MARK EDWARD SOPER

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CompTIA® A+ 220-901 and 220-902 Cert Guide

Mark Edward Soper

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CompTIA® A+ 220-901 and 220-902 Cert Guide

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Contents at a Glance

Table of Contents

About the Author

Mark Edward Soper has been working with PCs since the days of the IBM PC/XT and AT as a salesperson, technology advisor, consultant, experimenter, and technology writer and content creator. Since 1992, he has taught thousands of students across the country how to repair, manage, and troubleshoot the hardware, software, operating systems, and firmware inside their PCs. He has created many versions of his experimental computer known as "FrankenPC" for this and previous books. Mark earned his CompTIA A+ Certification in 1999 and has written five other A+ Certification books covering previous versions of the A+ Certification exams for Pearson imprints. Mark is also the creator of *Building and Repairing PCs* (Que Video).

Mark has contributed to many editions of *Upgrading and Repairing PCs*, working on the 11th through 18th and 20th through 22nd editions; co-authored *Upgrading and Repairing Networks*, Fifth Edition; and has written two books about digital photography, *Easy Digital Cameras* and *The Shot Doctor: The Amateur's Guide to Taking Great Digital Photos*.

In addition, Mark has written *Easy Windows 10*, *Easy Windows 8.1*, *Easy Windows 8*, *Easy Microsoft Windows 7*, and *Sams Teach Yourself Microsoft Windows 7 in 10 Minutes*. He also wrote two books about Windows Vista: *Maximum PC Microsoft Windows Vista Exposed* and *Unleashing Microsoft Windows Vista Media Center*.

Mark has also contributed to Que's Special Edition *Using* series on Windows Me, Windows XP, and Windows Vista and to Que's *Windows 7 In Depth*. Mark has also created a number of hardware tutorial videos available from the OnGadgets&Hardware podcast channel at www.quepublishing.com.

Mark has also written many blog entries and articles for MaximumPC.com and *Maximum PC* magazine. He currently teaches Microsoft Office for University of Southern Indiana and Ivy Tech Corporate College in Evansville, Indiana, and also has taught A+ Certification and other technology-related subjects at Ivy Tech Community College. See Mark's website at www.markesoper.com for news and information about upcoming projects.

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Chris Crayton (MCSE) is an author, technical consultant, and trainer. He has worked as a computer technology and networking instructor, information security director, network administrator, network engineer, and PC specialist. Chris has authored several print and online books on PC repair, CompTIA A+, CompTIA Security+, and Microsoft Windows. He has also served as technical editor and content contributor on numerous technical titles for several of the leading publishing companies. He holds numerous industry certifications, has been recognized with many professional teaching awards, and has served as a state-level SkillsUSA competition judge.

Dedication

For Moses

Acknowledgments

After more than sixteen years as a full-time technology content provider, I realize more than ever how richly I have been blessed by God in my family and in the team of technology experts I get to work with.

Thanks first and foremost to Almighty God, who has given us the ability to create and to receive glimpses of the mysteries of the universe.

Thanks also to my family, PC and Mac users alike, who agree to disagree about the best technology, but work and play well with each other. Thanks especially to Cheryl for her love and patience.

As always, Pearson has put together an outstanding team for this edition, and I especially want to thank Dave Dusthimer for his vision of becoming the leading provider of CompTIA A+ study material. I wish him well in retirement.

A major thank you goes out to Michelle Newcomb, Ellie Bru, Sandra Schroeder, and Mandie Frank for keeping this process rolling along. And a big thank you to Technical Editor Chris Crayton for great suggestions and tips along the way and to Beth Smith for creating thought-provoking questions to test your skills.

Finally, a thank you to Vanessa, Tim, and Gary. We want to see you succeed both in passing your exams and in your IT career. We all wish you the very best.

We Want to Hear from You!

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Learn more: **Certification.CompTIA.org/aplus**

* Source: CompTIA 9th Annual Information Security Trends study: 500 U.S. IT and Business Executives Responsible for Security
** Source: CompTIA Employer Perceptions of IT Training and Certification

Introduction

CompTIA A+ Certification is widely recognized as the first certification you should receive in an information technology (IT) career. Whether you are planning to specialize in PC or mobile device hardware, operating systems management, security or network management, the CompTIA A+ Certification exams measure the baseline skills you need to master to begin your journey toward greater responsibilities and achievements in IT.

CompTIA A+ Certification is designed to be a "vendor-neutral" exam that measures your knowledge of industry-standard technology.

Goals and Methods

The number one goal of this book is a simple one: to help you pass the 2016 version of the CompTIA A+ Certification exams 220-901 and 220-902.

Because CompTIA A+ Certification exams now stress problem-solving abilities and reasoning more than memorization of terms and facts, our goal is to help you master and understand the required objectives for each exam.

To aid you in mastering and understanding the A+ Certification objectives, this book uses the following methods:

- The beginning of each chapter defines the topics to be covered in the chapter; it also lists the corresponding CompTIA A+ objective numbers.
- The body of the chapter explains the topics from a hands-on and a theory-based standpoint. This includes in-depth descriptions, tables, and figures that are geared to build your knowledge so that you can pass the exam. The chapters are broken down into several topics each.
- The key topics indicate important figures, tables, and lists of information that you should know for the exam. They are interspersed throughout the chapter and are listed in table format at the end of the chapter.
- You can find memory tables online in Appendix B, "Memory Tables" and Appendix C "Answers to Memory Tables." Use them to help memorize important information.
- Key terms without definitions are listed at the end of each chapter. Write down the definition of each term and check your work against the key terms in the glossary.

What's New?

You'll find plenty that's new and improved in this edition, including:

- Reorganized text to minimize duplication of coverage between objectives
- New coverage of Linux and OS X features and troubleshooting
- New coverage of MacBook features such as Thunderbolt 2
- Updated processor coverage
- Updated BIOS dialogs, including more UEFI BIOS examples
- USB 3.1 and USB-Type C
- mSATA and M.2 SSDs
- Improved photos and illustrations
- Enhanced laptop teardown and subassembly replacement procedures
- Updated memory coverage (DDR4 DIMMs and UniDIMMs)
- Updated coverage of mobile devices including teardown tips
- Enhanced coverage of desktop and laptop upgrades, including Thunderbolt and the miniPCIe card
- Updated coverage of docking stations and video cable adapters
- Updated power supply and cooling system information
- Improved coverage of network hardware and cabling
- Enhanced coverage of device troubleshooting, teardown, and upgrades
- New coverage of dealing with prohibited content/activity
- Enhanced coverage of Windows features
- Enhanced discussion of Windows upgrade paths and methods
- New Windows 8/8.1/10 features
- Enhanced coverage of ESD protection issues
- Enhanced coverage of Windows OS troubleshooting
- Enhanced Control Panel discussion
- Enhanced coverage of iOS and Android devices

- Enhanced coverage of security issues (physical, digital, wireless network, wired network, workgroup and homegroup folders)
- New coverage of network and cloud computing concepts
- Enhanced coverage of security issues
- New coverage of Linux and OS X OS troubleshooting

For a number of years, the CompTIA A+ Certification objectives were divided into a hardware exam and an operating systems exam. Starting with the 2006 exam, the exams were restructured so that knowledge of hardware and operating systems were needed for both exams. The 2012 exams were restructured again, and further restructuring has taken place for the 2016 exams. Exam 220-901 covers hardware, networking, mobile devices, and hardware and network troubleshooting. Exam 220-902 covers Windows operating systems; OS X, Linux, virtualization, cloud and network services; mobile operating systems; security; software troubleshooting for Windows, OS X, Linux, and mobile devices; and operational procedures.

For more information about how the A+ certification can help your career, or to download the latest official objectives, access CompTIA's A+ web page at https://certification.comptia.org/certifications/a.

In this book, we cover the major objectives but combine some of them when necessary to make a topic easier to understand. To make sure you can relate the book's contents to the CompTIA A+ Certification objectives, each chapter contains cross-references to the appropriate objectives as needed, and we provide a master cross-reference list later in this introduction.

Who Should Read This Book?

The CompTIA A+ exams measure the necessary competencies for an entry-level IT professional with the equivalent knowledge of 6 to 12 months of hands-on experience in the lab or field. This book is written for people who have that amount of experience working with desktop PCs, laptops, and mobile devices. Average readers will have attempted in the past to replace a hardware component within a PC or mobile device; they should also understand how to navigate through Windows, access the Internet, and have (or be willing to learn) a basic knowledge of OS X and Linux features.

Readers will range from people who are attempting to attain a position in the IT field to people who want to keep their skills sharp or perhaps retain their job due to a company policy that mandates that they take the new exams.

This book is also aimed at the reader who wants to acquire additional certifications beyond the A+ certification (Network+, Security+, and so on). The book is designed in such a way to offer easy transition to future certification studies.

Strategies for Exam Preparation

Strategies for exam preparation will vary depending on your existing skills, knowledge, and equipment available. Of course, the ideal exam preparation would consist of building a PC from scratch and installing and configuring the operating systems covered.

Chapter 1 contains lists of the tools, software, and operating systems recommended by CompTIA for exam study and preparation and how to track down the best deals. In Chapter 19, in the sidebar "Preparing for the A+ Certification Exam with Virtual Machines," we provide information on how to use popular virtualization programs and operating system trial versions to run Windows and Linux on your existing system. To run OS X as a VM, see http://techsviewer.com/how-to-install-mac-os-x-el-capitan-on-vmware-on-pc/.

This hands-on approach will really help to reinforce the ideas and concepts expressed in the book. However, not everyone has access to this equipment, so the next best step you can take is to read through the chapters in this book, jotting notes down with key concepts or configurations on a separate notepad. Each chapter contains a quiz that you can use to test your knowledge of the chapter's topics. It's located near the end of the chapter.

After you have read through the book, have a look at the current exam objectives for the CompTIA A+ Certification Exams listed at https://certification.comptia.org/certifications/a. If there are any areas shown in the certification exam outline that you would still like to study, find those sections in the book and review them.

When you feel confident in your skills, attempt the practice exam included on the companion website with this book. As you work through the practice exam, note the areas where you lack confidence and review those concepts or configurations in the book. After you have reviewed the areas, work through the practice exam a second time and rate your skills. Keep in mind that the more you work through the practice exam, the more familiar the questions will become.

After you have worked through the practice exam a second time and feel confident with your skills, schedule the real CompTIA A+ 220-901 and 220-902 exams through Pearson Vue (www.vue.com). To prevent the information from evaporating out of your mind, you should typically take the exam within a week of when you consider yourself ready to take the exam.

The CompTIA A+ Certification credential for those passing the certification exams is valid for three years. To renew your certification without retaking the exam, you need to participate in continuing education (CE) activities and pay an annual maintenance fee of $25.00 ($75.00 for three years). See https://certification.comptia.org/continuing-education/how-to-renew/ce-program-fees for fee details. To learn more about the certification renewal policy, see https://certification.comptia.org/continuing-education.

Table I-1 CompTIA A+ Exam Topics

Chapter	Exam Topics	CompTIA A+ Exam Objectives Covered
1	Computer/Device Anatomy 101	220-901 Objectives 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.8, 1.10, 1.11
	Essential tools, equipment, and software for the technician	
	CompTIA six-step troubleshooting theory	220-902 5.5
2	Understanding BIOS and UEFI firmware	220-901 Objective 1.1
	Configuration of BIOS and UEFI firmware	
	Updating BIOS and UEFI firmware	
	Using BIOS and UEFI diagnostics	
3	Motherboard form factors	220-901 Objective 1.2
	Expansion slots	
	Components	
	Power, fan and front-panel connectors	
	Bus speeds	
	Reset button	
4	RAM types	220-901 Objective 1.3
	RAM form factors	
	ECC vs Non-ECC	
	RAM configurations	
	RAM compatibility	
5	Expansion card and slot overview	220-901 Objective 1.4
	Installation and configuration of sound, video, network, USB, and other PC expansion cards	220-901 Objective 1.9
	Riser cards	

Chapter	Exam Topics	CompTIA A+ Exam Objectives Covered
6	Optical drive types	220-901 Objective 1.5
	Magnetic hard disk drive	
	Flash drive	
	Solid state drive (SSD)	
	Drive installation	
	Hot-swapping drives	
	RAID types	
	Tape drive capacities	
7	Processor characteristics	220-901 Objective 1.6
	Intel and AMD socket types	
	Heat sinks and cooling	
	Installation	
8	Rear-panel and expansion card ports	220-901 Objective 1.7
	USB	220-901 Objective 1.11
	FireWire	
	SATA and eSATA	
	Thunderbolt	
	Video	
	Audio	
	PS/2	
9	Custom PC configurations	220-901 Objective 1.8
	Power supply selection and installation	220-901 Objective 1.10
	Installing and configuring input, output, and i/o devices	220-901 Objective 1.12
10	Printers and multifunction devices	220-901 Objective 1.12
		220-901 Objective 1.13
		220-901 Objective 1.14
		220-901 Objective 1.15

Chapter	Exam Topics	CompTIA A+ Exam Objectives Covered
11	Networking	220-901 Objective 2.1
	Cables	220-901 Objective 2.2
	Hardware	220-901 Objective 2.3
	Ports	220-901 Objective 2.4
	TCP/IP	220-901 Objective 2.5
	Routers	220-901 Objective 2.6
	Wireless	220-901 Objective 2.7
		220-901 Objective 2.8
		220-901 Objective 2.9
12	Laptop expansion options	220-901 Objective 3.1
	Replace components	220-901 Objective 3.2
	Laptop display components	220-901 Objective 3.3
	Laptop features	220-901 Objective 3.4
	Tablets, Phablets, Smartphones	220-901 Objective 3.5
	Wearables	
	e-readers	
	Accessories	
13	Troubleshooting motherboards, RAM, power supplies, CPUs	220-901 Objective 4.1
	Troubleshooting hard drives and RAID arrays	220-901 Objective 4.2
	Troubleshooting video cards and displays	220-901 Objective 4.3
	Troubleshooting networks	220-901 Objective 4.4
	Troubleshooting mobile devices	220-901 Objective 4.5
	Troubleshooting printers	220-901 Objective 4.6
14	Windows features	220-902 Objective 1.1
	Booting and installing Windows	220-902 Objective 1.2
	Partitions and file systems	
	Installing updates	
	Factory recovery partition	

Chapter	Exam Topics	CompTIA A+ Exam Objectives Covered
15	Using Microsoft Windows command line tools, features, and Control Panel utilities	220-902 Objective 1.3
		220-902 Objective 1.4
		220-902 Objective 1.5
16	Configuring and managing networks and sharing in Microsoft Windows	220-902 Objective 1.6
17	Safety procedures	220-902 Objective 5.1
	Environmental controls	220-902 Objective 5.2
	Addressing prohibited content and activity	220-902 Objective 5.3
	Software licensing issues	220-902 Objective 5.4
	Policies and security best practices	
	Communicating methods and professional behavior	
18	OS X and Linux common functions	220-902 Objective 2.1
	Backup	
	Tools	
	Basic Linux commands	
	Features	
19	Client-side virtualization	220-902 Objective 2.2
	SaaS, public cloud, and other cloud computing concepts	220-902 Objective 2.3
	Roles of network hosts (servers, Internet appliances, legacy/embedded systems)	220-902 Objective 2.4
20	Basic features of Android, iOS, and Windows Mobile operating systems	220-902 Objective 2.5
		220-902 Objective 2.6
	Configuring connectivity and email	220-902 Objective 2.7
	Mobile device synchronization	
21	Security threats and vulnerabilities	220-902 Objective 3.1
	Prevention methods	220-902 Objective 3.2
	Windows security settings	220-902 Objective 3.3
	Security best practices for workstations	220-902 Objective 3.4
	Securing mobile devices	220-902 Objective 3.5
	Data destruction and disposal	220-902 Objective 3.6
	SOHO network security	220-902 Objective 3.7

Chapter	Exam Topics	CompTIA A+ Exam Objectives Covered
22	Troubleshoot Windows, Linux, OS X operating systems	220-902 Objective 4.1
	Troubleshooting iOS and Android devices, applications, security	220-902 Objective 4.2
		220-902 Objective 4.3
		220-902 Objective 4.4

Companion Website

Register this book to get access to the Pearson IT Certification test engine and other study materials plus additional bonus content. Check this site regularly for new and updated postings written by the author that provide further insight into the more troublesome topics on the exam. Be sure to check the box that you would like to hear from us to receive updates and exclusive discounts on future editions of this product or related products.

To access this companion website, follow these steps:

Step 1. Go to www.pearsonITcertification.com/register and log in or create a new account.

Step 2. Enter the ISBN: 9780789756527.

Step 3. Answer the challenge question as proof of purchase.

Step 4. Click on the Access Bonus Content link in the Registered Products section of your account page to be taken to the page where your downloadable content is available.

Please note that many of our companion content files can be very large, especially image and video files.

If you are unable to locate the files for this title by following the steps, please visit www.pearsonITcertification.com/contact and select the "Site Problems/ Comments" option. Our customer service representatives will assist you.

Pearson IT Certification Practice Test Engine and Questions

The companion website includes the Pearson IT Certification Practice Test engine—software that displays and grades a set of exam-realistic multiple-choice questions. Using the Pearson IT Certification Practice Test engine, you can either study by going through the questions in Study Mode or take a simulated exam that mimics real exam conditions.

The installation process requires two major steps: installing the software and then activating the exam. The website has a recent copy of the Pearson IT Certification Practice Test engine. The practice exam—the database of exam questions—is not on this site.

NOTE The cardboard case in the back of this book includes the companion website and a piece of paper. The paper lists the activation code for the practice exam associated with this book. Do not lose the activation code. On the opposite side of the paper from the activation code is a unique, one-time use coupon code for the purchase of the Premium Edition eBook and Practice Test.

Install the Software

The Pearson IT Certification Practice Test is a Windows-only desktop application. You can run it on a Mac using a Windows Virtual Machine, but it was built specifically for the PC platform. The minimum system requirements are:

- Windows 10, Windows 8.1, or Windows 7
- Microsoft .NET Framework 4.5 Client
- Pentium class 1 GHz processor (or equivalent)
- 512 MB RAM
- 650 MB disc space plus 50 MB for each downloaded practice exam
- Access to the Internet to register and download exam databases

The software installation process is pretty routine as compared with other software installation processes. If you have already installed the Pearson IT Certification Practice Test software from another Pearson product, there is no need for you to reinstall the software. Simply launch the software on your desktop and proceed to activate the practice exam from this book by using the activation code included in the access code card sleeve in the back of the book.

The following steps outline the installation process:

Step 1. Download the exam practice test engine from the companion site.

Step 2. Respond to Windows prompts as you would with any typical software installation process.

The installation process will give you the option to activate your exam with the activation code supplied on the paper in the cardboard sleeve. This process requires that you establish a Pearson website login. You will need this login in order to activate

the exam, so please do register when prompted. If you already have a Pearson website login, there is no need to register again. Just use your existing login.

Activate and Download the Practice Exam

Once the exam engine is installed, you should then activate the exam associated with this book (if you did not do so during the installation process) as follows:

Step 1. Start the Pearson IT Certification Practice Test software from the Windows **Start** menu or from your desktop shortcut icon.

Step 2. To activate and download the exam associated with this book, from the **My Products** or **Tools** tab, select the **Activate Exam** button.

Step 3. At the next screen, enter the Activation Key from paper inside the cardboard holder in the back of the book. Once entered, click the **Activate** button.

Step 4. The activation process will download the practice exam. Click **Next**, then click **Finish.**

Once the activation process is completed, the **My Products** tab should list your new exam. If you do not see the exam, make sure you have selected the **My Products** tab on the menu. At this point, the software and practice exam are ready to use. Simply select the exam and click the **Open Exam** button.

To update a particular exam you have already activated and downloaded, simply select the **Tools** tab and select the **Update Products** button. Updating your exams will ensure you have the latest changes and updates to the exam data.

If you wish to check for updates to the Pearson Cert Practice Test exam engine software, simply select the **Tools** tab and select the **Update Application** button. This will ensure you are running the latest version of the software engine.

Activating Other Exams

The exam software installation process, and the registration process, only has to happen once. Then, for each new exam, only a few steps are required. For instance, if you buy another new Pearson IT Certification Cert Guide or Cisco Press Official Cert Guide, extract the activation code from the cardboard sleeve in the back of that book—you don't even need the exam engine at this point. From there, all you have to do is start the exam engine (if not still up and running), and perform steps 2 through 4 from the previous list.

Premium Edition eBook and Practice Tests

This book also includes an exclusive offer for 70% off the Premium Edition eBook and Practice Tests edition of this title. Please see the coupon code included with the cardboard sleeve for information on how to purchase the Premium Edition.

This chapter covers the following subjects:

- **Introduction to BIOS/UEFI**—This section explains the motherboard's firmware, known as the BIOS or UEFI.
- **BIOS/UEFI Configuration**—This section demonstrates how to access the BIOS and modify settings; for example, RAM, processor, and video settings.
- **Flash Upgrade BIOS/UEFI**—In this section, you learn how to upgrade the BIOS through a process known as flashing.
- **Using BIOS/UEFI Diagnostics**—In this section, you learn about diagnostic features built into many BIOS/UEFI chips.

Configure and Use BIOS/UEFI Tools

The **Basic Input/Output System (BIOS)** is an essential component of the motherboard. This boot firmware, also known as System BIOS or, on most recent systems, unified extensible firmware interface (UEFI), is the first code run by a computer when it is booted. It prepares the machine by testing it during bootup and paves the way for the operating system to start. It tests and initializes components such as the processor, RAM, video card, hard drives, optical, and USB drives. If any errors occur, the BIOS/UEFI reports them as part of the testing stage, known as the **power-on self-test (POST)**. The BIOS/UEFI resides on a ROM chip and stores a setup program that you can access when the computer first boots up. From this program, a user can change settings in the BIOS and upgrade the BIOS as well. In this chapter, you find out about how the BIOS/UEFI, **CMOS**, and batteries on the motherboard interact and learn how to configure and upgrade the BIOS.

From this point on, the term *BIOS* refers to both traditional BIOS and UEFI firmware except when they differ in function.

220-901: Objective 1.1 Given a scenario, configure settings and use BIOS/UEFI tools on a PC.

Foundation Topics

BIOS/UEFI Configuration

The system BIOS has default settings provided by the system or motherboard maker, but as a system is built up with storage devices, memory modules, adapter cards, and other components, it is usually necessary to alter the standard settings.

To perform this task, the system assembler must use the BIOS setup program to make changes and save them to the CMOS (complementary metal oxide semiconductor) chip. Originally, the BIOS setup program was run from a bootable floppy disk, but for many years virtually all system BIOS chips have included the setup program.

Accessing the BIOS Setup Program

The BIOS configuration program is stored in the BIOS chip itself. Just press the key or key combination displayed onscreen (or described in the manual) to get started.

Key Topic

Although these keystrokes vary from system to system, the most popular keys on current systems include the escape (Esc) key, the Delete (Del) key, the F1 key, the F2 key, or the F10 key.

Most recent systems display the key(s) necessary to start the BIOS setup program at startup, as shown in Figure 2-1. However, if you don't know which key to press to start your computer's BIOS setup program, check the system or motherboard manual for the correct key(s).

1. Keystrokes for configuration options at startup

Figure 2-1 A typical splash screen displays the keystrokes needed to start the BIOS setup program.

NOTE Because the settings you make in the BIOS setup program are stored in the nonvolatile CMOS, the settings are often called CMOS settings or BIOS settings. The contents of CMOS are maintained by a battery. See Chapter 3, "Motherboard Components," for typical BIOS chip and CMOS battery locations on current systems.

CAUTION BIOS configuration programs vary widely, but the screens used in the following sections are representative of the options available on typical recent systems; your system might have similar options but place the settings on different screens than those shown here. Laptops, corporate desktops, and Windows tablets generally offer fewer options than those shown here.

OS X uses operating system menus to make changes to system devices, rather than permitting direct access to the BIOS. See Chapter 18, "OS X and Linux," for details.

Be sure to consult the manual that came with your computer or motherboard before toying with the settings you find here. Fiddling with the settings can improve performance, but it can also wreak havoc on an otherwise healthy device if you don't know what you're doing. Be warned!

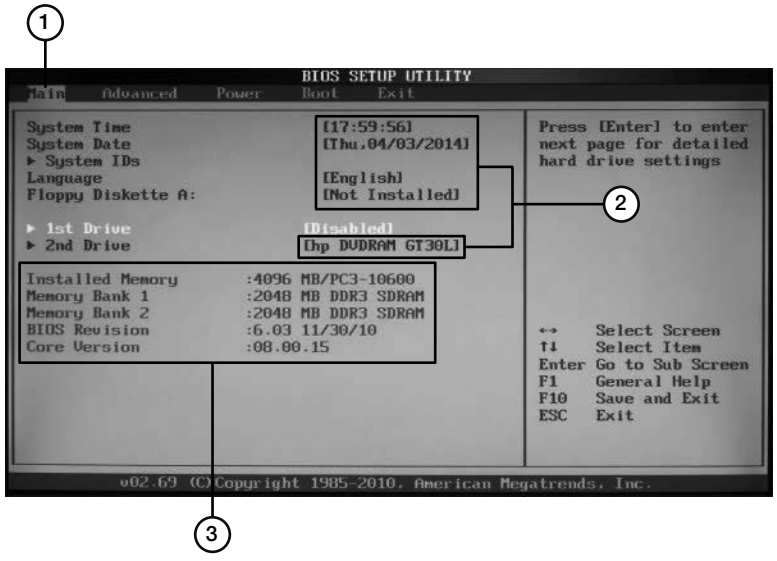
UEFI and Traditional BIOS

Key Topic

Most recent desktop and laptop computers (and all desktop and laptop computers from 2014 on) now use a new type of firmware called the Unified Extensible Firmware Initiative (UEFI) to display a mouse-driven GUI or text-based menu for BIOS setup. OS X computers all use UEFI firmware. Compared to a traditional Flash ROM BIOS, UEFI has the following advantages:

- Support for hard drives of 2.2TB and higher capacity. These drives require the use of the GUID Partition Table (GPT) to access full capacity.
- Faster system startup (booting) and other optimizations.
- Larger-size ROM chips used by UEFI make room for additional features, better diagnostics, the ability to open a shell environment for easy flash updates, and the ability to save multiple BIOS configurations for reuse.

UEFI firmware offers similar settings to those used by a traditional BIOS (see Figure 2-2) along with additional options (refer to Figures 2-3 and beyond). Most desktop systems with UEFI firmware use a mouse-driven graphical interface. However, many laptops with UEFI firmware use a text-based interface similar to BIOS.



1. Selected menu
2. Editable items
3. Reported by system; not editable

Figure 2-2 This computer uses a traditional BIOS.

To learn more about UEFI, visit http://www.uefi.org/.

NOTE For more information about BIOS and UEFI functions, beep codes, and upgrades, see the BIOS chapter in the 22nd edition of Scott Mueller's Upgrading and Repairing PCs.

BIOS Settings Overview

The following sections review the typical setup process using various UEFI firmware versions on systems running Intel Core i3 3227U, Intel Core i5 i6600, AMD FX-8350, and AMD A10-5800K processors.

Table 2-1 provides a detailed discussion of the most important CMOS/BIOS settings. Use this table as a quick reference to the settings you need to make or verify in any system. Examples of these and other settings are provided in the following sections.

Key Topic

Table 2-1 Major CMOS/BIOS/UEFI Settings

Option	Settings	Notes
Boot Sequence	Hard drive, optical (CD/DVD, Blu-ray), USB, network ROM; order as wanted	To boot from bootable OS or diagnostic CDs or DVDs, place the CD or DVD (optical) drive before the hard drive in the boot sequence. To boot from a bootable USB device, place the USB device before the hard drive in the boot sequence. You can enable or disable additional boot devices on some systems.
Memory Configuration	By SPD or Auto (default); manual settings (Frequency, CAS Latency [CL], Fast R-2-R turnaround, and so on) also available	Provides stable operation using the settings stored in memory by the vendor. Use manual settings (frequency, CAS latency, and so on) for overclocking (running memory at faster than normal speeds) or to enable memory of different speeds to be used safely by selecting slower settings.
CPU **Clock** and Frequency	Automatically detected on most recent systems	Faster or higher settings overclock the system but could cause instability (see Chapter 8, "Ports and Interfaces," for details). Some systems default to low values when the system doesn't start properly.
Hardware Monitor	Enable display for all fans plugged in to the motherboard	Also known as PC Health on some systems; can be monitored from within the OS with vendor-supplied or third-party utilities.
Onboard Audio, Modem, or Network	Enable or disable	Enable when you don't use add-on cards for any of these functions; disable each setting before installing a replacement card. Some systems include two network adapters.
USB Legacy	Enable when USB keyboard is used	Enables USB keyboard to work outside the OS.
Serial Ports	Disable unused ports; use default settings for port you use	Also known as COM ports. Most systems no longer have serial ports.
Parallel Port	Disable unused port; use EPP/ECP mode with default IRQ/DMA when parallel port or device is connected	Compatible with almost any parallel printer or device; be sure to use an IEEE-1284-compatible printer cable. Most recent systems no longer include parallel (LPT) ports.
USB Function	Enable	When motherboard supports USB 2.0 (Hi-Speed USB) ports, be sure to enable USB 2.0 function and load USB 2.0 drivers in the OS.

Option	Settings	Notes
USB 3.0 Function	Enable	USB 3.0 ports also support USB 3.1, 2.0, and USB 1.1 devices. Disable when USB 3.0 drivers are not available for operating system.
Keyboard	NumLock, auto-repeat rate/ delay	Leave at defaults (NumLock On) unless keyboard has problems.
Plug-and-Play OS	Enable for all except some Linux distributions, Windows NT, MS-DOS	When enabled, Windows configures devices.
Primary VGA BIOS	Varies	Select the primary graphics card type (PCIe or onboard).
Shadowing	Varies	Enable shadowing for video BIOS; leave other shadowing disabled.
Quiet Boot	Varies	Disable to display system configuration information at startup.
Boot-Time Diagnostic Screen	Varies	Enable to display system configuration information at startup.
Virtualization	Varies	Enable to run hardware-based virtualization programs such as Hyper-V or Parallels so that you can run multiple operating systems, each in its own window.
Power Management (Menu)	Enable unless you have problems with devices	Enable CPU fan settings to receive warnings of CPU fan failure.
S1 or S3 standby	Enable S3	Use S1 (which saves minimal power) only when you use devices that do not properly wake up from S3 standby.
AC Pwr Loss Restart	Enable restart or Full on	Prevents the system from staying down when a power failure takes place.
Wake on LAN (WOL)	Enable when you use WOL-compatible network card or modem	WOL-compatible cards use a small cable between the card and the motherboard. Some integrated network ports also support WOL.
User/Power-On Password	Blocks system from starting when password is not known	Enable when physical security settings are needed, but be sure to record the password in a secure place.
Setup Password	Blocks access to setup when password is not known	Both passwords can be cleared on both systems when CMOS RAM is cleared.

Option	Settings	Notes
Write-Protect Boot Sector	Varies	Enable for normal use, but disable when installing drives or using a multiboot system. Helps prevent accidental formatting but might not stop third-party disk prep software from working.
Boot Virus Detection (Antivirus Boot Sector)	Enable	Stops true infections but allows multiboot configuration.
SATA Drives	Varies	Auto-detects drive type and settings at startup time. Select CD/DVD for CD/DVD/Blu-ray drive; select None when drive is not present or to disable an installed drive.
SATA Drive configuration	IDE, AHCI, RAID	IDE setting emulates now-obsolete PATA drives. To take advantage of hot-swapping and Native Command Queuing (NCQ) to improve performance, select AHCI. Use RAID when the drive will be used as part of a RAID array.

Automatic Configuration of BIOS/CMOS Settings

As you can see from Table 2-1, there are many options to select when configuring BIOS settings. Many BIOS firmware versions enable you to automatically configure your system with a choice of these options from the main menu:

- BIOS defaults (also referred to as Original/Fail-Safe on some systems)
- Setup defaults (also referred to as Optimal on some systems)

These options primarily deal with performance configuration settings in the BIOS firmware, such as memory timings, memory cache, and the like. The settings used by each BIOS setup option are customized by the motherboard or system manufacturer.

Use BIOS defaults to troubleshoot the system because these settings are conservative in memory timings and other options. Normally, the setup defaults provide better performance. As you view the setup screens in this chapter, you'll note these options are listed.

CAUTION If you use automatic setup after you make manual changes, all your manual changes will be overridden. Use Setup Defaults and then make any other changes you want.

With many recent systems, you can select Optimal or Setup defaults, save your changes, and then exit; the system will then work acceptably. However, to configure drive settings, USB settings, or to enable or disable ports, you also need to work with individual BIOS settings, such as the ones shown in the following sections.

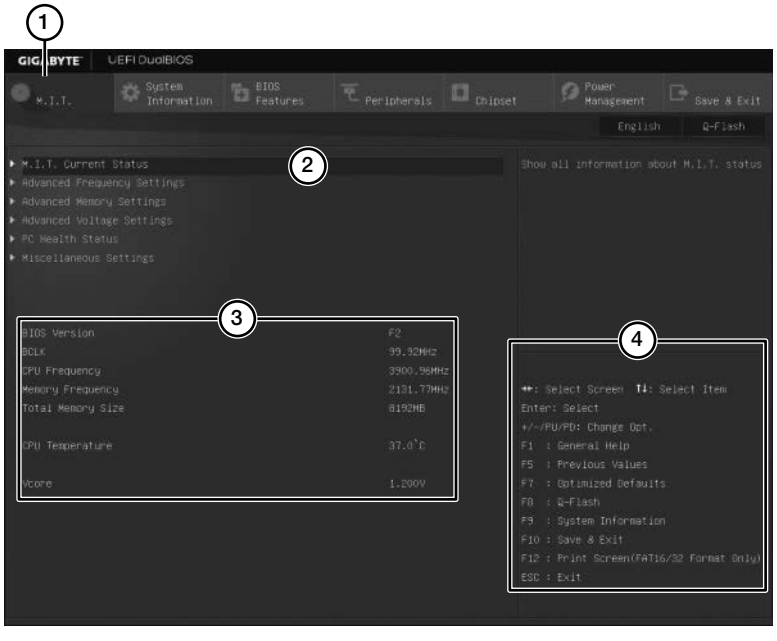
TIP On typical systems, you set numerical settings, such as date and time, by scrolling through allowable values with keys such as + and – or page up/page down. However, to select settings with a limited range of options, such as enable/disable or choices from a menu, press Enter or the right-arrow key on the keyboard and then choose the option you want from the available choices.

Main Menu

When you start the BIOS configuration program for your system, you might see a GUI menu similar to the UEFI CMOS Setup Utility menus shown in Figures 2-3 and 2-4. Many laptops and corporate-oriented desktop computers with UEFI BIOS use a text-based menu such as the one shown in Figure 2-5 (later in this chapter).

From this menu, you can go to any menu, select default settings, save changes, or exit setup without saving any changes.

Key Topic



1. Selected menu
2. Current submenu
3. BIOS, Memory, and CPU information
4. Keystroke legend

Figure 2-3 A typical UEFI main setup menu for a desktop system with an Intel processor (UEFI BIOS for Gigabyte Z170XP-SLI).

TIP When you need to quickly find a particular BIOS setting and don't have the manual for the system or the motherboard, visit the system or motherboard vendor's website and download the manual. In most cases, especially with a motherboard-specific manual, the BIOS screens are illustrated. Most vendors provide the manuals in Adobe Reader (PDF) format.

Key Topic

1. Current menu
2. UEFI BIOS and memory information
3. Keystroke legend

Figure 2-4 A typical UEFI main setup menu for a desktop system with an AMD processor (UEFI BIOS for BIOSTAR Hi-Fi A85W).

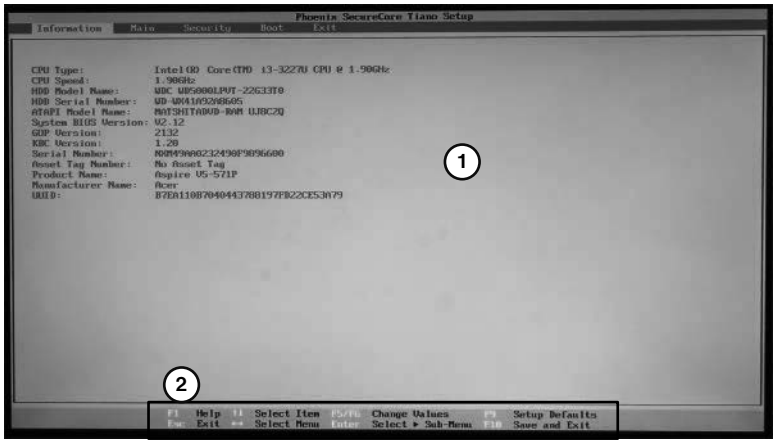
Main/Standard Features/Settings

The Main/Standard Features/Settings menus (refer to Figures 2-3 and 2-4) frequently report system features (such as the motherboard model and onboard RAM) and sometimes also configure the system's date and time. To access other settings, use arrow keys or your mouse to highlight the appropriate icon or text menu.

Discovering System Information

Most systems display system information such as processor type, clock speed, cache memory size, installed memory (RAM), and BIOS information from within the

BIOS (see Figure 2-5). Use this information to help determine whether a system needs a processor, memory, or BIOS update.



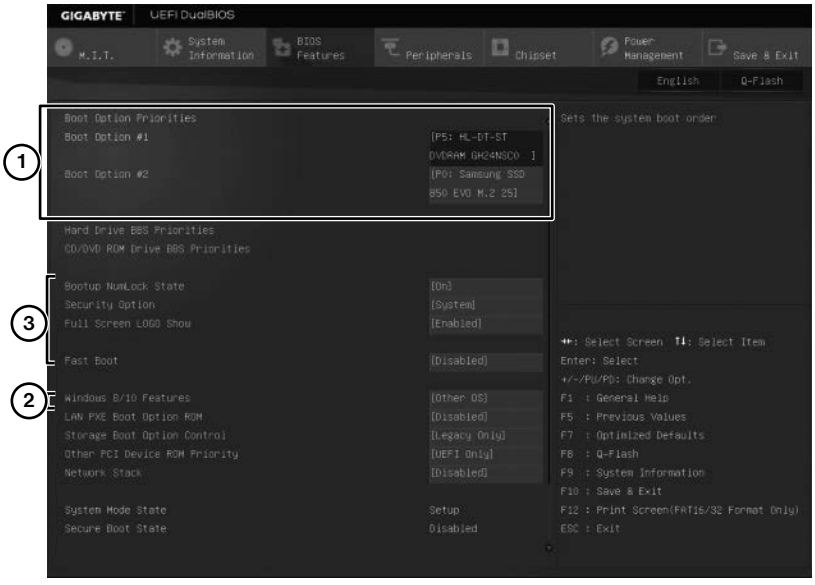
1. Processor and BIOS information
2. Keystroke legend

Figure 2-5 Information dialog on a typical laptop with text-based UEFI firmware.

NOTE You might need to look at multiple screens to locate all CPU and BIOS information desired, depending upon the system.

Boot Settings and Boot Sequence

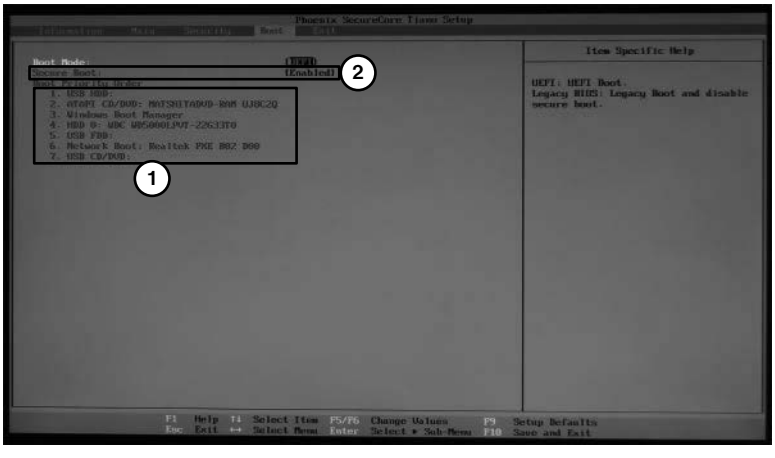
Most computers include settings that control how the system boots and the sequence in which drives are checked for bootable operating system files. Depending on the system, these settings might be part of a larger menu, such as an Advanced Settings menu, a BIOS Features menu (see Figure 2-6), or a separate Boot menu (see Figure 2-7).



1. **Boot sequence**
2. **Other OS setting [eq] secure boot disabled**
3. **Other boot options**

Figure 2-6 Boot sequence and other boot settings in the BIOS Features menu.

Key Topic



1. **CD/DVD and USB flash boot before windows boot manager or hard disk drive**
2. **Secure boot enabled**

Figure 2-7 A typical Boot menu configured to permit booting from a CD/DVD or USB flash drive before the hard drive.

Enabling Fast Boot skips memory and drive tests to enable faster startup. Enabling Boot Up NumLock turns on the keyboard's NumLock option.

Secure Boot

When enabled, **Secure Boot** (see Figure 2-7)—also known as Windows 8/10 Features in Figure 2-6)—blocks installation of other operating systems and also requires the user to access UEFI setup by restarting the computer in a special Troubleshooting mode from within Windows 8 or later. Secure Boot is enabled by default on systems shipped with Windows 8, 8.1, or 10. Windows 7 users, Linux users, or those who want more flexibility in accessing UEFI BIOS (for example, technicians making changes in UEFI firmware) should disable Secure Boot.

The menus shown in Figures 2-6 and 2-7 are used to adjust the order in which drives are checked for bootable media. For faster booting, set the hard drive with system files as the first boot device. However, when you want to have the option to boot from an optical (CD/DVD/Blu-ray) disk or from a USB flash or hard drive for diagnostics or operating system installations, put those drives before SATA hard drives in the boot order.

NOTE Even when the first boot drive is set up as CD/DVD, some discs will prompt the user to press a key to boot from the CD/DVD drive when a bootable disc is found. Otherwise, the system checks the next available device for boot files.

Integrated Ports and Peripherals

Typical desktop systems are loaded with onboard ports and features, and the menus shown in Figures 2-8, 2-9, 2-10, and 2-11 are typical of the BIOS menus used to enable, disable, and configure storage, audio, network, and USB ports.

SATA Configuration

Use the SATA configuration options (such as those shown in Figure 2-8) to enable or disable SATA and eSATA ports and to configure SATA host adapters to run in compatible (emulating PATA), native (AHCI), or RAID modes. AHCI supports Native Command Queuing (NCQ) for faster performance and permits hot-swapping of eSATA drives.

To learn more about RAID configuration, see "RAID Types" in Chapter 6, "Storage Devices."

USB Host Adapters and Charging Support

Most systems have separate settings for the USB (2.0) and USB 3.0 (a.k.a. SuperSpeed) controllers (on systems that have USB 3.0 ports). If you don't enable USB 2.0 or USB 3.0 in your system BIOS, all your system's USB ports will run at the next lower speed.

Some USB configuration utilities can also be used to enable a specified USB port to output at a higher amperage than normal to enable faster charging of smartphones. Figure 2-9 illustrates a system with USB 3.0 support enabled and battery charting support being enabled.

1. SATA ports enabled
2. SATA ports configured to run in AHCI mode
3. Port 0 is connected to a 250GB SSD
4. Port 1 is connected to a DVD optical drive

Figure 2-8 A UEFI configuration dialog for SATA ports.

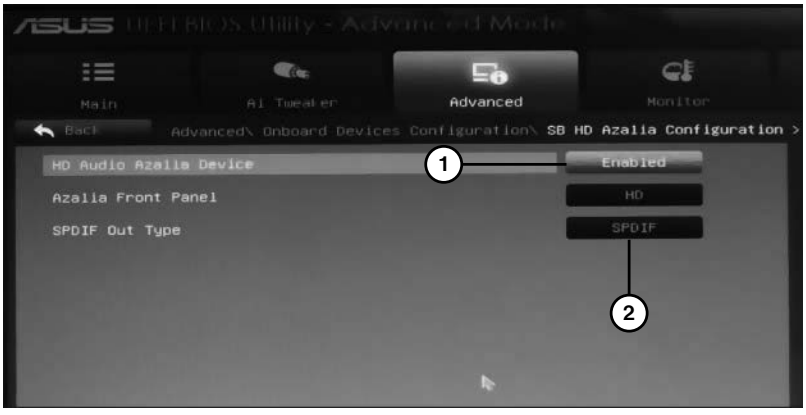
1. **USB 3.0 host adapter enabled**
2. **Charging option being edited**

Figure 2-9 Configuring a USB host adapter for battery charging.

Audio and Ethernet Ports

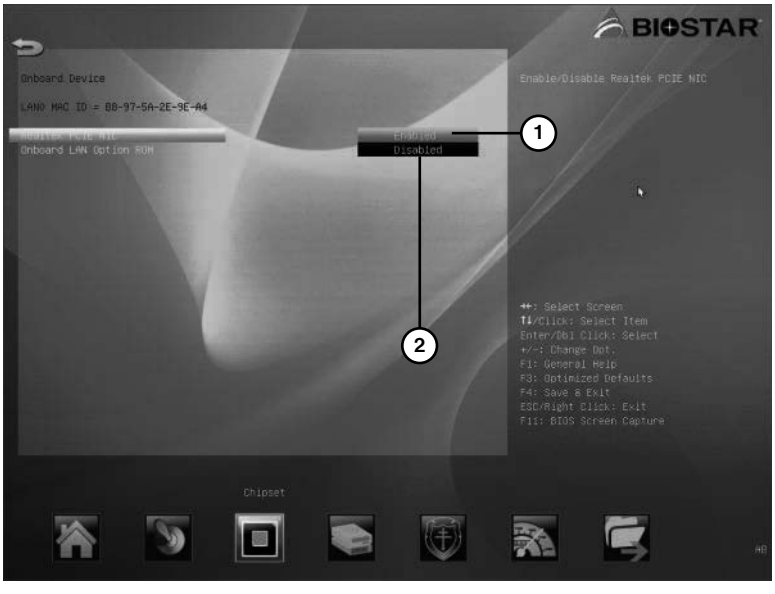
Depending upon the system, these and other integrated ports might be configured using a common menu or on separate menus. In Figure 2-10, the HD "Azalia" onboard audio is enabled; if a separate sound card was installed, onboard audio should be disabled. SPDIF audio can be directed through the SPDIF digital audio port (default) or the HDMI AV port (optional) using this menu.

In Figure 2-11, the onboard LAN option ROM is disabled on this system. Enable it when you want to boot from an operating system that is stored on a network drive.



1. HD Audio enabled
2. Change to HDMI to permit HDMI cable to carry audio as well as video signals

Figure 2-10 Configuring onboard HD Audio.



1. Ethernet network adapter enabled
2. LAN Option ROM (for booting from network) disabled

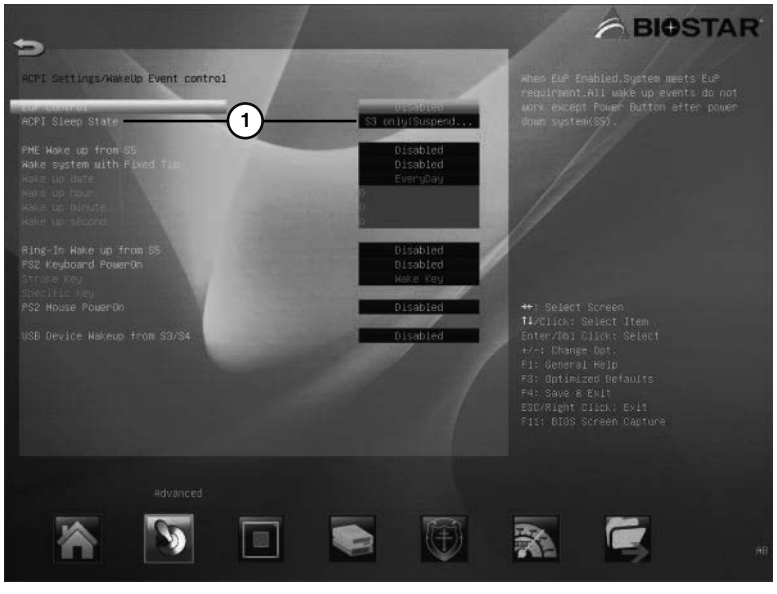
Figure 2-11 Configuring the onboard network adapter.

NOTE Systems with support for legacy ports such as floppy, serial (COM), and parallel (LPT) use a separate BIOS settings menu for configuration. Do not enable these ports unless you use them.

Power Management

Although operating systems include power management features, the BIOS controls how any given system responds to standby or power-out conditions. Figure 2-12 illustrates a typical power management menu.

Key Topic



1. ACPI S3 sleep state enabled

Figure 2-12 Typical power management configuration menu.

ACPI is the power management function used in modern systems, replacing the older APM standard; it should be enabled. Most systems offer two ACPI standby states: S1/POS (power on standby) and S3/STR (suspend to RAM). Use S3/STR whenever possible because it uses much less power when the system is idle.

You can also configure your system power button, specify how to restart your system when AC power is lost, and specify how to wake up a system from standby, sleep, or hibernation modes. Some systems display these settings in the same dialog as power management, whereas others use a separate dialog or submenu.

Monitoring

As hot as a small room containing a PC can get, it's a whole lot hotter inside the PC itself. Excessive heat is the enemy of system stability and shortens the life of your hardware. Adding fans can help, but when they fail, you have problems. See Chapter 7, "CPUs," for more information.

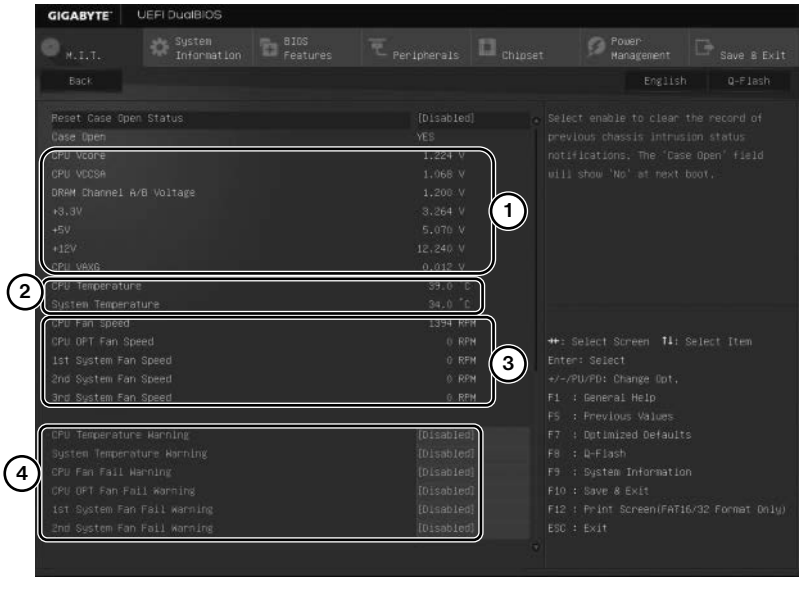
The Hardware Monitor BIOS dialog (sometimes referred to as PC Health) is a common feature in most recent desktop systems. It is used to display the following (refer to Figure 2-13):

- Temperature monitoring
- Fan speeds
- Intrusion detection/notification
- **Voltage**

Many systems can also be configured to warn when CPU or system temperatures reach a dangerously high level or when fans stop turning or spin at too low a speed for proper cooling.

Windows-based hardware monitoring programs can also be used to display this information during normal system operation.

Key Topic

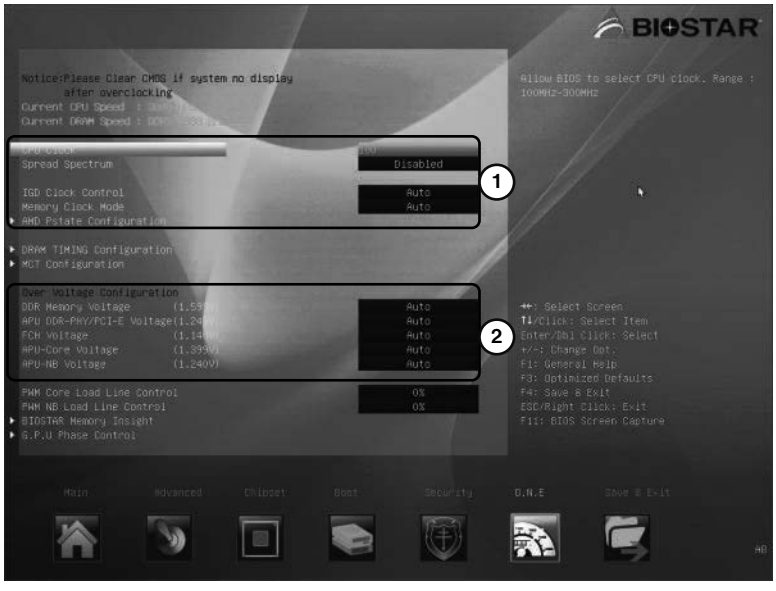


1. Voltage levels
2. Temperature levels
3. Fan speeds
4. Warnings (not configured)

Figure 2-13 Typical PC Health hardware monitoring menu.

Processor and Memory Configuration

To monitor system clock and **bus speed** settings, check the processor and memory configuration dialog typically available on gaming-oriented systems or others designed for overclocking (see Figure 2-14). On these systems, you can disable the normal Auto settings and manually tweak speeds, voltages, and other timing settings.



1. Clock adjustment options
2. Voltage adjustments

Figure 2-14 CPU configuration dialog used for viewing and changing clock and bus speeds for overclocking.

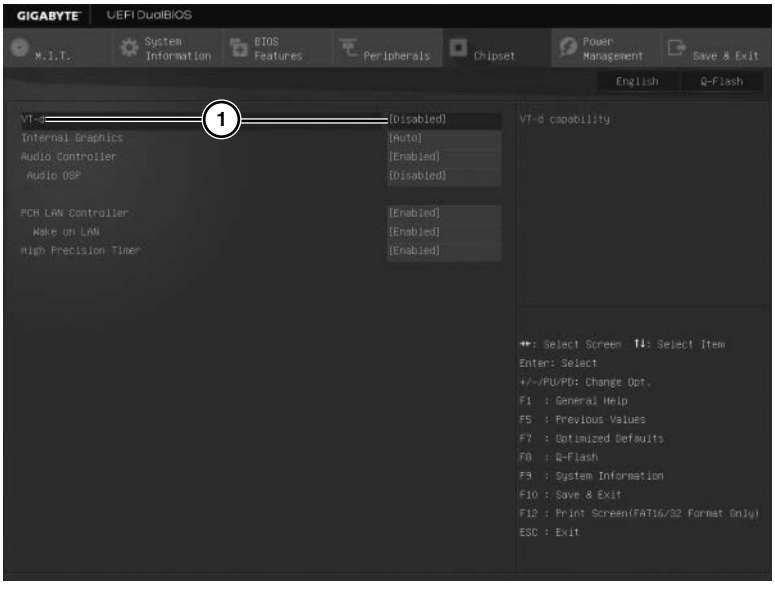
Virtualization Support

Virtualization is the capability to run multiple operating systems on a single computer at the same time. Although virtualization does not require processor support, virtualization programs such as Windows Virtual PC and Hyper-V, Oracle VM VirtualBox, and versions of VMware Workstation provide much better performance on systems that have hardware-assisted **virtualization support** enabled.

For a system to support hardware-assisted virtualization, it must include a CPU that supports virtualization and virtualization must be enabled in the system BIOS.

NOTE Intel processors that include VT-x technology support hardware-assisted virtualization. AMD processors that include AMD-V technology support hardware-assisted virtualization. To determine whether a computer running Windows can support hardware-assisted virtualization, download and run havdetectiontool.exe, which is available from the Microsoft Download Center at www.microsoft.com.

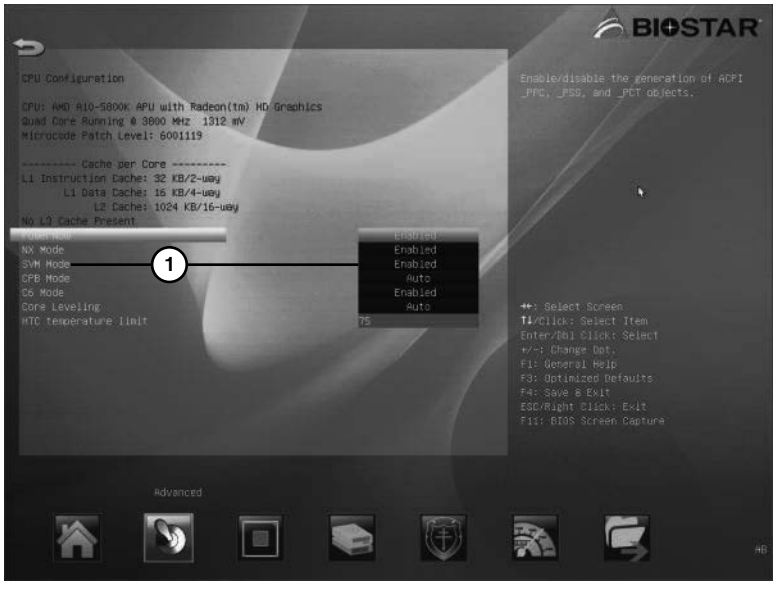
Intel-based systems with VT support might have two entries for virtualization. Intel Virtualization Technology (also known as VT or VT-x) must be enabled for hardware-assisted virtualization to be supported. Intel VT with Directed I/O (VT-d Tech) can also be enabled to help improve I/O performance, although processors that support VT-x vary in their levels of VT-d support. Some systems, such as the one shown in Figure 2-15, have a single entry that enables or disables virtualization. When VT-d is enabled, VT-x is also enabled.



1. Intel virtualization not enabled

Figure 2-15 Virtualization is not enabled on this Intel-based system.

AMD-based systems that support hardware-assisted virtualization feature a single BIOS setting that might be labeled Virtualization, Secure Virtual Machine Mode, or SVM (see Figure 2-16).



1. AMD virtualization enabled.

Figure 2-16 Virtualization has been enabled on this AMD-based system.

Security Features

Security features of various types are scattered around the typical system BIOS/UEFI dialogs. Features and their locations vary by system and might include:

- **BIOS password**—BIOS Settings Password or Security dialogs
- **Power-on password**—Configured through the Security dialog
- **Chassis intrusion**—Various locations
- **Boot sector protection**—Advanced BIOS Features dialog
- **Secure Boot**—Boot or other dialogs
- **LoJack for Laptops**—An after-market product embedded in firmware or installed by the end user; not managed with BIOS dialogs
- **TPM (trusted program module)**—Security dialog

Enable the BIOS password feature to permit access to BIOS setup dialogs only for those with the password. The power-on password option prevents anyone without the password from starting the system. Note that these options can be defeated by opening the system and clearing the CMOS memory.

Intrusion detection/notification, also known as Chassis Intrusion, when enabled, displays a warning on startup that the system has been opened.

Boot sector protection, found primarily on older systems, protects the default system drive's boot sector from being changed by viruses or other unwanted programs. Depending on the implementation, this option might need to be disabled before an operating system installation or upgrade.

Secure Boot is a feature that permits only software trusted by the PC manufacturer to be used to boot the system. When Secure Boot is enabled, the UEFI firmware checks for signatures on the boot software, option ROMs, and the operating system. Secure Boot support was first introduced in Windows 8, Windows RT, Windows Server 2012, and is also supported in newer versions.

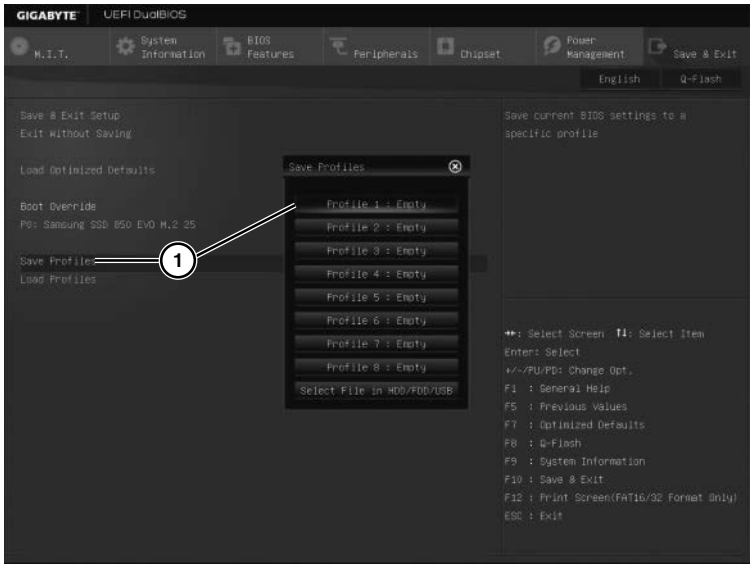
A **TPM (trusted program module)** is used by Windows editions that support BitLocker full-disk encryption feature to protect the contents of the system hard drive (Vista) or any specified drive (Windows 7/8/8.1/10). Although many corporate laptops include a built-in TPM module, desktop computers and servers might include a connection for an optional TPM. For more information about using BitLocker, see Chapter 21, "Security."

LoJack for Laptops (and other mobile devices) is a popular security feature embedded in the laptop BIOSes of a number of systems and can be added to other systems. It consists of two components: a BIOS-resident component and the Computrace Agent, which is activated by LoJack when a computer is reported as stolen. To learn more about LoJack for laptops, tablets, and smartphones see www.absolute.com/en/lojackforlaptops/home.aspx.

Exiting BIOS and Saving/Discarding Changes

When you exit the BIOS setup program, you can elect to save configuration changes or discard them. Many systems with UEFI firmware permit the user to save multiple BIOS configuration settings (see Figure 2-17).

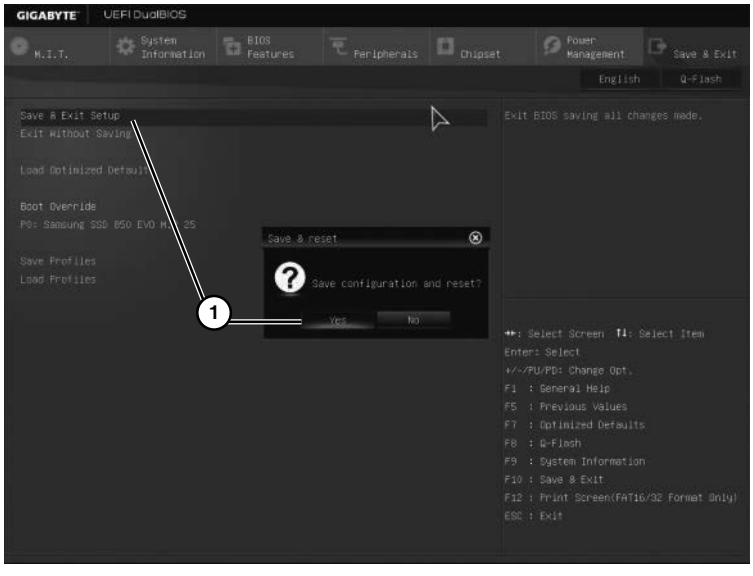
Key Topic



1. Selecting a location for storing the current UEFI firmware settings

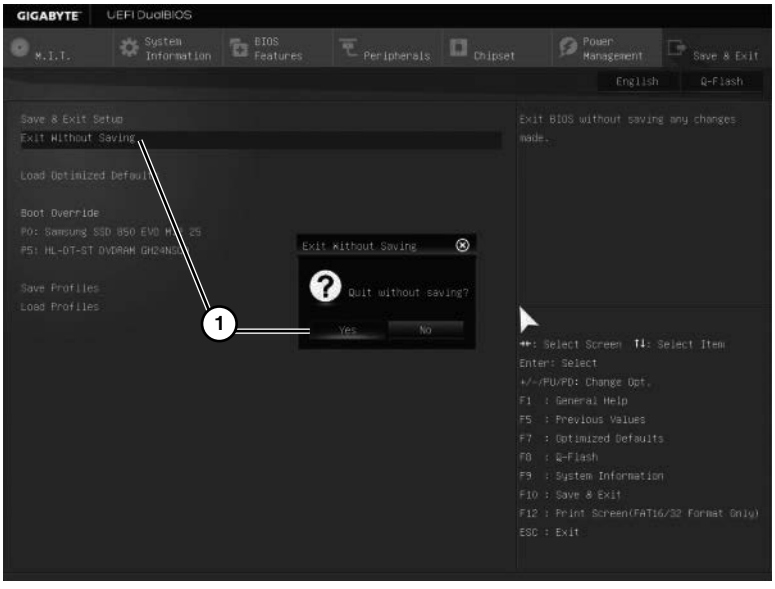
Figure 2-17 Preparing to save the current BIOS configuration to a file.

If you made changes you want to keep, choose the option to save changes (see Figure 2-18). If you were "just looking" and did not intend to make any changes, choose the option to discard changes (see Figure 2-19). When you exit the BIOS setup program with either option, the system restarts.



1. Exiting and saving the current UEFI firmware configuration

Figure 2-18 Preparing to save changes and exit the BIOS configuration menu.



1. Exiting and discarding the current BIOS configuration

Figure 2-19 Preparing to discard changes and exit the BIOS configuration menu.

Flash Upgrade BIOS

The BIOS chip can be regarded as the "glue" that binds the hardware to the operating system. If the BIOS doesn't recognize the operating system or the hardware it communicates with, you're sure to have problems.

Because the BIOS chip bridges hardware to the operating system, you need to update the BIOS whenever your current BIOS version is unable to properly support

- New hardware, such as large SATA hard drives and different types of removable-storage drives
- New CPU models
- Memory modules with different capacities or timings
- New operating systems and features (such as virtualization or power management)
- New BIOS options

BIOS updates can also be used to solve problems with power management or other hardware-related issues.

A computer that is more than one year old or that is a candidate for a new processor might need a BIOS update. In the 1980s into the early 1990s, a BIOS update required a physical chip swap and, sometimes, reprogramming the chip with a device called an Electrically Erasable Programmable Read-Only Memory (EEPROM) burner. If the replacement or reprogrammed BIOS chip was installed incorrectly into the socket, it could be destroyed.

Fortunately, since the mid-1990s, a BIOS update can now be performed with software. The Flash BIOS chips in use on practically every recent system contain a special type of memory that can be changed through a software download from the system or motherboard maker.

Although Flash BIOS updates are easier to perform than the older, replace-the-chip style, you still need to be careful. An incomplete or incorrect BIOS update will prevent your system from being accessed. No BIOS, no boot! Regardless of the method, for maximum safety, follow these initial steps:

Step 1. Back up important data.

Step 2. Record the current BIOS configuration, especially hard drive settings as discussed earlier in this chapter.

CAUTION BIOS configuration information might need to be reentered after a BIOS update, especially if you must install a different chip.

Flash BIOS Update

So you've decided you need a Flash BIOS update. Where do you get it? Don't ask the BIOS manufacturers (Phoenix, Insyde, AMI, and Award/Phoenix). They don't sell BIOS updates because their basic products are modified by motherboard and system vendors. Following are the general steps to locate a Flash BIOS update and install it:

Step 1. For major brands of computers, go to the vendor's website and look for "downloads" or "tech support" links. The BIOS updates are listed by system model and by version; avoid beta (prerelease) versions.

TIP If your system is a generic system (that is, it came with a mainboard or motherboard manual and other component manuals rather than a full system manual), you need to contact the motherboard maker.

To determine the motherboard's make and model, you can download and run Belarc Advisor (free for personal use) from www.belarc.com/free_download.html.

See the following websites for additional help:

- Wim's BIOS page (www.wimsbios.com)
- eSupport (www.biosagentplus.com)
- American Megatrend's BIOS Support page (www.ami.com/support/bios.cfm)

You can also buy a replacement flash BIOS file from www.eSupport.com if you cannot get an updated BIOS code from your system or motherboard vendor.

Step 2. Locate the correct BIOS update for your system or motherboard. For generic motherboards, Wim's BIOS page also has links to the motherboard vendors' websites.

Step 3. Determine the installation media needed to install the BIOS image. Many recent systems use a Windows-based installer, but some use a bootable CD or USB flash drive.

Step 4. Be sure to download all files needed to install the BIOS image. In most cases, a download contains the appropriate loader program and the BIOS image, but for some motherboards, you might also need to download a separate loader program. If the website has instructions posted, print or save them for reference.

For installation from bootable media, see Steps 5 and 6.

Step 5. If you need to create bootable media, follow the vendor's instructions to create the media and place the loader and BIOS image files on the media.

Step 6. To install from bootable media, make sure the drive is the first item in the BIOS boot sequence. Insert or connect your media and restart the system. If prompted, press a key to start the upgrade process. Some upgrades run automatically, others require you to choose the image from a menu, and still others require the actual filename of the BIOS. The BIOS update might also prompt you to save your current BIOS image. Choose this option if possible so that you have a copy of your current BIOS in case there's a problem. After the process starts, it takes approximately three minutes to rewrite the contents of the BIOS chip with the updated information.

For installation from Windows, see Step 5a and Step 6a.

Step 5a. Close all Windows programs before starting the update process.

Step 6a. Navigate to the folder containing the BIOS update and double-click it to start the update process. Follow the prompts onscreen to complete the process. It takes approximately three minutes to rewrite the contents of the BIOS chip with the updated information.

CAUTION While performing a Flash upgrade, make sure you don't turn off the power to your PC and that you keep children or pets away from the computer to prevent an accidental shutdown. (Read: Your four-year-old decides to unplug the computer.) Wait for a message indicating the BIOS update has been completed before you even think about touching the computer. If the power goes out during the Flash update, the BIOS chip could be rendered useless.

Step 7. Remove the media and restart the system to use your new BIOS features. Reconfigure the BIOS settings if necessary.

Recovering from a Failed BIOS Update

If the primary system BIOS is damaged, keep in mind that some motherboard vendors offer dual BIOS chips on some products. The secondary BIOS performs the same functions as the primary BIOS so the system can continue to run.

If you use the wrong Flash BIOS file to update your BIOS, or if the update process doesn't finish, your system can't start. You might need to contact the system or motherboard maker for service or purchase a replacement BIOS chip.

Some BIOSes contain a "mini-BIOS" that can be reinstalled from a reserved part of the chip. Systems with this feature have a jumper on the motherboard called the Flash recovery jumper.

Key Topic

To use this feature, download the correct Flash BIOS, make a bootable disc from it, and take it to the computer with the defective BIOS. Set the jumper to Recovery, insert the bootable media, and then rerun the setup process. Because the video won't work, you'll need to listen for beeps and watch for the drive light to run during this process. Turn off the computer, reset the jumper to Normal, and then restart the computer.

If the update can't be installed, your motherboard might have a jumper that write-protects the Flash BIOS. Check the manual to see whether your system has this feature. To update a BIOS on a system with a write-protected jumper, you must follow these steps:

Step 1. Disable the write protection.

Step 2. Perform the update.

Step 3. Re-enable the write-protection to keep unauthorized people from changing the BIOS.

Using BIOS/UEFI Diagnostics

Some system vendors provide UEFI diagnostics programs that can be installed on a bootable USB drive or might be available to run at system startup time. These diagnostic programs can be used to test the motherboard, RAM, displays, drives, fans, and other components. Figure 2-20 illustrates the main menu of the HP Hardware Diagnostics utility.

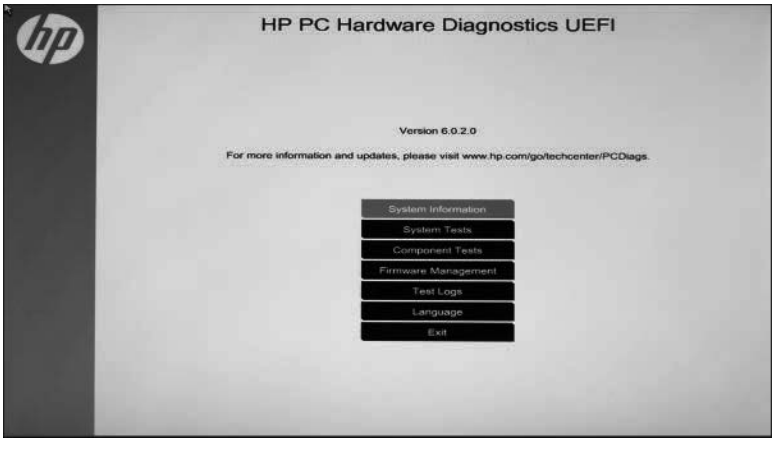


Figure 2-20 Preparing to test a computer with HP PC Hardware Diagnostics UEFI.

Exam Preparation Tasks

Review All the Key Topics

Review the most important topics in the chapter, noted with the Key Topic icon in the outer margin of the page. Table 2-2 lists a reference to these key topics and the page numbers on which each is found.

Table 2-2 Key Topics for Chapter 2

Key Topic Element	Description	Page Number
Text	Common keystrokes used to access BIOS Setup	32
Text	Definition of UEFI firmware	33
Table 2-1	Major CMOS/BIOS/UEFI Settings	35
Figure 2-3	A typical CMOS UEFI Setup main menu	38
Figure 2-4	A typical UEFI main setup menu for a desktop system with an AMD processor (UEFI BIOS for BIOSTAR Hi-Fi A85W).	39
Figure 2-7	A typical Boot Sequence submenu configured to permit booting from a CD/DVD or USB flash drive before the hard disk	41
Figure 2-12	Typical power management configuration menu	46
Figure 2-13	A typical hardware monitor screen	47
Figure 2-17	Typical exit dialog with the option to save changes to a file	52
Text	Flash BIOS update	56

Complete the Tables and Lists from Memory

Print a copy of Appendix C, "Memory Tables" (found on the CD), or at least the section for this chapter, and complete the tables and lists from memory. Appendix D, "Answers to Memory Tables," also on the CD, includes completed tables and lists to check your work.

Define Key Terms

Define the following key terms from this chapter, and check your answers in the glossary.

Basic Input/Output System (BIOS), power-on self-test (POST), CMOS, virtualization support, TPM, LoJack for Laptops, Secure Boot, Intrusion detection/notification, voltage, clock, bus speed

Complete Hands-On Labs

Complete the hands-on labs, and then see the answers and explanations at the end of the chapter.

Lab 2-1: Disable Onboard Audio

Scenario: You are a technician working at a PC repair bench. You need to install a sound card into a system that has onboard audio. Before you can do this, you need to turn off the onboard audio feature in the system BIOS.

Step 1. Review the BIOS screens listed earlier in this chapter. From Figure 2-3, which menu selection would you choose?

Step 2. Review the BIOS screens (see Figures 2-6 through 2-17). Which figure has the correct menu option for disabling onboard audio?

Step 3. What is the menu called?

Step 4. What is the option called?

Step 5. What is the current setting?

Step 6. What is the setting you need to select?

Step 7. What key do you press to exit setup and save changes?

Lab 2-2: Check Fan and Voltage Levels

Scenario: You are a technician working at a PC repair bench. Your client reports that the computer is overheating. You need to check the performance of fans connected to the motherboard and the voltage levels on the motherboard.

Step 1. Review the CMOS (BIOS) setup screens listed earlier in this chapter. From Figure 2-3, which menu selection would you choose?

Step 2. Review the CMOS (BIOS) setup screens (see Figures 2-6 through 2-17). Which figure displays fan speeds and voltage levels?

Step 3. What is the CPU fan speed?

Step 4. What is the CPU voltage called?

Step 5. What is the voltage for the CPU?

Step 6. What key do you press to exit setup without saving changes?

Answer Review Questions

Answer these review questions and then see the answers and explanations at the end of the chapter.

1. Which of the following best describes the BIOS?
   a. Firmware contained on a ROM chip
   b. The first code run when the computer starts up
   c. Volatile and requires a battery to maintain its memory
   d. Program contained in the Master Boot Record (MBR)
2. When the user wants to change the default settings in the BIOS startup program, where are those changes saved and stored?
   a. UEFI
   b. POST
   c. MBR
   d. CMOS
3. Which of the following statements is false?
   a. UEFI does not support traditional Master Boot Record (MBR) hard drive partitioning.
   b. UEFI is capable of working with the GUID Partition Table (GPT).
   c. UEFI enables more efficient use of larger hard drives than traditional BIOS.
   d. Apple OS X uses UEFI.
4. If there were a problem during startup with your computer's memory, where would that problem be reported?
   a. CMOS
   b. POST
   c. MBR
   d. TPM
5. Which of the following steps should be taken before installing a new sound card?
   a. You should disable the onboard audio controller in POST.
   b. You should use POST to configure the new sound card.
   c. You should disable the onboard audio controller in the BIOS settings.
   d. You should configure the new sound card in the MBR.

6. Which of the following statements best describes the function of the Secure Boot setting in UEFI firmware?
   a. It prevents Windows 8 or Windows 10 from booting.
   b. It allows Linux to be used as an operating system.
   c. It enables AHCI mode.
   d. It enables only Windows 8 or Windows 10 to be used as an operating system.
7. In which of the following configuration programs might you navigate the menu screens using a mouse?
   a. UEFI
   b. CMOS
   c. BIOS
   d. POST
8. In the following figure, which of the following actions makes and saves changes to the CMOS chip?

1. Keystrokes for configuration options at startup

   a. Pressing Del
   b. Pressing Tab
   c. Pressing F9
   d. Pressing F12

9. Which of the following information is *not* found in the BIOS/UEFI startup settings?
   a. Time and date
   b. Installed memory
   c. CPU temperature
   d. CPU type and speed
   e. IP address
10. Which of the following statements best describes the effect of enabling Quick Boot in the startup program?
   a. It omits POST.
   b. It does not run the memory and drive tests.
   c. It does not check CMOS settings.
   d. It activates the S3 power saving program.
11. What is the power management system used for in modern computers?
   a. APM
   b. SATA
   c. ATAPI
   d. ACPI
12. A friend has just bought a new computer and has given you his old computer. The old computer has a 30 GB IDE hard drive that you want to upgrade to a new 3 TB SATA hard drive, but when you install your new hard drive, you find that you can access only about 2 TB of space. Which of the following statements best describes how to remedy the situation?
   a. You should install new drivers for the new SATA drive.
   b. You should enable the new drive in the CMOS settings.
   c. You should upgrade your current motherboard along with the new hard drive.
   d. You should return the hard disk drive and use a 2 TB hard disk drive instead.
13. In Table 2-3, identify which of the following are stored on ROM chips and which are stored on RAM chips. Also indicate which require(s) an outside source of power to maintain its memory.

Table 2-3 ROM/RAM/POWER

Options	BIOS	UEFI	CMOS
ROM or RAM?			
Requires Battery or No Power Source?			

14. Match the following security features with their definitions.

Features	Definitions
A. TPM	1. Warns when chassis has been opened
B. Secure Boot	2. Limits access to startup screens to users with proper authorization
C. BIOS password	3. Supports BitLocker encryption
D. Power-on password	4. Requires user to provide identification when turning system on
E. Intrusion detection	5. Checks signature of boot software and permits only trusted software to start the system
	6. Allows computer's location to be traced if stolen
	7. Warns when a virus tries to attack the system

15. Which of the following best describes to permanently change or upgrade the BIOS program?

- **a.** Download a new program from the system manufacturer and flash the BIOS.
- **b.** Make any necessary changes to the CMOS program and save those changes to the BIOS.
- **c.** Make any necessary changes to the POST program as it is testing and initializing the various components.
- **d.** After the MBR has been run, save any changes to the BIOS.

Answers and Explanations to Hands-On Labs

Lab 2-1: Disable Onboard Audio

To access the onboard audio screen from Figure 2-3, the most likely menu to go to is the Peripherals menu. However, on other systems, the correct answer might be Advanced or other options.

Figure 2-10 is the figure including the HD Audio setting.

The menu is the Advanced menu.

The option is called HD Audio Azalia Device.

The current setting is Enabled.

The setting to select is Disabled.

The key to save changes and exit varies by BIOS/UEFI firmware. In Figure 2-17, the key is F10 (the most common choice). However, a different BIOS/UEFI firmware dialog shown in Figure 2-16 uses F4.

Lab 2-2: Check Fan and Voltage Levels

The PC Health Status menu is the most likely place to find this information. Figure 2-13 illustrates a typical dialog.

The CPU fan speed is 1394 RPM (rpm). The CPU voltage is listed as two values: CPU Vcore and CPU VCCSA. CPU Vcore is 1.224V, and the CPU VCCSA is 1.068V.

To exit without saving changes, use the Esc key.

Answers and Explanations to Review Questions

1. **A**. During startup, the BIOS program (or the more recent UEFI) is the first program to run and is responsible for starting the computer. The BIOS is stored on a ROM chip and is not volatile. The BIOS is not part of the MBR.
2. **D**. When changes are made to the startup program in either the BIOS or the newer UEFI, those changes are stored on the CMOS chip.
3. **A**. UEFI does support traditional Master Boot Record (MBR) hard drive partitioning and is also capable of working with the GUID Partition Table (GPT) and modern large hard drives. UEFI is also used by OS X.
4. **B**. During startup, the BIOS program runs POST, which tests and initializes components such as memory, CPU, hard drives, optical drives, USB drives, and video cards and then reports any problems found.
5. **C**. Restart the computer and open the startup settings. Disable the onboard audio before installing the new sound card and save the changes to CMOS.
6. **D**. Secure Boot must be disabled when the user wants to install a different operating system.
7. **A**. The UEFI display uses a mouse-driven GUI in addition to the keyboard navigation used by the BIOS.

8. **A**. CMOS is a RAM chip that is used to store changes made to the startup program within the BIOS or UEFI. To edit the startup program, you should check the user's manual or restart the computer and watch the screen for instructions to enter the BIOS setup. In the diagram, pressing Del allows you to enter the startup program. Any changes made here may be saved in CMOS.
9. **E**. The IP address is found in the Network and Sharing Center or through the command-line interface, not in the BIOS or UEFI.
10. **B**. Quick Boot enables faster system startup by skipping the memory and drive tests when booting the computer. POST and CMOS are always involved in the boot process. The S3 power setting does not affect the boot process.
11. **D**. ACPI replaced APM as the power management utility on modern computers. SATA is a type of hard drive. ATAPI is the standard for CDs and DVDs.
12. **C**. An older traditional BIOS can support only a maximum hard drive size of 2.2 TB. To use the new 3 TB hard drive, you need to replace the motherboard with a newer one that supports UEFI (which supports up to 9.4 ZB hard drives).
13.

ROM/RAM/POWER Answers

Options	BIOS	UEFI	CMOS
ROM or RAM?	ROM	ROM	RAM
Requires Battery or No Power Source?	No power source	No power source	Requires battery

BIOS and UEFI are both stored on ROM chips and therefore are permanent and do not require an additional power source. CMOS is stored in RAM, which is volatile and requires a CMOS battery to provide a constant trickle of power to maintain its memory.

14. A. 3; B. 5; C. 2; D. 4; E.1. Incorrect definitions: 6, 7.
15. A. The BIOS program (or the newer UEFI program) is stored as permanent memory in ROM. To permanently change the programming for either of these chips, you must download a new program from the manufacturer and flash that program onto the BIOS or UEFI. Changes made to the CMOS chip, which is RAM, are temporary and will be lost if power is lost in the CMOS battery. POST and the MBR do not affect the contents of either the BIOS or the UEFI.

Index

Symbols

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z