801-1.8 Install an appropriate power supply based on a given scenario.
- ✓ 801-3.1 Install and configure laptop hardware and components.
- ✓ 801-5.1 Given a scenario, use appropriate safety procedures.
- ✓ 801-5.2 Explain environmental impacts and the purpose of environmental controls.
- ✓ 801-5.3 Given a scenario, demonstrate proper communication and professionalism.
- ✓ 802-1.4 Given a scenario, use appropriate operating system features and tools.
- ✓ 802-1.5 Given a scenario, use Control Panel utilities.
- ✓ 802-4.2 Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU, and power with appropriate tools.
- ✓ 802-4.8 Given a scenario, troubleshoot, and repair common laptop issues while adhering to the appropriate procedures.

Disassembly Overview

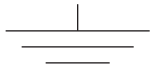
It is seldom necessary to completely disassemble a computer. However, when a technician is first learning about PCs, disassembly can be both informative and fun. Technicians might disassemble parts of a computer to perform preventive cleaning or to troubleshoot a problem. It may also be appropriate to disassemble a computer when it has a problem of undetermined cause. Sometimes, the only way to diagnose a problem is to disassemble the computer outside the case or remove components one by one. Disassembling a computer outside the case may help with grounding problems. A **grounding** problem occurs when the motherboard or adapter is not properly installed and a trace (a metal line on the motherboard or adapter) touches the computer frame, causing the adapter and possibly other components to stop working. Don't forget to remove jewelry and use proper lifting techniques, as described in Figure 1.1 (see Chapter 1) before disassembling a computer.

Electrostatic Discharge (ESD)

You must take many precautions when disassembling a computer. The electronic circuits located on the motherboard and adapters are subject to ESD. **ESD** (electrostatic discharge) is a difference of potential between two items that causes static electricity. Static electricity can damage electronic equipment without the technician's knowledge. The average person requires a static discharge of 3,000 volts before he or she feels it. An electronic component can be damaged with as little as 30 volts. Some electronic components may not be damaged the first time static electricity occurs. However, the effects of static electricity can be cumulative, weakening or eventually destroying a component. An ESD event is not recoverable—nothing can be done about the damage it induces. Electronic chips and memory modules are most susceptible to ESD strikes.

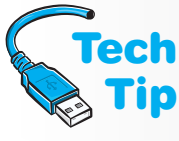
Atmospheric conditions affect static electricity. When humidity is low, the potential for ESD is greater than at any other time; however, too much humidity is bad for electronics. Keep humidity between 45 and 55 percent to reduce the threat of ESD.

A technician can prevent ESD by using a variety of methods. The most common tactic is to use an **antistatic wrist strap**. One end encircles the technician's wrist. At the other end, an alligator clip attaches to the computer. The clip attaches to a grounding post or a metal part such as the power supply. The electronic symbol for ground follows:



An antistatic wrist strap allows the technician and the computer to be at the same voltage potential. As long as the technician and the computer or electronic part are at the same potential, static electricity does not occur. An exercise at the end of the chapter demonstrates how to attach an antistatic wrist strap and how to perform maintenance on it. Technicians should use an ESD wrist strap whenever possible.

A resistor inside an antistatic wrist strap protects the technician in case something accidentally touches the ground to which the strap attaches while he or she is working inside a computer. This resistor cannot protect the technician against the possible voltages inside a monitor. See Figure 4.1 for an illustration of an antistatic wrist strap. Figure 4.2 shows a good location for attaching an antistatic wrist strap.



When *not* to wear an antistatic wrist strap

Technicians should not wear an ESD wrist strap when working inside a CRT monitor because of the high voltages there.

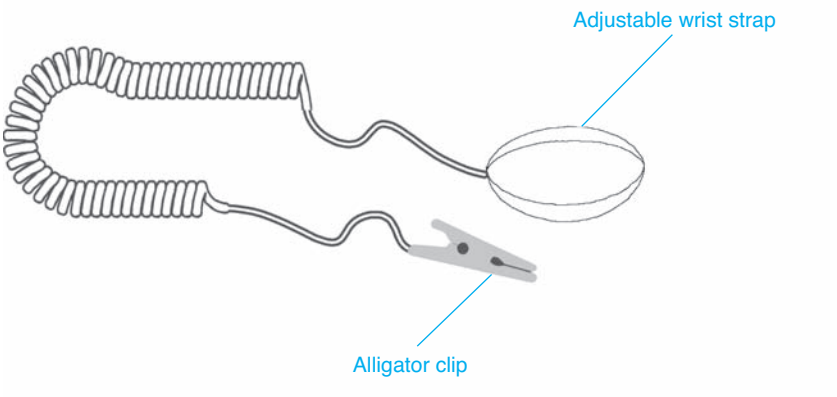


Figure 4.1 Antistatic wrist strap

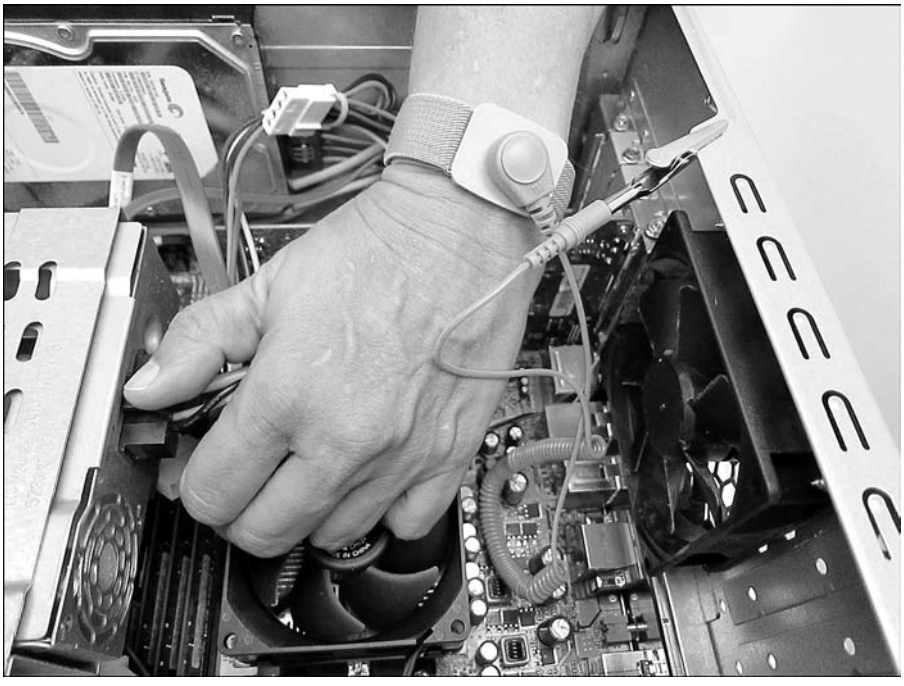


Figure 4.2 Attaching an antistatic wrist strap

Antistatic bags are good for storing spare adapters and motherboards when the parts are not in use. However, antistatic bags lose their effectiveness after a few years. Antistatic mats are available to place underneath a computer being repaired; such a mat may have a snap for connecting the antistatic wrist strap. Antistatic heel straps are also available.

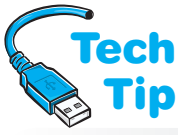
If an antistatic wrist strap is not available, you can still reduce the chance of ESD damage. After removing the computer case, stay attached to an unpainted metal computer part. One such part is the power supply. If you are right-handed, place your bare left arm on the power supply. Remove the computer parts one by one, always keeping your left elbow (or some other bare part of your arm) connected to the power supply. If you are left-handed, place your right arm on the power supply. By placing your elbow on the power supply, both hands are free to remove computer parts. This method is an effective way of keeping the technician and the computer at the same voltage potential, thus reducing the chance of ESD damage. It is not as safe as using an antistatic wrist strap. Also, removing the power cable from the back of the

computer is a good idea. A power supply provides a small amount of power to the motherboard even when the computer is powered off. Always unplug the computer and use an antistatic wrist strap when removing or replacing parts inside a computer!

EMI (Electromagnetic Interference)

EMI (electromagnetic interference, sometimes called EMR, for electromagnetic radiation) is noise caused by electrical devices. Many devices can cause EMI, such as a computer, a pencil sharpener, a motor, a vacuum cleaner, an air conditioner, and fluorescent lighting. The electrical devices around the computer case, including a CRT-type monitor and speakers, cause more problems than the computer.

A specific type of electromagnetic interference that affects computers is **RFI** (radio frequency interference). RFI is simply those noises that occur in the radio frequency range. Anytime a computer has an intermittent problem, check the surrounding devices for the source of that problem. For example, if the computer goes down only when the pencil sharpener operates or when using the optical drive, EMI could be to blame. EMI problems are very hard to track to the source. Any electronic device including computers and printers can be a source of EMI/RFI. EMI/RFI can affect any electronic circuit. EMI can also come through power lines. Move the computer to a different wall outlet or to a totally different circuit to determine if the power outlet is the problem source. EMI can also affect files on a hard drive.



Replace empty slot covers

To help with EMI and RFI problems, replace slot covers for expansion slots that are no longer being used. Slot covers also keep out dust and improve the air flow within the case.

Disassembly

Before a technician disassembles a computer, several steps should be performed or considered. The following disassembly tips are helpful:

- Do not remove the motherboard battery, or the configuration information in CMOS will be lost.
- Use proper grounding procedures to prevent ESD damage.
- Keep paper, a pen, a phone, and a digital camera nearby for note taking, diagramming, and photo taking. Even if you have taken apart computers for years, you might find something unique or different inside this one.
- Have ample flat and clean workspace.
- When removing adapters, do not stack the adapters on top of one another.
- If possible, place removed adapters inside a special ESD protective bag.
- Handle each adapter, motherboard, or processor on the side edges. Avoid touching the gold contacts on the bottom of adapters. Sweat, oil, and dirt cause problems.
- Remember that hard drives require careful handling. A very small jolt can cause damage to stored data.
- You can remove a power supply, but do not disassemble a CRT-style monitor or power supply without proper training and tools.
- Document screw and cable locations. Label them if possible.

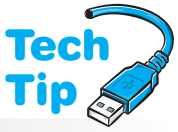
Tools

No chapter on disassembly and reassembly is complete without mentioning tools. Tools can be divided into two categories: (1) those you should not leave the office without and (2) those that are nice to have in the office, at home, or in the car.

Many technicians do not go on a repair call with a full tool case. Ninety-five percent of all repairs are completed with the following basic tools:

- Small and medium flat-tipped screwdrivers
- #0, #1, and #2 Phillips screwdrivers
- 1/4- and 3/16-inch hex nut drivers
- Small diagonal cutters
- Needlenose pliers

Screwdrivers take care of most disassemblies and reassemblies. Sometimes manufacturers place tie wraps on new parts, new cables, or the cables inside the computer case. The diagonal cutters are great for removing the tie wraps without cutting cables or damaging parts. Needlenose pliers are good for straightening bent pins on cables or connectors, and doing a million other things. Small tweaker screwdrivers and needlenose pliers are indispensable.



Do not use magnetized screwdrivers

Avoid using a magnetic screwdriver when working on a computer. It can cause permanent loss of data on hard drives or floppy disks. Magnetism can also induce currents into components and damage them. Sometimes, technicians are tempted to use a magnetic screwdriver when they drop a small part such as a screw into a hard-to-reach place, but avoid using a magnetic screwdriver.

Many technicians start with a basic $15 microcomputer repair kit and build from there. A bargain table 6-in-1 or 4-in-1 combination screwdriver that has two sizes of flat-tipped and two sizes of Phillips screwdrivers is a common tool among new technicians. A specialized Swiss army knife with screwdrivers is the favorite of some technicians. Other technicians prefer to carry an all-in-one tool in a pouch that connects to their belt.

Alternatives to the magnetic screwdriver include a screw pick-up tool and common sense. A screw pick-up tool is used in hard-to-reach places and sometimes under the motherboard. If a screw rolls under the motherboard and cannot be reached, tilt the computer so that the screw rolls out. Sometimes the case must be tilted in different directions until the screw becomes dislodged.

There are tools that no one thinks of as tools but that should be taken on a service call every time. They include a pen or pencil with which to take notes and fill out the repair slip and a bootable disc containing the technician's favorite repair utilities. Usually a technician has several bootable discs for different operating systems and utilities. Often a flashlight comes in handy because some rooms and offices are dimly lit. Finally, do not forget to bring a smile and a sense of humor.

Tools that are nice to have but not used daily include the following:

- Multimeter
- Screw pick-up tool
- Screwdriver extension tool
- Soldering iron, solder, and flux
- Screw-starter tool
- Medium-size diagonal cutters
- Metric nut drivers
- Cable-making tools
- Cable tester
- Loopback plug
- Punch down tool
- Toner probe
- Wire stripper
- Crimper

- AC circuit tester
- Right-angled, flat-tipped, and Phillips screwdrivers
- Hemostats
- Pliers
- Optical laser cleaning kit
- Nonstatic vacuum or toner vacuum
- Disposable gloves
- Small plastic scribe
- T8, 10, 15, 20, and 25 Torx (star) screwdriver

You could get some nice muscle tone from carrying all these nice-to-have but normally unnecessary tools. When starting out in computer repair, get the basics. As your career path and skill level grow, so will your tool kit. Getting to a job site and not having the right tool can be a real hassle. However, because there are no standards or limitations on what manufacturers can use in their product lines, it is impossible to always have the right tool on hand. However, always remember that no tool kit is complete without an antistatic wrist strap.

Opening the Case

Opening or removing the case is sometimes the hardest part of disassembly. Some manufacturers have tabs or covers over the retaining screws, and others have retention levers or tabs that have to be depressed before the cover slides open or away. For some computers you must press a tab on top of the computer downward while simultaneously pressing upward on a tab on the bottom of the computer. Once the tabs are pressed, the cover can be pried open. Sound like a two-person job? Sometimes it is.

Some cases have screws that loosen but do not have to be removed all the way to remove or open the case. For all computer screws, make diagrams and use an egg carton and label each section of the carton with where you got the screws. When possible, refer to the manufacturer's directions when opening a case.

Cables and Connectors

Internal cables commonly connect from a device to the motherboard, the power supply to a device, the motherboard to the front panel buttons or ports, and/or from a card that occupies an expansion space to the motherboard. Cables can be tricky. Inserting a cable backward into a device or adapter can damage the device, motherboard, or adapter. Most cables are keyed so the cable inserts into the connector only one way. However, some cables or connectors are *not* keyed.

Removing a cable for the first time requires some muscle. Many cables have a pull tab or plastic piece used to remove the cable from the connector and/or device. Use this if possible and do not yank on the cable. Some cables have connectors with locking tabs. Release the locking tab *before* disconnecting the cable; otherwise, damage can be done to the cable and/or connector.

Be careful with hard drive cables. Some of the narrow drive cables, such as the one shown in Figure 4.3, are not as sturdy and do not connect as firmly as some of the other computer cables. Also, with this particular cable type, it does not matter which cable end attaches to the device. A 90^0-angled cable (see Figure 4.4) may attach to devices in a case that has a limited-space design and may have a release latch.

Figure 4.3 Both cable ends are the same

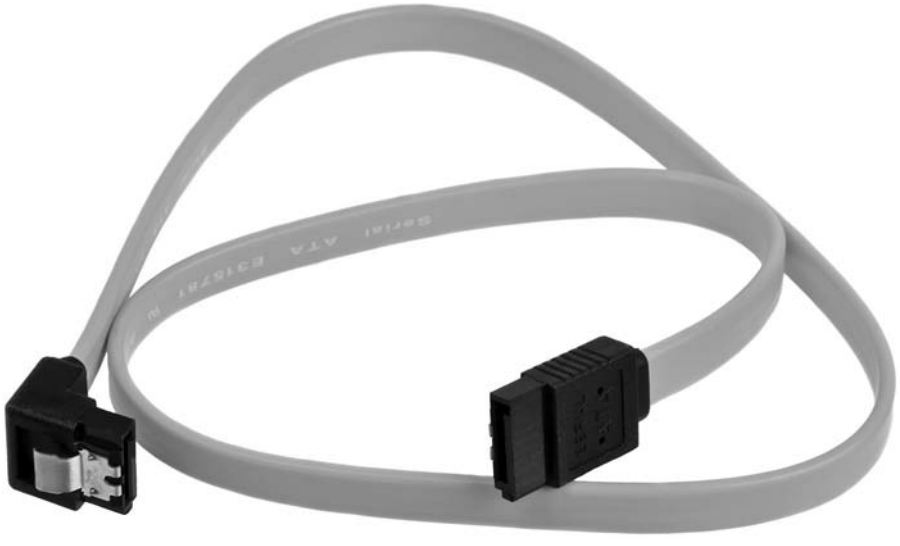


Figure 4.4 90°-angled cable with a latch

Each cable has a certain number of pins, and all cables have a **pin 1**. Pin 1 on a cable connects to pin 1 on a connector. In the event that the pin 1 is *not* easily identified, both ends of the cable should be labeled with either a 1 or 2 on one side or a higher number, such as 24, 25, 49, 50, and so on, on the other end. Pins 1 and 2 are always on the same end of a cable. If you find a higher number, pin 1 is on the opposite end. Also, the cable connector usually has an arrow etched into its molding showing the pin 1 connection. Figure 4.5 shows pin 1 on a ribbon cable.

Pin 1 is the cable edge that is colored

Pin 1 on a ribbon cable is easily identified by the colored stripe that runs down the edge of the cable.

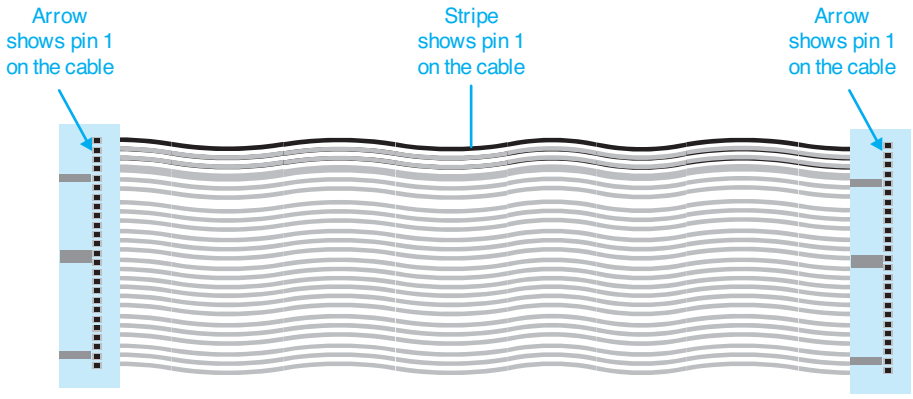
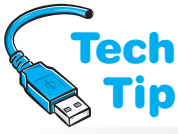


Figure 4.5 Pin 1 on a ribbon cable



Snug connections

When connecting cables to a motherboard or internal components, ensure that each cable is connected tightly, evenly, and securely.

Just as every cable has a pin 1, all connectors on devices, adapters, or motherboards have a pin 1. Pin 1 on a cable inserts into pin 1 on a connector. Cables are normally keyed so that they insert only one way. Some manufacturers stencil a 1 or a 2 by the connector on the motherboard or adapter; however, on a black connector, it's difficult to see the small number. Numbers on adapters are easier to distinguish. When the number 2 is etched beside the adapter's connector, connect the cable's pin 1 to this side. Remember that pins 1 and 2 are always on the same side, whether on a connector or on a cable. Some technicians use a permanent marker to label a cable's function. Figure 4.6 shows an example of a stenciled marking beside an adapter's connector. Figure 4.6 illustrates the number 2 etched onto the adapter, but other manufacturers stencil a higher number, such as 33, 34, 39, or 40, beside the opposite end of the connector.

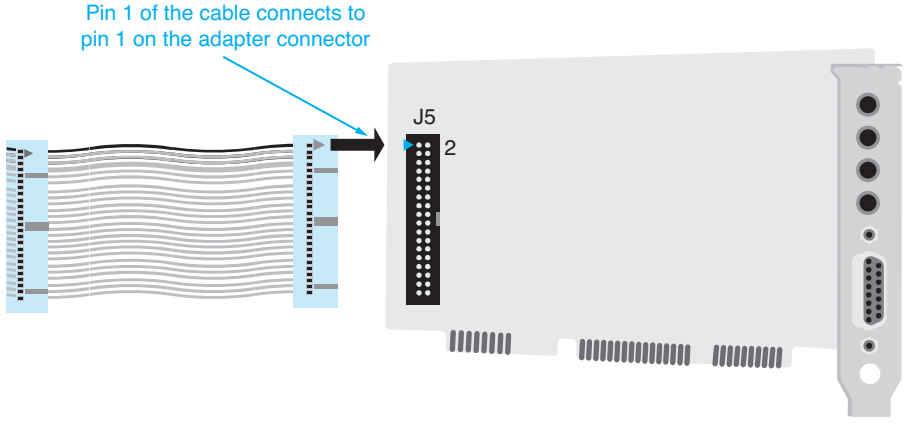


Figure 4.6 Pin 1 on an adapter

Motherboard connectors are usually notched so that the cable inserts only one way; however, not all cables are notched. Some motherboards have pin 1 (or the opposite pin) labeled. Always refer to the motherboard documentation for proper orientation of a cable into a motherboard connector. Figure 4.7 shows the motherboard connectors used for the thin cables shown in Figures 4.3 and 4.4. These connectors commonly have hard drives and optical drives attached. Figure 4.8 show three other motherboard connectors that are notched.

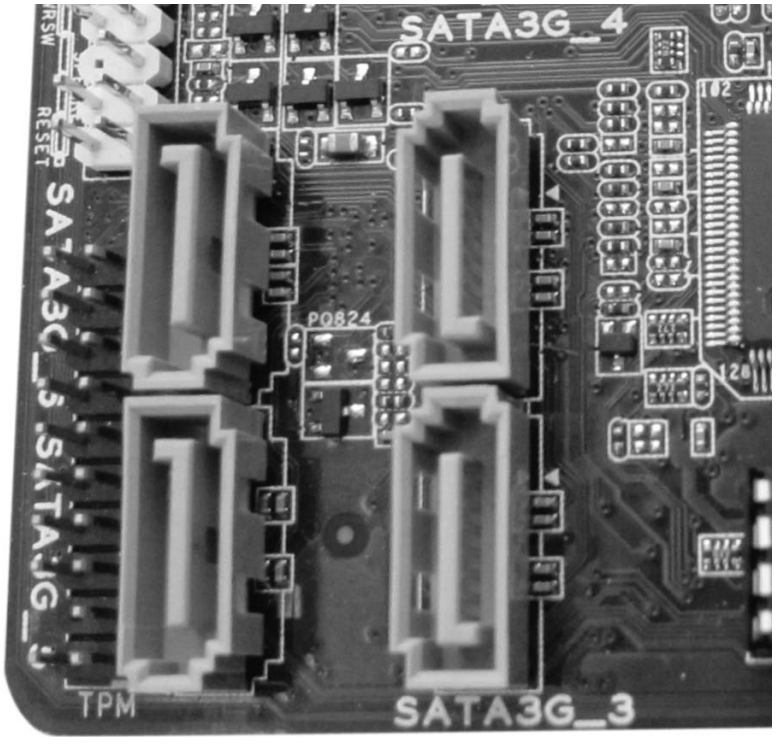


Figure 4.7 Motherboard connectors for narrow cables

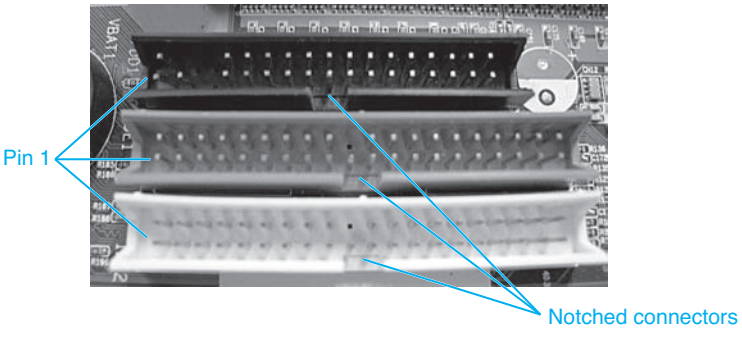
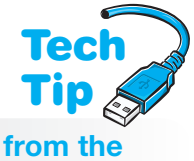


Figure 4.8 Three motherboard connectors

Some manufacturers do not put any markings on the cable connector; even so, there is a way to determine which way to connect the cable. Remove the adapter, motherboard, or device from the computer. Look where the connector solders or connects to the motherboard or adapter. Turn over the adapter. Notice the silver blobs, known as solder joints, on the back of the motherboard or adapter. Solder joints connect electronic components to the motherboard or adapter. The connector's solder joints are normally round, except for the solder joint for pin 1, which is square. Look for the square solder joint on the back of the connector. If the square solder joint is not apparent on the connector, look for other connectors or solder joints that are square. All chips and connectors mount onto a motherboard in the same direction—all pin 1s are normally oriented in the same direction. If one pin 1 is found, the other connectors orient in the same direction. Insert the cable so pin 1 matches the square solder joint of the connector. Figure 4.9 shows a square solder joint for a connector on the back of an adapter.



Pin 1 is on the opposite end from the higher stenciled number

If a higher number, such as 39 or 40, is stenciled beside the connector, connect pin 1 and 2 of the cable *to the opposite end of that connector*.

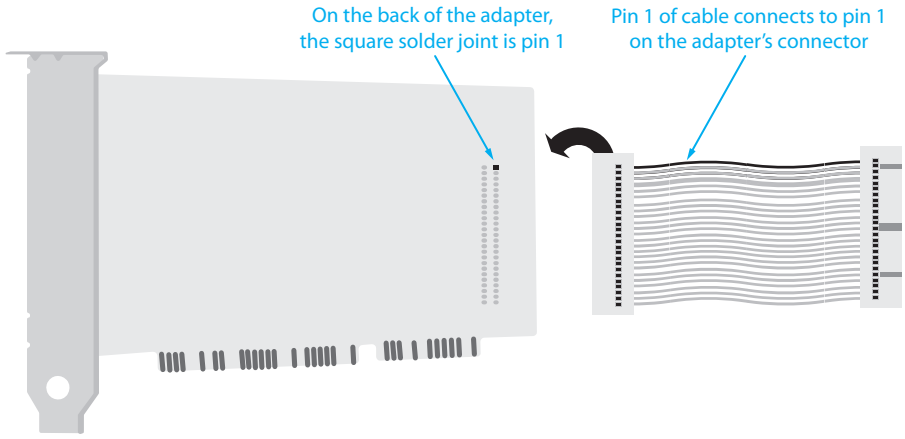


Figure 4.9 Pin 1 on a connector

Specific cables connect a motherboard to lights, ports, or buttons on the front panel. These include the power button, a reset button, USB ports, IEEE 1394 ports, a microphone port, a headphone port, speakers, fans, the hard drive usage light, and the power light, to name a few. Be very careful when removing and reinstalling these cables. Usually, each one of these has a connector that must attach to the appropriate motherboard pins. Be sure to check all ports and buttons once you have reconnected these cables. Refer to the motherboard documentation if your diagramming or notes are inaccurate or if you have no diagrams or notes. Figure 4.10 shows the motherboard pins and the connectors.

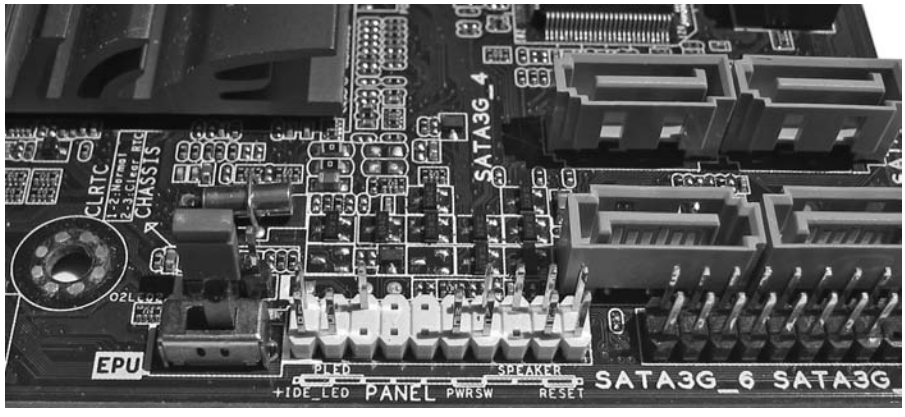


Figure 4.10 Motherboard front panel connectors

Storage Devices

Hard drives must be handled with care when disassembling a computer. Inside traditional hard drives are hard platters with tiny read/write heads located just millimeters above the platters. If dropped, the read/write heads can touch the platter, causing damage to the platter and/or the read/write heads. The platter is used to store data and applications. Today's mechanical hard drives have self-parking heads that pull the heads away to a safe area when the computer is powered off or in a power-saving mode. Always be careful neither to jolt nor to jar the hard drive when removing it from the computer. Even with self-parking heads, improper handling can cause damage to the hard drive.

A solid-state drive does not contain fragile heads. However, these drives are susceptible to ESD. Use proper antistatic handling procedures when removing/installing them. Store a solid-state drive in an antistatic bag when not in use. Avoid touching the drive with a metal tool.

Motherboards

Chapter 2 covered motherboard replacement extensively, and here we discuss issues related to building a computer from scratch or disassembling a computer: I/O shield, standoffs, and retaining clips. Some cases include a standard I/O panel shield that may need to be removed to install the I/O shield that comes with some motherboards. The **I/O shield** is a part what allows for optimum air flow and grounding for the motherboard ports. The I/O shield helps ensure the motherboard is installed correctly and properly aligned with the case. Figure 4.11 shows a motherboard I/O shield.

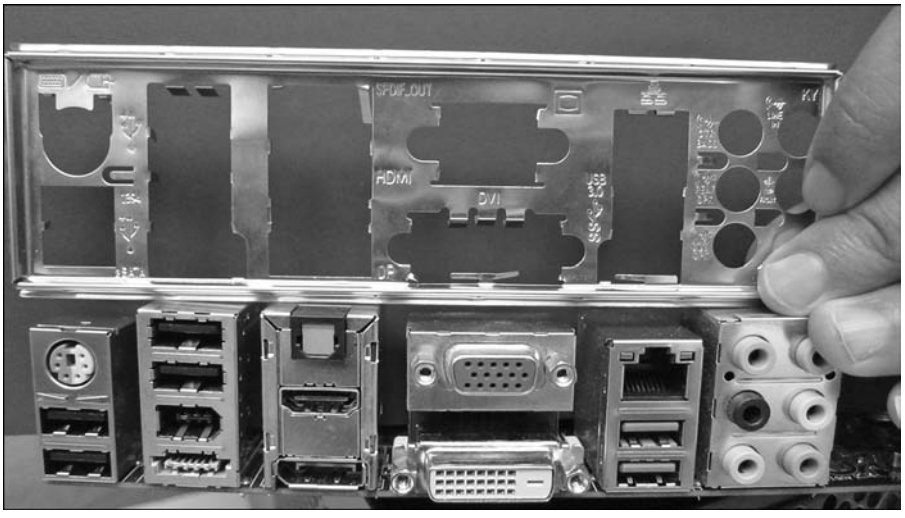


Figure 4.11 Motherboard I/O shield

Some computer cases have plastic or metal (commonly brass) **standoffs** that allow the motherboard to be screwed into the case without the motherboard solder joints touching and grounding to the computer case, causing the motherboard not to work. Some standoffs are plastic, and they slide into slots on the computer case. Do not remove these types of standoffs but just leave them attached and slide the motherboard out of the slots. The most common type of standoff is a metal standoff that screws into the case; this standoff has a threaded side that the motherboard sits on and a screw that attaches the motherboard to the standoff, as shown in Figure 4.12.

Figure 4.12 Motherboard standoff

Some motherboards not only have screws that attach them to the metal standoffs but one or more retaining clips. A retaining clip might need to be pressed down, lifted up, or bent upward in order to slide the motherboard out of the case. The case might contain one or more notches and require the motherboard to be slid in a particular direction (usually in the direction going away from the back I/O ports) before being lifted from the case.

Mobile Device Issues

Chapter 1 contains information on removing laptop keyboards, and Chapter 2 includes information on removing laptop adapters, motherboards, and CPUs. Other laptop issues relating to disassembling a laptop include memory, plastics, the DC power jack, and the speaker. Whenever taking anything out of a laptop, one of the major issues is tiny screws. Many manufacturers label the type of screen or location for ease of explaining disassembly. Always keep like screws together (in containers or an egg carton) and take notes. All the parts are manufacturer dependent, but the following explanation and graphics/photos should help with these portable devices.

Laptop memory and expansion cards are commonly located in a bottom compartment accessed by removing a screw. Figure 4.13 shows this on a netbook computer.

Figure 4.13 Netbook memory compartment

Some laptop and mobile device compartments require levering the compartment cover away from the case or removing plastic parts such as the cover that fits over a mobile computer keyboard. A plastic **scribe** is the best tool to use for this levering. Figure 4.14 shows a plastic scribe being used to lift the plastic part that is between the keyboard and the laptop screen.

Figure 4.14 Scribe used to remove a laptop plastic piece

Laptop/netbook speakers commonly mount above or to the side of the keyboard. The keyboard usually has to be removed to reach the speakers. Sometimes, speaker cables run alongside the keyboard and must be pried out of the case. The DC power plug commonly has a similar cable, as shown in Figure 4.15.

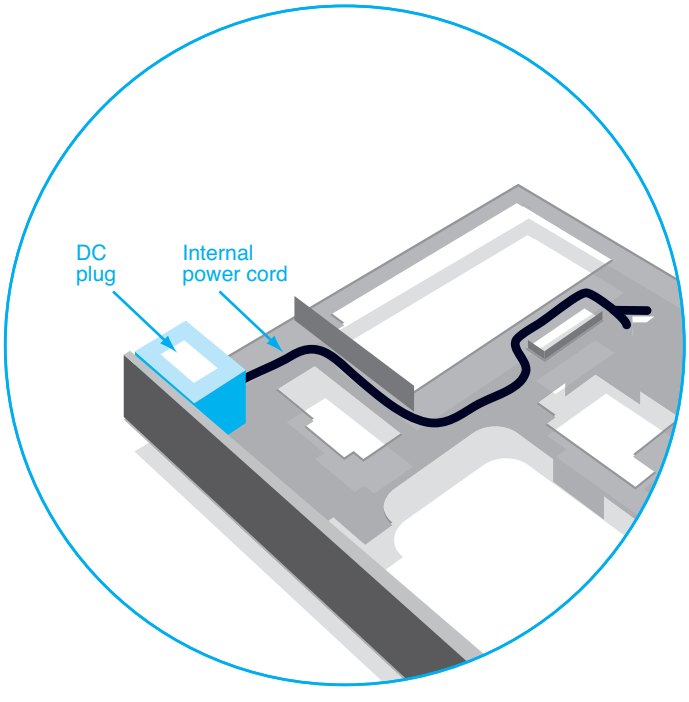


Figure 4.15 Laptop DC power plug cable

Reassembly

Reassembling a computer is easy if the technician is careful and properly diagrams the disassembly. Simple tasks such as inserting the optical drive in the correct drive bay become confusing after many parts have been removed. Writing down reminders takes less time than having to troubleshoot the computer because of poor reassembly. Reinsert all components into their proper place; be careful to replace all screws and parts. Install missing slot covers, if possible.

Three major reassembly components are motherboards, cables, and connectors. When reinstalling a motherboard, reverse the procedure used during disassembly. Ensure that the motherboard is securely seated into the case and that all retaining clips and/or screws are replaced. This procedure requires practice, but eventually a technician will be able to tell when a motherboard is seated into the case properly. Visual inspection can also help. Ensure that the ports extend fully from the case through the I/O shield. As a final step, ensure that the drives and cover are aligned properly when the case is reinstalled.

Cables and connectors are the most common source of reassembly problems once the motherboard is installed. Ensure that cables are fully attached to devices and the motherboard. Ensure that power cables are securely attached. Matching pin 1 on the cable to pin 1 on the motherboard connector is critical for older ribbon cables. Attaching the correct device to the correct cable can be difficult if proper notes were not taken.

Preventive Maintenance

Preventive maintenance includes certain procedures performed to prolong the life of a computer. Some computer companies sell maintenance contracts that include preventive maintenance programs. A computer in a normal working environment should be cleaned at least once a year. Typical preventive measures include vacuuming the computer/printer and cleaning the optical drive laser, keyboard keys, printers, and display screen. Be sure to power down the computer and remove the power cord for any computer, remove the battery and AC adapter for a laptop/netbook, and allow a laser printer to cool before accessing internal parts. Preventive exercises for many individual devices are described in their respective chapters. For example, the steps detailing how to clean CDs/DVDs/BDs are included in Chapter 8. This section gives an overview of a preventive maintenance program and some general tips about cleaning solvents.

When performing preventive maintenance, power on the computer to be certain it operates. Perform an audio and visual inspection of the computer as it boots. It is a terrible feeling to perform preventive maintenance on a computer only to power it on and find it does not work. You will wonder if the cleaning you performed caused the problem or if the computer had a problem before the preventive maintenance.

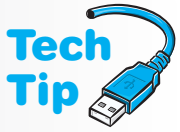
Repair companies frequently provide a preventive maintenance kit for service calls. The kit normally includes a portable vacuum cleaner, special vacuum cleaner bags for laser printers, a can of compressed air, a floppy head cleaning kit, urethane swabs, monitor wipes, lint-free cloths, general-purpose cloths, general-purpose cleanser, denatured alcohol, a mouse ball cleaning kit, an antistatic brush, gold contact cleaner, and an optical drive cleaning kit.

The vacuum is used to suck dirt from the inside of the computer. Ensure that you use nonmetallic attachments. Some vacuum cleaners have the ability to blow air. Vacuum first and then set the vacuum cleaner to blow to get dust out of hard-to-reach places. Compressed air can also be used in these situations. The floppy head cleaning kit is used to clean the read/write heads on the floppy drive. Monitor wipes are used on the front of the monitor screen. Monitor wipes with antistatic solution work best.

Urethane swabs are used to clean between the keys on a keyboard. If a key is sticking, remove the keyboard before spraying or using contact cleaner on it. Touchpads normally require no maintenance except being wiped with a dampened lint-free cloth to remove residual finger oil.

General-purpose cleanser is used to clean the outside of the case and to clean the desktop areas under and around the computer. Never spray or pour liquid on any computer part. Liquid cleaners are used with soft lint-free cloths or lint-free swabs.

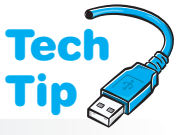
Be careful when cleaning LCD monitors and laptop displays



Use one of the following to clean LCD monitors and laptop displays: (1) wipes specifically designed for LCDs or (2) a soft lint-free cloth dampened with either water or a mixture of isopropyl alcohol and water. Never put liquid directly on the display and ensure that the display is dry before closing the laptop.

Denatured alcohol is used on rubber rollers, such as those found inside printers. An antistatic brush can be used to brush dirt away from hard-to-reach places. Gold contact cleaner is used to clean adapter contacts as well as contacts on laptop batteries and the contacts where the battery inserts. A useful CD/DVD/BD cleaning kit can include a lens cleaner that removes dust and debris from an optical lens; a disk cleaner that removes dust, dirt, fingerprints, and oils from the disk; and a scratch repair kit used to resurface, clean, and polish CDs, DVDs, and BDs.

Many cleaning solution companies provide MSDS (material safety data sheets) that contain information about a product, including its toxicity, storage, disposal, and health/safety concerns. Your state may also have specific disposal procedures for chemical solvents. Check with the company's safety coordinator for storage and disposal information.

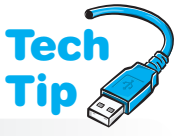


Know your state aerosol can disposal laws

Some states have special requirements for disposal of aerosol cans, especially those that are clogged and still contain some product.

To perform the preventive maintenance, power off the computer, remove the power cord, and vacuum the computer with a nonmetallic attachment. Do not start with compressed air or by blowing dust out of the computer because the dirt and dust will simply go into the air and eventually fall back into the computer and surrounding equipment. After vacuuming as much as possible, use compressed air to blow the dust out of hard-to-reach places, such as inside the power supply and under the motherboard. If you are performing maintenance on a notebook computer, remove as many modules as possible, such as the optical drive, battery, and hard drive, before vacuuming or using compressed air. Inform people in the immediate area that they might want to leave the area if they have allergies.

If you remove an adapter from an expansion slot, replace it into the same slot. If the computer battery is on a riser board, it is best to leave the riser board connected to the motherboard so the system does not lose its configuration information. The same steps covered in the disassembly section of this chapter hold true when you are performing preventive maintenance.



Use a preventive maintenance call as a time for updates

A preventive maintenance call is a good time to check for operating system, BIOS, antivirus, and driver updates.

When you perform preventive maintenance, take inventory and document what is installed in the computer, such as the hard drive size, amount of RAM, available hard drive space, and so on. During the maintenance procedure, communicate with the user. Ask if the computer has been giving anyone trouble lately or if it has been performing adequately. Computer users like to know that you care about their computing needs. Also, users frequently ask questions such as whether sunlight or cold weather harms the computer. Always respond with answers the user can understand. Users appreciate it when you explain things in terms they comprehend and that make sense.

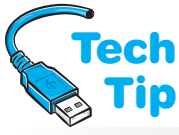
A preventive maintenance call is the perfect opportunity to check computers for viruses. Normally, first you clean the computer. Then, while the virus checker is running, you might clean external peripherals such as printers. Preventive maintenance measures help limit computer problems as well as provide a chance to interact with customers and help with a difficulty that may seem minuscule but could worsen. A preventive maintenance call is also a good time to take inventory of all hardware and software installed. In a preventive maintenance call, entry-level technicians can see the different computer types and begin learning the computer components.

Basic Electronics Overview

A technician needs to know a few basic electronic terms and concepts when testing components. The best place to start is with electricity. There are two types of electricity: AC and DC. The electricity provided by a wall outlet is **AC** (alternating current), and the type of electricity used by computer components is **DC** (direct current). Devices such as radios, TVs, and toasters use AC power. Low-voltage DC power is used for a computer's internal components and anything powered by batteries. A computer's power supply converts AC electricity from the wall outlet to DC for the internal components. Electricity involves electrons flowing through a conductor, similar to the way that water runs through a pipe. With AC, the electrons flow alternately in both directions. With DC, the electrons flow in one direction only.

Electronics Terms

Voltage, current, power, and resistance are terms commonly used in the computer industry. **Voltage**, which is a measure of the pressure pushing electrons through a circuit, is measured in **volts**. A power supply's output is measured in volts. Power supplies typically put out +3.3 volts, +5 volts, +12 volts, and –12 volts. You will commonly see these voltages shown in power supply documentation as +5V or +12V. Another designation is +5VSB. This is for the computer's **standby power**. This power is always provided, even when the computer is powered off. This supplied voltage is why you have to unplug a computer when working inside it.



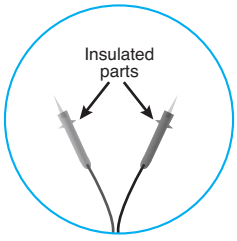
Polarity is important only when measuring DC voltage

When a technician measures the voltage coming out of a power supply, the black meter lead (which is negative) connects to the black wire from the power supply (which is ground). The red meter lead connects to either the +5 or +12 volt wires from the power supply.

The term *volts* is also used to describe voltage from a wall outlet. Wall outlet voltage is normally 120VAC (120 volts AC). Exercises at the end of the chapter explain how to take both AC and DC voltage readings. Figure 4.16 shows a photograph of a multimeter being used to take a DC voltage reading on the power connectors coming from a power supply. When the meter leads are inserted correctly, the voltage level shown is of the correct polarity.

Figure 4.16 DC voltage reading

The reading on the meter could be the opposite of what it should be if the meter's leads are reversed. Since electrons flow from one area where there are many of them (negative polarity) to an area where there are few electrons (positive polarity), polarity shows which way an electric current will flow. Polarity is the condition of being positive or negative with respect to some reference point. Polarity is not important when measuring AC. Figure 4.17 shows rules to observe when working with meters.



1. Select AC or DC on the meter (some meters automatically select AC or DC).

   VAC or ACV or ~ or $\tilde{V}$

   VDC or DCV or — or ⎓ or $\overline{V}$

2. Select the appropriate voltage range (0-10V, 0-100V, etc). The meter can be damaged if you measure a high voltage in a low range (but not the reverse). Use the highest range for unknown voltages.

3. Touch only the insulated parts of the meter probes.

Figure 4.17 Meter rules

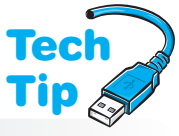
Monitors and power supplies can have dangerous voltage levels. Monitors can have up to 35,000 volts going to the back of the CRT. Note that flat-panel displays and mobile device displays use low DC voltage and AC voltage, but not at the voltage levels of CRTs. 120 volts AC is present inside the power supply. Power supplies and monitors have capacitors inside them. A **capacitor** is a component that holds a charge even after the computer is turned off. Capacitors inside a monitor can hold a charge for several hours after the monitor has been powered off.

Current is measured in **amps** (amperes), which is the number of electrons going through a circuit every second. In the water pipe analogy, voltage is the amount of pressure applied to force the water through the pipe, and current is the amount of water flowing. Every device needs a certain amount of current to operate. A power supply is rated for the amount of total current (in amps) it can supply at each voltage level. For example, a power supply could be rated at 20 amps for the 5-volt level and 8 amps for the 12-volt level.

Do not work inside a CRT monitor unless you have special training

Monitors require high-voltage meters and special precautions.

Power is measured in **watts**, which is a measurement of how much work is being done. It is determined by multiplying volts by amps. Power supplies are described as providing a maximum number of watts. This is the sum of all outputs: For example, 5 volts × 20 amps (100 watts) plus 12V 8 amps (96 watts) equals 196 watts. An exercise at the end of the chapter explains how current and power relate to a technician's job.

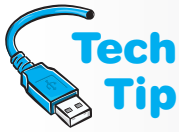


Current is what kills people when an electrical shock is received

Voltage determines how much current flows through the body. A high-current and low-voltage situation is the most dangerous.

Resistance is measured in **ohms**, which is the amount of opposition to current in an electronic circuit. The resistance range on a meter can be used to check continuity or check whether a fuse is good. A **continuity** check is used to determine whether a wire has a break in it. A conductor (wire) in a cable or a good fuse will have very low resistance to electricity (close to zero ohms). A broken wire or a bad fuse will have a very high resistance (millions of ohms, sometimes shown as infinite ohms, or OL). For example, a cable is normally made up of several wires that go from one connector to another. If you measure the continuity from

one end of a wire to the other, it should show no resistance. If the wire has a break in it, the meter shows infinite resistance. Figure 4.18 shows examples of a good wire reading and a broken wire reading.



Always unplug a computer before working inside it

The power supply provides power to the motherboard, even if the computer is powered off. Leaving the power cord attached can cause damage when replacing components such as the processor or RAM.

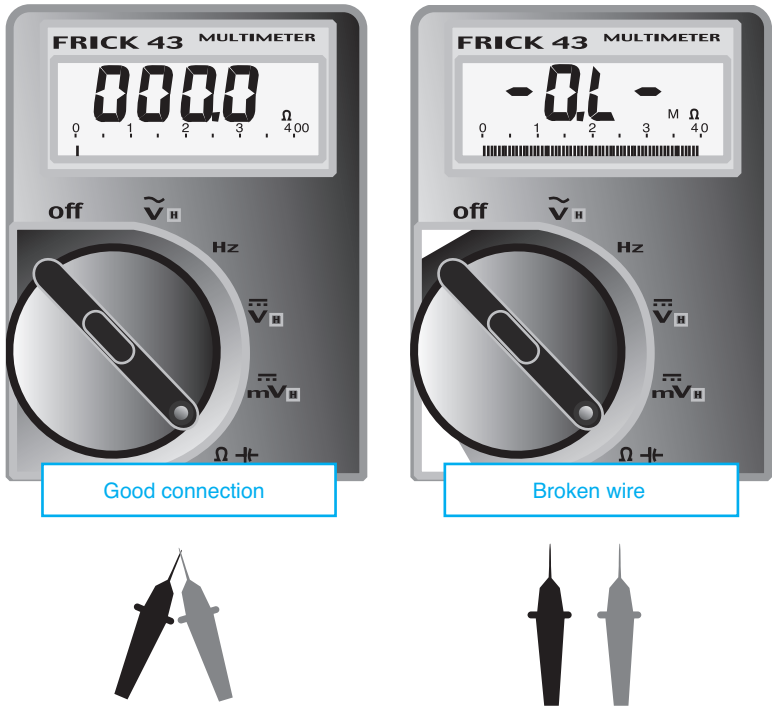
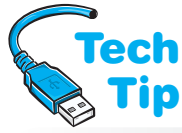


Figure 4.18 Sample resistance meter readings



Digital meters have different ways of displaying infinity. Always refer to the meter manual for this reading. When checking continuity, the meter is placed on the ohms setting, as shown in Figure 4.18. The ohms setting is usually illustrated by an omega symbol (Ω).

Dealing with small connections and a meter

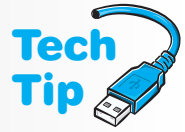
Some connectors have small pin connections. Use a thin meter probe or insert a thin wire, such as a paper clip, into the hole and touch the meter to the wire to take your reading.

Polarity is not important when performing a continuity check. Either meter lead (red or black) can be placed at either end of the wire. However, you do need a pin-out diagram (wiring list) for the cable before you can check continuity because pin 1 at one end could connect to a different pin number at the other end. An exercise at the end of the chapter steps through this process.

The same concept of continuity applies to fuses. A fuse has a tiny wire inside it that extends from end to end. The fuse is designed so that the wire melts (breaks) if too much current flows through it. The fuse keeps excessive current from damaging electronic circuits or starting a fire. A fuse is rated for a particular amount of current. For example, a 5-amp fuse protects a circuit if the amount of current exceeds 5 amps.

Use the right fuse or lose

Never replace a fuse with one that has a higher amperage rating. You could destroy electronic circuits or cause a fire by allowing too much current to be passed by the fuse, defeating the fuse's purpose.



Take a fuse out of the circuit before testing it. A good fuse has a meter reading of 0 ohms (or close to that reading). A blown fuse shows a meter reading of infinite ohms. Refer to the section on resistance and Figure 4.18. An exercise at the end of this chapter demonstrates how to check a fuse.

A technician needs to be familiar with basic electronics terms and checks. Table 4.1 consolidates this information.

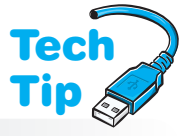
Table 4.1 Basic electronics terms

Term	Value	Usage
Voltage	Volts	Checking AC voltage on a wall outlet (typically 120VAC). Checking the DC output voltage from a power supply (typically +/– 12, +3.3, and +/– 5 VDC).
Current	Amps (amperes)	Each device needs a certain amount of current to operate. A power supply is rated for total current in amps for each voltage level (such as 24 amps for 5-volt power and 50 amps for 12-volt power).
Resistance	Ohms	Resistance is the amount of opposition to electric current. Resistance is used to check continuity on cables and fuses. A cable that shows little or no resistance has no breaks in it. A good fuse shows no resistance. If a cable has a break in it or if a fuse is bad, the resistance is infinite.
Wattage (power)	Watts	Watts is a measure of power and is derived by multiplying amps by volts. Power supply output is measured in watts. Also, A UPS (uninterruptible power supply) is rated in volt-amps. The size of UPS to purchase depends on how many devices will plug in to it.

Power Supply Overview

A power supply is an essential component within a computer; no internal computer device works without it. The power supply converts AC to DC, distributes lower-voltage DC power to components throughout the computer, and provides cooling through the use of a fan located inside the power supply. The AC voltage a power supply accepts is normally either 100 to 120 volts or 200 to 240 volts. Some dual-voltage power supplies can accept either. This type of power supply can have a selector switch on the back or can automatically detect the input voltage level. The power supply is sometimes a source of unusual problems. The effects of the problems can range from those not noticed by the user to those that shut down the system.

There are two basic types of power supplies: switching and linear. A computer uses a switching power supply. It provides efficient power to all the computer's internal components (and possibly to some external ones, such as USB devices). It also generates minimum heat, comes in small sizes, and is cheaper than linear power supplies. A switching power supply requires a load (something attached to it) in order to operate properly. With today's power supplies, a motherboard is usually a sufficient load, but a technician should always check the power supply specifications to be sure.

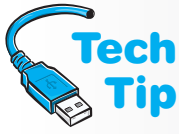


Powering on a power supply without anything attached could damage the power supply

Do not power on a power supply without connecting to the motherboard and possibly a device such as an optical drive or hard drive. An ATX power supply usually requires a motherboard connection at a minimum.

Power Supply Form Factors

Just as motherboards come in different shapes and sizes, so do power supplies. Today's power supply form factors are ATX, ATX12V v1.x, ATX12V v2.x, and micro-ATX. Other form factors include LFX12V (low profile), SFX12V (small form factor), EPS12V (used with server motherboards and has an extra 8-pin connector), CFX12V (compact form factor), SFX12V (small form factor), TFX12V (thin form factor), WTX12V (workstation form factor for high-end workstations and select servers), and FlexATX (smaller systems that have no more than three expansion slots). Intel, AMD, and video card manufacturers certify specific power supplies that work with their processors and video cards. A computer manufacturer can also have a proprietary power supply form factor that is not compatible with different computer models or other vendors' machines. Laptop power supplies are commonly proprietary.



The motherboard and power supply must be compatible

The motherboard form factor and the power supply form factor must fit in the case and work together. For optimum performance, research what connectors and form factors are supported by both components.

The ATX12V version 2 standard has a 24-pin motherboard connector instead of a 20-pin version 1 connector. This did away with the need for the extra 6-pin auxiliary connector. In addition, version 2 power supplies have a SATA power connector. Some 24-pin motherboard connectors accept the 20-pin power supply connector. Table 4.2 lists the possible ATX power supply connectors.

Table 4.2 ATX power supply connectors

Connector	Notes	Voltage(s)
24-pin	Main ATX power connector to the motherboard	+3.3, +5, +12, –12
20-pin	Main power connector to the motherboard	+3.3, +5, –5, +12, –12
15-pin	SATA connector	+3, +5, +12
8-pin	12V for CPU used with an ATX12V v1 power supply	+12
8-pin	PCIe video; connects to a PCIe video adapter. Note that some connectors are 6+2-pin meaning they accept either the 6- or 8-pin cable.	+12
6-pin	PCIe video; connects to PCIe video adapter	+12
6-pin	Sometimes labeled as AUX; connects to the motherboard if it has a connector	+3.3, +5
4-pin **Molex**	Connects to peripheral devices such as hard drives and CD/DVD drives	+5, +12
4-pin **Berg**	Connects to peripheral devices such as the floppy drive	+5, +12
4-pin	Sometimes labeled as AUX or 12V; connects to the motherboard for CPU	+12
3-pin	Used to monitor fan speed	N/A

Figure 4.19 shows a few ATX power supply connectors. Figure 4.20 shows more ATX power supply connectors.

4-pin CPU power connector | SATA power connector | 6-pin PCIe power connector

Figure 4.19 Common power supply connectors

Not all 24-pin motherboard connectors accept 20-pin power supply connectors

Tech Tip

You can purchase a 24-pin to 20-pin power adapter. The site http://www.formfactors.org provides information regarding power supply form factors.

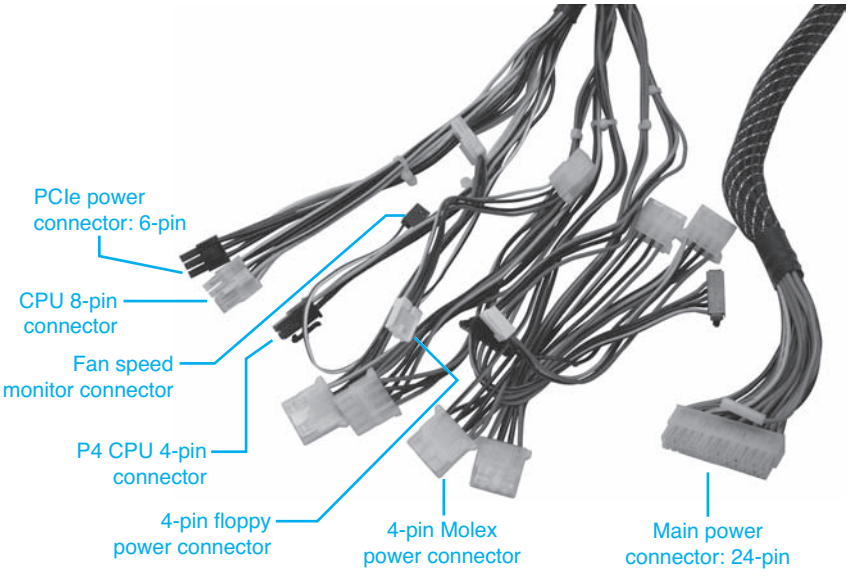


Figure 4.20 ATX power supply connectors

Figure 4.21 illustrates the compatibility between the ATX 20- and 24-pin motherboard connector standards. Notice in Figure 4.21 that the power cable is only one connector, notched so the cable inserts into the connector one way only. This is a much better design than older power supplies, where two connectors were used and could be reversed. Also, notice that a **power good signal** (labeled PWR_OK in Figure 4.21) goes to the motherboard. When the computer is turned on, part of POST is to allow the power supply to run a test on each of the voltage levels. The voltage levels must be correct before any other devices are tested and allowed to initialize. If the power is okay, a power good signal is sent to the motherboard. If the power good signal is not sent from the power supply, a timer chip on the motherboard resets the CPU. Once a power good signal is sent, the CPU begins executing software from the BIOS. Figure 4.21 also shows the +5vsb connection to provide standby power for features such as Wake on LAN or Wake on Ring (covered later in this chapter).

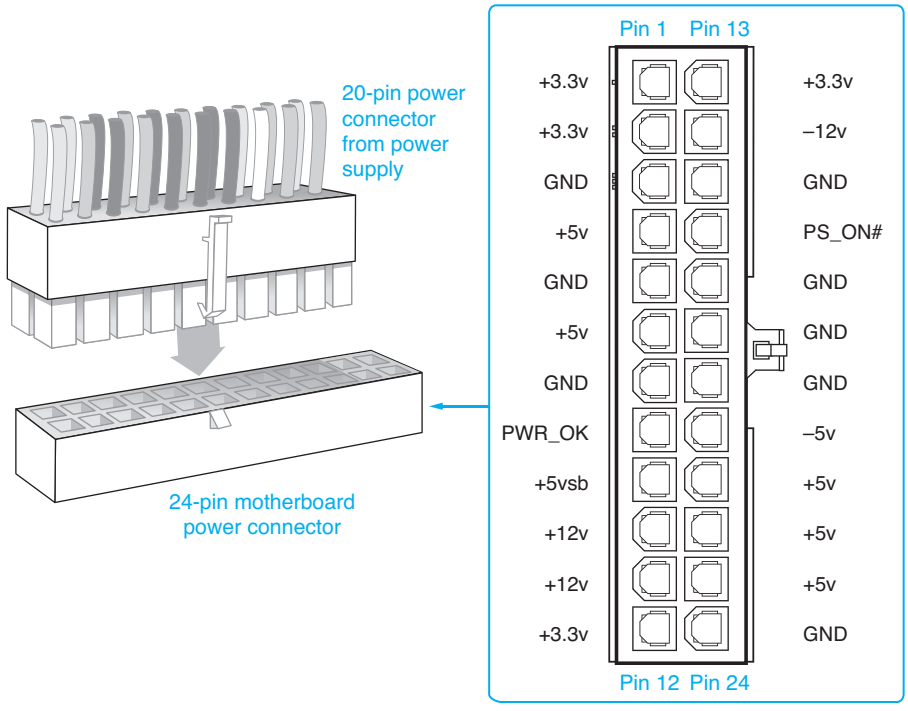


Figure 4.21 ATX 24- and 20-pin motherboard connectivity

A high-quality power supply delays sending the power good signal until all of the power supply's voltages have a chance to stabilize. Some cheap power supplies do not delay the power good signal. Other cheap power supplies do not provide the power good circuitry, but instead, tie 5 volts to the signal (which sends a power good signal even when it is not there).

The number and quantity of connectors available on a power supply depends on the power supply manufacturer. If a device requires a Berg connector and the only one available is a Molex, a Molex-to-Berg connector converter can be purchased. If a SATA device needs a power connection, a Molex-to-SATA converter is available. Figure 4.22 shows a Molex-to-SATA converter and a Molex-to-Berg converter.

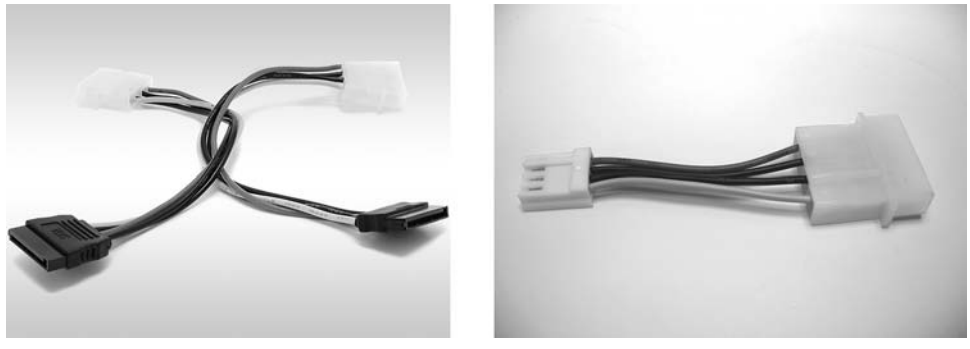


Figure 4.22 Molex-to-SATA and Molex-to-Berg converters

Power supply connectors can connect to any device; there is not a specific connector for the hard drive, the optical drive, and so on. If there are not enough connectors from the power supply for the number of devices installed in a computer, a Y power connector can be purchased at a computer or electronics store. The Y connector adapts a single Molex connector to two Molex connectors for two devices. Verify that the power supply can output enough power to handle the extra device being installed. Figure 4.23 shows a Y power connector.

Power converters and Y connectors are good to have in your tool kit

In case a service call involves adding a new device, having various power converters available as part of your tool kit is smart.

Tech Tip

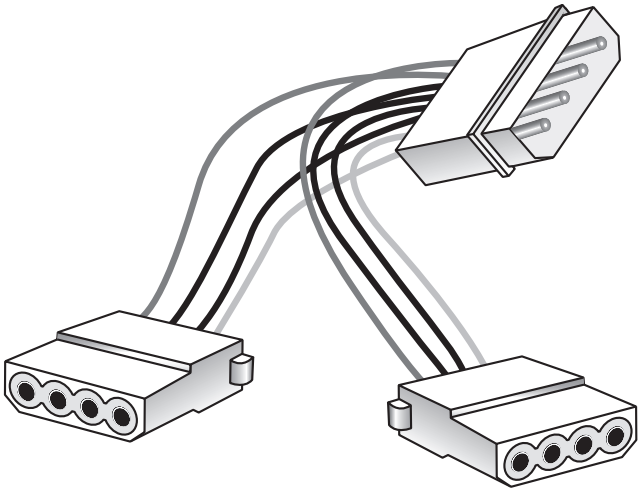


Figure 4.23 Y Molex connector

Purposes of a Power Supply

The power from a wall outlet is high-voltage AC. The type of power computers need is low-voltage DC. All computer parts (the electronic chips on the motherboard and adapters, the electronics on the drives, and the motors in the hard drive and optical drive) need DC power to operate. Power supplies in general come in two types: linear and switching. Computers use switching power supplies. The main functions of a power supply include the following:

- Convert AC to DC
- Provide DC voltage to the motherboard, adapters, and peripheral devices
- Provide cooling and facilitate air flow through the case

One purpose of a power supply is to convert AC to DC so the computer has proper power to run its components. An ATX power supply does not connect to the front panel switch as the old AT-style power supplies did. With the ATX power supply, a connection from the front panel switch to the motherboard simply provides a 5-volt signal that allows the motherboard to tell the power supply to turn on. This 5-volt signal allows ATX power supplies to support ACPI, which is covered later in the chapter, and also lets the motherboard and operating system control the power supply. Figures 4.24 and 4.25 show the front panel connections to the motherboard on two different computers.

On an ATX power supply that has an on/off switch, ensure that it is set to the *on* position

If an ATX power supply switch is present and in the off position, the motherboard and operating system cannot turn on the power supply. Some ATX power supplies do not have external on/off switches, and the computer can be powered down only via the operating system.

Tech Tip

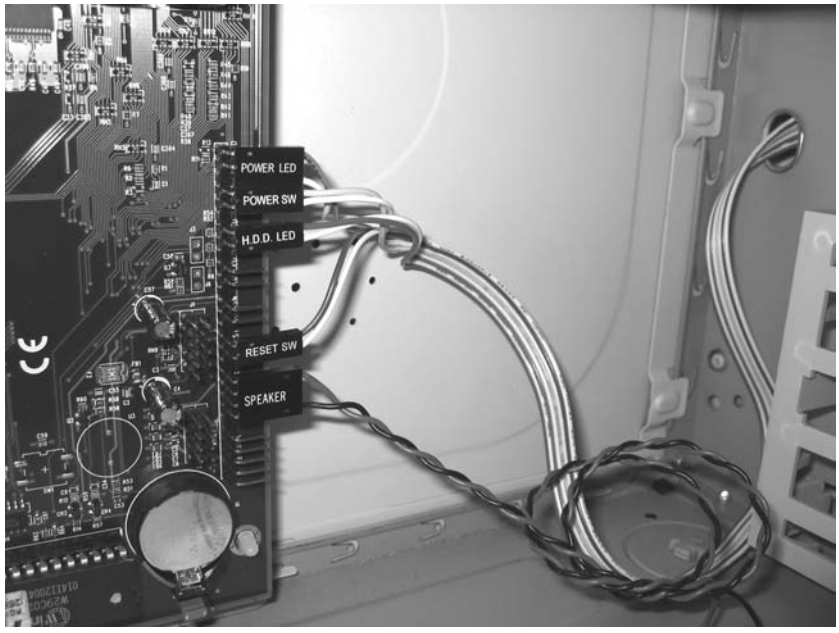


Figure 4.24 Front panel connections to a motherboard

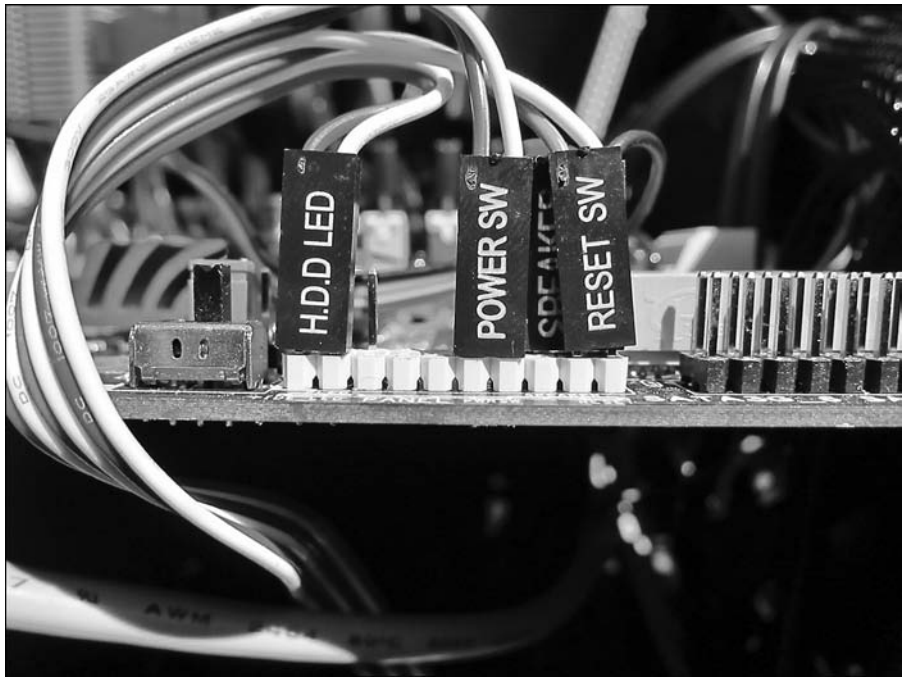


Figure 4.25 Another view of front panel connections

Another purpose of a power supply is to distribute proper DC voltage to each component. Several cables with connectors come out of the power supply. With ATX motherboards, there is only a 20- or 24-pin connector used to connect power to the motherboard. The power connector inserts only one way into the motherboard connector. Figure 4.26 shows an ATX connector being inserted into a motherboard.

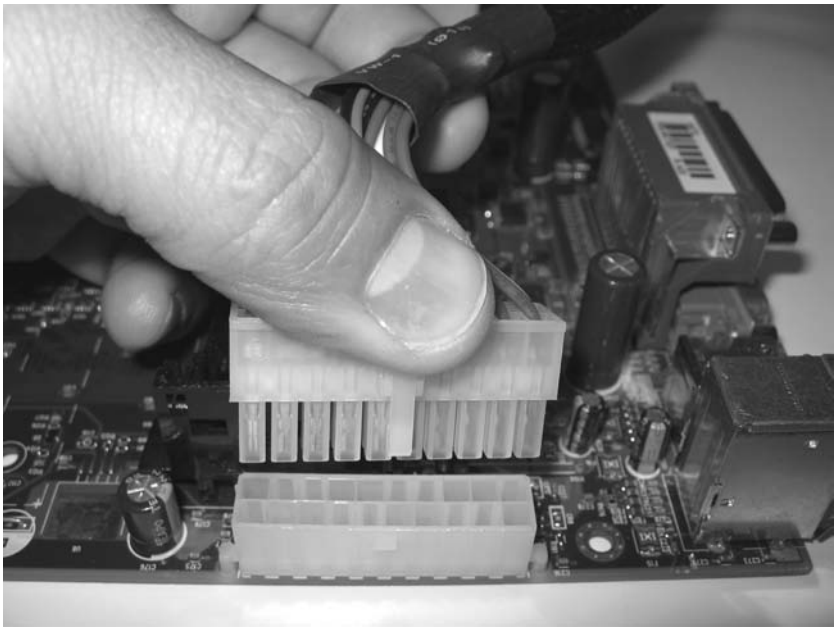


Figure 4.26 Installing an ATX power connector on a motherboard

Another purpose for a power supply is to provide cooling for the computer. The power supply's fan circulates air throughout the computer. Most computer cases have air vents on one side, on both sides, or in the rear of the computer. The ATX-style power supply blows air inside the case instead of out the back. This is known as reverse flow cooling. The air blows over the processor and memory to keep them cool. This type of power supply keeps the inside of the computer cleaner than older styles.

Don't block air vents

Tech Tip

Whether a computer is a desktop model, a tower model, or a desktop model mounted in a stand on the floor, ensure that nothing blocks the air vents in the computer case. Do not place a laptop on a blanket or pillow, causing the vents to be blocked.

Electronic components generate a great deal of heat but are designed to withstand fairly high temperatures. Auxiliary fans can be purchased to help cool the internal components of a computer. Some cases have an extra mount and cutout for an auxiliary fan. Some auxiliary fans mount in adapter slots or drive bays.

Be careful when installing an auxiliary fan

Tech Tip

Place the fan so the outflow of air moves in the same direction as the flow of air generated by the power supply. If an auxiliary fan is installed inside a case in the wrong location, the auxiliary air flow could work against the power supply air flow, reducing the cooling effect. Figure 2.19 in Chapter 2 details how air flow can be aided with an auxiliary fan.

Power Supply Voltages

Refer to Figure 4.21 and notice how +3.3, +5, –5, +12, and –12 volts are supplied to the motherboard. The motherboard and adapters use +3.3 and +5 volts. The –5 volts is seldom used. If the motherboard has integrated serial ports, they sometimes use +12V and –12V power. Hard drives and optical drives commonly use +5 and +12 volts. The +12 voltage is used to operate

the device motors found in drives, the CPU, internal cooling fans, and the graphics card. Drives are now being made that use +5V motors. Chips use +5 volts and +3.3 volts. The +3.3 volts are also used for memory, AGP/PCI/PCIe adapters, and some laptop fans. The negative voltages are seldom used.

A technician must occasionally check voltages in a system. There are four basic checks for power supply situations: (1) wall outlet AC voltage, (2) DC voltages going to the motherboard, (3) DC voltages going to a device, and (4) ground or lack of voltage with an outlet tester. A **power supply tester** can be used to check DC power levels on the different power supply connectors.

Mobile Device Travel and Storage

When traveling with a laptop, remove all cards that insert into slots and store them in containers so that their contacts do not become dirty and cause intermittent problems. Remove all media discs such as CDs, DVDs, or BDs. Check that drive doors and devices are securely latched. Ensure that the mobile device is powered off or in hibernate mode (not in sleep/suspend or standby power mode, which is covered later in this chapter).

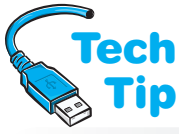
Carry the device in a padded case. If you have to place the device on an airport security conveyor belt, ensure that the device is not placed upside down, which could cause damage to the display. Never place objects on top of a mobile device or pick up a laptop by the edges of the display when the laptop is opened. When shipping a mobile device, place it in a properly padded box. The original shipping box is a safe container.

The United States has regulations about lithium batteries on airplanes. If battery contacts come in contact with metal or other batteries, the battery could short-circuit and cause a fire. For this reason, any lithium batteries are to be kept in original packaging. If original packaging is not available, place electrical tape over the battery terminals or place each battery in an individual bag. Spare lithium batteries are not allowed in checked baggage but can be taken in carry-on bags.

Like other electronic devices, laptops have heating issues. The following can help with laptop overheating:

- Locate air vents and keep them unblocked and clean. Do not place a laptop on your lap to work.
- In the BIOS settings, check the temperature settings for when fans turn on.
- Check the laptop manufacturer website or documentation for any fan/temperature monitoring gauges.
- Place a laptop on something that elevates it from the desk, such as drink coasters. In addition, pads, trays, and mats can be purchased with fans that are AC powered or USB powered.

Mobile Device Power



Check input voltage selector

Some power supplies and laptops have input voltage selectors; others have the ability to accept input from 100 to 240 volts for use in various countries (dual voltage). Ensure that the power supply accepts or is set to the proper input voltage.

A portable computer (laptop/netbook/ultrabook/tablet) uses either an AC connection or a battery as its power source. On most models, when the mobile device connects to AC power, the battery normally recharges. Laptop batteries are usually modules with one or two release latches that are used to remove the module. Smartphone batteries either have a release latch or you slide part of the phone away and reveal the battery. Figure 4.27 shows a netbook computer with its battery module removed. Battery technologies have improved in the past few years, probably due to the development of more devices that need battery power, such as tablets, digital cameras, and portable CD, DVD, and BD players.

Figure 4.27 Netbook battery

NiCad (nickel cadmium) batteries originally used in laptops were replaced with lighter and more powerful NiMH (nickel-metal hydride) batteries. These batteries were replaced with **Li-ion** (lithium-ion) **batteries**, which are very light and can hold a charge longer than any other type. They are also more expensive. Mobile phones, tablets, portable media players, and digital cameras also use Li-ion batteries. These batteries lose their charge over time even if they are not being used. Use your laptop with battery-provided power. Ensure that a laptop that has an Li-ion battery is not plugged into an AC outlet all the time. Calibrate a laptop battery according to manufacturer instructions so the battery meter displays correctly.

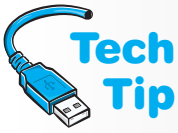
Li-ion polymer batteries are similar to Li-ion batteries except that they are packed in pouched cells. This design allows for smaller batteries and a more efficient use of space, which is important in the portable computer and mobile devices industries. For environmentalists, the zinc-air battery is the one to watch. AER Energy Resources, Inc., has several patents on a battery that uses oxygen to generate electricity. Air is allowed to flow during battery discharge and is blocked when the battery is not in use. This battery holds a charge for extended periods of time. Another upcoming technology is fuel cells. Fuel cells used for a laptop can provide power for 5 to 10 hours.

Do not power on after a temperature change

Computers are designed to work within a range of temperatures, but sudden change is not good for them. If a mobile device is in a car all night and the temperature drops, allow the device to return to room temperature before powering on. Avoid direct sunlight. Inside the computer case, it is usually 40°F hotter than outside.

Do not fully discharge a Li-ion battery

Li-ion batteries do not suffer from the memory effect, as do some nickel-based batteries. Fully discharging a lithium battery, such as an Li-ion battery, is actually bad for it. However, most lithium batteries have a circuit to prevent the battery from being totally discharged.



Keep Li-ion batteries cool

Li-ion batteries last longer if they are kept cool (not frozen). When you store an Li-ion battery, the battery should be only 40 percent charged and placed in a refrigerator to prolong its life.

Mobile devices rely on their batteries to provide the mobility. The following tips can help you get more time out of your batteries:

- Most people do not need a spare Li-ion battery. If you are not using an Li-ion battery constantly, it is best not to buy a spare. The longer the spare sits unused, the shorter the lifespan it will have.
- Buy the battery recommended by the laptop manufacturer.
- For a mobile device or smartphone, use an AC outlet rather than a USB port for faster charging.
- If using a USB port for charging a mobile device or smartphone, unplug all unused USB devices. Note that not all USB ports can provide a charge if the host device is in sleep mode.
- Do not use the optical player when running on battery power.
- Turn off the wireless adapter if a wireless network is not being used. For Windows-based devices, use the *Network and Internet* Control Panel. For smaller mobile devices, use flight mode to turn off both the wireless and the cellular (3G/4G) networks. Apple iOS devices can use *Settings* to access *Airplane Mode*. Android devices can use the *Settings* option to access *Flight mode* through the *Wireless and network* option.
- In the power options, configure the mobile device for hibernate rather than standby (covered later in the chapter).
- Save work only when necessary and turn off the autosave feature.
- Reduce the screen brightness. In Windows, use the *Display* Control Panel link found within the *Hardware and Sound* Control Panel. In Apple iOS, us the *Brightness & Wallpaper* setting; on an Android device, use the *Sound and display* option from the *Settings* application.
- Keep the hard drive defragmented especially before running on battery power.
- Avoid using external USB devices such as flash drives or external hard drives.
- Add more RAM to reduce swapping of information from the hard drive to RAM to CPU or to just be more efficient.
- Keep battery contacts clean with a dab of rubbing alcohol on a lint-free swab once a month.
- Use your mobile device until the battery is drained when possible and then recharge it. Constantly recharging the battery reduces the battery life. Most lithium batteries have a circuit that keeps the battery from being discharged completely.
- Avoid running multiple programs. To close an application on an iOS-based device, hold down on the icon from the home menu. On an Android-based device, use the *Applications* > *Manage Applications* option from the *Settings* application.
- Disable automatic updates. In Windows, use the *Windows Update* link from the *System and Security* Control Panel. On iOS or Android systems, disable push reports and application notifications that make sounds or vibrations from within the *Settings* option. Have the OS check less often for mail; use the *Mail, Contacts, Calendars* option to change the settings.
- Avoid temperature extremes.

All power supplies are not created equal

A technician needs to replace a power supply with one that provides an equal or greater amount of power. Search the Internet for power supply reviews. A general rule of thumb is that if two power supplies are equal in wattage, the heavier one is better because it uses a bigger transformer, bigger heat sinks, and more quality components.

Tech Tip

ACPI (Advanced Configuration and Power Interface)

Today's computer user needs to leave a computer on for extended periods of time in order to receive faxes, run computer maintenance tasks, automatically answer phone calls, and download software upgrades and patches. Network managers want control of computers so they can push out software upgrades, perform backups, download software upgrades and patches, and perform tests. Laptop users have always been plagued by power management problems, such as short battery life, inconsistent handling of screen blanking, and screen blanking in the middle of presentations. Such problems occurred because originally the BIOS controlled power. Power management has changed.

ACPI (Advanced Configuration and Power Interface) gives the BIOS and operating system control over various devices' power and modes of operation, as shown in Figure 4.28.

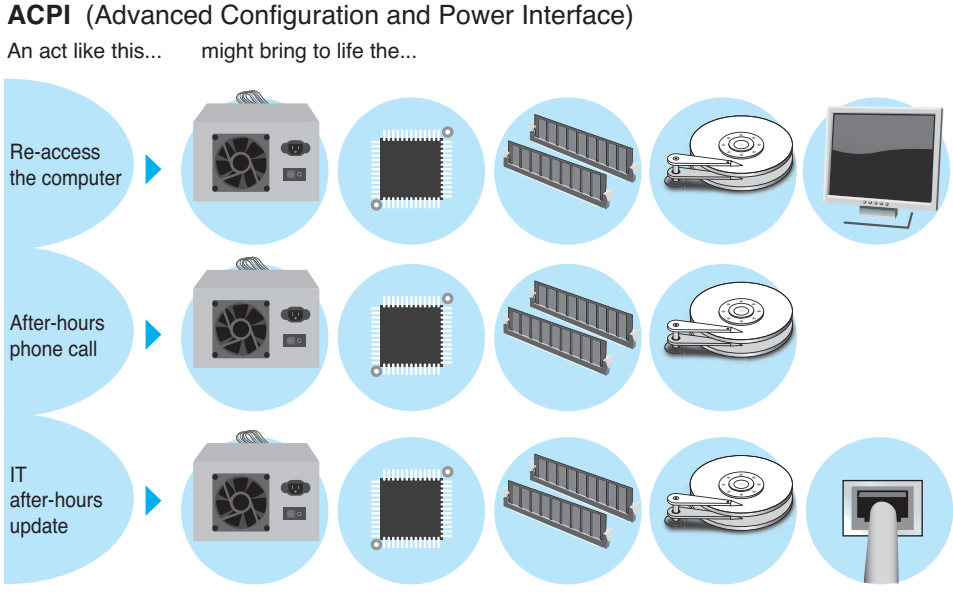
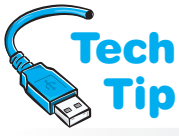


Figure 4.28 ACPI actions

With ACPI, the user can control how the power switch operates and when power to specific devices, such as the hard drive and monitor, is lowered. For example, the *Instant On/Off* BIOS setting can control how long the power switch is held in before the power supply turns on or off. Case temperatures, CPU temperatures, and CPU fans can be monitored. The power supply can be adjusted for power requirements. The CPU clock can be throttled or slowed down to keep the temperature lower and prolong the life of the CPU and reduce power requirements especially in portable devices when activity is low or nonexistent. ACPI has various operating states, as shown in Table 4.3.

Table 4.3 ACPI operating states

Global system state	Sleep state	Description
G0 Working	(S0)	The computer is fully functional. Software, such as the autosave function used with Microsoft products, can be optimized for performance or lower battery usage.
G1 Sleeping		Requires less power than the G0 state and has multiple sleeping states: S1, S2, S3, and S4.
	(S1)	CPU is still powered, and unused devices are powered down. RAM is still being refreshed. Hard disks are not running.
	(S2)	CPU is not powered. RAM is still being refreshed. System is restored instantly upon user intervention.
	(S3)	Power supply output is reduced. RAM is still being refreshed. Some info in RAM is restored to CPU and cache.
	(S4)	Lowest-power sleep mode and takes the longest to come up. Info in RAM is saved to hard disk. Some manufacturers call this the hibernate state.
G2	(S5)	Also called soft off. Power consumption is almost zero. Requires the operating system to reboot. No information is saved anywhere.
G3		Also called off, or mechanical off. This is the only state where the computer can be disassembled. You must power on the computer to use it again.



Windows power management

Use the *Power Options* link from within the *System and Security* Control Panel to configure power from within the Windows environment.

Two common BIOS and adapter features that take advantage of ACPI are Wake on LAN and Wake on Ring. The **Wake on LAN** feature allows a network administrator to control the power to a workstation remotely and directs the computer to come out of sleep mode. Software applications can also use the Wake on LAN feature to perform updates, upgrades, and maintenance tasks. The feature can also be used to bring up computers immediately before the business day starts. Wake on LAN can be used with Web or network cameras to start recording when motion is detected or to bring up a network printer so that it can be used when needed. **Wake on Ring** allows a computer to come out of sleep mode when the telephone line has an incoming call. This lets the computer receive phone calls, faxes, and emails when the user is not present. Common BIOS settings related to ACPI are listed in Table 4.4.

Table 4.4 Common BIOS power settings

Setting	Description
Delay Prior to Thermal	Defines the number of minutes the system waits to shut down the system once an overheating situation occurs.
CPU Warning Temperatures	Specifies the CPU temperature at which a warning message is displayed on the screen.
ACPI Function	Enables or disables ACPI. This is the preferred method for disabling ACPI in the event of a problem.

Setting	Description
Soft-off	Specifies the length of time a user must press the power button to turn off the computer.
Deep S4/S5	Uses less power and only wakes from S4/S5 states with the power button or a RTC (real time clock) alarm, such as waking the computer to complete a task.
Power on by Ring, Resume by Ring, or Wakeup	Allows the computer to wake when an adapter or an external device supports Wake on Ring.
Resume by Alarm	Allows a date and time to be set when the system is awakened from Suspend mode. Commonly used to update the system during nonpeak periods.
Wake Up on LAN	Allows the computer to wake when a Wake on LAN signal is received across the network.
CPU THRM Throttling	Allows a reduction in CPU speed when the system reaches a specific temperature.
Power on Function	Specifies which key (or key combination) will activate the system's power.
Hot Key Power On	Defines what keystrokes will reactivate system power.
Doze Mode	When the system is in a reduced activity state, the CPU clock is throttled (slowed down). All other devices operate at full speed.
After Power Failure	Sets power mode after a power loss.

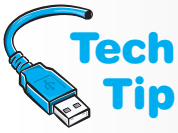
Windows 7 has three power plans available, and you can customize these power plans. You might want to customize a power plan when there is a problem with poor video quality when playing a movie. Use the *Change plan settings* link followed by the *Change advanced power settings* link to expand a section such as the *Multimedia settings* option. Table 4.5 shows the three main power plans you can just click and select.

Table 4.5 Windows 7 power plans

Power plan	Description
Balanced	The most common plan because it provides full power when you need it and saves power when the computer is not being used.
Power saver	Saves power by running the CPU more slowly and reducing screen brightness.
High performance	Select the *Show additional plans* link to see this option. This provides the maximum performance possible.

Sometimes, when a computer comes out of Sleep mode, not all devices respond, and the computer's power or reset button has to be pressed to reboot the computer. The following situations can cause this to happen:

- A screen saver conflicts with ACPI
- All adapters/devices are not ACPI compliant
- An adapter/device has an outdated driver
- The system BIOS or an installed adapter BIOS needs to be updated



Power values for energy-efficient monitors

Always keep the screen saver timeout value shorter than the power saver timeout value, especially with green (energy-efficient) monitors!

To see if the screen saver causes a problem, use the *Display* Control Panel and set the screen saver option to *None*. Identifying a problem adapter, device, or driver will take Internet research. Check each adapter, device, and driver one by one. Use the *Power Options* Control Panel to change the power scheme. Also check all devices for a *Power Management* tab on the *Properties* dialog box. Changes can be made there.

Links on the left of the *Power Options* Control Panel provide access to advanced settings such as requiring a password to come out of sleep mode. The power options for a Windows 7 laptop are shown in Figure 4.29.

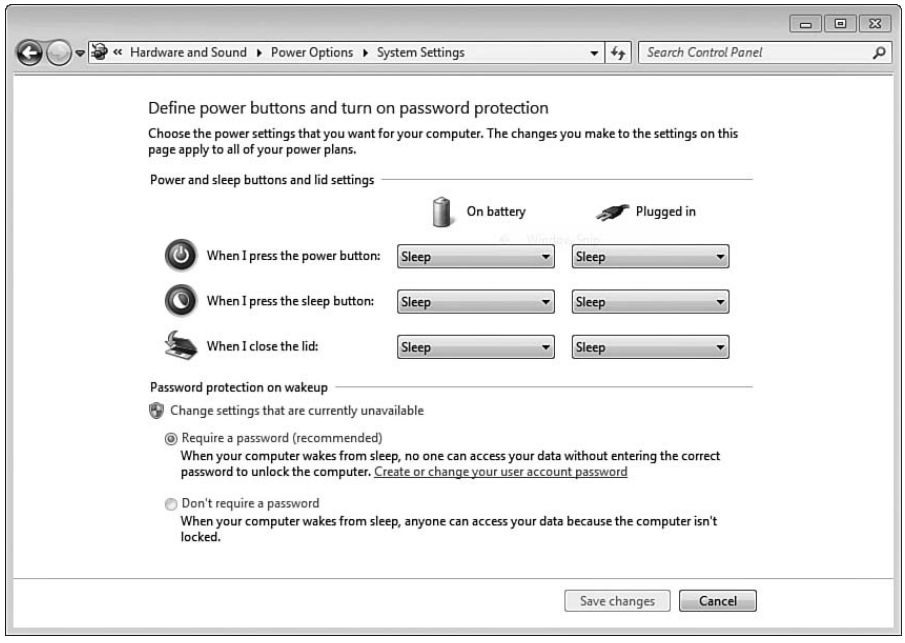


Figure 4.29 Windows 7 power settings

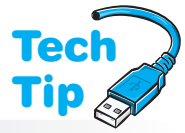
Other laptop *Power Options* Control Panel settings include the following links: *Require a password on wakeup, Choose what the power button does* (as shown in Figure 4.29), *Choose what closing the lid does*, *Create a power plan*, *Choose when to turn off the display*, and *Change when the computer sleeps*. Laptop power settings affect battery life. Users and technicians should adjust these settings to best fit how the laptop or mobile device is used.

In Windows Vista and 7, use the *Power Options* Control Panel to edit the power settings. Select the *Change advanced power settings* link to configure passwords, standby power behavior, and other power-related settings. If the computer does not go into the Sleep mode, check the following:

- Determine if ACPI is enabled in BIOS.
- Try disabling the antivirus program to see if it is causing the problem.
- Set the screen saver to *None* to see if it is causing the problem.
- Determine if all device drivers are ACPI compliant.
- Determine if power management is enabled through the operating system (use the *Power Options* Control Panel).
- Disconnect USB devices to see if they are causing problems.

Replacing or Upgrading a Power Supply

Power supplies are rated in watts. Today's typical computers have power supplies with ratings ranging from 250 to 500 watts, although powerful computers, such as network servers or higher-end gaming systems, can have power supplies rated 600 watts or higher. Each device inside a computer uses a certain amount of power, and the power supply must provide enough to run all the devices. The power each device or adapter requires is usually defined in the documentation for the device or adapter or on the manufacturer's website. The computer uses the wattage needed, not the total capacity of a power supply. The efficiency (more AC is converted to DC) is what changes the electricity bill.



Watch the wattage

Many manufacturers overstate the wattage. The wattage advertised is *not* the wattage available at higher temperatures, such as when mounted inside a computer. Research a model before purchasing.

Some power supplies are listed as being dual or triple (or tri) rail. A **dual-rail power supply** has two +12V output lines. A triple-rail power supply simply has three +12V output lines for devices. Keep in mind that most manufacturers do not have two or more independent 12V sources; they all derive from the same 12V source but have independent output lines. Figure 4.30 shows how the +12V rails might be used.

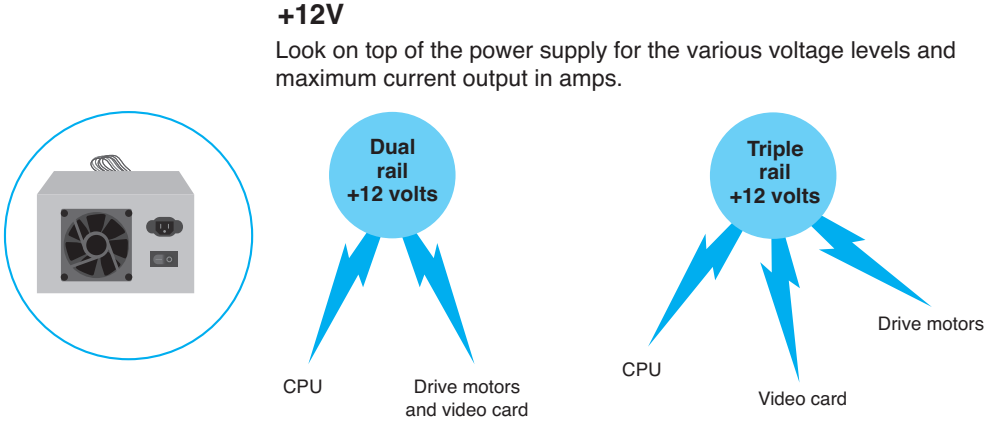


Figure 4.30 12V rails

Power supplies can be auto-switching or have a fixed input. An **auto-switching** power supply monitors the incoming voltage from the wall outlet and automatically switches itself accordingly. Auto-switching power supplies accept voltages from 100 to 240VAC at 50 to 60Hz. These power supplies are popular in mobile devices and are great for international travel. A power supply might also allow adjusting the input value by manually selecting the value through a voltage selector switch on the power supply. A fixed-input power supply is rated for a specific voltage and frequency for a country, such as 120VAC 60Hz for the United States.

Some people are interested in exactly how much power their system is consuming. Every device in a computer consumes power, and each device could use one or more different voltage levels (+5V, –5V, +12V, –12V, +3.3V). A power supply has a maximum amperage for each voltage level (for example, 30 amps at +5 volts and 41 amps at +12V). To determine the maximum power being used, in watts, multiply the amps and volts. If you add all the maximum power levels, the amount will be greater than the power supply's rating. This means that you cannot use the maximum power at every single voltage level (but since the –5V and –12V are not used very often, normally this is not a problem).

In order to determine the power being consumed, you must research every device to determine how much current it uses at a specific voltage level. Internet power calculators are available to help with this task. Table 4.6 lists sample computer components' power requirements.

Table 4.6 Sample computer component power requirements

Component	Power consumption
Motherboard (without processor)	5 to 150W
Processor	10 to 140W
Floppy drive	5W
PATA hard drive	3 to 30W
SATA hard drive	2 to 15W
Optical drive	10 to 30W
Non-video adapter	4 to 25W
AGP video adapter	20 to 50W
PCIe video card with one power connector	50-150W
PCIe video card with two power connectors	100-300W
Extra fan	3W
RAM stick	15W

Different physical sizes of power supplies are available. When replacing a power supply, purchasing a power supply for a new computer, or upgrading a power supply, verify that the power supply will fit in the computer case. Also, verify that the power supply produces enough power for the installed devices and for future upgrades. Do not forget to check that the on/off switch on the new power supply is in a location that fits in the computer case.

When purchasing a new power brick for a laptop or battery for a mobile device, ensure that it has the same specifications as the one from the manufacturer. Less expensive models might not provide the same quality as approved models. Ensure that the replacement has a power jack that does not wiggle when it is inserted into the device. Ensure that a laptop power brick has the appropriate DC voltage required by the laptop. Current (amperage) should be equal to or more than the original power brick.

Power management on both laptops and desktops is important. Most computer components are available as energy-efficient items. ENERGY STAR is a joint effort by the U.S. EPA (Environmental Protection Agency) and Department of Energy to provide device standards and ratings that easily identify products (including computer components) that are energy efficient. Many computers today are on more than they are off, and settings such as power options, CPU throttling, and some advanced BIOS settings affect power settings. A technician must be aware of all these options and be willing to offer advice such as turn the computer off when finished working on it; set the power management option to allow work to be performed at an affordable cost; disable options not being used, such as wireless capabilities when wired networking is functioning; be aware of monitor costs (CRT-type monitors take the most energy, followed by plasma displays and then LCD or flat-panel technology); and purchase energy-efficient parts and computers.

Symptoms of Power Supply Problems

The following is a list of symptoms of a power supply problem:

- The power light is off and/or the device won't turn on.
- The power supply fan does not turn when the computer is powered on.

- The computer sounds a continuous beep. (This could also be a bad motherboard or a stuck key on the keyboard.)
- When the computer powers on, it does not beep at all. (This could also be a bad motherboard.)
- When the computer powers on, it sounds repeating short beeps. (This could also be a bad motherboard.)
- During POST, a 02*X* or parity POST error code appears (where *X* is any number); one of the POST checks is a power good signal from the power supply; a 021, 022, . . . error message indicates that the power supply did not pass the POST test.
- The computer reboots or powers down without warning.
- The power supply fan is noisy.
- The power supply is too hot to touch.
- The computer emits a burning smell.
- The power supply fan spins, but there is no power to other devices.
- The monitor has power light, but nothing appears on the monitor, and no PC power light illuminates.

Solving Power Supply Problems

When you suspect that the power supply is causing a problem, swap the power supply, make the customer happy, and be on your way! Power problems are not usually difficult to detect or troubleshoot.

Do not disassemble a power supply

Power supplies are not normally disassembled. Manufacturers often rivet them shut. Even when a power supply can be disassembled, you should not take it apart unless you have a background in electronics.

Do not overlook the most obvious power supply symptom. Start by checking the computer power light. If it is off, check the power supply's fan by placing your palm at the back of the computer. If the fan is turning, it means the wall outlet is providing power to the computer and you can assume that the wall outlet is functioning. Check the motherboard for LEDs and refer to the manual for their meaning. Test the power outlet with another device. Ensure that the power cord is inserted fully into the wall outlet and the computer. If you suspect that the wall outlet is faulty, use an **AC circuit tester** to verify that the wall outlet is wired properly.

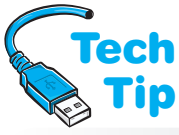
On a mobile device that is running on battery power, check the battery charge icon through the operating system. Try using the device on AC power. If it works on AC power, try recharging the battery. If the battery does not recharge, replace it. Wiggle the AC power to see if the connection is loose. Remove the battery for a moment and then re-insert it (and attach AC power if battery power does not work). On a laptop, see if the power brick has a power light on it and whether it is lit. Try a different AC adapter from the same manufacturer because AC adapters are proprietary between laptop vendors.

If a mobile device or smartphone won't power on after recharging the battery, remove the battery for about a minute. Reinstall the battery and try powering on again. If the system will still not power on, try powering on with the power cable attached. If the system works with the power cable attached, the battery probably needs to be replaced.

The following troubleshooting questions can help you determine the location of a power problem:

- Did the power supply work before? If not, check the input voltage selector switch on the power supply and verify that it is on the proper setting.
- Is the power supply's fan turning? If yes, check voltages going to the motherboard. If they are good, maybe just the power supply fan is bad. If the power supply's fan is not turning, check the wall outlet for proper AC voltages.

- Is a surge strip used? If so, check to see if the surge strip is powered on, then try a different outlet in the surge strip, or replace the surge strip.
- Is the computer's power cord okay? Verify that the power cord plugs snugly into the outlet and into the back of the computer. Swap the power cord to verify that it is functioning.
- Is the front panel power button stuck?
- Are the voltages going to the motherboard at the proper levels? If they are low, something may be overloading the power supply. Disconnect the power cable to one device and recheck the voltages. Replace the power cable to the device. Remove the power cable from another device and recheck the motherboard voltages. Continue doing this until the power cord for each device has been disconnected and the motherboard voltages have been checked. A single device can short out the power supply and cause the system to malfunction. Replace any device that draws down the power supply's output voltage and draws too much current. If none of the devices is the cause of the problem, replace the power supply. If replacing the power supply does not solve the problem, replace the motherboard.



If a computer does not boot properly, but it does boot when you press Ctrl + Alt + Delete, the power good signal is likely the problem. Some motherboards are more sensitive to the power good signal than others. For example, say that a motherboard has been replaced and the system does not boot. At first glance, this may appear to be a bad replacement board, but the problem could be caused by a power supply failing to output a consistent power good signal.

Check the power good (sometimes called power OK) signal

Check the power supply documentation to see if the power supply outputs a power good signal (rather than the normal +5 volts). Turn on the computer. Check the power good signal going into the motherboard power connector. Do this before replacing the motherboard. A power supply with a power good signal below +3V needs to be replaced.

Sometimes, none of these troubleshooting actions work. A grounding problem might be the issue. Build the computer outside the computer case, on an antistatic mat, if possible. Start with only the power supply, motherboard, and speaker connected. Even though it will normally produce a POST audio error, verify that the power supply fan will turn. Most power supplies issue a click before the audio POST beeps. Next, verify the voltages from the power supply. If the fan turns and the voltages are correct, power down the machine and add a video adapter and monitor to the system. If the machine does not work, put the video adapter in a different expansion slot and try again. If placing the video adapter in a different expansion slot does not work, swap out the video adapter.

If the video adapter works, continue adding devices one by one and checking the voltages. Just as any one device can cause the system not to operate properly, so can any one adapter. If one particular adapter causes the system to malfunction, try a different expansion slot before trying a different adapter.

If the expansion slot proves to be a problem, check the slot for foreign objects. If none are found but the problem still occurs, place a note on the expansion slot so that no one will use it.

Adverse Power Conditions

There are two adverse AC power conditions that can damage or adversely affect a computer: overvoltage and undervoltage. **Overvoltage** occurs when the output voltage from the wall outlet (the AC voltage) is over the rated amount. Normally, the output of a wall outlet is 110 to 130 volts AC. When the voltage rises above 130 volts, an overvoltage condition exists. The power supply takes the AC voltage and converts it to DC. An overvoltage condition is harmful to the components because too much DC voltage destroys electronic circuits. An overvoltage condition can be a surge or a spike.

When the voltage falls below 110 volts AC, an **undervoltage** condition exists. If the voltage is too low, a computer power supply cannot provide enough power to all the components. Under these conditions, the power supply draws too much current, causing it to overheat, weakening or damaging the components. An undervoltage condition is known as a brownout or sag. Table 4.7 explains these power terms.

Table 4.7 Adverse power conditions

Major type	Subtype	Explanation
Overvoltage	spike	A spike lasts 1 to 2 nanoseconds. A nanosecond is one-billionth of a second. A spike is harder to guard against than a surge because it has such short duration and high intensity.
	surge	A surge lasts longer (3 or more nanoseconds) than a spike. Also called transient voltage. Causes of surges include lightning, poorly regulated electricity, faulty wiring, and devices that turn on periodically, such as elevators, air conditioners, and refrigerators.
Undervoltage	brownout	In a brownout, power circuits become overloaded. Occasionally, an electric company intentionally causes a brownout to reduce the power drawn by customers during peak periods.
	sag	A sag occurs when the voltage from the wall outlet drops momentarily.
	blackout	A blackout is a total loss of power.

Electric companies offer surge protection for homes. Frequently, there are two choices. A basic package protects large appliances, such as refrigerators, air conditioners, washers, and dryers. It allows no more than 800 volts to enter the electrical system. A premium package protects more sensitive devices (TVs, stereos, and computers) and reduces the amount of voltage allowed to 323 volts or less. Some suppressors handle surges up to 20,000 volts. The exterior surge arrestor does not protect against voltage increases that originate inside the building, such as those caused by faulty wiring.

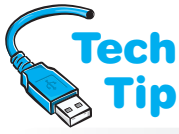
Adverse Power Protection

Power supplies have built-in protection against adverse power conditions. However, the best protection for a computer is to unplug it during a power outage or thunderstorm. Surge protectors and UPSs (uninterruptible power supplies) are commonly used to protect against adverse power conditions. A line conditioner can also be used. Each device has a specific purpose and guards against certain conditions. A technician must be familiar with each device in order to make recommendations for customers.

Surge Protectors

A **surge protector**, also known as a surge strip or surge suppressor, is commonly a multi-outlet strip that offers built-in protection against overvoltage. Surge protectors do not protect against undervoltage; they protect against voltage increases. Figure 4.31 shows a picture of a surge protector.

Figure 4.31 Surge protector



Do not create a trip hazard with a surge strip

When installing a surge protector, do not install it in such a manner that it causes a trip hazard because the cord lies in an area where people walk.

Most surge protectors have an electronic component called an **MOV** (metal oxide varistor), which protects the computer or device that plugs into one of the outlets on the surge strip. An MOV is positioned between the AC coming in and the outlet into which devices are plugged. When a surge occurs, the MOV prevents the extra voltage from passing to the outlets. An MOV, however, has some drawbacks. If a large surge occurs, the MOV will take the hit and be destroyed, which is better than damaging the computer. However, with small overvoltages, each small surge weakens the MOV. A weakened MOV might not give the proper protection to the computer in the event of a bigger surge. Also, there is no simple check for an MOV's condition. Some MOVs have indicator lamps attached, but they indicate only when the MOV has been destroyed, not when it is weakened. Still, having an indicator lamp is better than nothing at all. Some surge protectors also have replaceable fuses and/or indicator lamps for the fuse. A fuse works only once and then is destroyed during a surge in order to protect devices plugged into surge protector outlets.

Several surge protector features deserve consideration. Table 4.8 outlines some of them.

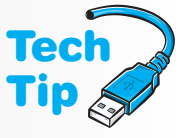
Table 4.8 Surge protector features

Feature	Explanation
Clamping voltage	The level at which surge protector starts protecting the computer. The lower the value, the better the protection.
Clamping speed	How much time elapses before protection begins. The lower the value, the better the protection. Surge protectors cannot normally protect against power spikes (overvoltages of short duration) because of their rated clamping speed.

Feature	Explanation
Energy absorption/ dissipation	The greater the number of joules (a unit of energy) that can be dissipated, the more effective and durable a surge protector is. This feature is sometimes called energy absorption. A surge protector rating of 630 joules is more effective than a rating of 210 joules.
TVS (transient voltage suppressing) **rating**	This is also known as response time. The lower the rating the better. For example, a 330 TVS-rated surge protector is better than a 400 TVS-rated one.
UL rating	UL (Underwriters Laboratories) developed the **UL 1449 VPR** (voltage protection rating) standard to measure the maximum amount of voltage a surge protector will let through to the attached devices. The UL 497A standard is for phone line protection, and the UL 1283 standard is for EMI/RFI.

The federal government designates surge suppressor grades—A, B, and C. Suppressors are evaluated on a basis of 1,000 surges at a specific number of volts and amps. A Class A rating is the best and indicates tolerance up to 6,000 volts and 3,000 amps.

Which surge strip to buy?



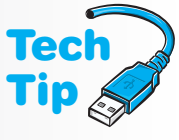
When purchasing or recommending a surge protector, be sure it conforms to the UL 1449 standard and has an MOV status lamp. Also, check to see if the vendor offers to repair or replace the surge-protected equipment in the event that they are damaged during a surge.

Surge protectors are not the best protection for a computer system because most provide very little protection against other adverse power conditions. Even the good ones protect only against overvoltage conditions. Those with the UL 1449 rating and an MOV status lamp are usually more expensive. Unfortunately, people tend to put their money into their computer parts, but not into the protection of those parts.

Line Conditioners

An alternative for computer protection is a line conditioner. **Line conditioners**, sometimes known as power conditioners, are more expensive than surge protectors, but they protect a computer from overvoltages, undervoltages, and adverse noise conditions over electrical lines. A line conditioner monitors AC electricity. If the voltage is too low, the line conditioner boosts voltage to the proper range. If the voltage level is too high, the line conditioner clamps down the voltage and sends the proper amount to the computer. Figure 4.32 shows a line conditioner.

Be careful not to plug too many devices into a line conditioner

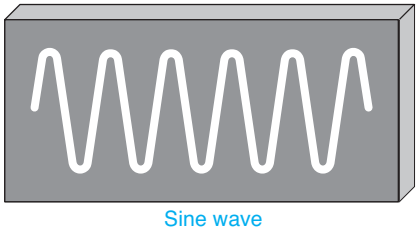


A line conditioner is rated for a certain amount of current. Some devices, such as laser printers, can draw a great deal of current (up to 15 amps). Some line conditioners are not rated to handle these devices. Because laser printers draw so much current, if a computer and a laser printer are on the same electrical circuit, that circuit should be wired to a 20-amp circuit breaker. Most outlets in today's buildings are on 20-amp breakers.

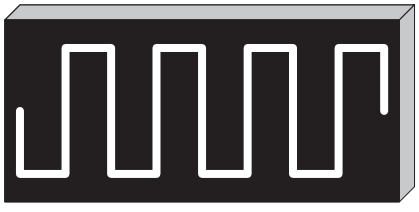
Figure 4.32 Line conditioner

Uninterruptible Power Supply (UPS)

A **UPS** (uninterruptible power supply), sometimes called an online (or true) UPS or a line interactive UPS, provides power to a computer or other device for a limited amount of time when there is a power outage. A UPS provides enough time to save work and safely shut down the computer. Some operating systems do not operate properly if power abruptly cuts off and the computer is not brought to a logical stopping place. A network server, the main computer for a network, is a great candidate for a UPS. Network operating systems are particularly susceptible to problems during a power outage. Some UPSs have a connection for a cable and special software that automatically maintains voltages to the computer, quits all applications, and powers off the computer. Some UPS units have USB and/or network connections as well.



Sine wave

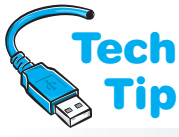


Square wave

Figure 4.33 Sine wave and square wave

A UPS also provides power conditioning for the devices attached to it. The AC power is used to charge a battery inside the UPS. The battery inside the UPS supplies power to an inverter. The inverter makes AC for the computer. When AC power from the outlet fails, the battery inside the UPS continues to supply power to the computer. The battery inside the UPS outputs DC power, and the computer accepts (and expects) AC power. Therefore, the DC power from the battery must be converted to AC voltage. AC voltage looks like a sine wave when it is in its correct form, but cheaper UPSs produce a square wave (especially when power comes from the battery) that is not as effective. Some computer systems and peripherals do not work well on a 120VAC square wave, modified sine wave, or quasi-sine wave. Figure 4.33 illustrates a sine wave and a square wave.

A UPS can be the best protection against adverse power conditions because it protects against overvoltage and undervoltage conditions, and it provides power so a system can be shut down properly. When purchasing a UPS, be sure that (1) the amount of battery time is sufficient to protect all devices; (2) the amount of current the UPS produces is sufficient to protect all devices; and (3) the output waveform is a sine wave.



Do not plug a laser printer into a UPS unless it has a rating less than 1400VA

Most UPSs cannot handle the very high current requirements of a laser printer.

To install a UPS, perform the following steps:

1. Connect the UPS to a wall outlet and power it on. When a UPS is first plugged in, the battery is not charged. See the UPS manufacturer's installation manual for the specific time it will take to charge.
2. Power off the UPS.
3. Attach device power cords, such as the PC, to the UPS. Ensure that the UPS is rated to supply power to the number and type of connected devices.
4. Power on the UPS.

A UPS has a battery inside that is similar to a car battery (except that the UPS battery is sealed). Because this battery contains acid, you should never drop a UPS or throw it in the trash. Research your state's requirements for recycling batteries. All batteries fail after some time, and most UPSs have replaceable batteries.

UPS troubleshooting is not difficult. In addition to following the manufacturer's recommendations for troubleshooting, try the following guidelines:

- If a UPS will not power on, check the on/off switch. Verify that the UPS is attached to an electrical outlet. Ensure that the outlet has power and that the circuit breaker for the outlet has not been tripped. Ensure that the battery is installed properly.
- Check whether the UPS unit has a self-test procedure and include a self-test button.
- With some UPS units, a beep indicates that a power interruption has occurred. This is a normal function.
- Some UPS units beep at a different rate when the battery is low. Others have a light indicator to indicate that it's time to recharge or replace the battery.
- If a UPS is overloaded—that is, has too many devices attached—the UPS may shut off, trip a circuit breaker, beep, or turn on a light indication for this problem.

Figure 4.34 shows the front of an American Power Conversion UPS. Notice the diagnostic lights on it.

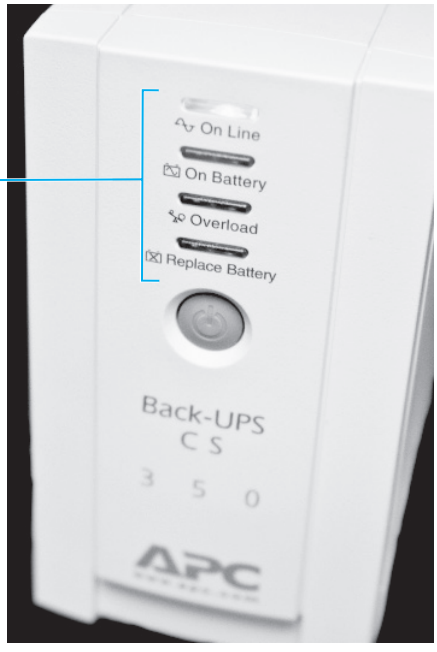
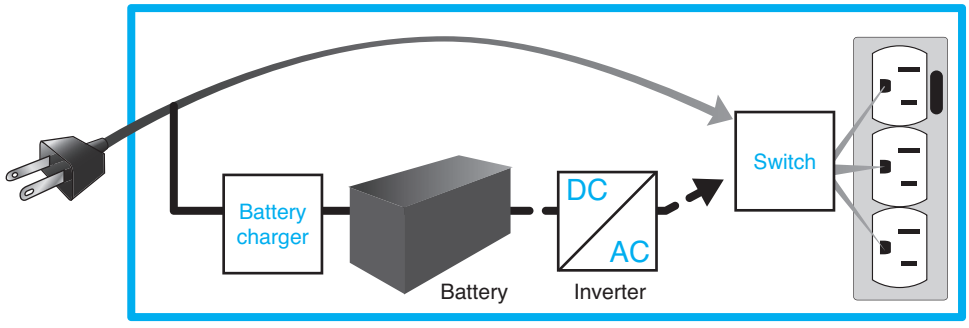


Figure 4.34 Front of an American Power Conversion UPS

Standby Power Supply (SPS)

A device similar to a UPS is an **SPS** (standby power supply). An SPS contains a battery like the UPS, but the battery provides power to the computer only when it loses AC power. It does not provide constant power, like the UPS. An SPS is not as effective as a UPS because the SPS must detect a power-out condition first and then switch over to the battery to supply power to the computer. As a result, SPS switching time is important. Any time under 5 milliseconds is fine for most systems. Figures 4.35 and 4.36 show the differences between how SPSs and UPSs work.



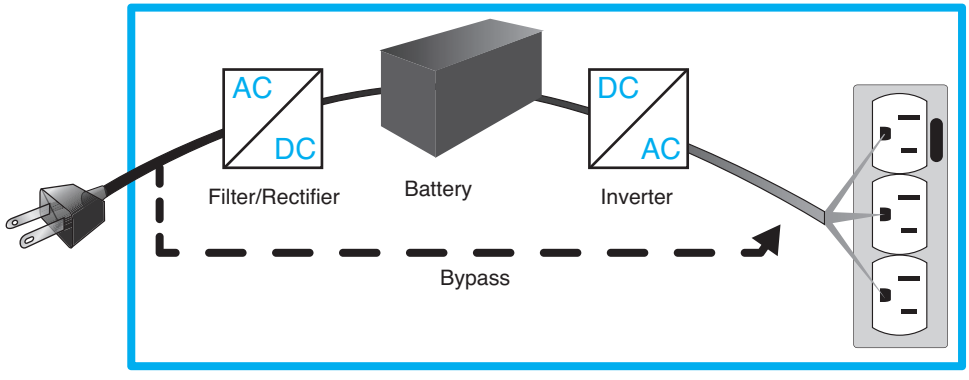
SPS/Line interactive UPS normal operation (solid line)

1. AC power is brought through the UPS.
2. The battery is charged simultaneously.
3. With some units, small over or undervoltages are evened out before sending through the UPS.

SPS/Line interactive UPS abnormal power operation (dashed line)

1. When high voltage or large undervoltage for some units and with loss of power is present in all units, DC power from the battery is sent to the inverter for as long as the battery lasts.
2. The DC power is converted to AC and provided to the attached devices.

Figure 4.35 SPS/line interactive UPS operation



Online UPS normal operation (solid line)

1. AC power is brought into the UPS and cleaned up by the filter and converted to DC by the rectifier.
2. The battery is charged and outputs DC to the inverter.
3. The DC is converted to AC and provided to the attached devices.

Online UPS abnormal power operation (dashed line)

1. When the battery has died, the attached devices still receive power through the bypass circuit.

Figure 4.36 Online UPS operation

Phone Line Isolator

Just like AC power outlets, phone outlets can experience power fluctuations. A power surge can enter a computer through a modem, a device used to connect a computer to a phone line. Not only can a modem be damaged by a power surge on the phone line, but other electronics inside the computer, such as the motherboard, can be damaged. A **phone line isolator**, sometimes called a **modem isolator**, can be purchased at an electronics store. It provides protection against phone line surges. No computer connected to a phone line through a modem should be without one. Many surge protectors now come with a modem isolator built into the strip. Figure 4.31 shows an example of a surge strip that has modem protection integrated into the unit.

Power supplies and associated protection equipment are not exciting topics, but they are very important to a technician. Power problems can catch you unaware. Always keep power in your mind as a potential suspect when troubleshooting a computer.

Electrical Fires

No discussion of power is complete without a brief warning about fire. Electrical fires are uncommon in computers, but if one occurs, a technician must know what to do. If a fire occurs inside a computer or peripheral, unplug the equipment if possible, but do not put yourself in harm's way attempting to do this. Use a **Type C** or a **Type A-B-C fire extinguisher** to put out the fire. Type C fire extinguishers are made specifically for electrical (Type C) fires. Type A-B-C fire extinguishers can be used for Class A, Class B, and Class C fires. Class A fires involve paper, wood, cloth, or other normal combustibles. Class B fires involve flammable liquids and gases. It is also a good idea to have a dry chemical 20lb ABC fire extinguisher in homes for the electronics (including computers) located there. Home computer equipment should be listed on the home insurance policy. Figure 4.37 shows a Type A-B-C fire extinguisher.

Figure 4.37 Type A-B-C fire extinguisher

When a fire occurs, pull out the fire extinguisher pin. Aim the fire extinguisher nozzle at the base (bottom) of the fire. Squeeze the fire extinguisher's handle and move the nozzle back and forth in a slow sweeping motion. With electrical fires, the smoke is a breathing hazard. Burning plastics produce lethal toxic fumes. Always evacuate the people in the building and call the fire department.

Computer Disposal/Recycling

Computers and other electronic devices can contain materials such as beryllium, chromium, cadmium, lead, mercury, nickel, and zinc. The levels of these materials are increasing dramatically every year in landfills and can pose a threat to our environment. Plastics that are part of computers are hard to isolate and recycle. CRTs (cathode ray tubes) are found in older monitors and TVs and usually contain enough lead and mercury to be considered hazardous waste. However, the EPA has been successful in obtaining exclusions from the federal hazardous waste standards for unbroken CRTs, so they can be recycled more effectively.

Batteries contain acids that can burn or hurt body parts. Batteries can introduce lead and acid into the environment. Heavy metals can leach into the ground and water sources.

Every state and many cities have specific guidelines about how to dispose of electronics. These rules must be followed by technicians who replace broken computer equipment. For example, in Florida and New York, steps have been taken to increase CRT recycling; however, other states regulate all CRTs as hazardous waste and ban them from being sent to landfills. If you are unsure about how to get rid of any piece of broken electronic equipment, contact your direct supervisor for instructions.

The following list provides alternatives and suggestions for being environmentally conscious about discarding electronics:

- Donate equipment that is operational to schools and charities so that those who do not have access to technology can get some exposure. If the operating system is not transferred to another system, leave the operating system on it and provide proof of purchase along with documentation. Also, do not forget to erase all data stored on the computer before donating it.
- Recycle very outdated electronics. If the devices are so outdated that a school or charity does not want them, consider recycling them. Many companies accept old electronics and have determined ways to reuse some of their parts.
- Remove parts that do work and donate or recycle them.
- Buy electronics that are designed with saving resources in mind and are easy to upgrade, which extends their usefulness period; are energy efficient; contain fewer toxins; use recycled materials; and offer leasing or recycling programs.
- Check with the computer or component manufacturer to see if it has a recycling program. Most of them do.

Soft Skills—Written Communications Skills

When technicians are in school, they seldom think that the skills they should be learning involve writing. However, in the workplace, technicians use written communication skills when they document problems and use email. Advisory committees across the country say that in addition to having technical knowledge, it is important that technicians be able to communicate effectively both written and orally, be comfortable working in a team environment, and possess critical thinking skills (that is, solve problems even though they have not been taught the specific problem).

Regardless of the size of a company, documentation is normally required. The documentation may only be the number of hours spent on a job and a basic description of what was done, but most companies require a bit more. Documentation should be written so others can read and understand it. Keep in mind that if another technician must handle another problem from the same customer, it saves time and money to have good documentation. The following list includes complaints from managers who hire technicians. You can use this list to improve and avoid making the same mistakes:

- Avoids doing documentation in a timely manner
- Does not provide adequate or accurate information on what was performed or tried
- Has poor spelling, grammar, capitalization, and punctuation skills
- Writes in short, choppy sentences, using technical jargon
- Does not provide updates on the status of a problem

Email is a common means of communication for technicians. However, most technicians do not take the time to communicate effectively using email. The following is a list of guidelines for effective email communication:

- Do not use email when a meeting or a phone call is more appropriate.
- Include a short description of the email topic in the subject line.
- Do not write or respond to an email when you are angry.
- Send email only to the appropriate people.
- Stick to the point; do not digress.
- Use a spelling and grammar checker; if one is not included in the email client, write the email in a word processing application, check it, and then paste the document into the email.
- Use proper grammar, punctuation, and capitalization; do not write in all uppercase or all lowercase letters.
- Do not copy others unnecessarily.
- Write each email as if you were putting the message on a billboard; you never know how the content might be used or who might see it.

The number-one complaint about technical support staff is not their lack of technical skills but their lack of communication skills. Spend as much of your education practicing your communication skills as you do your technical skills.

Chapter Summary

- Wearing a wrist strap or staying in contact with unpainted metal keeps you and the computing device at the same electrical potential so you won't induce current into any part and weaken/damage it.
- EMI and RFI cause issues. Move the computer or the offending device and replace all slot covers/openings.
- When removing parts, have the right tools, lighting, antistatic items, and ample work space. Take notes. Don't use magnetized tools. Avoid jarring hard drives.
- Be careful installing an I/O shield and be aware of standoffs when dealing with the motherboard.
- Laptops and mobile devices frequently have compartments for memory and expansion card. These devices frequently have plastic parts that must be removed. A scribe helps with prying plastics and covers off. Laptop speakers and DC power plug frequently have cables that run along the back or sides of the device. Keep screws separated and take notes for any parts removal.
- Ribbon cables have a colored stripe indicating pin 1. Pin 1 of a cable must attach to pin 1 of a connector.
- Preventive maintenance procedures prolong the life of the computer. Vacuum before spraying compressed air.
- An MSDS describes disposal and storage procedures and contains information about toxicity and health concerns. Cities/states have specific disposal rules for chemicals, batteries, CRTs, electronics, and so on. Always know the disposal rules in the area where you work.
- AC power goes into the power supply or mobile device power brick. DC power is provided to all internal parts of the computing device. AC and DC voltage checks can be done and only with DC power does polarity matter. Use the highest meter setting possible with unknown voltage levels. Power is measured in watts.
- Continuity checks are done on cabling and a good wire shows close to 0 ohms.
- A power supply converts AC to DC, distributes DC throughout a unit, and provides cooling. The power supply must be the correct form factor and able to supply the current amount of wattage for a particular voltage level such as +5V or +12V. Multiple "rails" are commonly available for +12V since the CPU commonly needs its own connection. The number and type of connectors vary, but converters can be purchased.
- Li-ion batteries are used with mobile devices. If a device must be attached to AC power or a USB port to work, replace the battery with one of with the correct DC power jack, appropriate DC voltage level, and current (amperage) equal to or higher than the original power brick.
- Conserve mobile device power by adding more RAM, turning off wireless/Bluetooth, configuring power options, reducing screen brightness, and avoiding temperature extremes.
- You use ACPI to control power options through BIOS and the operating system. Wake on LAN and Wake on Ring are power features that allow a device to be powered up from a lowered power condition for a specific purpose.
- An AC circuit tester, multimeter, and power supply tester are tools used with power problems.
- Power issues include overvoltage conditions such as a surge or spike that can be helped with surge protectors, power conditioners, and UPSs. Power conditioners and UPSs help with undervoltage conditions such as a sag. A UPS is the only device that powers a computer when a blackout occurs.

- Ensure that a surge protector has a Class A rating and adheres to the UL 1449 standard.
- Ensure that a UPS outputs a sine wave from the battery and can output enough power for attached devices.
- Have a Type C or Type A-B-C fire extinguisher around in case of fire.
- In all communications and written documentation, be professional and effective. Use proper capitalization, grammar, punctuation, and spelling.

Key Terms

Review Questions

1. What would happen if you removed the battery from the motherboard by accident?

2. List three tasks commonly performed during preventive maintenance.

3. Computers used in a grocery store warehouse for inventory control have a higher part failure rate than the other company computers. Which of the following is most likely to help in this situation?
   a. an antistatic wrist strap
   b. a preventive maintenance plan
   c. antistatic pads
   d. high wattage power supplies

4. Which of the following can prolong the life of a computer and conserve resources? (Select all that apply.)
   a. a preventive maintenance plan
   b. antistatic mats and pads
   c. upgraded power supply
   d. a power plan
   e. using a Li-ion battery as a replacement
   f. extra case fans
5. Which power component has a 20- or 24-pin connector?
   a. ATX power supply
   b. UPS
   c. line conditioner
   d. SPS
   e. surge protector
6. An optical drive randomly becomes unavailable, and after replacing the drive, the technician now suspects a power issue. What could help in this situation?
   a. a UPS
   b. a surge protector
   c. antistatic wipes
   d. a preventive maintenance plan
   e. a multimeter
7. Which unit would you recommend for the help desk people who sit at a computer for a 24/7 operation where help must be provided at all times?
   a. a UPS
   b. a surge protector
   c. an upgrade power supply
   d. a line conditioner
8. When disassembling a computer, which tool will help you remove the memory module?
   a. magnetic screwdriver
   b. needlenose pliers
   c. #1 or #2 Phillips screwdriver
   d. antistatic wrist strap
9. How would a technician normally access a memory module that needs to be replaced on a netbook? (Select the best answer.)
   a. by removing the DC power jack
   b. by removing a secured bottom compartment
   c. by removing the speaker
   d. by removing the display
10. Which part would be specialized when used with a laser printer?
    [surge strip | vacuum | multimeter | antistatic wrist strap]
11. Which two of the following would most likely cause a loud noise on a desktop computer? (Select two.) [motherboard | USB drive | power supply | case fan | memory | PCIe adapter]

12. A computer will not power on. Which of the following would be used to check the wall outlet? [power supply tester | UPS | multimeter | POST]
13. A computer will not power on. After checking the wall outlet and swapping the power cord, what would the technician use next?
    a. power supply tester
    b. UPS
    c. antistatic wrist strap
    d. magnetic screw driver
    e. nonmagnetic screw driver
14. Which of the following is affected by the power supply wattage rating?
    a. number of internal storage devices
    b. number of power supply connectors
    c. speed of the processor
    d. type of processor
    e. type of power supply connectors
15. Which of the following would help with computer heat?
    a. increased power supply wattage
    b. larger power supply form factor
    c. unplug unused power connectors
    d. install case fans
16. Lightning is prevalent in Jacksonville, Florida. What would you recommend for home owners who would like to keep working even when a storm is rolling through? [surge protector | phone line protector | UPS | line conditioner]
17. Consider the following email.

> From: Cheryl a. Schmidt
>
> To: Network Engineering Technology Faculty
>
> Subj: [None]
>
> We have little time to get the PMS done on the PCs and N/W gear. What software do you want?

Reword this email to illustrate good written communication skills.

18. List three recommendations for good technical written communication.

19. What type of fire extinguisher can be used on electronic equipment?

20. List three recommendations for saving power on a laptop.

Exercises

Lab 4.1 Performing Maintenance on an Antistatic Wrist Strap

Objective: To understand how to care for and properly use an antistatic wrist strap

Parts: Antistatic wrist strap
Computer chassis
Multimeter

Note: Electrostatic discharge (ESD) has great potential to harm the electronic components inside a computer. Given this fact, it is vitally important that you practice proper ESD precautions when working inside a computer case. One tool you can use to prevent ESD is an antistatic wrist strap. This tool channels any static electricity from your body to the computer's chassis, where it is dissipated safely.

Procedure: Complete the following procedure and answer the accompanying questions.

1. Examine the wrist strap for any obvious defects such as worn or broken straps, loose grounding lead attachments, dirt or grease buildup, and so on.
2. If necessary, remove any dirt or grease buildup from the wrist strap, paying close attention to the electrical contact points such as the wrist contact point, the ground lead attachment point, and the computer chassis attachment clip. Use denatured alcohol to clean these contact points.
3. If possible, use a multimeter to check continuity between the wrist contact point and the computer chassis attachment clip. A reading of zero ohms of resistance indicates a good electrical pathway.

   How many volts of static electricity does it take to harm a computer's electrical components?
4. Adjust the wrist strap so it fits snugly yet comfortably around your wrist. Ensure that the wrist contact is in direct contact with your skin, with no clothing, hair, etc., being in the way.
5. Attach the ground lead to the wrist strap and ensure it snaps securely into place.
6. Attach the computer chassis attachment clip to a clean metal attachment point on the computer chassis.
7. Any static electricity generated or attracted by your body will now be channeled through the antistatic wrist strap to the computer chassis, where it will be safely dissipated.

   How many volts will an ESD be before you will feel anything?

Should you use an antistatic wrist strap when working inside a monitor?

Instructor initials: _____

Lab 4.2 Computer Disassembly/Reassembly

Objective: To disassemble and reassemble a computer correctly

Parts: A computer to disassemble
A tool kit
An antistatic wrist strap (if possible)

Note: Observe proper ESD handling procedures when disassembling and reassembling a computer.

Procedure: Complete the following procedure and answer the accompanying questions.

1. Gather the proper tools needed to disassemble the computer.
2. Clear as much workspace as possible around the computer.
3. Power on the computer.

   Why is it important to power on the computer before you begin?

External Cables

4. Turn *off* the computer and all peripherals. Remove the power cable from the wall outlet and then remove the power cord from the computer.
5. Note where the monitor cable plugs into the back of the computer. Disconnect the monitor including the power cord and move it to a safe place. Take appropriate notes.
6. Remove all external cables from the back of the computer. Take notes on the location of each cable. Move the peripheral devices to a safe place.

   Did the mouse cable connect to a PS/2 or USB port?

Computer Case Removal

7. If possible, remove the computer case. This is usually the hardest step in disassembly if the computer is one that has not been seen before. Diagram the screw locations. Keep the cover screws separate from other screws. An egg carton or a container with small compartments makes an excellent screw holder. Label each compartment and reuse the container. Otherwise, open the case as directed by the manufacturer.

Adapter Placement

8. Make notes or draw the placement of each adapter in the expansion slots.
9. On your notes, draw the internal cable connections *before* removing any adapters or cables from the computer. Make notes regarding how and where the cable connects to the adapter. Do not forget to include cables that connect to the motherboard or to the computer case.

   List some ways to determine the correct orientation for an adapter or cable.

Internal Cable Removal

10. Remove all internal cables. WARNING: Do not pull on a cable; use the pull tab, if available, or use the cable connector to pull out the cable. Some cables have connectors with locking tabs. Release the locking tabs *before* you disconnect the cable. Make appropriate notes regarding the cable connections. Some students find that labeling cables and the associated connectors makes reassembly easier, but good notes usually suffice.

Adapter Removal

11. Start with the left side of the computer (facing the front of the computer) and locate the leftmost adapter.
12. Write down any jumpers or switch settings for this adapter. This step may need to be performed after you remove the board from the computer if the settings are inaccessible.
13. If applicable, remove the screw or retaining bracket that holds the adapter to the case. Place the screw in a separate, secure location away from the other screws already removed. Make notes about where the screw goes or any other notes that will help you when reassembling the computer.
14. Remove the adapter from the computer.

    Why must you be careful not to touch the gold contacts at the bottom of each adapter?

15. Remove the remaining adapters in the system by repeating Steps 12–15. Take notes regarding screw locations, jumpers, switches, and so forth for each adapter.

Drives

16. Remove all power connections to drives, such as hard drives, floppy drives, CD/DVD/BD drives, and so on. Note the placement of each drive and each cable, as well as any reminders needed for reassembly.
17. Remove any screws holding the drives in place. Make notes about where the screws go. Keep these screws separate from any previously removed screws.
18. Remove all drives.

    Why must you be careful when handling a mechanical hard drive?

    What would you do differently when handling an SSD than a SATA hard drive?

Power Supply

19. Before doing this step, ensure that the power cord is removed from the wall outlet and the computer. Remove the connectors that connect the power supply to the motherboard.
20. Take very good notes here so you will be able to insert the connectors correctly when reassembling.
21. Remove the power supply.

    What is the purpose of the power supply?

Motherboard

22. Make note of any motherboard switches or jumpers and indicate whether the switch position is on or off.

    What is the importance of documenting switches and jumpers on the motherboard?

23. Remove any remaining connectors except those that connect a battery to the motherboard. Take appropriate notes.
24. Remove any screws that hold the motherboard to the case. Place these screws in a different location from the other screws removed from the system. Write any notes pertaining to the motherboard screws. Look for retaining clips or tabs that hold the motherboard into the case.
25. Remove the motherboard. Make notes pertaining to the motherboard removal. The computer case should be empty after you complete this step.

Instructor initials: _____

Reassembly

26. Reassemble the computer by reversing the steps for disassembly. Pay particular attention to cable orientation when reinstalling cables. Before reconnecting a cable, ensure that the cable and the connectors are correctly oriented and aligned before pushing the cable firmly in place. Refer to your notes. The first step is to install the motherboard in the computer case and reconnect all motherboard connections and screws.
27. Install the power supply by attaching all screws that hold the power supply in the case. Reattach the power connectors to the motherboard. Refer to your notes.
28. Install all drives by attaching screws, cables, and power connectors. Refer to your notes. Attach any cables that connect the drive to the motherboard.
29. Install all adapters. Attach all cables from the adapter to the connecting device. Replace any retaining clips or screws that hold adapters in place. Refer to your previous notes and diagrams.
30. Connect any external connectors to the computer. Refer to previously made notes, when necessary.
31. Replace the computer cover. Ensure that slot covers are replaced and that the drives and the front cover are aligned properly. Ensure that all covers are installed properly.
32. Reinstall the computer power cable.
33. Once the computer is reassembled, power on all external peripherals and the computer. A chassis intrusion error message may appear. This is just an indication that the cover was removed.

    Did the computer power on with POST error codes? If so, recheck all diagrams, switches, and cabling. Also, check a similar computer model that still works to see if you made a diagramming error. A chapter on logical troubleshooting comes next in the book. However, at this point in the course, the most likely problem is with a cable connection or with an adapter not seated properly in its socket.

Instructor initials: _____

Lab 4.3 Amps and Wattage

Objective: To determine the correct capacity and wattage of a power supply

Parts: Power supply
Internet access (as needed)

Procedure: Complete the following procedure and answer the accompanying questions.

1. Locate the documentation stenciled on the power supply, if possible.

   Can you determine from the documentation how many amps of current the power supply is rated for at 5 volts? If not, proceed to Optional Step 2.

2. Optional: Use the Internet to find the power supply's documentation on the manufacturer's website. Use the information you find to answer the remaining questions.

   How many amps is the power supply rated for at 5 volts?

   How many amps is the power supply rated for at 12 volts?

   How many +12V rails does the power supply have?

   What is the maximum rated output power of the power supply in watts?

Instructor initials: _____

Lab 4.4 Continuity Check

Objective: To perform a continuity check on a cable and find any broken wires

Parts: Multimeter
Cable and pin-out diagram

Procedure: Complete the following procedure and answer the accompanying questions.

1. Obtain a meter, cable, and pin-out diagram from your instructor.
2. Set the meter to ohms.
3. Power on the meter.
4. Lay the cable horizontally in front of you. The connector on the left is referred to as Connector A. The connector on the right is referred to as Connector B.
5. Determine the number of pins on the cable connector. On a separate sheet of paper, write numbers vertically down the left side of the paper, similar to the numbering used in Lab 4.5. There should be a number for each connector pin. At the top of the numbers write Connector A as the heading. Create a corresponding set of identical numbers vertically on the right side of the paper.
6. Check the continuity of each wire. Document your findings by placing a check mark beside each pin number that has a good continuity check.

   What meter setting did you use to check continuity, and what meter symbol is used for this setting?

7. Power off the meter and return all supplies to the instructor.

Instructor initials: _____

Lab 4.5 Pin-Out Diagramming

Objective: To draw a pin-out diagram using a working cable

Parts: Multimeter
Good cable

Procedure: Complete the following procedure and perform the accompanying activities.

1. Obtain a meter and a good cable from your instructor.
2. Set the meter to ohms.

Instructor initials: _____

3. Power on the meter.
4. Lay the cable horizontally in front of you. The connector on the left is referred to as Connector A. The connector on the right is referred to as Connector B.
5. Touch one meter lead to Connector A's pin 1. Touch the other meter lead to every Connector B pin. Notice when the meter shows zero resistance, indicating a connection. Using the table that follows, draw a line from Connector A's pin 1 to any Connector B pins that show zero resistance. Add more pin numbers as needed to the table or use a separate piece of paper. Remember that all pins do not have to be used in the connector. There are no review questions; however, there is a connector table that contains connection lines. The lines will be cable dependent.

Connector A	Connector B
❒ 1	❒ 1
❒ 2	❒ 2
❒ 3	❒ 3
❒ 4	❒ 4
❒ 5	❒ 5
❒ 6	❒ 6
❒ 7	❒ 7
❒ 8	❒ 8
❒ 9	❒ 9
❒ 10	❒ 10
❒ 11	❒ 11
❒ 12	❒ 12
❒ 13	❒ 13
❒ 14	❒ 14
❒ 15	❒ 15
❒ 16	❒ 16
❒ 17	❒ 17
❒ 18	❒ 18
❒ 19	❒ 19
❒ 20	❒ 20

6. Power off the meter.

Instructor initials: _____

7. Return all supplies to the instructor.

Lab 4.6 Fuse Check

Objective: To determine if a fuse is good

Parts: Multimeter
Fuse

Procedure: Complete the following procedure and answer the accompanying questions.

1. Obtain a meter and a fuse from your instructor.
2. Look at the fuse and determine its amp rating.
   What is the amperage rating of the fuse?
3. Set the meter to ohms.

Instructor initials: _____

4. Power on the meter.
5. Connect one meter lead to one end of the fuse. Connect the other meter lead to the opposite end.
6. Look at the resistance reading on the meter.
   What is the resistance reading?
   Is the fuse good?
7. Power off the meter.

Instructor initials: _____

8. Return all materials to the instructor.

Lab 4.7 Using a Multimeter

Objective: To check voltage and resistance levels using a multimeter

Parts: Multimeter
AA, AAA, C, D, or 9-volt battery
Extended paperclip or wire

Caution: Keep both hands on the behind the protective rings on the meter handles. See Figures 4.16 and 4.17.

Procedure: Complete the following procedure and perform the accompanying activities.

1. All voltage inside the computer is DC voltage (except for some parts inside the power supply, of course). Learning how to measure DC voltage is important for a technician. The best place to start is with a battery. Obtain a battery. Look carefully at the battery and determine where the positive end or connector is located (usually has a + (plus) symbol nearby) and where the negative end or connector is located.
   Why is it important to locate positive and negative on a battery?

2. Look carefully at the battery and determine the voltage rating. Document your findings.
   DC voltage**:**

3. Place the battery on a flat surface. If the battery is an AA, AAA, C, or D battery, place the battery so that the positive side (the side with a nodule) pointing toward your right side. If the battery is a 9-volt battery, place the battery so that the connectors are facing you and the positive connector (the smaller connector) is on your right side.

4. If the meter has leads that attach, attach the black meter lead to the appropriate port colored as a black port or has the COM labeling. Attach the red meter lead to the positive or port marked with a plus sign (+).
5. Turn on the meter. Set the meter so that it is measuring VDC (DC voltage). This may involve manually rotating a dial and/or pushing a button. Note that some meters can autodetect the setting, but most involve configuration.

   Document what you did to configure the meter for VDC.

   What indication, if any, did the meter show in the meter window that VDC is being measured?

6. Hold the meter leads so that the black lead is in your left hand and the right lead is in your right hand. Ensure your hands are behind the protective ring on the meter handle. Refer to Figure 4.16 if you are unsure.
7. Place the black meter lead to the negative side (left side or left connector). Also touch the red meter lead to the positive side (right side or right connector) of the battery. Make a note of the meter reading.

   DC volts:

   Based on your findings, is the battery good (usable in an electronic device)?

8. Now reverse the meter leads—place the black lead to the positive side and the red lead to the negative side. Record your findings.

   DC volts:

   What was different from the original meter reading?

9. Perform this voltage check on any other batteries given to you by the instructor or lab assistant.
10. Straighten a paperclip or obtain a wire. Place the paperclip or wire on a flat surface.
11. Change the meter so that it reads ohms. This is normally shown by the omega symbol (Ω).

    While having the meter leads up in the air (not touching each other), what does the meter display?
12. Touch the meter leads together to make a complete circuit or path.

    What does the meter display now?
13. Touch one meter lead to one end of the paperclip or wire, and touch the other meter lead to the opposite paperclip or wire end. Sometimes it is easier to just lay the meter lead on top of the wire close to the end.

    What is the meter reading?
14. Some meters have the ability to make a sound when a wire is good. This is frequently shown on your meter as a sound wave (). If your meter has this ability, configure the meter and redo the test. You can see how much easier this would be than trying to hold your meter leads straight and watch the meter.

Instructor initials: _____

15. Power off the meter. Disconnect the leads as necessary. Return all parts to the appropriate location.

Lab 4.8 Wall Outlet and Power Cord AC Voltage Check

Objective: To check the voltage from a wall outlet and through a power cord

Parts: Multimeter
Computer power cord

Caution: Exercise extreme caution when working with AC voltages!

Procedure: Complete the following procedure and perform the accompanying activities.

1. Set the multimeter to AC VOLTAGE (refer to the meter's manual if you are unsure about this setting). Important: Using a current or resistance setting could destroy the meter.
2. Power on the multimeter. Locate an AC power outlet. Refer to Figure 4.38 for the power connections.

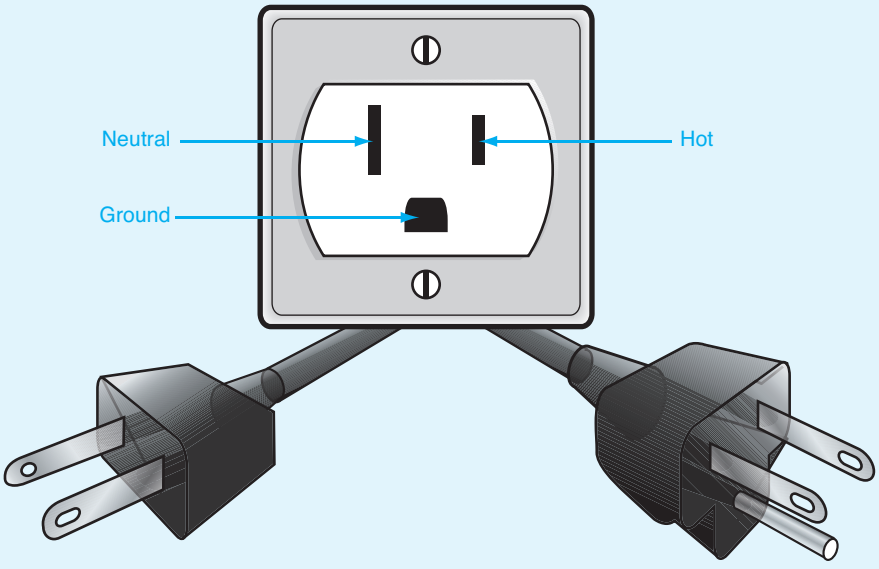


Figure 4.38 AC outlet

3. Insert the meter's black lead into the round (Ground) AC outlet plug.
4. Insert the meter's red lead into the smaller flat (Hot) AC outlet plug. The meter reading should be around 120 volts. Use Table 4.9 to record the reading.
5. Move the meter's red lead into the larger flat (Neutral) AC outlet plug. The meter reading should be 0 volts. Use Table 4.9 to record the reading.

Table 4.9 Wall outlet AC checks

Connections	Expected voltage	Actual voltage
GND to hot	120VAC	
GND to neutral	0VAC	
Hot to neutral	120VAC	

6. Remove both leads from the wall outlet.
7. Insert the meter's black lead into the smaller flat (hot) AC outlet plug.
8. Insert the meter's red lead into the larger flat (neutral) AC outlet plug. The meter reading should be around 120 volts. Use Table 4.9 to record the reading.
9. Plug the computer power cord into the AC wall outlet that was checked using Steps 3 through 8.
10. Verify the other end of the power cord is not plugged into the computer.
11. Perform the same checks you performed in Steps 3 through 8, except this time check the power cord end that plugs into the computer. Use Table 4.10 to record the reading.

Table 4.10 Power cord AC checks

Connections	Expected voltage	Actual voltage
GND to hot	120VAC	
GND to neutral	0VAC	
Hot to neutral	120VAC	

12. If the voltage through the power cord is correct, power off the meter. Notify the instructor of any incorrect voltages.

Instructor initials: _____

Lab 4.9 Device DC Voltage Check

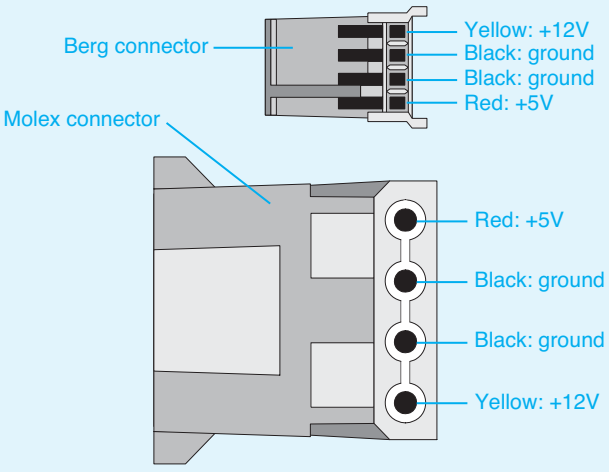
Objective: To check the power supply voltages sent to various devices

Parts: Multimeter
Computer

Procedure: Complete the following procedure and perform the accompanying activities.

1. Set the multimeter to DC VOLTAGE (refer to the meter's manual if unsure about the setting).
2. Power on the multimeter.
3. Power off the computer.
4. Remove the computer case.
5. Locate a Molex or Berg power connector. If one is not available, disconnect a power connector from a device.
6. Power on the computer.
7. Check the +5 volt DC output from the power supply by placing the meter's *black* lead in (if the connector is a Molex) or on (if the connector is a Berg) one of the grounds* (a black wire). Place the meter's *red* lead on the +5 volt wire (normally a red wire) in or on the connector. Consult Figure 4.39 for the layout of the Molex and Berg power supply connections. Figure 4.39 also contains a table with the acceptable voltage levels.

   *Use and check both ground connections (black wires going into the connector); do not check all the voltages using only one ground connection.



Voltages	Minimum	Maximum
+ 5 Volts	+ 4.75	+ 5.25
+ 12 Volts	+ 11.4	+ 12.6

Figure 4.39 Molex and Berg power connectors

Write the voltage level found for the +5 volt wire in Table 4.11.

Table 4.11 +5 volt check

Voltage being checked	Voltage found
+5 volts	

8. Check the +12 volt DC output by placing the meter's *black* lead in (if the connector is a Molex) or on (if the connector is a Berg) one of the grounds. Place the meter's *red* lead on the +12 volt wire in or on the connector. See Figure 4.39 for the layout of the Molex and Berg power supply connections. The figure also contains a table with acceptable voltage levels. Write the voltage level found for the +12 volt wire in Table 4.12.

Table 4.12 +12 volt check

Voltage being checked	Voltage found
+12 volts	

9. Notify the instructor of any voltages out of the acceptable range.
10. Power off the meter.

Instructor initials: _____

11. Power off the computer.

Lab 4.10 Windows XP Power Options

Objective: To be able to control power options via BIOS and Windows XP

Parts: Computer with Windows XP loaded

Procedure: Complete the following procedure and answer the accompanying questions.

1. Power on the computer and ensure it boots properly before the exercise begins.
2. Reboot the computer and access BIOS Setup.

List the BIOS options related to power management.

Can ACPI be disabled via BIOS?

3. Exit the BIOS setup program without saving any settings. Boot to Windows XP.
4. From the *Start* button > access *Control Panel* > *Classic view* > and the *Power Options* Control Panel.
   On the *Power Schemes* tab, what is the current setting used?

   Using the *Power Schemes* drop-down menu, list the power schemes available.

   What is the current setting for the monitor power scheme?

   What is the current setting for the hard drive power scheme?

   What is the current setting for the system standby?

   What is the maximum amount of time the monitor can be on and then be shut off by the operating system?

5. Select the *Advanced* tab.
   Describe the power savings icon shown on this window.

   What options are available for the power button?

6. Select the *Hibernate* tab.
   How much disk space is required for hibernation?

7. Click *Cancel*.

Lab 4.11 Windows Vista/7 Power Options

Objective: To be able to control power options via BIOS and Windows Vista/7

Parts: Computer with Windows Vista or 7 loaded

Procedure:

1. Power on the computer and ensure it boots properly before the exercise begins.
2. Reboot the computer and access BIOS Setup.
   List the BIOS options related to power management.

   Can ACPI be disabled via BIOS?

3. Exit the BIOS Setup program without saving any settings. Boot to Windows Vista/7.
4. Access the current power settings by using the *Start* > *Control Panel* > *System and Maintenance* (Vista)/*System and Security* (7) > *Power Options*.
   What power plan is currently configured?

5. Select the *Create a power plan* link on the left. Type a unique name in the *Plan name* textbox. Click *Next*.

6. Use the *Turn off the display* drop-down menu to select a time. Use the *Put the computer to sleep* drop-down menu to select a time for the computer to go into reduced power mode. Note that on a laptop computer there will be two columns of choices: *On battery* and *Plugged in*.

   What global ACPI state do you think this would assign? Look back through the chapter to review.

7. Click the *Create* button. Notice that your new plan appears in the list of preferred plans. Also notice that the *Show additional plans* reveal arrow might be in the center of the window on the right if someone has hidden the additional plans. Click on *Show additional plans*, and other plans are revealed.
8. Click on the *Change plan settings* link under or beside the plan you just created. Select the *Change advanced power settings* link.

   List at least three devices for which you can have power controlled through this control panel.

9. Expand the USB settings, if possible, and the *USB selective suspend* setting.

   What is the current setting?

10. Expand the *Processor power management* setting, if possible.

    What is the minimum processor state?

    What is the maximum processor state?

11. Expand the *Multimedia* settings, if possible.

    What setting(s) is configured with this option?

12. Click the *Cancel* button to return to the Change settings window. Click the *Cancel* button again. Show the instructor or lab assistant your settings.

Instructor initials: _____

13. To delete a power plan you created (the default ones cannot be deleted), select the radio button for the original power plan. Refer to Step 4, if necessary. Under the plan you created, select the *Change settings for the plan* link. Select the *Delete this plan* link and click *OK*. The plan should be removed from the power options list. Show the instructor or lab assistant that the plan has been deleted.

Instructor initials: _____

Activities

Internet Discovery

Objective: To obtain specific information on the Internet regarding a computer or its associated parts

Parts: Computer with Internet access

Procedure: Complete the following procedure and answer the accompanying questions.

1. Locate an Internet site that provides tips for doing computer preventive maintenance.

   Write 10 of the tips and the URL where you found the information.

2. Locate an Internet site to buy a computer tool kit that contains non-magnetic screwdrivers.
   List the URL where you found the tool kit and at least three sizes of screwdrivers or bits provided.

3. Locate a surge protector for the whole house. Determine if it replaces the need for individual surge protectors.
   Write the name and part number as well as your findings.

4. A customer owns a Belkin 12-outlet surge protector with phone/Ethernet/coaxial protection and an extended cord.
   What is the warranty amount for this surge protector and at what URL did you find this information?

5. A customer has a Rosewill CAPSTONE-450 power supply.
   What is the power supply's maximum power output (in watts) and how many amps are provided for +3.3V, +5V, and +12V (combined amount for +12V)? Write the URL where you found this information as well.

6. A customer has an Enermax Liberty ELT500AWT power supply.
   Does this power supply comply with the ATXV12 version 2.2 or higher specification?

   How many PCIe connectors are provided?

   Does the power supply have any SATA power connectors? If so, how many?

   At what website did you find this information?

7. A customer owns a Toshiba Satellite R845-ST6N02 laptop.
   What type of battery provides power for the longest amount of time for this model? Write the URL where you found this information.

8. Your company has a Tripp Lite Smart 700 UPS.
   What are the part number and cost for a replacement battery? At what website did you find this information?

9. Locate an A-B-C fire extinguisher.
   Give the model, cost, and URL where you found this information.

Soft Skills

Objective: To enhance and fine-tune a future technician's ability to listen, communicate in both written and oral form, and support people who use computers in a professional manner

Activities:

1. Using the information gathered in Critical Thinking Skills Activity 1 or researching an appropriate replacement power supply for any computer, prepare a business proposal for the power supply as if you were offering it to a customer. Present your proposal to the class.

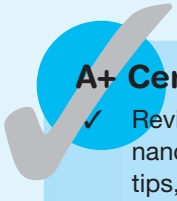
2. Work in teams to decide the best way to inform a customer about the differences between a line conditioner and a UPS. Present your description to the class as if you were talking to the customer. Each team member must contribute. Each classmate votes for the best team explanation.

Critical Thinking Skills

Objective: To analyze and evaluate information as well as apply learned information to new or different situations

Activities:

1. Locate a computer on the Internet that lists each device that is installed and the type of motherboard, integrated ports, and so on. Then locate a power supply calculator. Find a replacement power supply, based on the calculations performed. Write the details of what you looked for in the replacement power supply, the power supply, vendor, number and type of connectors, and cost.
2. For one of the computers in the classroom, locate an appropriate UPS that can provide power for 10 minutes. Write the details of your findings in a report.



A+ Certification Exam Tips

- ✓ Review the chapter summary. Quite a few questions are about preventive maintenance procedures. Don't forget that other chapters have preventive maintenance tips, too, including the chapters on storage devices, multimedia devices, and other peripherals chapters.
- ✓ Power down a computer, remove the power cord/power brick/battery, and allow a laser printer to cool before performing maintenance.
- ✓ Know what the +5 and +12 volts are used for in a computer.
- ✓ Review a couple of videos on laptop disassembly. Know where the common parts, including the following, are located on different vendors' products: memory, wireless antennas, mini PCI/PCIe adapters, DC power jack, and speakers.
- ✓ Know what tools are commonly used: flat-tip/Phillips screwdrivers, #0 Phillips screwdriver for laptop and mobile device screws, antistatic wrist strap (don't use in a CRT monitor or inside a power supply).
- ✓ Know all about static electricity, RFI, and EMI and how to prevent them.
- ✓ Know the purpose of various power protection devices: surge protector, line conditioner, SPS, UPS, and modem isolator.
- ✓ Know what type of fire extinguishers are used with electronic devices.
- ✓ Be able to identify all motherboard, PCIe adapter, and power supply power connectors.
- ✓ The following communication and professionalism skills are part of the 220-801 exam: Provide proper documentation on the services provided.
- ✓ Be familiar with all the power options that can be set on a desktop and a mobile device.

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