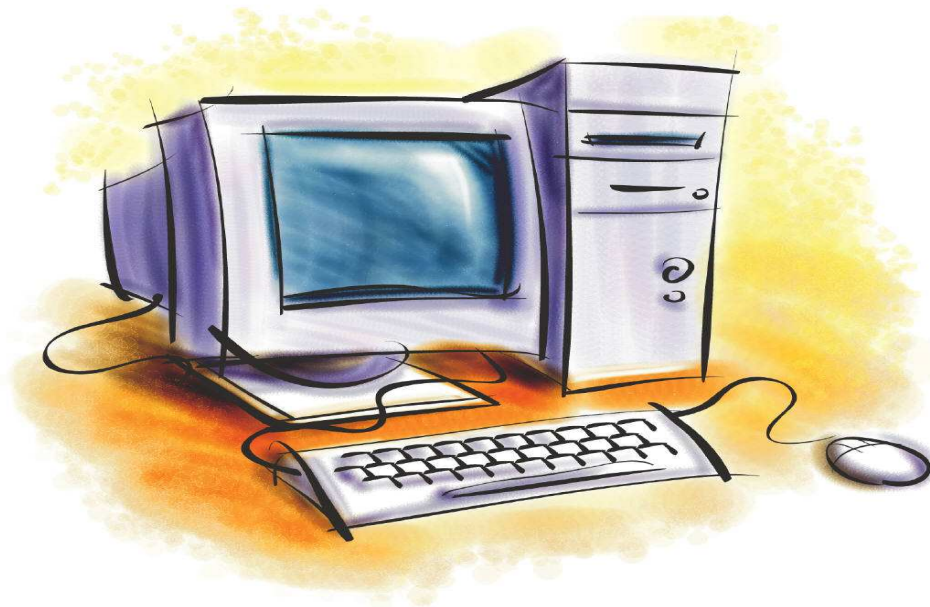




UNESCO-NIGERIA TECHNICAL &
VOCATIONAL EDUCATION
REVITALISATION PROJECT-PHASE II



NATIONAL DIPLOMA IN COMPUTER TECHNOLOGY



Computer System Troubleshooting1

COURSE CODE: COM 216

**YEAR 2 SEMESTER 1
THEORETICAL BOOK
Version 1: December 2008**

Table Of Content

Opening the Display Properties Panel	107
The Layout of the Panel	108
Background	108
Screen Saver.....	109
Appearance	110
Effects	111
Web	111
Settings.....	112

Week 1

This Week Learning Outcome

To Understand:

➤ The Process of Fault diagnosis

The Universal Troubleshooting Process

Regardless of how complex your particular computer or peripheral device might be, a dependable troubleshooting procedure can be broken down into four basic steps (Fig. 4-1): define your symptoms, identify and isolate the potential source (or location) of your problem, replace the suspected sub-assembly, and re-test the unit thoroughly to be sure that you have solved the problem. If you have not solved the problem, start again from Step #1. This is a “universal” procedure that you can apply to any sort of troubleshooting—not just for personal computer equipment.

Define Your Symptoms

When a PC breaks down, the cause might be as simple as a loose wire or connector, or as complicated as an IC or sub-assembly failure. Before you open your tool box, you must have a firm understanding of all the symptoms. Think about the symptoms carefully—for example:

- Is the disk or tape inserted properly?
- Is the power or activity LED lit?
- Does this problem occur only when the computer is tapped or moved?

By recognizing and understanding your symptoms, it can be much easier to trace a problem to the appropriate assembly or component. Take the time to write down as many symptoms as you can. This note-taking might seem tedious now, but once you have begun your repair, a written record of symptoms and circumstances will help to keep you focused on the task at hand. It will also help to jog your memory if you must explain the symptoms to someone else at a later date. As a professional troubleshooter, you must of-ten log problems or otherwise document your activities anyway.

Identify and Isolate

Before you try to isolate a problem within a piece of computer hardware, you must first be sure that the equipment itself is causing the problem. In many circumstances, this will be fairly obvious, but some situations might appear ambiguous (i.e., there is no power, no DOS prompt, etc.). Always remember that a PC works because of an intimate mingling of hardware and software. A faulty or improperly configured piece of software can cause confusing system errors. Chapter 3 touched on some of the problems that operating systems can encounter.

When you are confident that the failure lies in your system’s hardware, you can begin to identify possible problem areas. Because this book is designed to deal with sub-assembly troubleshooting, start your diagnostics there. The troubleshooting procedures throughout

this book will guide you through the major sections of today's popular PC components and peripherals, and aid you in deciding which sub-assembly might be at fault. When you have identified a potential problem area, you can begin the actual repair process and swap the suspect sub-assembly.

Replace

Because computers and their peripherals are designed as collections of sub-assemblies, it is almost always easier to replace a sub-assembly outright, rather than attempt to troubleshoot the sub-assembly to its component level. Even if you had the time, documentation, and test equipment to isolate a defective component, many complex parts are proprietary, so it is highly unlikely that you would be able to obtain replacement components without a significant hassle. The labor and frustration factor involved in such an endeavor is often just as expensive as replacing the entire sub-assembly to begin with (perhaps even more expensive). On the other hand, manufacturers and their distributors often stock a selection of sub-assemblies and supplies. You might need to know the manufacturer's part number for the sub-assembly to obtain a new one.

During a repair, you might reach a roadblock that requires you to leave your equipment for a day or two, or maybe longer. This generally happens after an order has been placed for new parts, and you are waiting for those parts to come in. Make it a point to reassemble your system as much as possible before leaving it. Gather any loose parts in plastic bags, seal them shut, and mark them clearly. If you are working with electronic circuitry, be sure to use good-quality anti-static boxes or bags for storage. Partial re-assembly (combined with careful notes) will help you remember how the unit goes together later on. Another problem with the fast technological progress we enjoy is that parts rarely stay on the shelf long. That video board you bought last year is no longer available.

Changing Parts

Once a problem is isolated, technicians face another problem: the availability of spare parts. Novice technicians often ask what kinds and quantity of spare parts they should keep on hand. The best answer to give here is simply: none at all. The reason for this somewhat drastic answer is best explained by the two realities of PC service.

Parts Are Always Changing

After only 15 years or so, the PC is in its sixth CPU generation (with such devices as the AMD K6 and Intel Pentium II). As a result, a new generation matures every 24 to 36 months (although the newer generations have been arriving in 18 to 24 months). Even the "standardized" products, such as CD-ROM drives, have proliferated in different speeds and versions (8, 10', 12', 16', and even 20' speeds). Once production stops for a drive or board, stock rarely remains for very long. You see, even if you know what the problem is, the chances of your locating an exact replacement part are often quite slim if the part is more than two years old. Notice the word exact—this is the key word in PC repair.

The Booting Process

Computer initialization is a process—not an event. From the moment that power is applied until the system sits idle at the command-line prompt or graphical desktop, the PC boot process is a sequence of predictable steps that verify the system and prepare it for operation.

By understanding each step in system initialization, you can develop a real appreciation for the way that hardware and software relate to one another—you also stand a much better chance of identifying and resolving problems when a system fails to boot properly. This part of the chapter provides a step-by-step review of a typical PC boot process.

Applying Power

PC initialization starts when you turn the system on. If all output voltages from the power supply are valid, the supply generates a Power Good (PG) logic signal. It can take between 100 ms and 500 ms for the supply to generate a PG signal. When the motherboard timer IC receives the PG signal, the timer stops forcing a Reset signal to the CPU. At this point, the CPU starts processing.

The Bootstrap

The very first operation performed by a CPU is to fetch an instruction from address FFFF:0000h. Because this address is almost at the end of available ROM space, the instruction is almost always a jump command (JMP) followed by the actual BIOS ROM starting address. By making all CPUs start at the same point, the BIOS ROM can then send program control anywhere in the particular ROM (and each ROM is usually different).

This initial search of address FFFF:0000h and the subsequent re-direction of the CPU is traditionally referred to as the bootstrap in which the PC “pulls itself up by its bootstraps”—or gets itself going. Today, we have shortened the term to boot, and have broadened its meaning to include the entire initialization process.

Core Tests

The core tests are part of the overall Power-On Self-Test (POST) sequence, which is the most important use of a system BIOS during initialization. As you might expect, allowing on the display (and system initialization will halt). Remember that POST codes and their meanings will vary slightly between BIOS manufacturers. If the POST completes successfully, the system will respond with a single beep from the speaker. Chapter 15 covers I/O port POST codes.

Finding the OS

The system now needs to load an operating system (usually DOS or Windows 95). The first step here is to have the BIOS search for a DOS volume boot sector (VBS) on the A: drive. If there is no disk in the drive, you will see the drive light illuminate briefly, and then BIOS will search the next drive in the boot order (usually drive C:). If a disk is in drive A:, BIOS will load sector 1 (head 0, cylinder 0) from the disk's DOS volume boot sector into memory, starting at 0000:7C00h. There are a number of potential problems when

attempting to load the VBS. Otherwise, the first program in the directory (IO.SYS) will begin to load, followed by MSDOS.SYS.

- ☛ If the first byte of the DOS VBS is less than 06h (or if the first byte is greater than or equal to 06h and next nine words of the sector contain the same data pattern), you will see an error message similar to: “Diskette boot record error.”
 - If the IO.SYS and MSDOS.SYS are not the first two files in the directory (or some other problem is encountered in loading), you’ll see an error such as: “Non-system disk or disk error.”
 - If the boot sector on the diskette is corrupted and cannot be read (DOS 3.3 or earlier), you’ll probably get a Disk boot failure message.
- If the OS cannot be loaded from any floppy drive, the system will search the first fixed drive (hard drive). Hard drives are a bit more involved than floppy disks. BIOS loads sector 1 (head 0, cylinder 0) from the hard drive’s master partition boot sector (called the master boot sector, MBS) into memory, starting at 0000:7C00h, and the last two bytes of the sector are checked. If the final two bytes of the master-partition boot sector are not 55h and AAh respectively, the boot sector is invalid, and you will see an error message similar to: “No boot device available and system initialization will halt.” Other systems might depict the error differently or attempt to load ROM BASIC. If the BIOS attempts to load ROM BASIC and there is no such feature in the BIOS, you’ll see a ROM BASIC error message.

Otherwise, the disk will search for and identify any extended partitions (up to 24 total partitions). Once any extended partitions have been identified, the drive’s original boot sector will search for a boot-indicator byte, marking a partition as active and bootable. If none of the partitions are marked as bootable (or if more than one partition is marked bootable), a disk error message will be displayed such as: “Invalid partition table.” Some older BIOS versions might attempt to load ROM BASIC, but will generate an error message in most cases anyway.

When an active bootable partition is found in the master partition boot sector, the DOS Volume Boot Sector (VBS) from the bootable partition is loaded into memory and tested. If the DOS VBS cannot be read, you will see an error message similar to: “Error loading operating system.” When the DOS volume boot sector does load, the last two bytes are

Loading the OS

If no problems are detected in the disk’s DOS volume boot sector, IO.SYS (or IBM-BIO.COM) is loaded and executed. If Windows 95 is on the system, IO.SYS might be re-named WINBOOT.SYS, which will be executed instead. IO.SYS contains extensions to BIOS that start low-level device drivers for such things as the keyboard, printer, and block devices. Remember that IO.SYS also contains initialization code that is only needed during system startup. A copy of this initialization code is placed at the top of conventional memory which takes over initialization. The next step is to load MSDOS.SYS (or IBM-DOS.COM), which is loaded so that it overlaps the part of IO.SYS containing the initialization code. MSDOS.SYS (the MS-DOS kernel) is then executed to initialize base device drivers, detect system status, reset the disk system, initialize devices (such as the printer and serial

port), and set up system-default parameters. The MS-DOS essentials are now loaded and control returns to the IO.SYS/WINBOOT.SYS initialization code in memory.

Establishing the Environment

If a CONFIG.SYS file is present, it is opened and read by IO.SYS/WINBOOT.SYS. The DEVICE statements are processed first in the order they appear, then INSTALL statements are processed in the order they appear. A SHELL statement is handled next. If no SHELL statement is present, the COMMAND.COM processor is loaded. When COMMAND.COM is loaded, it overwrites the initialization code left over from IO.SYS (which is now no longer needed). Under Windows 95, COMMAND.COM is loaded only if an AUTOEXEC.BAT file is present to process the AUTOEXEC.BAT statements. Finally, all other statements in CONFIG.SYS are processed, and WINBOOT.SYS also looks for the SYSTEM.DAT registry file. When an AUTOEXEC.BAT file is present, COMMAND.COM (which now has control of the system) will load and execute the batch file. After the batch-file processing is complete, the familiar DOS prompt will appear. If there is no AUTOEXEC.BAT in the root directory, COMMAND.COM will request the current date and time, then show the DOS For Windows 95 systems, IO.SYS (or WINBOOT.SYS) combines the functions of IO.SYS and MSDOS.SYS.

Creating a DOS Boot Disk

The most persistent problem with PC troubleshooting is that it can be difficult to boot a system successfully—especially if there are hard-drive problems. This makes it particularly important to have a bootable floppy diskette on hand. The two means of creating a boot disk are: automatically (through an existing Windows 95 platform) or manually (through a DOS6.22 platform). In either case, you're going to need access to a running PC with an operating system that is similar to the version you plan to install on the new PC. Windows 95 Windows 95 comes with an automatic "Startup Disk" maker. If you have access to a Windows 95 system, use the following procedure to create a DOS 7.x startup disk: Label a blank diskette and insert it into your floppy drive.

- Click on Start, Settings, and Control Panel.
- Double-click on the Add/remove programs icon.
- Select the Startup disk tab.
- Click on Create disk.
- The utility will remind you to insert a diskette, then prepare the disk automatically.

When the preparation is complete, test the diskette. The preparation process takes several minutes, and will copy the following files to your diskette: ATTRIB, CHKDSK, COMMAND, DEBUG, DRVSPACE.BIN, EDIT, FDISK, FORMAT, REGEDIT, SCANDISK, SYS, and UNINSTAL. All of these files are DOS 7.x-based files, so you can run them from the A: prompt.

The Windows 95 FDISK utility has been reported to have a bug that can cause problems when creating more than one partition on the same drive. Later releases of Windows 95 (i.e., OSR 2) claim to have corrected this issue, but if you encounter problems with FDISK, use the DOS 6.22 version.

Process of Fault Diagnosis

Before getting into the troubleshooting details, it is important to know about what goes on during the startup process. The reason is, there are actually quite a few steps that occur in between switching the power ON and hearing the familiar Windows 95, 98 or Windows ME./XP startup sounds and seeing the Windows desktop. In fact, there are a whole series of files that are automatically loaded one after the other when you turn your computer on. The trick with troubleshooting startup problems is trying to figure out which of those files (or what step in the process) causes a specific problem in the computer. If we know approximately where in the startup process the problem occurs (Computer gets stuck), we can diagnose the problem easily.

This chapter explains the various problems that occur in a computer and the troubleshooting procedures. The system to initialize and run with flaws in the motherboard, memory, or drive systems can have catastrophic consequences for files in memory or on disk. To ensure system integrity, a set of hardware-specific self-test routines checks the major motherboard components, and identifies the presence of any other specialized BIOS ICs in the system (i.e., drive-controller BIOS, video BIOS, SCSI BIOS, and so on). BIOS starts with a test of the motherboard hardware such as the CPU, math co-processor, timer ICs, Direct Memory Access (DMA) controllers, and interrupt (IRQ) controllers.

If an error is detected in this early phase of testing, a series of beeps (or beep codes) are produced. By knowing the BIOS manufacturer and the beep code, you can determine the nature of the problem. Chapter 15 deals with beep and error codes in more detail. Beep codes are used because the video system has not been initialized. Next, BIOS looks for the presence of a video ROM between memory locations C000:0000h through C780:000h. In just about all systems, the search will reveal a video BIOS ROM on a video adapter board, plugged into an available expansion slot. If a video BIOS is found, its contents are evaluated with a checksum test. If the test is successful, control is transferred to the video BIOS, which loads and initializes the video adapter.

When initialization is complete, you will see a cursor on the screen and control returns to the system BIOS. If no external video adapter BIOS is located, the system BIOS will provide an initialization routine for the motherboard's video adapter and a cursor will also appear.

Once the video system initializes, you are likely to see a bit of text on the display identifying the system or video BIOS ROM maker and revision level. If the checksum test fails, you will see an error message such as: C000 ROM Error or Video ROM Error. Initialization will usually halt right there.

Now that the video system is ready, system BIOS will scan memory from C800:0000h through DF80:0000h in 2KB increments to search for any other ROMs that might be on other adapter cards in the system. If other ROMs are found, their contents are tested and run. As each supplemental ROM is executed, they will show manufacturer and revision ID information. In some cases, a supplemental (or "adapter") ROM might alter an existing

BIOS ROM routine. For example, an Ultra DMA/33 drive-controller board with its own on-board ROM will replace the motherboard's older drive routines. When a ROM fails the checksum test, you will see an error message such as: "XXXX ROM Error." The XXXX indicates the segment address where the faulty ROM was detected. If a faulty ROM is detected, system initialization will usually halt.

Post

BIOS then checks the memory location at 0000:0472h. This address contains a flag that determines whether the initialization is a cold start (power first applied) or a warm start (reset button or <Ctrl>+<Alt>+ key combination). A value of 1234h at this address indicates a warm start—in which case, the (POST) routine is skipped. If any other value is found at that location, a cold start is assumed, and the full POST routine will be executed. The full POST checks many of the other higher-level functions on the motherboard, memory, keyboard, video adapter, floppy drive, math co-processor, printer port, serial port, hard drive, and other sub-systems. Dozens of tests are performed by the POST.

When an error is encountered, the single-byte POST code is written to I/O port 80h, where it might be read by a POST-code reader. In other cases, you might see an error message

BIOS

When your computer is first turned on, it automatically loads a program called the BIOS, or Basic Input/Output System, which is stored on a special chip on your computer's motherboard. The BIOS is essentially a combination of software and hardware in that it consists of software, but the contents of that software is stored in a hardware chip.

One of the first things we should see on your computer's monitor when we start the PC is some type of message like "Hit Esc to enter Setup," although instead of Esc it may say F2 or F10 or any number of other keys and instead of Setup it may say CMOS Setup or BIOS Setup or just CMOS. Make note of the key required to enter the Setup program because we may need that later (some startup problems can only be solved by changing some BIOS/CMOS settings via the Setup program).

Power-On Self Test (POST)

The first thing that the BIOS does when it boots the PC is to perform what is called the **Power-On Self-Test**, or **POST** for short. The POST is a built-in diagnostic program that checks the hardware to ensure that everything is present and functioning properly, before the BIOS begins the actual boot. It later continues with additional tests such as the memory test and then it lists any devices that it finds attached to the computer's internal IDE controller(s). (that is seen on the screen of the monitor) as the boot process is proceeding.

The POST runs very quickly, and you will normally not even noticed that it is happening--unless it finds a problem. You may have encountered a PC that, when turned on, made beeping sounds and then stopped without booting up. That is the POST telling you

something is wrong with the machine. The speaker is used because this test happens so early on, before the video is activated! These beep patterns can be used to diagnose many hardware problems with the PC. The exact patterns depend on the maker of the BIOS; the most common are Award and AMI BIOS.

BIOS Startup Screen

When the system BIOS starts up, you will see its familiar screen display, normally after the video adapter displays its information. These are the contents of a typical BIOS start up screen:

- **The BIOS Manufacturer and Version Number.**
- **The BIOS Date:** The date of the BIOS can be important in helping you determine its capabilities.
- **Setup Program Key:** The key or keys to press to enter the BIOS setup program. (This is usually {Del}, sometimes {F2}, and sometimes another key combination.)
- **System Logo:** The logo of the BIOS company, or in some cases the PC maker or motherboard manufacturer.
- **The "Energy Star" Logo:** This distinctive logo is displayed if the BIOS supports the Energy Star standard, which almost all newer ones do.
- **The BIOS Serial Number:** This is normally located at the bottom of the screen. Since BIOSes are highly customized to the particular motherboard, this serial number can be used in many cases to determine the specific motherboard and BIOS version you are using. Check out Wim Bervoets' BIOS site for a huge list of these numbers

Troubleshooting BIOS Beep Codes

When a problem is identified with the system during the POST, the BIOS will normally produce an error message. However, in some cases the problem is detected so early in the test that the BIOS cannot even access the video card to print the message! In this case the BIOS will produce a beeping pattern on the speaker to tell you what the problem is.

The exact meaning of the beep codes depends on the type and version of BIOS that you have. The three most popular types of BIOS are those made by Award, American Megatrends (AMI) and Phoenix. The beep codes for these BIOS products are described in this part of the troubleshooter. If you are using a PC made by a company that writes its own BIOS, you will have to consult your owner's manual

A single beep during the boot process, usually right before the BIOS startup screen is displayed, is normal and does not indicate a failure as long as the boot continues on.

Beep codes can be in several different patterns, depending on the BIOS that you are using. Some BIOSes use very simple beep codes in a pattern of varying numbers of short beeps, while others may mix short and long beeps. The Phoenix BIOS is famous for its

complicated beep patterns that are actually in up to four groups--one or more beeps and then a pause, followed by as many as three more patterns.

Fault Report Forms

To make maintenance easy forms are needed to document systems and corresponding fault

1. PC configuration form Use this form when installing or configuring the PC and its expansion boards.
2. System CMOS sheet Use this form to record system parameters (as shown in the system SETUP screens).
3. BIOS upgrade Use this form when planning a BIOS upgrade for your PC.
4. Customer billing a simple time and material form for beginning technicians.

Week2

This Week Learning Outcome

To Understand:

➤ Usage of Software Diagnostic Programs for Hardware

Diagnostic Programs

Software and hardware complement one another Diagnostic program is used to detect both hardware and software problems the computer memory can be diagnosed to know the size the processor types too can also be checked to do these well one has to know how to distinguish hardware problem from the software.

Bench Marking

We all know that today's personal computers are capable of astounding performance. If you doubt that, consider any of the current 3D games, such as Quake II or Monster Truck Madness. However, it is often important to quantify the performance of a system. Just saying that a PC is "faster" than another system is simply not enough—we must often apply a number to that performance to measure the improvements offered by an upgrade, or to objectively compare the performance of various systems. Benchmarks are used to test and report the performance of a PC by running a set of well-defined tasks on the system. A benchmark program has several different uses in the PC industry depending on what you're needs are:

System Comparisons: Benchmarks are often used to compare a system to one or more competing machines (or to compare a newer system to older machines). Just flip through any issue of PC Magazine or Byte, and you'll see a flurry of PC ads all quoting numerical performance numbers backed up by benchmarks. You might also run a benchmark to establish the overall performance of a new system before making a purchase decision.

Upgrade Improvements: Benchmarks are frequently used to gauge the value of an up-grade. By running the benchmark before and after the upgrade process, you can get a numerical assessment of just how much that new CPU, RAM, drive, or motherboard might have improved (or hindered) system performance.

- Diagnostics Benchmarks sometimes have role in system diagnostics. Systems that are performing poorly can be benchmarked as key components are checked or reconfigured. This helps the technician isolate and correct performance problems far more reliably than simple "visual" observations.

Avoiding Benchmark Problems

One of the most serious problems encountered with benchmarks is the integrity of their numbers. You've probably heard that "statistics can lie," and the same thing is true of benchmarks. In order for benchmarks to provide you with reliable results, you must take some precautions:

- Note the complete system configuration When you run a benchmark and achieve a result, be sure to note the entire system configuration (i.e., CPU, RAM, cache, OS version, etc.).
- Run the same benchmark on every system Benchmarks are still software, and the way in which benchmark code is written can impact the way it produces results on a given computer. Often, two different versions of the same benchmark will yield two different results. When you use benchmarks for comparisons between systems, be sure to use the same program and version number.
- Minimize hardware differences between hardware platforms A computer is an assembly of many interdependent sub-assemblies (i.e., motherboard, drive controllers, drives, CPU, etc.), but when a benchmark is run to compare a difference between systems, that difference can be masked by other elements in the system. For example, suppose you're using a benchmark to test the hard-drive data transfer on two systems. Different hard drives and drive controllers will yield different results (that's expected). However, even if you're using identical drives and controllers, other differences between the systems (such as BIOS versions, TSRs, OS differences, or motherboard chipsets) can also influence different results.
- Run the benchmarks under the same load The results generated by a benchmark do not guarantee that same level of performance under "real-world" applications. This was one of the flaws of early computer benchmarking—small, tightly written benchmark code resulted in artificially high performance, but the system still performed poorly when real applications were used. Use benchmarks that make use of (or simulate) actual programs, or otherwise simulate your true workload.

Obtaining Benchmarks

Benchmarks have been around since the earliest computers, and there are now a vast array of benchmark products to measure all aspects of the PC—as well as measure more specialized issues, such as networking, real-time systems, and UNIX (or other operating system) platforms. Table 4-1 highlights a cross-section of computer benchmarks for your reference. In many cases, the table includes a URL or FTP site where you can obtain source code for the benchmark, or download the complete benchmark program. Today, Ziff Davis and CMP publish a suite of freeware benchmark utilities that have become standard tools for end users and technicians alike.

BatteryMark **BatteryMark** uses a combination of hardware and software to measure the battery life of notebook computers under real-world conditions (the hardware used in **BatteryMark** is the same ZDigit II device required by version 1.0). **BatteryMark** exercises a different 32-bit software workload engines for processor, disk, and graphics tasks.

BatteryMark mixes these workloads together and adds periodic breaks in the work that reflect the way users pause while working. **BatteryMark** 2.0 works with Advanced Power Management (APM) under Windows 95.

NetBench **NetBench** is our benchmark test for checking the performance of net-work file servers. NetBench provides a way to measure, analyze, and predict how a file server will handle network file I/O requests. It monitors the response of the server as multiple clients request data, and reports the server's total throughput. To test application servers, you should use the ServerBench utility instead.

ServerBench **ServerBench** is the latest version of Ziff-Davis' standard benchmark for measuring the performance of servers in a true client/server environment. Server-Bench clients make requests of an application that runs on the server—the server's ability to service those requests is reported in transactions per second. ServerBench 4.0 runs on IBM's OS/2 Warp Server, Microsoft's Windows NT Server 4.0 (for both Digital Alpha and x86-compatible processors), Novell's NetWare 4.11, Sun's Solaris 2.5 on SPARC, and SCO's OpenServer Release 5 and UnixWare 2.1. To test network file servers, use the NetBench utility instead.

WebBench **WebBench** is the Ziff Davis benchmark test for checking performance of Web-server hardware and software. Standard test suites produce two overall scores for the server: requests per second and throughput (as measured in bytes per second). WebBench includes static testing (which involves only HTML pages), and dynamic testing (including CGI executables, Internet Server API libraries, and Netscape Server API dynamic link libraries).

JMark **JMark** is a suite of 11 synthetic benchmark tests for evaluating the performance of Java virtual machines. The JMark 1.01 suite simulates a number of important tests of Java functionality. It includes Java versions of a number of classic benchmark test algorithms, as well as tests designed to measure graphics performance in a GUI environment. You can download JMark 1.01 from Ziff Davis, or run the tests online within your browser.

Wintune 97 **Wintune** for Windows 95/NT is a recent benchmark entry from CMP, the publishers of Windows Magazine. Wintune 97 is an overall benchmark to measure Windows 95/NT performance. It has a fast user interface that allows the program to load much faster than the earlier Wintune 95, and will now support testing of the latest Pentium II systems. Wintune 97 tests video systems on the fastest new computers at full-screen resolution.

Troubleshooting BIOS Beep Codes - AMI BIOS

The AMI BIOS is one of the most popular in the PC world today, and fortunately is quite consistent in its use of beep codes, across its many different versions. Please select the beep pattern you are hearing from the list in the table given below.

Beep	Explanation	Diagnosis	Troubleshooting steps
------	-------------	-----------	-----------------------

Beep	Explanation	Diagnosis	Troubleshooting steps
1 Beep:	DRAM refresh failure The system is having a problem accessing the system memory to refresh it. Refreshing is done on all system memory to keep its contents active.	This code usually means a problem either with the system memory or with the motherboard itself.	<ul style="list-style-type: none"> • Troubleshoot the motherboard. • Treat as an apparent memory failure.
2 Beeps	Parity circuit failure The parity circuit is responsible for generating and checking the parity bit on the system memory when <u>parity checking</u> is used. This circuitry is not working properly.	This code usually means a problem with either the system memory or the motherboard.	<ul style="list-style-type: none"> • Treat as an apparent memory failure. • Troubleshoot the motherboard
3 Beeps	Base 64K RAM failure There is a failure of some sort within the first 64 KB of system memory.	The first bank of memory probably has a bad memory chip in it somewhere. It is possible that there is a failure related to the motherboard or a system device as well.	<ul style="list-style-type: none"> • Treat as an apparent memory failure. • Troubleshoot the motherboard.
4 Beeps	System timer failure There is a problem with one or more of the timers used by the system to control functions on the motherboard.	This is usually a motherboard failure.	<ul style="list-style-type: none"> • Troubleshoot the motherboard.
5 Beeps	Processor failure The system processor is generating an error condition indicating a problem with it.	There is a problem related to the processor or motherboard. Note that this doesn't mean that the processor is necessarily dead; with a dead processor the system won't boot at all (it runs the BIOS code that is used to start up the PC.)	<ul style="list-style-type: none"> • Troubleshoot the processor. • If the processor is not at fault, troubleshoot the motherboard.
6 Beeps	Keyboard controller / gate A20 failure The <u>keyboard controller</u> is a chip on the motherboard that communicates with your keyboard. It also controls the A20 gate that provides access to the <u>high memory area (HMA)</u> . This component is indicating a failure.	This is usually a problem with either the keyboard or the motherboard	<ul style="list-style-type: none"> • Troubleshooting the keyboard is relatively easy; try that first. • Troubleshoot the keyboard controller. <p>Troubleshoot as a motherboard failure</p>
7 Beeps	Virtual mode exception error	There is a problem related to the processor or motherboard.	<ul style="list-style-type: none"> • Troubleshoot the processor.

Beep	Explanation	Diagnosis	Troubleshooting steps
	<p>Virtual mode is one of the different modes that the processor can run in. The system is reporting an error when testing this mode.</p>	<p>Note that this doesn't mean that the processor is necessarily dead, since the system won't boot at all with a dead processor.</p>	<ul style="list-style-type: none"> • Troubleshoot the motherboard.
<p>8 Beeps</p>	<p>Display memory read/write failure</p> <p>The BIOS is unable to write to the frame buffer memory on the video card.</p>	<p>This is usually caused by a problem with the video card, or the memory on the video card. It can also be a motherboard issue.</p> <p>Note: Unlike the other AMI beep codes, this one is "non-fatal". The system may continue to boot despite this error.</p>	<ul style="list-style-type: none"> • Troubleshoot the video card. • Troubleshoot the motherboard
<p>9 Beeps</p>	<p>ROM BIOS checksum failure</p> <p>The <u>read-only memory (ROM) containing the BIOS program</u> (which is what is running when you turn on the PC and what generates this error) uses a checksum value as a double-check that the ROM code is correct. This checksum is compared against the values in the ROM each time the PC is booted and if there is a mismatch, this code is generated</p>	<p>The BIOS ROM chip on the motherboard is probably faulty. It could also be another component on the motherboard.</p>	<p>Troubleshoot the motherboard. It is possible to replace just the BIOS ROM chip but often replacing the motherboard will make more sense for cost and simplicity reasons.</p>
<p>10 Beeps</p>	<p>CMOS shutdown register read/write error</p> <p>A component of the motherboard is producing an error interacting with the <u>CMOS memory that holds the BIOS settings</u>.</p>	<p>There is likely a problem with the motherboard.</p>	<p>Troubleshoot the motherboard.</p>
<p>11 Beeps</p>	<p>Cache memory error</p> <p>The system has attempted to verify the operation of the</p>	<p>This usually means a problem with the system cache. It may also be a more general problem with the motherboard.</p>	<ul style="list-style-type: none"> • Troubleshoot the secondary cache. • Troubleshoot the

Beep	Explanation	Diagnosis	Troubleshooting steps
	secondary (level 2) cache and has encountered an error.		motherboard.
Continuous Beeping	Memory or video problem The system is producing constant beeping in no specific pattern, or a fast "ringing" sound.	This is usually caused by a problem with the system memory, or possibly the video card. The memory is more likely--the system complains long and loud if it can't find any usable memory, as there is no way to even start the boot process when this is the case. The motherboard itself could also be the problem.	<ul style="list-style-type: none"> • Troubleshoot the system memory. • Troubleshoot the video card. • Troubleshoot the motherboard.

Troubleshooting BIOS Beep Codes - Award BIOS

Award is the other major BIOS provider today, along with AMI. Award uses by far the fewest beep codes of any of the BIOS manufacturers.

Beep	Explanation	Diagnosis	Troubleshooting steps
1 Long Beep	Memory problem There is a failure of some sort related to the system memory.	The first bank of memory probably has a failure of some sort; this is usually just a physical problem such as an incorrectly inserted module, but may also mean a bad memory chip in a module. It is possible that there is a failure related to the motherboard or a system device as well.	<ul style="list-style-type: none"> • Treat as an apparent memory failure. • Troubleshoot the motherboard.
1 Long, then 2 Short Beeps	Video error The BIOS is unable to access the video system in order to write any error messages to the screen.	This is usually caused by a problem with the video card, or the memory on the video card. It can also be a motherboard issue.	<ul style="list-style-type: none"> • Troubleshoot the video card. • If the video card is not at fault, troubleshoot the motherboard.

Beep	Explanation	Diagnosis	Troubleshooting steps
<p>1 Long, then 3 Short Beeps</p>	<p>Video error</p> <p>The BIOS is unable to access the video system in order to write any error messages to the screen.</p>	<p>This is usually caused by a problem with the video card, or the memory on the video card. It can also be a motherboard issue.</p>	<ul style="list-style-type: none"> • Troubleshoot the video card. • If the video card is not at fault, troubleshoot the motherboard.
<p>Continuous Beeping</p>	<p>Memory or video problem</p> <p>The system is producing constant beeping in no specific pattern, or a fast "ringing" sound</p>	<p>This is usually caused by a problem with the system memory, or possibly the video card. The memory is more likely--the system complains long and loud if it can't find any usable memory, as there is no way to even start the boot process when this is the case. The motherboard itself could also be the problem.</p>	<ul style="list-style-type: none"> • Troubleshoot the system memory. • Troubleshoot the video card. • Troubleshoot the motherboard.

Week 3

This Week Learning Outcome

To Understand:

➤ Cause of Startup Failure

The Boot Process

Computer initialization is a process—not an event. From the moment that power is applied until the system sits idle at the command-line prompt or graphical desktop, the PC boot process is a sequence of predictable steps that verify the system and prepare it for operation. By understanding each step in system initialization, you can develop a real appreciation for the way that hardware and software relate to one another—you also stand a much better chance of identifying and resolving problems when a system fails to boot properly. This part of the chapter provides a step-by-step review of a typical PC boot process.

Applying Power

PC initialization starts when you turn the system on. If all output voltages from the power supply are valid, the supply generates a Power Good (PG) logic signal. It can take between 100 ms and 500 ms for the supply to generate a PG signal. When the motherboard timer IC receives the PG signal, the timer stops forcing a Reset signal to the CPU. At this point, the CPU starts processing.

The Bootstrap

The very first operation performed by a CPU is to fetch an instruction from address FFFF:0000h. Because this address is almost at the end of available ROM space, the instruction is almost always a jump command (JMP) followed by the actual BIOS ROM starting address. By making all CPUs start at the same point, the BIOS ROM can then send program control anywhere in the particular ROM (and each ROM is usually different). This initial search of address FFFF:0000h and the subsequent re-direction of the CPU is traditionally referred to as the *bootstrap* in which the PC “pulls itself up by its bootstraps”—or gets itself going. Today, we have shortened the term to *boot*, and have broadened its meaning to include the entire initialization process.

Core Tests

The core tests are part of the overall *Power-On Self-Test (POST)* sequence, which is the most important use of a system BIOS during initialization. As you might expect, allowing

The Boot Process 65

The system to initialize and run with flaws in the motherboard, memory, or drive systems can have catastrophic consequences for files in memory or on disk. To ensure system

integrity, a set of hardware-specific self-test routines checks the major motherboard components, and identifies the presence of any other specialized BIOS ICs in the system (i.e., drive-controller BIOS, video BIOS, SCSI BIOS, and so on). BIOS starts with a test of the motherboard hardware such as the CPU, math co-processor, timer ICs, *Direct Memory Access (DMA)* controllers, and *interrupt (IRQ)* controllers.

If an error is detected in this early phase of testing, a series of beeps (or beep codes) are produced. By knowing the BIOS manufacturer and the beep code, you can determine the nature of the problem. Chapter 15 deals with beep and error codes in more detail. Beep codes are used because the video system has not been initialized.

Next, BIOS looks for the presence of a video ROM between memory locations C000:0000h through C780:000h. In just about all systems, the search will reveal a video BIOS ROM on a video adapter board, plugged into an available expansion slot. If a video BIOS is found, its contents are evaluated with a checksum test. If the test is successful, control is transferred to the video BIOS, which loads and initializes the video adapter. When initialization is complete, you will see a cursor on the screen and control returns to the system BIOS. If no external video adapter BIOS is located, the system BIOS will provide an initialization routine for the motherboard's video adapter and a cursor will also appear.

Once the video system initializes, you are likely to see a bit of text on the display identifying the system or video BIOS ROM maker and revision level. If the checksum test fails, you will see an error message such as: C000 ROM Error or Video ROM Error.

Initialization will usually halt right there. Now that the video system is ready, system BIOS will scan memory from C800:0000h through DF80:0000h in 2KB increments to search for any other ROMs that might be on other adapter cards in the system. If other ROMs are found, their contents are tested and run. As each supplemental ROM is executed, they will show manufacturer and revision ID information. In some cases, a supplemental (or "adapter") ROM might alter an existing BIOS ROM routine. For example, an Ultra DMA/33 drive-controller board with its own on-board ROM will replace the motherboard's older drive routines. When a ROM fails the checksum test, you will see an error message such as: "XXXX ROM Error." The XXXX indicates the segment address where the faulty ROM was detected. If a faulty ROM is detected, system initialization will usually halt.

Post

BIOS then checks the memory location at 0000:0472h. This address contains a flag that determines whether the initialization is a cold start (power first applied) or a warm start (reset button or <Ctrl>+<Alt>+ key combination). A value of 1234h at this address indicates a warm start—in which case, the (POST) routine is skipped. If any other value is found at that location, a cold start is assumed, and the full POST routine will be executed. The full POST checks many of the other higher-level functions on the motherboard, memory, keyboard, video adapter, floppy drive, math co-processor, printer port, serial port, hard drive, and other sub-systems. Dozens of tests are performed by the POST.

When an error is encountered, the single-byte POST code is written to I/O port 80h, where it might be read by a POST-code reader. In other cases, you might see an error message.

66 Operating Systems and the Boot Process

On the display (and system initialization will halt). Remember that POST codes and their meanings will vary slightly between BIOS manufacturers. If the POST completes successfully, the system will respond with a single beep from the speaker. Chapter 15 covers I/O port POST codes.

Finding the OS

The system now needs to load an operating system (usually DOS or Windows 95). The first step here is to have the BIOS search for a DOS volume boot sector (VBS) on the A: drive. If there is no disk in the drive, you will see the drive light illuminate briefly, and then BIOS will search the next drive in the boot order (usually drive C:). If a disk is in drive A:, BIOS will load sector 1 (head 0, cylinder 0) from the disk's DOS volume boot sector into memory, starting at 0000:7C00h. There are a number of potential problems when attempting to load the VBS. Otherwise, the first program in the directory (IO.SYS) will begin to load, followed by MSDOS.SYS.

- If the first byte of the DOS VBS is less than 06h (or if the first byte is greater than or equal to 06h and next nine words of the sector contain the same data pattern), you will see an error message similar to: "Diskette boot record error."
- If the IO.SYS and MSDOS.SYS are not the first two files in the directory (or some other problem is encountered in loading), you'll see an error such as: "Non-system disk or disk error."
- If the boot sector on the diskette is corrupted and cannot be read (DOS 3.3 or earlier), you'll probably get a *Disk boot* failure message.

If the OS cannot be loaded from any floppy drive, the system will search the first fixed drive (hard drive). Hard drives are a bit more involved than floppy disks. BIOS loads sector 1 (head 0, cylinder 0) from the hard drive's master partition boot sector (called the *master boot sector*, *MBS*) into memory, starting at 0000:7C00h, and the last two bytes of the sector are checked. If the final two bytes of the master-partition boot sector are not 55h and AAh respectively, the boot sector is invalid, and you will see an error message similar to: "No boot device available and system initialization will halt." Other systems might depict the error differently or attempt to load ROM BASIC. If the BIOS attempts to load ROM BASIC and there is no such feature in the BIOS, you'll see a ROM BASIC error message.

Otherwise, the disk will search for and identify any extended partitions (up to 24 total partitions). Once any extended partitions have been identified, the drive's original boot sector will search for a boot-indicator byte, marking a partition as active and bootable. If none of the partitions are marked as bootable (or if more than one partition is marked

bootable), a disk error message will be displayed such as: “Invalid partition table.” Some older BIOS versions might attempt to load ROM BASIC, but will generate an error message in most cases anyway.

When an active bootable partition is found in the master partition boot sector, the DOS *Volume Boot Sector (VBS)* from the bootable partition is loaded into memory and tested. If the DOS VBS cannot be read, you will see an error message similar to: “Error loading operating system.” When the DOS volume boot sector does load, the last two bytes are.

The Boot Process 67

Tested for a signature of 55h and AAh, respectively. If these signature bytes are missing, you will see an error message such as: “Missing operating system.” Under either error condition, system initialization will halt.

After the signature bytes are identified, the DOS volume boot sector (now in memory) is executed as if it were a program. This “program” checks the root directory to ensure that IO.SYS and MSDOS.SYS (or IBMBIO.COM and IBMDOS.COM) are available. In older MS-DOS versions, IO.SYS and MSDOS.SYS have to be the first two directory entries. If the DOS volume boot sector was created with MS-DOS 3.3 (or earlier) and the two startup files are not the first two files in the directory (or there is an error in loading the files), the system will produce an error code, such as: “Non-system disk or disk error.” If the boot sector is corrupt, you might see a message like: “Disk boot failure.”

Loading the OS

If no problems are detected in the disk’s DOS volume boot sector, IO.SYS (or IBMBIO.COM) is loaded and executed. If Windows 95 is on the system, IO.SYS might be renamed *WINBOOT.SYS*, which will be executed instead. IO.SYS contains extensions to BIOS that start low-level device drivers for such things as the keyboard, printer, and block devices. Remember that IO.SYS also contains initialization code that is only needed during system startup. A copy of this initialization code is placed at the top of conventional memory which takes over initialization. The next step is to load MSDOS.SYS (or IBMDOS.COM), which is loaded so that it overlaps the part of IO.SYS containing the initialization code. MSDOS.SYS (the MS-DOS kernel) is then executed to initialize base device drivers, detect system status, reset the disk system, initialize devices (such as the printer and serial port), and set up system-default parameters. The MS-DOS essentials are now loaded and control returns to the IO.SYS/WINBOOT.SYS initialization code in memory.

Establishing the Environment

If a CONFIG.SYS file is present, it is opened and read by IO.SYS/WINBOOT.SYS. The DEVICE statements are processed first in the order they appear, then INSTALL statements are processed in the order they appear. A SHELL statement is handled next. If no SHELL statement is present, the COMMAND.COM processor is loaded. When COMMAND.COM is loaded, it overwrites the initialization code left over from IO.SYS (which is now no longer needed). Under Windows 95, COMMAND.COM is loaded only if an AUTOEXEC.BAT file is present to process the AUTOEXEC.BAT statements. Finally, all

other statements in CONFIG.SYS are processed, and WINBOOT.SYS also looks for the SYSTEM.DAT registry file.

When an AUTOEXEC.BAT file is present, COMMAND.COM (which now has control of the system) will load and execute the batch file. After the batch-file processing is complete, the familiar DOS prompt will appear. If there is no AUTOEXEC.BAT in the root directory, COMMAND.COM will request the current date and time, then show the DOS.

68 Operating Systems and the Boot Process

For Windows 95 systems, IO.SYS (or WINBOOT.SYS) combines the functions of IO.SYS and MSDOS.SYS. Prompt. You can now launch applications or use any available OS commands. AUTOEXEC. BAT can also call a shell (such as Windows 3.1x) or start an application. Under Windows 95, IO.SYS/WINBOOT.SYS automatically loads HIMEM.SYS, IFSHLP.SYS, and SETVER.EXE, then loads the WIN.COM kernel to officially start Windows 95.

Creating A Dos Boot Disk

The most persistent problem with PC troubleshooting is that it can be difficult to boot a system successfully—especially if there are hard-drive problems. This makes it particularly important to have a bootable floppy diskette on hand. The two means of creating a boot disk are: automatically (through an existing Windows 95 platform) or manually (through a DOS 6.22 platform). In either case, you're going to need access to a running PC with an operating system that is similar to the version you plan to install on the new PC.

Windows 95 Windows 95 comes with an automatic “Startup Disk” maker. If you have access to a Windows 95 system, use the following procedure to create a DOS 7.x startup disk:

- Label a blank diskette and insert it into your floppy drive.
- Click on *Start, Settings, and Control Panel*.
- Doubleclick on the *Add/remove programs* icon.
- Select the *Startup disk* tab.
- Click on *Create disk*.
- The utility will remind you to insert a diskette, then prepare the disk automatically.

When the preparation is complete, test the diskette. The preparation process takes several minutes, and will copy the following files to your diskette: ATTRIB, CHKDSK, COMMAND, DEBUG, DRVSPACE.BIN, EDIT, FDISK, FORMAT, REGEDIT, SCANDISK, SYS, and UNINSTAL. All of these files are DOS 7.x-based files, so you can run them from the A: prompt.

DOS 6.22 If you don't have access to a system with Windows 95 already, you'll need to make a boot disk manually using DOS 6.22 utilities. Create a bootable diskette by using the SYS feature, such as: C:\DOS\> SYS A: <Enter> or use the *Format* command to make a bootable diskette like: C:\DOS\> FORMAT A: /S <Enter>

The Boot Process 69

The Windows 95 FDISK utility has been reported to have a bug that can cause problems when creating more than one partition on the same drive. Later releases of Windows 95 (i.e., OSR 2) claim to have corrected this issue, but if you encounter problems with FDISK, use the DOS 6.22 version.

Once the diskette is bootable, copy the following DOS utilities (usually from the DOS directory): FDISK, FORMAT, SYS, MEM, DEFRAG, SCANDISK, EDIT, HIMEM, EMM386, and EDIT. You might not need all of these utilities, but it can be handy to have them on-hand in case you need to check a disk or memory.

Week 3

This Week Learning Outcome

To Understand:

➤ Cause of Startup Failure

The Boot Process

Computer initialization is a process—not an event. From the moment that power is applied until the system sits idle at the command-line prompt or graphical desktop, the PC boot process is a sequence of predictable steps that verify the system and prepare it for operation. By understanding each step in system initialization, you can develop a real appreciation for the way that hardware and software relate to one another—you also stand a much better chance of identifying and resolving problems when a system fails to boot properly. This part of the chapter provides a step-by-step review of a typical PC boot process.

Applying Power

PC initialization starts when you turn the system on. If all output voltages from the power supply are valid, the supply generates a Power Good (PG) logic signal. It can take between 100 ms and 500 ms for the supply to generate a PG signal. When the motherboard timer IC receives the PG signal, the timer stops forcing a Reset signal to the CPU. At this point, the CPU starts processing.

The Bootstrap

The very first operation performed by a CPU is to fetch an instruction from address FFFF:0000h. Because this address is almost at the end of available ROM space, the instruction is almost always a jump command (JMP) followed by the actual BIOS ROM starting address. By making all CPUs start at the same point, the BIOS ROM can then send program control anywhere in the particular ROM (and each ROM is usually different). This initial search of address FFFF:0000h and the subsequent re-direction of the CPU is traditionally referred to as the *bootstrap* in which the PC “pulls itself up by its

bootstraps”—or gets itself going. Today, we have shortened the term to *boot*, and have broadened its meaning to include the entire initialization process.

Core Tests

The core tests are part of the overall *Power-On Self-Test (POST)* sequence, which is the most important use of a system BIOS during initialization. As you might expect, allowing.

The Boot Process 65

The system to initialize and run with flaws in the motherboard, memory, or drive systems can have catastrophic consequences for files in memory or on disk. To ensure system integrity, a set of hardware-specific self-test routines checks the major motherboard components, and identifies the presence of any other specialized BIOS ICs in the system (i.e., drive-controller BIOS, video BIOS, SCSI BIOS, and so on). BIOS starts with a test of the motherboard hardware such as the CPU, math co-processor, timer ICs, *Direct Memory Access (DMA)* controllers, and *interrupt (IRQ)* controllers.

If an error is detected in this early phase of testing, a series of beeps (or beep codes) are produced. By knowing the BIOS manufacturer and the beep code, you can determine the nature of the problem. Chapter 15 deals with beep and error codes in more detail. Beep codes are used because the video system has not been initialized.

Next, BIOS looks for the presence of a video ROM between memory locations C000:0000h through C780:000h. In just about all systems, the search will reveal a video BIOS ROM on a video adapter board, plugged into an available expansion slot. If a video BIOS is found, its contents are evaluated with a checksum test. If the test is successful, control is transferred to the video BIOS, which loads and initializes the video adapter. When initialization is complete, you will see a cursor on the screen and control returns to the system BIOS. If no external video adapter BIOS is located, the system BIOS will provide an initialization routine for the motherboard's video adapter and a cursor will also appear.

Once the video system initializes, you are likely to see a bit of text on the display identifying the system or video BIOS ROM maker and revision level. If the checksum test fails, you will see an error message such as: C000 ROM Error or Video ROM Error.

Initialization will usually halt right there. Now that the video system is ready, system BIOS will scan memory from C800:0000h through DF80:0000h in 2KB increments to search for any other ROMs that might be on other adapter cards in the system. If other ROMs are found, their contents are tested and run. As each supplemental ROM is executed, they will show manufacturer and revision ID information. In some cases, a supplemental (or “adapter”) ROM might alter an existing BIOS ROM routine. For example, an Ultra DMA/33 drive-controller board with its own on-board ROM will replace the motherboard's older drive routines. When a ROM fails the checksum test, you will see an error message such as: “XXXX ROM Error.” The XXXX indicates the segment address where the faulty ROM was detected. If a faulty ROM is detected, system initialization will usually halt.

Post

BIOS then checks the memory location at 0000:0472h. This address contains a flag that determines whether the initialization is a cold start (power first applied) or a warm start (reset button or <Ctrl>+<Alt>+ key combination). A value of 1234h at this address indicates a warm start—in which case, the (POST) routine is skipped. If any other value is found at that location, a cold start is assumed, and the full POST routine will be executed. The full POST checks many of the other higher-level functions on the motherboard, memory, keyboard, video adapter, floppy drive, math co-processor, printer port, serial port, hard drive, and other sub-systems. Dozens of tests are performed by the POST.

When an error is encountered, the single-byte POST code is written to I/O port 80h, where it might be read by a POST-code reader. In other cases, you might see an error message.

66 Operating Systems and the Boot Process

On the display (and system initialization will halt). Remember that POST codes and their meanings will vary slightly between BIOS manufacturers. If the POST completes successfully, the system will respond with a single beep from the speaker. Chapter 15 covers I/O port POST codes.

Finding the OS

The system now needs to load an operating system (usually DOS or Windows 95). The first step here is to have the BIOS search for a DOS volume boot sector (VBS) on the A: drive. If there is no disk in the drive, you will see the drive light illuminate briefly, and then BIOS will search the next drive in the boot order (usually drive C:). If a disk is in drive A:, BIOS will load sector 1 (head 0, cylinder 0) from the disk's DOS volume boot sector into memory, starting at 0000:7C00h. There are a number of potential problems when attempting to load the VBS. Otherwise, the first program in the directory (IO.SYS) will begin to load, followed by MSDOS.SYS.

- If the first byte of the DOS VBS is less than 06h (or if the first byte is greater than or equal to 06h and next nine words of the sector contain the same data pattern), you will see an error message similar to: "Diskette boot record error."
- If the IO.SYS and MSDOS.SYS are not the first two files in the directory (or some other problem is encountered in loading), you'll see an error such as: "Non-system disk or disk error."
- If the boot sector on the diskette is corrupted and cannot be read (DOS 3.3 or earlier), you'll probably get a *Disk boot* failure message.

If the OS cannot be loaded from any floppy drive, the system will search the first fixed drive (hard drive). Hard drives are a bit more involved than floppy disks. BIOS loads sector 1 (head 0, cylinder 0) from the hard drive's master partition boot sector (called the *master boot sector*, *MBS*) into memory, starting at 0000:7C00h, and the last two bytes of the sector are checked. If the final two bytes of the master-

partition boot sector are not 55h and AAh respectively, the boot sector is invalid, and you will see an error message similar to: “No boot device available and system initialization will halt.” Other systems might depict the error differently or attempt to load ROM BASIC. If the BIOS attempts to load ROM BASIC and there is no such feature in the BIOS, you’ll see a ROM BASIC error message.

Otherwise, the disk will search for and identify any extended partitions (up to 24 total partitions). Once any extended partitions have been identified, the drive’s original boot sector will search for a boot-indicator byte, marking a partition as active and bootable. If none of the partitions are marked as bootable (or if more than one partition is marked bootable), a disk error message will be displayed such as: “Invalid partition table.” Some older BIOS versions might attempt to load ROM BASIC, but will generate an error message in most cases anyway.

When an active bootable partition is found in the master partition boot sector, the DOS *Volume Boot Sector (VBS)* from the bootable partition is loaded into memory and tested. If the DOS VBS cannot be read, you will see an error message similar to: “Error loading operating system.” When the DOS volume boot sector does load, the last two bytes are.

The Boot Process 67

Tested for a signature of 55h and AAh, respectively. If these signature bytes are missing, you will see an error message such as: “Missing operating system.” Under either error condition, system initialization will halt.

After the signature bytes are identified, the DOS volume boot sector (now in memory) is executed as if it were a program. This “program” checks the root directory to ensure that IO.SYS and MSDOS.SYS (or IBMBIO.COM and IBMDOS.COM) are available. In older MS-DOS versions, IO.SYS and MSDOS.SYS have to be the first two directory entries. If the DOS volume boot sector was created with MS-DOS 3.3 (or earlier) and the two startup files are not the first two files in the directory (or there is an error in loading the files), the system will produce an error code, such as: “Non-system disk or disk error.” If the boot sector is corrupt, you might see a message like: “Disk boot failure.”

Loading the OS

If no problems are detected in the disk’s DOS volume boot sector, IO.SYS (or IBMBIO.COM) is loaded and executed. If Windows 95 is on the system, IO.SYS might be renamed *WINBOOT.SYS*, which will be executed instead. IO.SYS contains extensions to BIOS that start low-level device drivers for such things as the keyboard, printer, and block devices. Remember that IO.SYS also contains initialization code that is only needed during system startup. A copy of this initialization code is placed at the top of conventional memory which takes over initialization. The next step is to load MSDOS.SYS (or IBMDOS.COM), which is loaded so that it overlaps the part of IO.SYS containing the initialization code. MSDOS.SYS (the MS-DOS kernel) is then executed to initialize base device drivers, detect system status, reset the disk system, initialize devices (such as the printer and serial port), and set up system-default parameters. The MS-DOS essentials are now loaded and control returns to the IO.SYS/WINBOOT.SYS initialization code in memory.

Establishing the Environment

If a CONFIG.SYS file is present, it is opened and read by IO.SYS/WINBOOT.SYS. The DEVICE statements are processed first in the order they appear, then INSTALL statements are processed in the order they appear. A SHELL statement is handled next. If no SHELL statement is present, the COMMAND.COM processor is loaded. When COMMAND.COM is loaded, it overwrites the initialization code left over from IO.SYS (which is now no longer needed). Under Windows 95, COMMAND.COM is loaded only if an AUTOEXEC.BAT file is present to process the AUTOEXEC.BAT statements. Finally, all other statements in CONFIG.SYS are processed, and WINBOOT.SYS also looks for the SYSTEM.DAT registry file.

When an AUTOEXEC.BAT file is present, COMMAND.COM (which now has control of the system) will load and execute the batch file. After the batch-file processing is complete, the familiar DOS prompt will appear. If there is no AUTOEXEC.BAT in the root directory, COMMAND.COM will request the current date and time, then show the DOS.

68 Operating Systems and the Boot Process

For Windows 95 systems, IO.SYS (or WINBOOT.SYS) combines the functions of IO.SYS and MSDOS.SYS. Prompt. You can now launch applications or use any available OS commands. AUTOEXEC.BAT can also call a shell (such as Windows 3.1x) or start an application. Under Windows 95, IO.SYS/WINBOOT.SYS automatically loads HIMEM.SYS, IFSHLP.SYS, and SETVER.EXE, then loads the WIN.COM kernel to officially start Windows 95.

Creating A Dos Boot Disk

The most persistent problem with PC troubleshooting is that it can be difficult to boot a system successfully—especially if there are hard-drive problems. This makes it particularly important to have a bootable floppy diskette on hand. The two means of creating a boot disk are: automatically (through an existing Windows 95 platform) or manually (through a DOS 6.22 platform). In either case, you're going to need access to a running PC with an operating system that is similar to the version you plan to install on the new PC.

Windows 95 Windows 95 comes with an automatic “Startup Disk” maker. If you have access to a Windows 95 system, use the following procedure to create a DOS 7.x startup disk:

- Label a blank diskette and insert it into your floppy drive.
- Click on *Start, Settings, and Control Panel*.
- Doubleclick on the *Add/remove programs* icon.
- Select the *Startup disk* tab.
- Click on *Create disk*.
- The utility will remind you to insert a diskette, then prepare the disk automatically.

When the preparation is complete, test the diskette. The preparation process takes several minutes, and will copy the following files to your diskette: ATTRIB, CHKDSK, COMMAND, DEBUG, DRVSPACE.BIN, EDIT, FDISK, FORMAT, REGEDIT, SCANDISK, SYS, and UNINSTAL. All of these files are DOS 7.x-based files, so you can run them from the A: prompt.

DOS 6.22 If you don't have access to a system with Windows 95 already, you'll need to make a boot disk manually using DOS 6.22 utilities. Create a bootable diskette by using the SYS feature, such as: C:\DOS\> SYS A: <Enter> or use the *Format* command to make a bootable diskette like: C:\DOS\> FORMAT A: /S <Enter>

The Boot Process 69

The Windows 95 FDISK utility has been reported to have a bug that can cause problems when creating more than one partition on the same drive. Later releases of Windows 95 (i.e., OSR 2) claim to have corrected this issue, but if you encounter problems with FDISK, use the DOS 6.22 version.

Once the diskette is bootable, copy the following DOS utilities (usually from the DOS directory): FDISK, FORMAT, SYS, MEM, DEFRAG, SCANDISK, EDIT, HIMEM, EMM386, and EDIT. You might not need all of these utilities, but it can be handy to have them on-hand in case you need to check a disk or memory.

Week4

To Understand

➤ Startup Problems(Power Supply Unit)

Power Supply

The power supply is the silver box that is usually located in the rear right quarter of the enclosure. Ac enters the supply through the ac line cord, which is connected at the rear of the enclosure. A supply then produces a series of dc outputs that power the motherboard and drives. The importance of a power supply is easy enough to understand, but its implications for system integrity and expandability might not be as obvious. Power supplies sustain a great deal of electrical stress in normal everyday operation.

The conversion of ac into dc results in substantial heat, which is why so many power supplies are equipped with a cooling fan. Surges, spikes, and other anomalies that plague ac power distribution (especially in underdeveloped regions of the world) also find their way into PC power supplies, where damage can occur. The quality of a power supply's design and components and design dictate how long it will last in operation. A quality supply will resist power problems and tolerate the rigors of normal operation, but a sub-standard supply can fail spontaneously after only a few months of operation. When replacing or upgrading a power supply, be sure to choose a reliable model. Power supplies also limit a system's expandability. Every element used in the PC requires a certain amount of power (marked *W* for *watts*). The supply must be capable of producing enough power to adequately meet the system's demand. An under-powered supply (typical in low-profile systems) or a supply overloaded by excessive expansion (which frequently occurs in tower systems) might not be able to support the power needs of the system. Inadequate power results in very strange system behavior such as unpredictable system lockups, random memory faults, or disk-access problems. When replacing a power supply, be certain that the new supply can provide at least as much power as the supply being replaced. When upgrading a supply, choose a supply that offers at least 50 watts more than the original supply.

Week5

This Week Learning Outcome To Understand:

➤ Startup Diagnostic (Hardware)

Hardware Diagnostic Utility

After the PC has been cleaned and checked inside and out, it's time to check the hard drive for potential problems. This involves checking the drive's file system, reorganizing files, and creating an updated boot disk. To perform a drive check, you'll need a copy of ScanDisk and Defrag. Because these utilities are already built into Windows 95, you can reboot the system and use those utilities directly. If you are more comfortable with running these utilities from DOS, create a startup disk from within Windows 95 and boot from that diskette. Then run ScanDisk and Defrag right from the startup disk. You should perform the drive check very regularly—once a month is usually recommended, or whenever you make major additions or deletions of files from your system.

Run Scandisk

The ScanDisk utility is designed to check your drive for file problems (such as lost or cross-linked clusters), then correct those problems. ScanDisk is also particularly useful for testing for potential media (surface) errors on a disk. ScanDisk will report any problems and give you the option of repairing the problems.

Run Defrag

Operating systems like DOS and Windows 95 segregate drive space into groups of sectors called *clusters*. Clusters are used on an "as found" basis, so it is possible for the clusters that compose a file to be scattered across a drive. This forces the drive to work harder (and take longer) to read or write the complete file because a lot of time is wasted moving around the drive. The Defrag utility allows related file clusters to be relocated together. Defrag will relocate every file on the disk so that all their clusters are positioned together (contiguous).

Week6

This Week Learning Outcome

To Understand and Recognize:

➤ Memory Failure

Memory is a cornerstone of the modern PC. Memory that holds the program code and data that is processed by the CPU—and it is this intimate relationship between memory and the CPU that forms the basis of computer performance. With larger and faster CPUs constantly being introduced, and more complex software is developed to take advantage of the processing power. In turn, the more complex software demands larger amounts of faster memory. With the explosive growth of Windows (and more recently, Windows 95) the demands made on memory performance are more acute than ever. These demands have resulted in a proliferation of memory types that go far beyond the simple, traditional DRAM. Cache (SRAM), fast page-mode (FPM) memory, extended data output (EDO) memory, video memory (VRAM), synchronous DRAM (SDRAM), flash BIOS, and other exotic memory types (such as RAMBUS) now compete for the attention of PC technicians.

These new forms of memory also present some new problems. This chapter will provide you an understanding of memory types, configurations, installation concerns, and troubleshooting options.

Memory Package Styles and Structures

Ultimately, the memory die is mounted in a package just like any other IC. The completed memory packages can then be soldered to your motherboard or attached to plug-in structures, such as SIMMs, DIMMs, and memory cards. Only four package styles are normally used for memory devices:

- *DIP (Dual In-line Package)* This classic IC package is used for through-hole mounting (prior to surface-mount technology). The advantage of DIP ICs is their compatibility with IC sockets, which allows ICs to be inserted or removed as required. Unfortunately, the long metal pins can bend and break if the IC is inserted or removed incorrectly. Also, the overall size of the package demands extra space. DIP ICs were used in older PCs (286 and earlier systems) and older VGA/SVGA video boards. DIPs are still sometimes used on motherboards to provide cache RAM.
- *SIP (Single In-line Package)* This type of IC package is rarely used today—there are simply not enough pins. However, they did make a short appearance with memory devices in late-model 286 and early 386 systems, which flirted with proprietary memory expansions. I remember NEC using such devices in a 2MB add-on for their 386SX/20— and you needed to add that module before you added

- even more memory in the form of proprietary SIMMs. SIPs can be troublesome because they are difficult to find replacements for, so expect replacement memory modules using them to cost a premium.
- *SOJ (Small-Outline “J” Lead)* This is the contemporary package style for surface mount circuits. The leads protrude from the package like a DIP, but are bent around just under the package in the form of a “j”. Sockets for SOJ packages are often used for replaceable memory ICs, such as the BIOS ROM, but most RAM devices are soldered directly to the motherboard as system memory (or a video board as video RAM). SIMMs often use SOJ memory components.
 - *TSOP (Thin, Small-Outline Package)* Like the SOJ, a TSOP is also a surface-mount package style. However, its small, thin body makes TSOP memory ideal for narrow spaces. Expect to find such devices serving as memory in notebook/sub-notebook systems or PCMCIA cards (a.k.a., PC Cards).

Add-On Memory Devices

Memory has always pushed the envelope of IC design. This trend has given us tremendous amounts of memory in very small packages, but it also has kept memory relatively expensive. Manufacturers responded by providing a minimum amount of memory with the system, then selling more memory as an add-on option—this keeps the cost of a basic machine down and increases profit through add-on sales. As a technician, you should understand the three basic types of add-on memory.

Proprietary Add-On Modules: Once the Intel i286 opened the door for more than 1MB of memory, PC makers scrambled to fill the void. However, the rush to more memory resulted in a proliferation of non-standard (and incompatible) memory modules. Each new motherboard came with a new add-on memory scheme—this invariably led to a great deal of confusion among PC users and makers alike. You will likely find proprietary memory modules in 286 and early 386 systems.

SIMMs and DIMMs: By the time 386 systems took hold in the PC industry, proprietary memory modules had been largely abandoned in favor of the “Memory Module” (Fig. 23-3). A SIMM (Single In-line Memory Module) is light, small, and contains a relatively large block of memory, but perhaps the greatest advantage of a SIMM is standardization. Using a standard pin layout, a SIMM from one PC can be installed in any other PC. The 30-pin SIMM (Table 23-1) provides 8 data bits, and generally holds up to 4MB of RAM.

The 30- 748 Memory Troubleshooting

A 72-pin SIMM

A 168-pin DIMM

Memory Organization

The memory in your computer represents the result of evolution over several computer generations. Memory operation and handling is taken care of by your system’s microprocessor.

As CPUs improved, memory-handling capabilities have improved as well. Today's microprocessors, such as the Intel Pentium or Pentium Pro, are capable of addressing more than 4GB of system memory—well beyond the levels of contemporary software applications.

Unfortunately, the early PCs were not nearly so powerful. Older PCs could only address 1MB of memory because of the limitations of the 8088 microprocessor.

Because backward compatibility is so important to computer users, the drawbacks and limitations of older systems had to be carried forward into newer computers, instead of being eliminated. Newer systems overcome their inherent limitations by adding different “types” of memory, along with the hardware and software to access the memory. This part of the chapter describes the typical classifications of computer memory: conventional, extended, and expanded memory. This chapter also describes high memory concepts. Notice that these memory types have nothing to do with the actual ICs in your system, but the way in which software uses the memory.

Memory Considerations

Memory has become far more important than just a place to store bits for the microprocessor.

It has proliferated and specialized to the point where it is difficult to keep track of all the memory options and architectures that are available. This part of the chapter reviews established memory types, and explains some of the current memory architectures.

Memory Speed and Wait States

The PC industry is constantly struggling with the balance between price and performance. Higher prices usually bring higher performance, but low cost makes the PC appealing to more people. In terms of memory, cost-cutting typically involves using cheaper (slower) memory devices. Unfortunately, slow memory cannot deliver data to the CPU quickly enough, so the CPU must be made to wait until memory can catch up. All memory is rated in terms of speed—specifically, *access time*. Access time is the delay between the time data in memory is successfully addressed, to the point at which the data has been successfully delivered to the data bus. For PC memory, access time is measured in nanoseconds (ns), and current memory offers access times of 50 to 60 ns. 70-ns memory is extremely common.

The question often arises: “Can I use faster memory than the manufacturer recommends?” The answer to this question is almost always “Yes,” but rarely does performance benefit. As you will see in the following sections, memory and architectures are typically tailored for specific performance. Using memory that is faster should not hurt the memory or impair system performance, but it costs more and will not produce a noticeable performance improvement. The only time such a tactic would be advised is when your current system is almost obsolete, and you would want the new memory to be useable on a new, faster motherboard if you choose to upgrade the motherboard later on.

A wait state orders the CPU to pause for one clock cycle to give memory additional time to operate. Typical PCs use one wait state, although very old systems might require two or

three. The latest PC designs with high-end memory or aggressive caching might be able to operate with no (zero) wait states. As you might imagine, a wait state is basically a waste of time, so more wait states result in lower system performance. Zero wait states allow optimum system performance. Table 23-9 illustrates the general relationship between CPUs, wait states, and memory speed. It is interesting to note that some of the fastest systems allow the most wait states. This flexibility lets the system support old, slow memory,

Week6

This Week Learning Outcome

To Understand and Recognize:

➤ Memory Failure

Memory is a cornerstone of the modern PC. Memory that holds the program code and data that is processed by the CPU—and it is this intimate relationship between memory and the CPU that forms the basis of computer performance. With larger and faster CPUs constantly being introduced, and more complex software is developed to take advantage of the processing power. In turn, the more complex software demands larger amounts of faster memory. With the explosive growth of Windows (and more recently, Windows 95) the demands made on memory performance are more acute than ever. These demands have resulted in a proliferation of memory types that go far beyond the simple, traditional DRAM. Cache (SRAM), fast page-mode (FPM) memory, extended data output (EDO) memory, video memory (VRAM), synchronous DRAM (SDRAM), flash BIOS, and other exotic memory types (such as RAMBUS) now compete for the attention of PC technicians.

These new forms of memory also present some new problems. This chapter will provide you an understanding of memory types, configurations, installation concerns, and troubleshooting options.

Memory Package Styles and Structures

Ultimately, the memory die is mounted in a package just like any other IC. The completed memory packages can then be soldered to your motherboard or attached to plug-in structures, such as SIMMs, DIMMs, and memory cards. Only four package styles are normally used for memory devices:

- *DIP (Dual In-line Package)* This classic IC package is used for through-hole mounting (prior to surface-mount technology). The advantage of DIP ICs is their compatibility with IC sockets, which allows ICs to be inserted or removed as required. Unfortunately, the long metal pins can bend and break if the IC is inserted or removed incorrectly. Also, the overall size of the package demands extra space. DIP ICs were used in older PCs (286 and earlier systems) and older VGA/SVGA video boards. DIPs are still sometimes used on motherboards to provide cache RAM.
- *SIP (Single In-line Package)* This type of IC package is rarely used today—there are simply not enough pins. However, they did make a short appearance with memory devices in late-model 286 and early 386 systems, which flirted with proprietary memory expansions. I remember NEC using such devices in a 2MB

- add-on for their 386SX/20— and you needed to add that module before you added even more memory in the form of proprietary SIMMs. SIPs can be troublesome because they are difficult to find replacements for, so expect replacement memory modules using them to cost a premium.
- *SOJ (Small-Outline “J” Lead)* This is the contemporary package style for surface mount circuits. The leads protrude from the package like a DIP, but are bent around just under the package in the form of a “j”. Sockets for SOJ packages are often used for replaceable memory ICs, such as the BIOS ROM, but most RAM devices are soldered directly to the motherboard as system memory (or a video board as video RAM). SIMMs often use SOJ memory components.
 - *TSOP (Thin, Small-Outline Package)* Like the SOJ, a TSOP is also a surface-mount package style. However, its small, thin body makes TSOP memory ideal for narrow spaces. Expect to find such devices serving as memory in notebook/sub-notebook systems or PCMCIA cards (a.k.a., PC Cards).

Add-On Memory Devices

Memory has always pushed the envelope of IC design. This trend has given us tremendous amounts of memory in very small packages, but it also has kept memory relatively expensive. Manufacturers responded by providing a minimum amount of memory with the system, then selling more memory as an add-on option—this keeps the cost of a basic machine down and increases profit through add-on sales. As a technician, you should understand the three basic types of add-on memory.

Proprietary Add-On Modules: Once the Intel i286 opened the door for more than 1MB of memory, PC makers scrambled to fill the void. However, the rush to more memory resulted in a proliferation of non-standard (and incompatible) memory modules. Each new motherboard came with a new add-on memory scheme—this invariably led to a great deal of confusion among PC users and makers alike. You will likely find proprietary memory modules in 286 and early 386 systems.

SIMMs and DIMMs: By the time 386 systems took hold in the PC industry, proprietary memory modules had been largely abandoned in favor of the “Memory Module” (Fig. 23-3). A SIMM (Single In-line Memory Module) is light, small, and contains a relatively large block of memory, but perhaps the greatest advantage of a SIMM is standardization. Using a standard pin layout, a SIMM from one PC can be installed in any other PC. The 30-pin SIMM (Table 23-1) provides 8 data bits, and generally holds up to 4MB of RAM.

The 30- 748 Memory Troubleshooting

A 72-pin SIMM

A 168-pin DIMM

Memory Organization

The memory in your computer represents the result of evolution over several computer generations. Memory operation and handling is taken care of by your system’s microprocessor.

As CPUs improved, memory-handling capabilities have improved as well. Today's microprocessors, such as the Intel Pentium or Pentium Pro, are capable of addressing more than 4GB of system memory—well beyond the levels of contemporary software applications.

Unfortunately, the early PCs were not nearly so powerful. Older PCs could only address 1MB of memory because of the limitations of the 8088 microprocessor.

Because backward compatibility is so important to computer users, the drawbacks and limitations of older systems had to be carried forward into newer computers, instead of being eliminated. Newer systems overcome their inherent limitations by adding different “types” of memory, along with the hardware and software to access the memory. This part of the chapter describes the typical classifications of computer memory: conventional, extended, and expanded memory. This chapter also describes high memory concepts. Notice that these memory types have nothing to do with the actual ICs in your system, but the way in which software uses the memory.

Memory Considerations

Memory has become far more important than just a place to store bits for the microprocessor.

It has proliferated and specialized to the point where it is difficult to keep track of all the memory options and architectures that are available. This part of the chapter reviews established memory types, and explains some of the current memory architectures.

Memory Speed and Wait States

The PC industry is constantly struggling with the balance between price and performance. Higher prices usually bring higher performance, but low cost makes the PC appealing to more people. In terms of memory, cost-cutting typically involves using cheaper (slower) memory devices. Unfortunately, slow memory cannot deliver data to the CPU quickly enough, so the CPU must be made to wait until memory can catch up. All memory is rated in terms of speed—specifically, *access time*. Access time is the delay between the time data in memory is successfully addressed, to the point at which the data has been successfully delivered to the data bus. For PC memory, access time is measured in nanoseconds (ns), and current memory offers access times of 50 to 60 ns. 70-ns memory is extremely common.

The question often arises: “Can I use faster memory than the manufacturer recommends?” The answer to this question is almost always “Yes,” but rarely does performance benefit. As you will see in the following sections, memory and architectures are typically tailored for specific performance. Using memory that is faster should not hurt the memory or impair system performance, but it costs more and will not produce a noticeable performance improvement. The only time such a tactic would be advised is when your current system is almost obsolete, and you would want the new memory to be useable on a new, faster motherboard if you choose to upgrade the motherboard later on.

A wait state orders the CPU to pause for one clock cycle to give memory additional time to operate. Typical PCs use one wait state, although very old systems might require two or three. The latest PC designs with high-end memory or aggressive caching might be able to operate with no (zero) wait states. As you might imagine, a wait state is basically a waste of time, so more wait states result in lower system performance. Zero wait states allow optimum system performance. Table 23-9 illustrates the general relationship between CPUs, wait states, and memory speed. It is interesting to note that some of the fastest systems allow the most wait states. This flexibility lets the system support old, slow memory,

Week7

This Week Learning Outcome

To Understand:

➤ Hard Drive Failure

Hard Drive Failure – Symptoms and Troubleshooting

The *hard-disk drive (HDD)* evolved to answer the incessant demands for permanent high-volume file and data storage in the PC. Early floppy disks provided simple and inexpensive storage, but they were slow and programs quickly became far too large to store adequately on diskettes. Switching between multiple diskettes also proved to be a cumbersome proposition. By the early 1980s, hard drives had become an important part of PC architecture (Fig. 17-1) and helped to fuel further OS and applications development. Today, the hard drive is an indispensable element of the modern PC. The hard drive holds the operating system, which boots the system, stores the multi-megabyte applications and files that we rely on, and even provides “virtual memory” for systems lean on RAM. Hard-drive performance also has a profound effect on overall system performance. As you might imagine, hard-drive problems can easily cripple a system. This chapter presents the technology and principles of hard-disk drives, and provides you with some solutions for drive testing and troubleshooting.

Drive Concepts

The first step in understanding hard drives is to learn the basic concepts involved. Many of the terms covered in Chapter 16 also apply to hard drives, but the additional performance requirements and operating demands placed on hard drives have resulted in an array of important new ideas. In principle, a hard-disk drive is very similar to a floppy drive—a magnetic recording media is applied to a substrate material, which is then spun at a high rate of speed. Magnetic read/write heads in close proximity to the media can step rapidly across the spinning media to detect or create flux transistions, as required. When you look closely, however, you can see that there are some major physical differences between floppy and hard drives.

Platters and Media

Where floppy disks use magnetic material applied over a thin, flexible substrate of mylar (or some other plastic), hard drives use rugged, solid substrates, called *platters*. You can clearly view the platters of a hard drive in Fig. 17-2. A platter is traditionally made of alu-

Power-Mode Definitions

Modern hard drives are not simply “on” or “off.” They operate in any one of several modes, and each mode makes different power demands on the host system. This is particularly important because today’s PCs are becoming ever-more power conscious, so the ability to control drive power is an integral part of PC power-conservation systems. Typical hard drives operate in any of five different power modes:

- *Spin-up* The drive is spinning up following initial application of power and has not yet reached full speed. This demands about 14 W and is particularly demanding of the power supply (if the supply is marginal or overloaded, the hard drive might not spin-up properly).
- *Seek* This is a random-access operation by the disk drive as it tries to locate the required track for reading or writing. This demands about 8.5- to 9.0 W.
- *Read/write* A seek has been completed, and data is being read from or written to the drive. This uses about 5.0 W.
- *Idle* This is a basic power-conservation mode, where the drive is spinning and all other circuitry is powered on, but the head actuator is parked and powered off. This drops power demands to about 4 W, yet the drive is capable of responding to read commands within 40 ms.
- *Standby* The spindle motor is not running (the drive “spins down”). This is the main power-conservation mode, and it requires just 1 W. It might require up to several seconds for the drive will leave this mode (or spin-up) upon receipt of a command that requires disk access.

Smart Command Set

Some of the newest hard drives use the *Self-Monitoring Analysis and Reporting Technology (SMART)* command set. SMART-compliant drives improve the data integrity and data availability of hard-disk drives by regularly checking for potential drive problems. In some cases, a SMART-compliant device will predict an impending failure with sufficient time to allow users to backup their data and replace the drive before data loss occurs.

Drive Testing and Troubleshooting

Hard-disk drives present some perplexing challenges for computer technicians and every day users alike. The problem with hard drives is that they are inaccessible devices. Unless you have the cleanroom environment to open the sealed drive platters, it is pointless to even consider replacing failed drive mechanics. Even if you could open a drive safely, the advances in hard-drive technology have been so fast and furious that no spare parts market has ever developed. Drive manufacturers themselves rarely bother to repair faulty drives or invest in specialized drive-testing equipment. Clearly, the course for hard-drive repair is to identify defective drives and replace faulty units with new (usually better) ones. Fortunately, not all hard-drive problems are necessarily fatal. True, you might lose some programs and data (backup your hard drive frequently), but many drive problems are recoverable without resorting to drive replacement. Instead of focusing on repairing a hard drive’s electronics or mechanics, today’s repair tactics focus on repairing a drive’s data. By reconstructing or relocating faulty drive information, it is often possible to re-

The important thing to remember when using this workaround is that you must keep a record of the translation values used so that they can be re-entered if the contents of CMOS RAM are lost, or if the drive is moved to another system. Write the values on masking tape and stick the tape on the drive itself. cover from a wide variety of drive problems. Before you begin any sort of drive troubleshooting, you should take the following steps:

- Gather a DOS boot disk or Windows 95 startup disk (refer to the end of Chapter 3). If you don't have a boot disk on hand, you should make one before continuing.
- Gather your DOS installation disk(s) or Windows 95 CD-ROM—if you need to reinstall the operating system, these will be invaluable.
- Gather any hard drive/controller diagnostics that you'll need.
- Backup as much as you can from your hard drive(s) before attempting any sort of drive service.

Hdd-Controller Bios Error Codes

There might be times when your hard-drive controller fails or cannot communicate properly with the hard drive. When this occurs, you'll often find that the controller returns an error code. Table 17-9 lists a selection of HDD controller error codes that are

Troubleshooting “DOS Compatibility Mode” Problems

One of the great advantages enjoyed by Windows 95 is that it operates in the “protectedmode”—that is, drivers and software can be executed beyond the traditional “real-mode” RAM limit of 1MB. By comparison, DOS is a real-mode environment. DOS programs and drivers can only be executed within the first 640KB of RAM (the “conventional memory” area). If Windows 95 cannot establish protected-mode operation for a drive, it will fall back to real-mode driver support. This is known as *DOS compatibility mode*. Unfortunately, real mode support often impairs system performance. If you notice that one or more of the hard drives in a system is using DOS compatibility mode (there might be an error message such as: “Compatibility mode paging reduces overall system performance”), you'll need to track down and correct the cause. In general, Windows 95 might invoke the DOS compatibility mode for any of the following reasons:

- A questionable device driver, TSR, or computer virus has hooked the INT 21h or INT 13h chain before Windows 95 loaded.
- The hard-disk controller in your computer was not detected by Windows 95.
- The hard-disk controller was removed from the current configuration in *Device manager*.
- There is a resource conflict between the hard-disk controller and another hardware device.
- The Windows 95 protected-mode driver is missing or damaged.
- The Windows 95 protected-mode driver detected incompatible or unsupported hardware.

You can use the following procedure to isolate and correct the cause of DOS compatibility mode problems:

1. Open the *Control panel*, double-click the *System* icon, then choose the *Performance* tab in the *System properties* dialog. You can identify which drive is using DOS compatibility mode and why.
2. If the driver name listed as causing the DOS compatibility mode is: MBRINT13.SYS, your computer might be infected with a boot-sector virus or you are running real-mode disk overlay software (for an IDE hard disk with more than

1024 cylinders) that is not compatible with Windows 95 protected-mode disk drivers.

- Run a recent anti-virus program to detect and remove boot-sector viruses (such as Norton Anti-Virus, NAV). You might need to rewrite your boot sector using a DOS command, such as *FDISK /MBR*.
- If you cannot detect any virus activity, check the disk-management software. Be sure that you're using Disk Manager 7.0 or later (use Disk Manager 7.04 if you're running DriveSpace 3, included with the Microsoft Plus! pack).
- 3. If the driver name that is listed is in the CONFIG.SYS file, contact the driver's manufacturer to determine whether there is a more recent version of the driver that allows protected-mode operation in Windows 95. You might be able to download the latest driver version from the driver manufacturer's Web site.

If no driver is listed on the *Performance* tab, check that the hard-disk controller is listed in the *Device manager*. If not, install it through the *Add new hardware* wizard. If the wizard cannot detect the controller automatically, run the wizard again, but do not let it attempt to detect the hardware in your computer—instead, select the controller specifically from the hardware list. If your particular controller is not listed, contact the manufacturer of the disk controller to obtain a Windows 95 protected-mode disk driver (or a Windows 3.1x 32-bit disk access (FastDisk) driver, if available).

- 5. If the hard-disk controller is listed in the *Device manager*, but has a yellow “!” over it, there is a resource conflict (IRQ, I/O, DMA, or BIOS address range) with another device, the protected-mode driver is missing or damaged, or the *Disable all 32-bit protected- mode disk drivers* check box has been selected in *File system* properties.
- Doubleclick the *System* icon in the *Control panel*, click the *Performance* tab, then click *File system*. Select the *Troubleshooting* tab and see that the *Disable all 32-bit protected- mode disk drivers* check box has not been selected.
- Resolve any resource conflicts with other devices in the system (refer to Chapter 10).
- Check that the protected-mode driver is in the Windows\SYSTEM\IOSUBSYS directory and is loading properly. To find which driver is providing 32-bit disk access, click *Properties* for the disk controller in *Device manager* and click the *Driver* tab to see which driver files are associated with the controller. For most IDE, EIDE, and ESDI disk controllers, 32-bit disk access is provided by the ESDI_506.PDR driver.

For SCSI controllers, Windows 95 often uses SCSIPT.PDR and a “mini port” (or .MPD) driver. Restart Windows 95, press <F8> when the “Starting Windows 95” message appears, then select a “Logged” (BOOTLOG.TXT) start. If the 32-bit driver is listed as loading properly, you're all set. Otherwise, the driver might be missing or damaged—try reinstalling the respective 32-bit drivers.

6. Load SYSTEM.INI into a text editor and check to see if the MH2BIT.386 driver is being loaded (check for a line that reads: “device=mh32bit.386”). This driver is installed by MicroHouse EZ-Drive software, and is not compatible with the Windows 95 protected mode disk drivers. Unfortunately, this driver is not removed by Windows 95 Setup, so you’ll need to disable the line manually, save your changes, and reboot the PC.
7. If all else fails, you might be able to achieve protected-mode support from the disk controller by disabling any of the controller’s advanced features (i.e., caching, fast or “turbo” modes), or reducing data-transfer rates. You might also try systematically disabling advanced IDE controller features in the CMOS setup.
8. If problems persist, you might have to replace the drive controller with a model that better supports protected-mode operation.

Symptoms and Solutions

Now it’s time to take a look at some problems and solutions. The important concept here is that a hard-drive problem does not necessarily mean a hard-drive failure. The failure of a

Drive Testing and Troubleshooting 623

If the hard-disk controller is listed in Device manager, but has a red “ X” over it, it has been removed from the current hardware profile. Click Properties for the controller in Device manager, then click the check box that corresponds to the current hardware profile under Device usage. Sector or track does not automatically indicate physical head or platter damage—that is why software tools have been so successful. Even if one or more sectors are physically damaged, millions of sectors are on a hard drive. A few bad sectors do not render a drive faulty.

One of the only times that a drive is truly irreparable is when physical media damage occurs on track 00, but software tools will help you to identify the scope of the problem.

Symptom 17-1. The hard drive is completely dead The drive does not spin up, the drive light doesn’t illuminate during power-up, or you see an error message indicating that the drive is not found or ready. In most cases, you should suspect a power problem first. Be sure that the 4-pin power connector is inserted properly and completely. If the drive is being powered by a “Y-connector,” be sure any interim connections are secure.

Use a voltmeter and measure the +5-V (pin 4) and +12-V (pin 1) levels. If either voltage (especially the +12-V supply) is unusually low or absent, replace the power supply. Also check your signal cable. See that the drive’s signal interface cable is connected securely at both the drive and controller ends. For IDE/EIDE drives, this is the 40-pin ribbon cable.

If the cable is visibly worn or damaged, try a new cable. The PC cannot use a hard drive that it can’t recognize, so enter the CMOS setup routine and see that all of the parameters entered for the drive are correct. Heads, cylinders, sectors per track, landing zone, and write precompensation must all be correct—otherwise, POST will not recognize the drive. If you have an “auto-detect” option available, try that also. Remember to save your changes in

CMOS and reboot the system. If problems continue, the hard drive itself might be defective. Try a known-good hard drive. If a known-good drive works as expected, your original drive is probably defective, and should be replaced. If a known-good hard drive fails to operate, replace the drive controller board.

Symptom 17-2. You see drive activity, but the computer will not boot from the hard drive. In most cases, there is a drive failure, boot-sector failure, or DOS/Windows file corruption. Check the signal cable first. Be sure that the drive's signal interface cable is connected securely at both the drive and controller. If the cable is visibly worn or damaged, try a new one. You should check the CMOS setup next—see that all of the parameters entered for the drive are correct. Heads, cylinders, sectors per track, landing zone, and write precompensation must all be correct. Otherwise, POST will not recognize the drive. If it has an option to “auto-detect” the drive, try that as well.

The boot sector might also be defective. Boot from a floppy disk and try accessing the hard drive. If the hard drive is accessible, chances are that the boot files are missing or corrupt.

Try a utility, such as DrivePro's Drive Boot Fixer or DISKFIX with PC Tools. You might also try running “FDISK /MBR,” which will rebuild the drive's master boot record.

Careful: the FDISK /MBR command might render the files on your drive inaccessible. Finally, you might have a problem with your drive-system hardware. If you cannot access the hard drive, run a diagnostic such as Windsor Technologies' PC Technician.

Test 624 Hard Drives

Drive troubleshooting has the potential of destroying any data on the drive(s). Before attempting to troubleshoot hard-disk problems, be sure to back up as much of the drive as possible. If no backup is available, do not repartition or reformat the drive unless absolutely necessary, and all other possible alternatives have been exhausted. Check the drive and drive controller. If the controller responds, but the drive does not, try repartitioning and reformatting the hard drive. If the drive still doesn't respond, replace the hard drive outright. If the controller doesn't respond, replace the hard-drive controller.

Symptom 17-3. One or more sub-directories appear lost or damaged. Both the root directory of a drive and its FAT contain references to sub-directories. If data in either the root directory or file allocation table is corrupt, one or more sub-directories might be inaccessible by the drive. Try repairing the drive's directory structure. Use DISKFIX (with PC Tools) or SCANDISK (with DOS 6.2 or later) to check the disk's directory structure for problems.

Symptom 17-4. Errors occur during drive reads or writes. Magnetic information does not last forever, and sector ID information can gradually degrade to a point where you encounter file errors. Start by checking for file structure problems on the drive.

Use a utility, such as DISKFIX or SCANDISK, to examine the drive and search for bad sectors. If a failed sector contains part of an .EXE or .COM file, that file is now corrupt and

should be restored from a backup. If you cannot isolate file problems, you might need to consider a *Low-Level (LL)* format. This is an ideal solution because LL formatting rewrites sector ID information, but the sophistication of today's drives makes LL formatting almost impossible. If the drive manufacturer provides a "drive preparation" utility, you should backup the drive, run the utility, FDISK, FORMAT, and restore the drive. Symptom 17-5. The hard drive was formatted accidentally A high-level format does not actually destroy data, but rather it clears the file names and locations kept in the root directory and FAT—this prevents DOS from finding those files. You will need to recover those files. Use a utility, such as UNFORMAT (with PC Tools), which can reconstruct root directory and FAT data contained in a MIRROR file. This is not always a perfect process and you might not be able to recover all files.

Symptom 17-6. A file has been deleted accidentally Mis-typing or forgetting to add a drive specification can accidentally erase files from places you did not intend to erase. You can often recover those files if you act quickly. Use a utility, such as UNDELETE (with PC Tools and DOS), to restore the deleted file. This is not always a perfect process and you might not be able to recover every file.

Symptom 17-7. The hard drive's root directory is damaged A faulty root directory can cripple the entire disk, rendering all sub-directories inaccessible. You might be able to recover the root directory structure. Use a utility, such as DISKFIX (with PC Tools), to reconstruct the damaged FATs and directories. If you have been running MIRROR, DISKFIX should be able to perform a very reliable recovery. You might also try other recovery

Drive Testing and Troubleshooting 625

In order for MIRROR data to be useful, do not save new files before running UNFORMAT. In order for UNDELETE to be useful, do NOT save new files before running UNDELETE. utilities, such as DrivePro or ScanDisk. However, if you cannot recover the root directory reliably, you will need to reformat the drive, then restore its contents from a backup.

Symptom 17-8. Hard drive performance appears to be slowing down over time In virtually all cases, diminishing drive performance can be caused by file fragmentation. To a far lesser extent, you might be faced with a computer virus. Start the PC with a "clean" boot disk and be sure that no TSRs or drivers are being loaded. After a clean boot, run your anti-virus checker and be sure that there are no memory-resident or file-based viruses. If the system checks clean for computer viruses, you should check for file fragmentation next. Start your defragmentation utility (such as COMPRESS with PC Tools or DEFRAG with DOS) and check to see the percentage of file fragmentation. If it has more than 10% fragmentation, you should consider running the defragmentation utility after preparing Windows. Before defragmenting a drive, reboot the system normally, start Windows, access the *Virtual memory* controls for your version of Windows, and shut down virtual memory. Then leave Windows and boot the system "clean" again. Restart your defragmentation utility and proceed to defragment the disk. This process might take several minutes, depending on the size of your drive. Once defragmentation is complete, reboot the

system normally, start Windows, access the *Virtual memory* controls for your version of Windows, and recreate a permanent swap file to support virtual memory. You should now notice a performance improvement.

Symptom 17-9. The hard drive accesses correctly, but the drive light stays on continuously. A continuous LED indication is not necessarily a problem as long as the drive seems to be operating properly. Check the drive and drive controller for drive “light jumpers”—examine the drive itself for any jumper that might select *Latched* mode vs. *Activity* mode. If no such jumpers are on the drive, check the drive controller or motherboard. Set the jumper to *Activity* mode to see the drive light during access only.

Next, consider the possibility of drive-light error messages. Some drive types (especially SCSI drives) use the drive-activity light to signal drive and controller errors. Check the drive and controller documents and see if any error is indicated by the light remaining on.

Symptom 17-10. The hard drive is not accessible and the drive light stays on continuously. This usually indicates a reversed signal cable, which is most common when upgrading or replacing a drive system. In virtually all cases, one end of the signal cable is reversed. Be sure that both ends of the cable are installed properly (remember that the red or blue stripe on one side of the cable represents pin 1). If problems persist, replace the drive controller. It is rare for a fault in the drive controller to cause this type of problem, but if trouble persists, try a known-good drive controller board.

Symptom 17-11. A “No fixed disk present” error message appears on the monitor. This kind of problem can occur during installation, or at any point in the PC’s working life. Check the power connector first, and be sure the 4-pin power connector is inserted properly and completely. If the drive is being powered by a Y-connector, be sure any interim connections are secure. Use a voltmeter and measure the +5-V (pin 4) and +12-V (pin 1) levels. If either voltage (especially the +12-V supply) is unusually low or absent, replace the power supply. Next, check the signal connector. Be sure that the drive’s signal cable is connected securely at both the drive and controller. If the cable is visibly worn or damaged, try a new one.

If problems persist, check the CMOS setup—enter the CMOS setup routine and see that all of the parameters entered for the drive are correct. Heads, cylinders, sectors per track, landing zone, and write precompensation must all be correct—otherwise, POST will not recognize the drive. You might also try “auto-detecting” the drive. Also check for hardware conflicts.

Be sure that no other expansion devices in the system use the same IRQs or I/O addresses used by your drive controller. If so, change the resources used by the conflicting device. If your drive system uses a SCSI interface, be sure that the SCSI cable is terminated properly. If problems continue, try a known-good hard drive. If a known-good drive works as expected, your original drive is probably defective. If problems persist with a known-good hard drive, replace the drive-controller board.

Symptom 17-12. The drive spins up, but the system fails to recognize it Your computer might flag this as a “Hard-disk error” or “Hard-disk controller failure” during system initialization. Start by checking the signal connector. Be sure that the interface signal cable is inserted properly and completely at the drive and controller. Try a new signal cable. Next, check any drive jumpers, and see that a primary (master) drive is configured as primary, and a secondary (slave) drive is configured as secondary. For SCSI drives, see that each drive has a unique ID setting and check that the SCSI bus is terminated properly.

Enter the CMOS setup routine and see that all of the parameters entered for the drive are correct. Heads, cylinders, sectors per track, landing zone, and write precompensation must all correct—otherwise, POST will not recognize the drive. Try using the “auto-detect” feature if it is available. If the CMOS is configured properly, you should suspect a problem with the partition. Boot from a floppy disk and run FDISK to check the partitions on your hard drive.

Be sure that there is at least one DOS partition. If the drive is to be your boot drive, the primary partition must be active and bootable. Repartition and reformat the drive, if necessary

If problems persist, try a known-good hard drive. If a known-good drive works as expected, your original drive is probably defective. If a known-good hard drive fails to work as expected, replace the drive controller. If problems persist with a known-good floppy drive, replace the drive-controller board.

Symptom 17-13. The IDE drive spins up when power is applied, then rapidly spins down gain The drive is defective, or it is not communicating properly with its host system. Check the power connector first. Be sure that the 4-pin power connector is inserted properly and completely into the drive. Always check the signal connector next, and see that the interface signal cable is inserted properly and completely at the drive and controller. Try a new signal cable.

Inspect the drive jumpers—the primary (master) drive should be configured as primary, and a secondary (slave) drive should be configured as secondary. For SCSI drives, see that each drive has a unique ID setting, and check that the SCSI bus is terminated properly. If problems persist, try a known-good hard drive. If a known-good drive works as expected, your original drive is probably defective.

Symptom 17-14. A “Sector not found” error message appears on the monitor This problem usually occurs after the drive has been in operation for quite some time, and is typically the result of a media failure. Fortunately, a bad sector will only affect one file. Try recovering the file. Use a utility, such as SpinRite (from Gibson Research) or another data-recovery utility, and attempt to recover the damaged file. Notice that you might be unsuccessful, and have to restore the file from a backup later. Check the media itself. Use a disk utility, such as ScanDisk, to evaluate the drive, then locate and map out any bad sectors that are located on the drive.

If problems persist, perform a low-level format (if possible). Lost sectors often occur as drives age and sector ID information degrades. LL formatting restores the sector IDs, but

LL formatting is performed at the factory for IDE/EIDE and SCSI drives. If an LL formatting utility is available for your particular drive (available right from the drive manufacturer), and ScanDisk reveals a large number of bad sectors, you might consider backing up the drive completely, running the LL utility, repartitioning, reformatting, then restoring the drive.

Finally, if ScanDisk maps out bad sectors, you might need to restore those files from a backup.

Symptom 17-15. A “1780 or 1781 ERROR” appears on the monitor The classic 1780 error code indicates a “Hard disk 0 failure,” and the 1781 error code marks a “Hard disk 1 failure.” Start the PC with a “clean” boot disk and be sure that no TSRs or drivers are being loaded. If you haven’t done so already, run your anti-virus checker and be sure that there are no memory-resident or file-based viruses. Next, if you can access the hard drive once your system is booted, chances are that the boot files are missing or corrupt.

Try a utility, such as DrivePro’s Drive Boot Fixer or DISKFIX with PC Tools. Otherwise, you will need to repartition and reformat the disk, then restore disk files from a backup. Check the hardware next—if you cannot access the hard drive, run a diagnostic such as Windsor Technologies’ PC Technician. Test the drive and drive controller. If the controller responds but the drive does not, try repartitioning and reformatting the hard drive. If the drive still doesn’t respond, replace the hard drive outright. If the controller doesn’t respond, replace the hard-drive controller.

Symptom 17-16. A “1790 or 1791 ERROR” appears on the monitor The classic 1790 error code indicates a “Hard Disk 0 Error,” although the 1791 error code marks a “Hard Disk 1 Error.” Check the signal connector first. Be sure that the interface signal cable is inserted properly and completely at the drive and controller. Try a new signal cable. There might also be a problem with the drive’s partition. Boot from a floppy disk and run FDISK to check the partitions on your hard drive. Be sure that there is at least one DOS partition. If the drive is to be your boot drive, the primary partition must be active and bootable. Repartition and reformat the drive, if necessary.

If problems persist, replace the hard drive. If a known-good drive works as expected, your original drive is probably defective. If problems persist with a known-good floppy drive, replace the drive-controller board.

Symptom 17-17. A “1701 ERROR” appears on the monitor The 1701 error code indicates a hard-drive POST error—the drive did not pass its POST test. Check the power connector first, and be sure that the 4-pin power connector is inserted properly and completely. If the drive is being powered by a Y connector, be sure that any interim connections are secure. Use a voltmeter and measure the +5-V (pin 4) and +12-V (pin 1) levels.

If either voltage (especially the +12-V supply) is unusually low or absent, replace the power supply. Enter the CMOS setup routine and see that all of the parameters entered for the drive are correct. Heads, cylinders, sectors per track, landing zone, and write

precompensation must all correct; otherwise, POST will not recognize the drive. Try “auto-detecting” the drive. If problems persist, perform a low-level format (if possible). ST506/412 and ESDI drives might require LL formatting, but LL formatting is performed at the factory for IDE/EIDE and SCSI drives. If an LL-formatting utility is available for your particular drive (available right from the drive manufacturer), you might consider backing up the drive completely, running the LL utility, repartitioning, reformatting, then restoring the drive.

Symptom 17-18. The system reports random data, seek, or format errors Random errors rarely indicate a permanent problem, but identifying the problem source can be a time-consuming task. Check the power connector first. Be sure that the 4-pin power connector is inserted properly and completely. If the drive is being powered by a “Y-connector,” be sure that any interim connections are secure. Use a voltmeter and measure the +5-V (pin 4) and +12-V (pin 1) levels. If either voltage (especially the +12-V supply) is unusually low, replace the power supply.

Check the signal connector next. Be sure that the interface signal cable is inserted properly and completely at the drive and controller. Try a new signal cable. Also try re-routing the signal cable away from the power-supply or “noisy” expansion devices. Check the drive orientation. If problems occur after remounting the drive in a different orientation, you might need to repartition and reformat the drive, or return it to its original orientation.

Try relocating the drive-controller away from cables and “noisy” expansion devices. If your system has a “turbo” mode, your ISA drive controller might have trouble operating while the system is in turbo mode. Take the system out of turbo mode. If the problem disappears, try a new drive controller. The media might also be defective. Use a utility, such as ScanDisk, to check for and map out any bad sectors. Once bad sectors are mapped out, you might need to restore some files from your backup.

Try the hard drive and controller in another system. If the drive and controller work in another system, excessive noise or grounding problems are probably in the original system.

Reinstall the drive and controller in the original system and remove all extra expansion boards. If the problem goes away, replace one board at a time and retest the system until the problem returns. The last board you inserted when the problem returned is probably the culprit. If the problem persists, there might be a ground problem on the motherboard. Try replacing the motherboard as an absolute last effort.

Symptom 17-19. A “Bad or Missing Command Interpreter” error message appears This is a typical error that appears when a drive is formatted in one DOS version, but loaded with another. Compatibility problems occur when you mix DOS versions.

Start by booting the PC with a “clean” boot disk, and be sure no TSRs or drivers are being loaded. If you haven’t done so already, run your anti-virus checker and be sure that there are no memory-resident or file-based viruses. Finally, be sure that the drive is partitioned

and formatted with the version of DOS that you intend to use. Also be sure to use FORMAT with the /S switch, or SYS C: to transfer system files to the drive.

Symptom 17-20. An “Error reading drive C:” error message appears Read errors in a hard drive typically indicate problems with the disk media, but might also indicate viruses or signaling problems. Check the signal connector first. Be sure that the interface signal cable is inserted properly and completely at the drive and controller. Try a new signal cable. Next, start the PC with a “clean” boot disk and be sure that no TSRs or drivers are being loaded. If you haven’t done so already, run your anti-virus checker and be sure that there are no memory-resident or file-based viruses.

Consider the drive’s orientation. If problems occur after remounting the drive in a different orientation, you might need to repartition and reformat the drive, or return it to its original orientation. Also check the media—use a utility, such as ScanDisk, to check for and map out any bad sectors. Once bad sectors are mapped out, you might need to restore some files from your backup. Try a known-good hard drive. If a known-good drive works as expected, your original drive is probably defective.

Symptom 17-21. A “Track 0 not found” error message appears A fault on track 00 can disable the entire drive because track 00 contains the drive’s *File Allocation Table (FAT)*. This can be a serious error, which might require you to replace the drive. Before going too far with this type of problem, check the signal connector and see that the interface signal cable is inserted properly and completely at the drive and controller. Try a new signal cable.

Boot from a floppy disk and run FDISK to check the partitions on your hard drive. Be sure that there is at least one DOS partition. If the drive is to be your boot drive, the primary partition must be active and bootable. Repartition and reformat the drive, if necessary. Try a known-good hard drive. If a known-good drive works as expected, your original drive is probably defective.

Symptom 17-22. Software diagnostics indicate an average access time that is longer than specified for the drive The average access time is the average amount of time needed for a drive to reach the track and sector, where a needed file begins.

Before you do anything else, check the drive specifications and verify the timing specifications for your particular drive. Start your defragmentation utility (such as COMPRESS with PC Tools or DEFRAG with DOS) and check to see the percentage of file fragmentation.

If there is more than 10% fragmentation, you should consider running the defragmentation utility after preparing Windows (see Symptom 8).

Also remember that different software packages measure access time differently. Be sure that the diagnostic subtracts system overhead processing from the access-time calculation.

Try one or two other diagnostics to confirm the measurement. Before you panic and replace a drive, try testing several similar drives for comparison. If only the suspect drive measures

incorrectly, you might not need to replace the drive itself just yet, but you should at least maintain frequent backups in case the drive is near failure.

Symptom 17-23. Software diagnostics indicate a slower data transfer rate than specified. This is often because of “less-than-ideal” data-transfer rates, rather than an actual hardware failure. Enter the CMOS setup routine and verify that any enhanced data-transfer modes are enabled (such as PIO Mode 3). This can increase data transfer rate substantially. Also check the drive specifications, and verify the timing specifications for your particular drive.

Check for fragmentation next. Start your defragmentation utility (such as COMPRESS with PC Tools or DEFRAG with DOS), and check to see the percentage of file fragmentation.

Broadly speaking a hard disk can fail in four ways that will lead to a potential loss of data:

1. Firmware Corruption / Damage to the firmware zone
2. Electronic Failure
3. Mechanical Failure
4. Logical Failure

Combinations of these four types of failure are also possible. Whether the data on the hard disk is recoverable or not depends on exactly what has happened to the disk and how bad the damage is. All hard disks also develop **bad sectors** which can lead to data loss and drive inaccessibility.

1. Firmware Corruption / Damage to the firmware zone

Hard disk firmware is the information that is used by the computer that allows it to correctly interact with the hard disk. If the firmware of a hard disk becomes corrupted or unreadable the computer is often unable to correctly interact with the hard disk. Frequently the data on the disk is fully recoverable once the drive has been repaired and reprogrammed.

2. Electronic Failure

Electronic failure usually relates to problems on the controller board of the actual hard disk. The computer may suffer a power spike or electrical surge that knocks out the controller board on the hard disk making it undetectable to the BIOS. Usually, the data on the hard disk has not suffered any damage and a 100% data recovery is possible.

3. Mechanical Failure

Usually worse than electronic failure, mechanical failure can quite often (especially if not acted on early) lead to a partial and sometimes total loss of data. Mechanical failure comes in a variety of guises such as read / write head failure and motor problems. One of the most common mechanical failures is a head crash. Varying in severity, a head crash

occurs when the read-write heads of the hard disk come into contact, momentarily or continuously, with the platters of the hard disk.

Head crashes can be caused by a range of reasons including physical shock, movement of the computer, static electricity, power surges and mechanical read-write head failure.

Mechanical failure can usually be spotted by a regular clicking or crunching noise. It's not necessarily a head crash, the most important things to do if you suspect mechanical problems is to switch off the drive immediately as further use will make matters worse.

4. Logical Errors

Often the easiest and the most difficult problems to deal with, logical errors can range from simple things such as an invalid entry in a file allocation table to truly horrific problems such as the corruption and loss of the file system on a severely fragmented drive.

Logical errors are different to the electrical and mechanical problems above as there is usually nothing 'physically' wrong with the disk, just the information on it.

Remedial Procedure

Some of the steps involved in the remedy of the Hard drive failure are given below:

- 1) The first thing to check for is whether or not the hard disk can be seen by the hard disk controller; usually on a true hard disk failure, the disk will not be detectable by the controller (but this is not always the case). Assuming you have an IDE hard disk, enter the BIOS setup program and use the IDE detection facility of the BIOS to see if the disk's parameters can be detected. If the disk cannot be auto detected using the auto detect feature in the BIOS program implies immediately some sort of hardware problem.
- 2) If you can see the hard disk when you auto detect, the problem is more likely to be software than hardware. Remember that you cannot usually boot a brand new hard disk until it has been partitioned and formatted.
- 3) See if the disk will boot up. If it will not boot, then boot from a floppy boot disk and then use the FDISK command (or other partitioning software) to see if you can see the disk.
- 4) If the drive will boot up, then you should be getting a more specific error message of some sort, or a more specific failure mode that you can use for troubleshooting.
- 5) If the drive is detected in the BIOS setup but cannot be booted or accessed when booting from a floppy disk, then there is a good chance that the disk itself may be bad. If possible, try connecting the hard disk to another system and see if the problem is present there as well.



6) If the hard disk is dead and needs to be replaced follow the procedure given below:

a) Remove the screws that hold the drive in the bay.



b) Remove the defective hard disk

c) Remove the IDE cable

d) Select a good hard disk, connect the IDE cable and replace the hard disk.



e) Secure the hard disk on the drive bay slot by tightening the screws.



Scandisk:

This is a maintenance procedure built into the Windows operating system that checks the hard drive to determine if there is physical damage or damage to the file system.

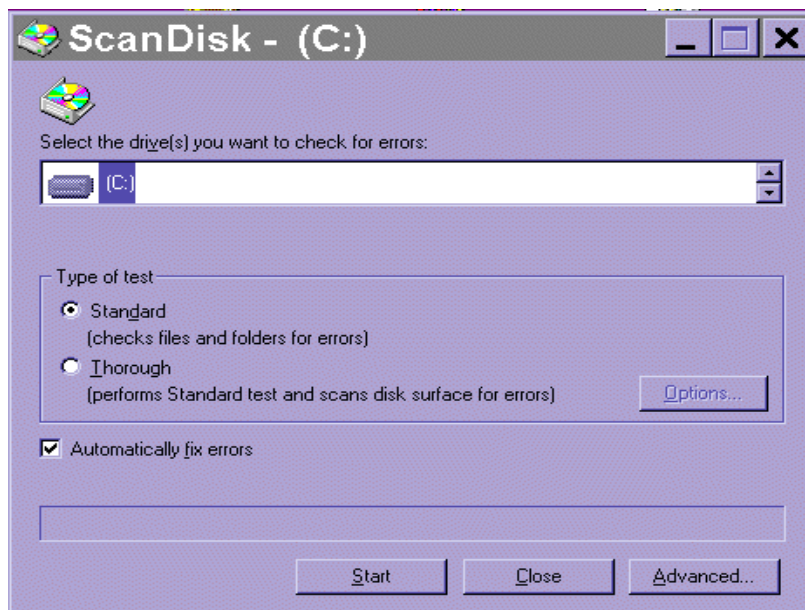
If the computer reports that it has corrupted, damaged, or missing files and the programs no longer operate properly, then this is the first step to try and fix the problem. Also, if the computer seems to be running slower than usual, sometimes this procedure will provide a fix. It is a good idea to perform this operation often.

Scandisk Procedure

1. Temporarily deactivate any screen saver. Click on START then SETTINGS then CONTROL PANEL then DISPLAY then SCREEN SAVER. Set the Screen Saver to NONE and click OK.
2. Click on START then PROGRAMS then ACCESSORIES then SYSTEM TOOLS then SCANDISK.

NOTE - Depending on what version of Windows you are running the above labels may be slightly different, but not so different that you will not be able to find it.

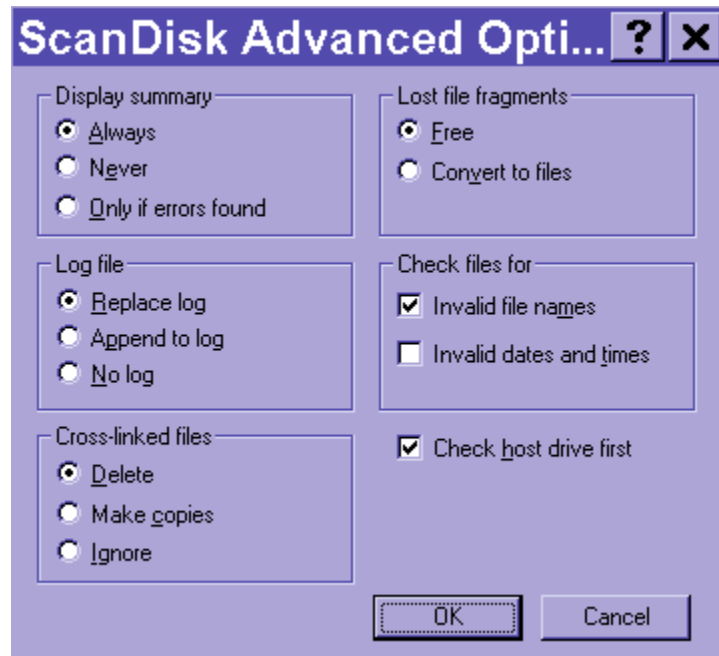
The following window will open on your screen.



3. Be sure to select "C:" from the drop down box if it is not already chosen. Then click on the radio button for **Standard** under **Type of test**. Next check the box (click on it) labelled **Automatically fix errors**.

The **Thorough** test option should not be selected unless you suspect the physical hard drive has been damaged. I suggest always running the **Standard** scandisk option first. Then If you still have problems rerun it with the **Thorough** option selected. Also, if you do not select **Automatically fix errors** the computer will stop and wait for you to answer some rather confusing questions.

4. Click on the button labelled **Advanced...** to launch the following sub-window.



5. Be sure to click on all of the radio buttons and check boxes EXACTLY as shown. Then press the **OK** button. This will return you to the former screen where you can press **START**.

The Scandisk process usually does not take long unless there are serious problems with the hard drive. Do not be concerned if the procedure restarts itself.

6. When the entire procedure is completed, you can reactivate the screen saver and then start working with applications. It is not necessary to restart the computer.

Reformatting a Hard disk

This procedure explains how to setup a **new hard disk**.

Warning - if you are setting up a hard disk which contains data, the following procedure would completely erase your hard disk and the data would be unrecoverable.

Before a new hard disk can be used it needs to be setup. This involves partitioning and formatting the hard disk. Windows 98 or ME boot disk contains the required software to perform this procedure. FDISK.EXE and FORMAT.COM are the files required in your bootable floppy disk.

1. Start the partition and format procedure by booting your PC using a Windows boot disk.

2. Make sure you set the BIOS so that the boot sequence is set to detect the floppy disk first. If your system has no problems booting you will be presented with a Windows boot disk menu. This gives you the option to start the system with or without CD-ROM support.
3. ROM support. Choose the option to boot without CD-ROM support. You should end up in the MS DOS prompt A: (A drive).
4. From A: command prompt type **fdisk**. You will be presented with following message:

```
Your computer has a disk larger than 512 MB. This version of Windows
includes improved support for large disks, resulting in more efficient
use of disk space on large drives, and allowing disks over 2 GB to be
formatted as a single drive.

IMPORTANT: If you enable large disk support and create any new drives on this
disk, you will not be able to access the new drive(s) using other operating
systems, including some versions of Windows 95 and Windows NT, as well as
earlier versions of Windows and MS-DOS. In addition, disk utilities that
were not designed explicitly for the FAT32 file system will not be able
to work with this disk. If you need to access this disk with other operating
systems or older disk utilities, do not enable large drive support.

Do you wish to enable large disk support (Y/N) . . . . . ? [Y]
```

4. Choose "Y" to enable large disk support. You will now be presented with the FDISK main menu as shown below.

```
Microsoft Windows 98
Fixed Disk Setup Program
(C) Copyright Microsoft Corp. 1983 - 1998

FDISK Options

Current Fixed disk drive: 1

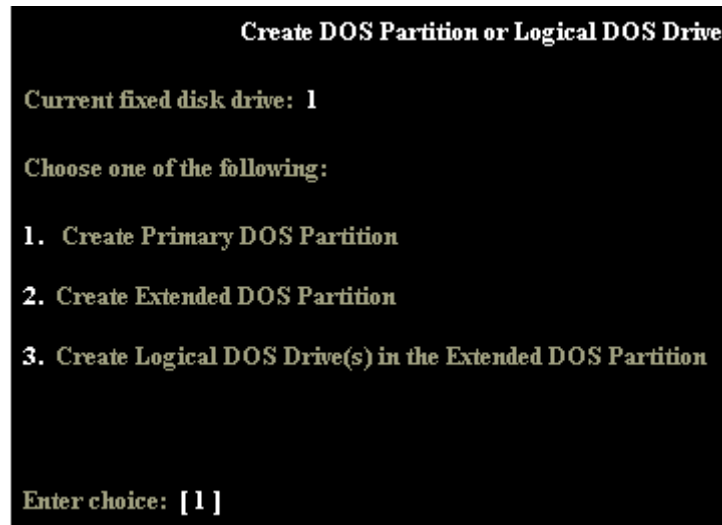
Choose one of the following:

1. Create DOS partition or Logical DOS Drive
2. Set active partition
3. Delete partition or Logical DOS Drive
4. Display partition information
5. Change current fixed disk drive

Enter choice: [ 1 ]

Press Esc to exit FDISK
```

5. From the menu, choose option 1 - Create DOS partition or Logical DOS drive. Another menu will present the following options.



6. Choose option 1 - Create primary DOS Partition. FDISK verifies the integrity of your drive and will ask you if want to use the maximum available size of your hard disk to create the primary partition and set it active. To keep things simple we will create one large partition.
7. Choose "Y" to use maximum available space. When the partition has been created successfully you will be notified by the system. Your drive is now known as C: (C drive). Press "Esc" to return to the menu. Press "Esc" again to exit FDISK. You need to restart your system for the changes to take affect. Leave boot disk in the drive.
8. When the system reboots, choose start without CD-ROM from the boot disk menu. While booting from floppy disk you might get error message like "Invalid media type reading drive C" this is OK for this stage as the hard disk is not formatted.
9. From A: command prompt type **format c:**
10. You will get a message saying "WARNING, ALL DATA ON NON-REMOVABLE DISK DRIVE C: WILL BE LOST. Proceed with Format (Y/N)?".
11. Since you do not have any data in the new hard disk. Choose "Y". The format will proceed showing a progress indicator. The time it takes to format a hard disk depends on the size and speed of the drive. This could be around 5-30 minutes. Restart system after format is complete.
12. Install an operating system.

Week8

This Week Learning Outcome

To Understand:

➤ The Cause of Floppy Drive Failure

Introduction (FLOPPY)

The ability to interchange programs and data between various compatible computers is a fundamental requirement of almost every computer system. This kind of file-exchange compatibility helped rocket IBM PC/XTs into everyday use and spur the personal computer industry into the early 1980s. A standardized operating system, file structure, and recording media also breathed life into the fledgling software industry. With the floppy disk, software developers could finally distribute programs and data to a mass-market of compatible computer users. The mechanism that allowed this quantum leap in compatibility is the *floppy-disk drive* (Fig. 16-1).

A floppy-disk drive (FDD) is one of the least expensive and most reliable forms of massstorage ever used in computer systems. Virtually every one of the millions of personal computers sold each year incorporates at least one floppy drive. Most notebook and laptop computers also offer a single floppy drive. Not only are FDDs useful for transferring files and data between various systems, but the advantage of removable media—the floppy disk itself—make floppy drives an almost intuitive backup system for data files. Although floppy drives have evolved through a number of iterations: from 8" to 5.25" to 3.5", their basic components and operating principles have changed very little.

Magnetic-Storage Concepts

Magnetic-storage media has been attractive to computer designs for many years—long before the personal computer had established itself in homes and offices. This popularity is primarily because magnetic media is non-volatile. Unlike system RAM, no electrical energy is needed to maintain the information once it is stored on magnetic media. Although electrical energy is used to read and write magnetic data, magnetic fields do not change on their own, so data remains intact until “other forces” act upon it (such as another floppy drive). It is this smooth, straightforward translation from electricity to magnetism and back again that has made magnetic storage such a natural choice. To understand how a floppy drive works and why it fails, you should have an understanding of magnetic storage.

This part of the chapter shows you the basic storage concepts used for floppy drives.

Media

For the purposes of this book, *media* is the physical material that actually holds recorded information. In a floppy disk, the media is a small mylar disk coated on both sides with a precisely formulated magnetic material, often referred to as the *oxide layer*. Every disk manufacturer uses their own particular formula for magnetic coatings, but most coatings

are based on a naturally magnetic element (such as iron, nickel, or cobalt) that has been alloyed with non-magnetic materials or rare earth. This magnetic material is then compounded with plastic, bonding chemicals, and lubricant to form the actual disk media.

The fascinating aspect of these magnetic layers is that each and every particle media acts as a microscopic magnet. Each magnetic particle can be aligned in one orientation or another under the influence of an external magnetic field. If you have ever magnetized a screwdriver's steel shaft by running a permanent magnet along its length, you have already seen this magnetizing process in action. For a floppy disk, microscopic points along the disk's surfaces are magnetized in one alignment or another by the precise forces applied by read/write (R/W) heads. The shifting of alignment polarities would indicate a logic 1, but no change in polarity would indicate a logic 0 (you will see more about data recording and organization later in this chapter).

In analog recording (such as audio tapes), the magnetic field generated by read/write heads varies in direct proportion to the signal being recorded. Such linear variations in field strength cause varying amounts of magnetic particles to align as the media moves.

On the other hand, digital recordings, such as floppy disks, save binary 1s and 0s by applying an overwhelming amount of field strength. Very strong magnetic fields saturate the media—that is, so much field strength is applied that any further increase in field strength will not cause a better alignment of magnetic particles at that point on the media. The advantage to operating in saturation is that 1s and 0s are remarkably resistant to the degrading effects of noise that can sometimes appear in analog magnetic recordings.

Although the orientation of magnetic particles on a disk's media can be reversed by using an external magnetic field, particles tend to resist the reversal of polarity. *Coercivity* is the strength with which magnetic particles resist change. More highly coercive material has a greater resistance to change, so a stronger external field will be needed to cause changes. High coercivity is generally considered to be desirable (up to a point) because signals stand out much better against background noise and signals will resist natural degradation because of age, temperature, and random magnetic influences. As you might expect, a highly coercive media requires a more powerful field to record new information.

Another advantage of increased coercivity is greater information density for media. The greater strength of each media particle allows more bits to be packed into less area. The move from 5.25" to 3.5" floppy disks was possible largely because of a superior (more coercive) magnetic layer. This coercivity principle also holds true for hard drives. To pack more information onto ever-smaller platters, the media must be more coercive. Coercivity is a common magnetic measurement with units in *oersteds* (pronounced "or-steds"). The coercivity of a typical floppy disk can range anywhere from 300 to 750 oersteds. By comparison, hard-drive and magneto-optical (MO) media usually offer coercivities up to 6000 oersteds or higher.

The main premise of magnetic storage is that it is static (once recorded, information is retained without any electrical energy). Such stored information is presumed to last forever, but in actuality, magnetic information begins to degrade as soon as it is recorded. A good

magnetic media will reliably remember (or retain) the alignment of its particles over a long period of time. The ability of a media to retain its magnetic information is known as *retentivity*. Even the finest, best-formulated floppy disks degrades eventually (although it could take many years before an actual data error materializes).

Ultimately, the ideal answer to media degradation is to refresh (or write over) the data and sector ID information. Data is re-written normally each time a file is saved, but sector IDs are only written once when the disk is formatted. If a sector ID should fail, you will see the dreaded “Sector Not Found” disk error and any data stored in the sector can not be accessed.

This failure mode also occurs in hard drives. Little can be done to ensure the integrity of floppy disks, aside from maintaining one or more backups on freshly formatted disks.

However, some commercial software is available for restoring disk data (especially hard drives).

Troubleshooting Floppy Disk Systems

This section of the chapter is concerned with drive problems that cannot be corrected with cleaning or mechanical adjustments. To perform some of the following tests, you should have a known-good diskette that has been properly formatted. The disk might contain files, but be certain that any such files are backed up properly on a hard drive or another floppy disk—if you can’t afford to lose the files on a disk, don’t use the disk.

Repair vs. Replace

As with so many other PC assemblies, the price of floppy drives has dropped tremendously over the last few years. Now that the price of a standard 8.89-cm drive is roughly that of two hours of labor, most technicians ask whether it is better to simply replace a floppy drive outright, rather than attempt a repair. Ultimately, the decision should depend on volume. Clearly, it makes little sense for a anyone to invest valuable time in repairing a single drive. If a large number of drives are to be repaired, however, an enterprising technician who chooses to deal in floppy-drive service can effectively provide rebuilt or refurbished drives to their customers.

Preliminary Testing

Proper testing is essential for any type of drive repair. Most drive-alignment packages, such as DriveProbe by Accurite Technologies or AlignIt by Landmark Research, measure and display a drive’s parameters (Fig. 16-10). When floppy drive trouble occurs, running a diagnostic can help determine whether the drive mechanics or electronics are at fault. Although you can swap a drive symptomatically, thorough testing is an inexpensive means to verify your suspicions before spending money to replace sub-assemblies.

Symptom 16-1. The floppy drive is completely dead The disk does not even initialize when inserted. Begin troubleshooting by inspecting the diskette itself. When a 3.5” disk is inserted into a drive, a mechanism should pull the disk’s metal shroud away and briefly

rotate the spindle motor to ensure positive engagement. Be sure that the disk is properly inserted into the floppy-drive assembly. If the diskette does not enter and seat just right within the drive, disk access will be impossible. Try several different diskettes to ensure that the test diskette is not defective. It might be necessary to partially disassemble the computer to access the drive and allow you to see the overall assembly. Free or adjust any jammed assemblies or linkages to correct disk insertion. If you cannot get diskettes to insert properly, change the floppy drive. 580 Floppy Drives For cleaning and testing your floppy drive, check out AUTOTEST.ZIP, CHKDRV.ZIP, CLEAN4.ZIP, and DFR.ZIP on the companion CDSymptom 16-2. The floppy drive rotates a disk, but will not seek to the desired track This type of symptom generally suggests that the head-positioning stepping motor is inhibited or defective, but all other floppy-drive functions are working properly. Begin by disassembling your computer and removing the floppy drive. Carefully

Troubleshooting Floppy Disk Systems 581

Figure 16-10 a Driveprobe Screen Display for Automatic Drive.

Accurite Technologies, Inc. inspect the head-positioning assembly to be certain that no broken parts or obstructions could jam the read/write heads. You might wish to examine the mechanical system with a disk inserted to be certain that the trouble is not a disk-alignment problem, which might be interfering with head movement. Gently remove any obstructions that you might find. Be careful not to accidentally misalign any linkages or mechanical components in the process of clearing an obstruction.

Remove any diskette from the drive and re-connect the drive's signal and power cables. Apply power to the computer and measure drive voltages with your multimeter. Ground your multimeter on pin 2 of the power connector and measure +12 Vdc at pin 1. Move the meter ground to pin 3 and measure +5 Vdc on pin 4. If either voltage is low or absent, troubleshoot your computer power supply.

Once confident that the drive's mechanics are intact and appropriate power is available, you must determine whether the trouble is in your floppy drive PC board or floppy-drive controller IC on the motherboard. Use your logic probe to measure the STEP signal in the physical interface (pin 20). When drive access is requested, you should find a pulse signal as the floppy controller attempts to position the R/W heads. If STEP pulses are missing, the floppy-drive controller board is probably defective and should be replaced.

If STEP pulses are present at the interface, check the pulses into the coil driver circuit. An absence of pulses into the coil driver circuit indicates a faulty control-circuit IC. If pulses reach the coil driver, measure pulses to the stepping motor. If no pulses leave the coil driver, replace the coil driver IC. When pulses are correct to the stepping motor but no motion is taking place, replace the defective stepping motor. If you do not have the tools or inclination to replace surface-mount ICs, you can replace the drive PC board. You can also replace the entire drive outright

Symptom 16-3. The floppy drive heads seek properly, but the spindle does not turn This symptom suggests that the spindle motor is inhibited or defective, but all other functions are working properly. Remove all power from the computer. Disassemble the system enough to remove the floppy drive. Carefully inspect the spindle

motor, drive belt (if used), and spindle assembly. Be certain that no broken parts or obstructions could jam the spindle. If a belt is between the motor and spindle, be sure that the belt is reasonably tight—it should not slip. You should also examine the floppy drive with a diskette inserted to be certain that the disk's insertion or alignment is not causing the problem. You can double-check your observations using several different diskettes. Gently remove any obstruction(s) that you might find. Be careful not to cause any accidental damage in the process of clearing an obstruction. Do not add any lubricating agents to the assembly, but gently vacuum or wipe away any significant accumulations of dust or dirt. Remove any diskette from the drive and re-connect the floppy drive's signal and power cables. Restore power to the computer and measure drive voltages with your multimeter. Ground your multimeter on pin 2 and measure +12 Vdc on pin 1. Move the meter ground to pin 3 and measure +5 Vdc on pin 4. If either voltage is low or absent, troubleshoot your computer power supply.

Once you are confident that the floppy drive is mechanically sound and appropriate power is available, you must determine whether the trouble is in the floppy drive PC board or the floppy drive controller board. Use your logic probe to measure the *Motor on* signal in the physical interface (pin 16). When drive access is requested, the *Motor on* signal 582 Floppy Drives should become true (in most cases an active low). If the *Motor on* signal is missing, the floppy drive-controller board is probably defective and should be replaced.

If the *Motor on* signal is present at the interface, check the signal driving the servo circuit. A missing *Motor on* signal at the servo circuit suggests a faulty control-circuit IC. If the signal reaches the servo circuit, the servo IC is probably defective. You can replace the servo IC, but your best course is usually to replace the spindle motor/PC board assembly as a unit. If you are unable to replace the spindle motor PC board, you can replace the floppy drive outright.

Symptom 16-4. The floppy drive will not read from/write to the diskette. All other operations appear normal. This type of problem can manifest itself in several ways, but your computer's operating system will usually inform you when a disk read or write error has occurred. Begin by trying a known-good, properly formatted diskette in the drive. A faulty diskette can generate some very perplexing read/write problems. If a known-good diskette does not resolve the problem, try cleaning the read/write heads, as described in the previous section. Do not run the drive with a head-cleaning disk inserted for more than 30 seconds at a time, or you risk damaging the heads with excessive friction. When a fresh diskette and clean R/W heads do not correct the problem, you must determine whether the trouble exists in the floppy-drive assembly or the floppy-controller IC.

If you cannot read data from the floppy drive, use your logic probe to measure the *Read data* signal (pin 30). When the disk is idle, the *Read data* line should read as a constant logic 1 or logic 0. During a read cycle, you should measure a pulse signal as data moves from the drive to the floppy-controller board. If no pulse signal appears on the *Read data* line during a read cycle, use your oscilloscope to measure analog signals from the R/W heads. If there are no signals from the R/W heads, replace the head or head carriage assembly. When signals are available from the R/W heads, the control-circuit IC is probably defective and should be replaced. If you are unable to replace the IC, you can

replace the drive's control PC board. You can also replace the entire drive outright. If a pulse signal does exist during a read cycle, the floppy-disk controller board is probably defective and should be replaced. When you cannot write data to the floppy drive, use your logic probe to measure the *Write gate* and *Write data* lines (pins 24 and 22, respectively). During a write cycle, the *Write gate* should be logic 0 and you should read a pulse signal as data flows from the floppy controller IC to the drive. If the *Write gate* remains logic 1 or no pulse is on the *Write data* line, replace the defective floppy controller board. When the two *Write* signals appear as expected, check the analog signal to the R/W heads with your oscilloscope. If you do not find analog write signals, replace the defective control-circuit IC. If analog signals are present to the heads, try replacing the heads or the entire head carriage assembly.

You can also replace the entire drive outright.

Symptom 16-5. The drive is able to write to a write-protected disk Before concluding that there is a drive problem, remove and examine the disk itself to ensure that it is actually write protected. If the disk is not write protected, write protect it appropriately and try the disk again. If the disk is already protected, use your multimeter to check the drive's write-protect sensor. For an unprotected disk, the sensor output should be a logic 1; a protected disk should generate a logic 0 (some drives might reverse this convention).

Week8

This Week Learning Outcome

To Understand:

➤ The Cause of Floppy Drive Failure

Introduction (FLOPPY)

The ability to interchange programs and data between various compatible computers is a fundamental requirement of almost every computer system. This kind of file-exchange compatibility helped rocket IBM PC/XTs into everyday use and spur the personal computer industry into the early 1980s. A standardized operating system, file structure, and recording media also breathed life into the fledgling software industry. With the floppy disk, software developers could finally distribute programs and data to a mass-market of compatible computer users. The mechanism that allowed this quantum leap in compatibility is the *floppy-disk drive* (Fig. 16-1).

A floppy-disk drive (FDD) is one of the least expensive and most reliable forms of mass storage ever used in computer systems. Virtually every one of the millions of personal computers sold each year incorporates at least one floppy drive. Most notebook and laptop computers also offer a single floppy drive. Not only are FDDs useful for transferring files and data between various systems, but the advantage of removable media—the floppy disk itself—make floppy drives an almost intuitive backup system for data files. Although floppy drives have evolved through a number of iterations: from 8" to 5.25" to 3.5", their basic components and operating principles have changed very little.

Magnetic-Storage Concepts

Magnetic-storage media has been attractive to computer designs for many years—long before the personal computer had established itself in homes and offices. This popularity is primarily because magnetic media is non-volatile. Unlike system RAM, no electrical energy is needed to maintain the information once it is stored on magnetic media. Although electrical energy is used to read and write magnetic data, magnetic fields do not change on their own, so data remains intact until “other forces” act upon it (such as another floppy drive). It is this smooth, straightforward translation from electricity to magnetism and back again that has made magnetic storage such a natural choice. To understand how a floppy drive works and why it fails, you should have an understanding of magnetic storage.

This part of the chapter shows you the basic storage concepts used for floppy drives.

Media

For the purposes of this book, *media* is the physical material that actually holds recorded information. In a floppy disk, the media is a small mylar disk coated on both sides with a precisely formulated magnetic material, often referred to as the *oxide layer*. Every disk manufacturer uses their own particular formula for magnetic coatings, but most coatings are based on a naturally magnetic element (such as iron, nickel, or cobalt) that has been

alloyed with non-magnetic materials or rare earth. This magnetic material is then compounded with plastic, bonding chemicals, and lubricant to form the actual disk media.

The fascinating aspect of these magnetic layers is that each and every particle media acts as a microscopic magnet. Each magnetic particle can be aligned in one orientation or another under the influence of an external magnetic field. If you have ever magnetized a screwdriver's steel shaft by running a permanent magnet along its length, you have already seen this magnetizing process in action. For a floppy disk, microscopic points along the disk's surfaces are magnetized in one alignment or another by the precise forces applied by read/write (R/W) heads. The shifting of alignment polarities would indicate a logic 1, but no change in polarity would indicate a logic 0 (you will see more about data recording and organization later in this chapter).

In analog recording (such as audio tapes), the magnetic field generated by read/write heads varies in direct proportion to the signal being recorded. Such linear variations in field strength cause varying amounts of magnetic particles to align as the media moves.

On the other hand, digital recordings, such as floppy disks, save binary 1s and 0s by applying an overwhelming amount of field strength. Very strong magnetic fields saturate the media—that is, so much field strength is applied that any further increase in field strength will not cause a better alignment of magnetic particles at that point on the media. The advantage to operating in saturation is that 1s and 0s are remarkably resistant to the degrading effects of noise that can sometimes appear in analog magnetic recordings.

Although the orientation of magnetic particles on a disk's media can be reversed by using an external magnetic field, particles tend to resist the reversal of polarity. *Coercivity* is the strength with which magnetic particles resist change. More highly coercive material has a greater resistance to change, so a stronger external field will be needed to cause changes. High coercivity is generally considered to be desirable (up to a point) because signals stand out much better against background noise and signals will resist natural degradation because of age, temperature, and random magnetic influences. As you might expect, a highly coercive media requires a more powerful field to record new information.

Another advantage of increased coercivity is greater information density for media. The greater strength of each media particle allows more bits to be packed into less area. The move from 5.25" to 3.5" floppy disks was possible largely because of a superior (more coercive) magnetic layer. This coercivity principle also holds true for hard drives. To pack more information onto ever-smaller platters, the media must be more coercive. Coercivity is a common magnetic measurement with units in *oersteds* (pronounced "or-steds"). The coercivity of a typical floppy disk can range anywhere from 300 to 750 oersteds. By comparison, hard-drive and magneto-optical (MO) media usually offer coercivities up to 6000 oersteds or higher.

The main premise of magnetic storage is that it is static (once recorded, information is retained without any electrical energy). Such stored information is presumed to last forever, but in actuality, magnetic information begins to degrade as soon as it is recorded. A good magnetic media will reliably remember (or retain) the alignment of its particles over a long

period of time. The ability of a media to retain its magnetic information is known as *retentivity*. Even the finest, best-formulated floppy disks degrades eventually (although it could take many years before an actual data error materializes).

Ultimately, the ideal answer to media degradation is to refresh (or write over) the data and sector ID information. Data is re-written normally each time a file is saved, but sector IDs are only written once when the disk is formatted. If a sector ID should fail, you will see the dreaded “Sector Not Found” disk error and any data stored in the sector can not be accessed.

This failure mode also occurs in hard drives. Little can be done to ensure the integrity of floppy disks, aside from maintaining one or more backups on freshly formatted disks.

However, some commercial software is available for restoring disk data (especially hard drives).

Troubleshooting Floppy Disk Systems

This section of the chapter is concerned with drive problems that cannot be corrected with cleaning or mechanical adjustments. To perform some of the following tests, you should have a known-good diskette that has been properly formatted. The disk might contain files, but be certain that any such files are backed up properly on a hard drive or another floppy disk—if you can’t afford to lose the files on a disk, don’t use the disk.

Repair vs. Replace

As with so many other PC assemblies, the price of floppy drives has dropped tremendously over the last few years. Now that the price of a standard 8.89-cm drive is roughly that of two hours of labor, most technicians ask whether it is better to simply replace a floppy drive outright, rather than attempt a repair. Ultimately, the decision should depend on volume. Clearly, it makes little sense for a anyone to invest valuable time in repairing a single drive. If a large number of drives are to be repaired, however, an enterprising technician who chooses to deal in floppy-drive service can effectively provide rebuilt or refurbished drives to their customers.

Preliminary Testing

Proper testing is essential for any type of drive repair. Most drive-alignment packages, such as DriveProbe by Accurite Technologies or AlignIt by Landmark Research, measure and display a drive’s parameters (Fig. 16-10). When floppy drive trouble occurs, running a diagnostic can help determine whether the drive mechanics or electronics are at fault. Although you can swap a drive symptomatically, thorough testing is an inexpensive means to verify your suspicions before spending money to replace sub-assemblies.

Symptom 16-1. The floppy drive is completely dead The disk does not even initialize when inserted. Begin troubleshooting by inspecting the diskette itself. When a 3.5” disk is inserted into a drive, a mechanism should pull the disk’s metal shroud away and briefly rotate the spindle motor to ensure positive engagement. Be sure that the disk is properly

inserted into the floppy-drive assembly. If the diskette does not enter and seat just right within the drive, disk access will be impossible. Try several different diskettes to ensure that the test diskette is not defective. It might be necessary to partially disassemble the computer to access the drive and allow you to see the overall assembly. Free or adjust any jammed assemblies or linkages to correct disk insertion. If you cannot get diskettes to insert properly, change the floppy drive. 580 Floppy Drives For cleaning and testing your floppy drive, check out AUTOTEST.ZIP, CHKDRV.ZIP, CLEAN4.ZIP, and DFR.ZIP on the companion CDSymptom 16-2. The floppy drive rotates a disk, but will not seek to the desired track This type of symptom generally suggests that the head-positioning stepping motor is inhibited or defective, but all other floppy-drive functions are working properly. Begin by disassembling your computer and removing the floppy drive. Carefully

Troubleshooting Floppy Disk Systems 581

Figure 16-10 a Driveprobe Screen Display for Automatic Drive.

Accurite Technologies, Inc. inspect the head-positioning assembly to be certain that no broken parts or obstructions could jam the read/write heads. You might wish to examine the mechanical system with a disk inserted to be certain that the trouble is not a disk-alignment problem, which might be interfering with head movement. Gently remove any obstructions that you might find. Be careful not to accidentally misalign any linkages or mechanical components in the process of clearing an obstruction.

Remove any diskette from the drive and re-connect the drive's signal and power cables. Apply power to the computer and measure drive voltages with your multimeter. Ground your multimeter on pin 2 of the power connector and measure +12 Vdc at pin 1. Move the meter ground to pin 3 and measure +5 Vdc on pin 4. If either voltage is low or absent, troubleshoot your computer power supply.

Once confident that the drive's mechanics are intact and appropriate power is available, you must determine whether the trouble is in your floppy drive PC board or floppy-drive controller IC on the motherboard. Use your logic probe to measure the STEP signal in the physical interface (pin 20). When drive access is requested, you should find a pulse signal as the floppy controller attempts to position the R/W heads. If STEP pulses are missing, the floppy-drive controller board is probably defective and should be replaced.

If STEP pulses are present at the interface, check the pulses into the coil driver circuit. An absence of pulses into the coil driver circuit indicates a faulty control-circuit IC. If pulses reach the coil driver, measure pulses to the stepping motor. If no pulses leave the coil driver, replace the coil driver IC. When pulses are correct to the stepping motor but no motion is taking place, replace the defective stepping motor. If you do not have the tools or inclination to replace surface-mount ICs, you can replace the drive PC board. You can also replace the entire drive outright

Symptom 16-3. The floppy drive heads seek properly, but the spindle does not turn This symptom suggests that the spindle motor is inhibited or defective, but all other functions are working properly. Remove all power from the computer. Disassemble the system enough to remove the floppy drive. Carefully inspect the spindle motor, drive belt (if used), and spindle assembly. Be certain that no broken parts or

obstructions could jam the spindle. If a belt is between the motor and spindle, be sure that the belt is reasonably tight—it should not slip. You should also examine the floppy drive with a diskette inserted to be certain that the disk's insertion or alignment is not causing the problem. You can double-check your observations using several different diskettes. Gently remove any obstruction(s) that you might find. Be careful not to cause any accidental damage in the process of clearing an obstruction. Do not add any lubricating agents to the assembly, but gently vacuum or wipe away any significant accumulations of dust or dirt. Remove any diskette from the drive and re-connect the floppy drive's signal and power cables. Restore power to the computer and measure drive voltages with your multimeter. Ground your multimeter on pin 2 and measure +12 Vdc on pin 1. Move the meter ground to pin 3 and measure +5 Vdc on pin 4. If either voltage is low or absent, troubleshoot your computer power supply.

Once you are confident that the floppy drive is mechanically sound and appropriate power is available, you must determine whether the trouble is in the floppy drive PC board or the floppy drive controller board. Use your logic probe to measure the *Motor on* signal in the physical interface (pin 16). When drive access is requested, the *Motor on* signal 582 Floppy Drives should become true (in most cases an active low). If the *Motor on* signal is missing, the floppy drive-controller board is probably defective and should be replaced.

If the *Motor on* signal is present at the interface, check the signal driving the servo circuit. A missing *Motor on* signal at the servo circuit suggests a faulty control-circuit IC. If the signal reaches the servo circuit, the servo IC is probably defective. You can replace the servo IC, but your best course is usually to replace the spindle motor/PC board assembly as a unit. If you are unable to replace the spindle motor PC board, you can replace the floppy drive outright.

Symptom 16-4. The floppy drive will not read from/write to the diskette All other operations appear normal. This type of problem can manifest itself in several ways, but your computer's operating system will usually inform you when a disk read or write error has occurred. Begin by trying a known-good, properly formatted diskette in the drive. A faulty diskette can generate some very perplexing read/write problems. If a known-good diskette does not resolve the problem, try cleaning the read/write heads, as described in the previous section. Do not run the drive with a head-cleaning disk inserted for more than 30 seconds at a time, or you risk damaging the heads with excessive friction. When a fresh diskette and clean R/W heads do not correct the problem, you must determine whether the trouble exists in the floppy-drive assembly or the floppy-controller IC.

If you cannot read data from the floppy drive, use your logic probe to measure the *Read data* signal (pin 30). When the disk is idle, the *Read data* line should read as a constant logic 1 or logic 0. During a read cycle, you should measure a pulse signal as data moves from the drive to the floppy-controller board. If no pulse signal appears on the *Read data* line during a read cycle, use your oscilloscope to measure analog signals from the R/W heads. If there are no signals from the R/W heads, replace the head or head carriage assembly. When signals are available from the R/W heads, the control-circuit IC is probably defective and should be replaced. If you are unable to replace the IC, you can replace the drive's control PC board. You can also replace the entire drive outright. If a

pulse signal does exist during a read cycle, the floppy-disk controller board is probably defective and should be replaced. When you cannot write data to the floppy drive, use your logic probe to measure the *Write gate* and *Write data* lines (pins 24 and 22, respectively). During a write cycle, the *Write gate* should be logic 0 and you should read a pulse signal as data flows from the floppy controller IC to the drive. If the *Write gate* remains logic 1 or no pulse is on the *Write data* line, replace the defective floppy controller board. When the two *Write* signals appear as expected, check the analog signal to the R/W heads with your oscilloscope. If you do not find analog write signals, replace the defective control-circuit IC. If analog signals are present to the heads, try replacing the heads or the entire head carriage assembly.

You can also replace the entire drive outright.

Symptom 16-5. The drive is able to write to a write-protected disk Before concluding that there is a drive problem, remove and examine the disk itself to ensure that it is actually write protected. If the disk is not write protected, write protect it appropriately and try the disk again. If the disk is already protected, use your multimeter to check the drive's write-protect sensor. For an unprotected disk, the sensor output should be a logic 1; a protected disk should generate a logic 0 (some drives might reverse this convention).

Week9

This Week Learning Outcome

To Understand:

➤ CD ROM Failure – Symptoms and Troubleshooting

The *compact disc (CD)* first appeared in the commercial marketplace in early 1982. Sony and Philips developed the CD as a joint venture and envisioned it as a reliable, high quality replacement for aging phonograph technology. With the introduction of the audio CD, designers demonstrated that huge amounts of information can be stored simply and very inexpensively on common, non-magnetic media. Unlike previous recording media, the CD recorded data in *digital* form through the use of physical “pits” and “lands” in the disc. The digital approach allowed excellent stereo sound quality, which does not degrade each time the disc is played, but also attracted the attention of PC designers, who saw CDs as a natural solution for all types of computer information (i.e., text, graphics, programs, video clips, audio files, etc.). The CD-ROM drive is now standard equipment on both desktop and mobile PC systems.

Although CD-ROM drives bring a great deal of reliable storage potential to the PC, it has not been possible to record CDs on the desktop—the technology required to create audio and computer CDs has traditionally been terribly complex and expensive, and limited by PC computing power of the day. Since the early 1990s, *CD recorder (CD-R)* technology has steadily become more reliable and economical. Today, virtually any Pentium-based PC with a SCSI bus and 1GB or more of hard drive space can support a CD-R drive for under \$500 (U.S.). This chapter explains the technologies and troubleshooting techniques for CD-ROM and CD-R drives (Fig. 7-1).

Understanding CD Media

CDs are mass-produced by stamping the pattern of pits and lands onto a molded polycarbonate disc (known as a *substrate*). This stamping process (much like the stamping used to produce vinyl records) places the data on the disc. But the disc is not yet readable—several finish steps must be performed to transform a clear plastic disc into viable, data-carrying media. The clear polycarbonate disc is given a silvered (reflective) coating so that it will reflect laser light. Silvering coats all parts of the disc side (pits and lands) equally. After silvering, the disc is coated with a tough, scratch-resistant lacquer that seals the disc from the element especially oxygen, which will oxidize and ruin the reflective coating). Finally, a label can be silk-screened onto the finished disc before it is tested and packaged. Figure 7-2 illustrates each of these layers in a cross-sectional diagram.

Recordable media appears very similar to “pressed” CD media (Fig. 7-2), but with two important variations. First, the polycarbonate CD-R substrate is pre-formed with a track spiral into which data will be written during recording. The substrate is then coated with a greenish translucent layer, and backed with a reflective layer of gold before protective

lacquer is applied over the gold. These translucent and gold layers allow the recorded pits and lands to be read back after recording.

CARING FOR COMPACT DISCS

A compact disc is a remarkably reliable long-term storage media (conservative expectations place the life estimates of a current CD at about 100 years. However, the longevity of a CD is affected by its storage and handling—a faulty CD can cause file and data errors that you might otherwise interpret as a defect in the drive itself. Here are some tips to help protect and maintain the disc itself:

Don't bend the disc Polycarbonate is a forgiving material, but you risk cracking or snapping (and thus ruining) the disc.

- *Don't heat the disk* Remember, the disc is plastic. Leaving it by a heater or on the dashboard of your car might cause it to melt.
- *Don't scratch the disc* Laser wavelengths have a tendency to “look past” minor scratches, but a major scratch can cause problems. Be especially careful of circular scratches (one that follows the spiral track). A circular scratch can easily wipe out entire segments of data, which would be unrecoverable.
- *Don't use chemicals on the disc* Chemicals containing solvents, such as ammonia, benzene, acetone, carbon tetrachloride, or chlorinated cleaners, can easily damage the disc's plastic surface.

Caring For Recordable Cds

As a rule, recordable CDs are as rugged and reliable as ordinary “pressed” CDs. Still, you should exercise some rules in the careful handling and storage of recordable media:

- *Maintain a comfortable environment* Don't expose recordable discs to sunlight or other strong light for long periods of time. Also avoid high heat and humidity, which can damage the physical disc. Always keep blank or recorded media in clean “jewel” cases for best protection.

148 CD-ROM And CD-R Drives

Eventually, a buildup of excessive dust or fingerprints can interfere with the laser beam enough to cause disc errors. If this happens, the disc can be cleaned easily using a dry, soft, lint-free cloth. Hold the disc from its edges and wipe radially (from hub to edge). Do not wipe in a circular motion. For stubborn stains, moisten the cloth in a bit of fresh isopropyl alcohol (do not use water). Place the cleaned disc in a caddie or jewel case for transport and storage.

- *Don't write on the disc* Don't use alcohol-based pens to write on discs—the ink might eventually eat through the top (lacquer) surface and damage your data. Also don't use ball-point or other sharp-tipped pens because you might scratch right through the lacquer surface and damage the reflective gold layer (and ruin your data).
- *Don't use labels on the disc* Don't put labels on discs unless they are expressly designed for recordable CDs. The glue might eat through the lacquer surface just as some inks do, and/or the label might unbalance the disc and cause problems in

reading it back or recording subsequent sessions. Never try to remove a label—you might tear off the lacquer and some of the reflecting surface.

- *Watch your media quality* Many different brands of recordable CD media are now available. Quality varies from brand to brand (and even from batch to batch within a given brand). If you have repeated problems that can be traced to the blank media you are using, try using a different brand or even a different batch of the same brand.
- *Don't use Kodak Photo CDs* Avoid the use of Kodak Photo CDs on everyday CD recorders. Kodak Photo CDs are designed to be used only with Kodak Photo CD professional workstations. Although the discs are inexpensive, they have a protection bit that prevents them from being written on many CD recorders. When you attempt to write these discs on the recorders, which recognize the protection bit, you will receive an error message.
- *Don't write on the disc* Don't use alcohol-based pens to write on discs—the ink might eventually eat through the top (lacquer) surface and damage your data. Also don't use ball-point or other sharp-tipped pens because you might scratch right through the lacquer surface and damage the reflective gold layer (and ruin your data).
- *Don't use labels on the disc* Don't put labels on discs unless they are expressly designed for recordable CDs. The glue might eat through the lacquer surface just as some inks do, and/or the label might unbalance the disc and cause problems in reading it back or recording subsequent sessions. Never try to remove a label—you might tear off the lacquer and some of the reflecting surface.
- *Watch your media quality* Many different brands of recordable CD media are now available. Quality varies from brand to brand (and even from batch to batch within a given brand). If you have repeated problems that can be traced to the blank media you are using, try using a different brand or even a different batch of the same brand.
- *Don't use Kodak Photo CDs* Avoid the use of Kodak Photo CDs on everyday CD recorders. Kodak Photo CDs are designed to be used only with Kodak Photo CD professional workstations. Although the discs are inexpensive, they have a protection bit that prevents them from being written on many CD recorders. When you attempt to write these discs on the recorders, which recognize the protection bit, you will receive
- *Don't write on the disc* Don't use alcohol-based pens to write on discs—the ink might eventually eat through the top (lacquer) surface and damage your data. Also don't use ball-point or other sharp-tipped pens because you might scratch right through the lacquer surface and damage the reflective gold layer (and ruin your data).
- *Don't use labels on the disc* Don't put labels on discs unless they are expressly designed for recordable CDs. The glue might eat through the lacquer surface just as some inks do, and/or the label might unbalance the disc and cause problems in reading it back or recording subsequent sessions. Never try to remove a label—you might tear off the lacquer and some of the reflecting surface.

- *Watch your media quality* Many different brands of recordable CD media are now available. Quality varies from brand to brand (and even from batch to batch within a given brand). If you have repeated problems that can be traced to the blank media you are using, try using a different brand or even a different batch of the same brand.
- *Don't use Kodak Photo CDs* Avoid the use of Kodak Photo CDs on everyday CD recorders. Kodak Photo CDs are designed to be used only with Kodak Photo CD professional workstations. Although the discs are inexpensive, they have a protection bit that prevents them from being written on many CD recorders. When you attempt to write these discs on the recorders, which recognize the protection bit, you will receive.

Creating a Bootable CD

With the acceptance of the “El Torito” standard for IDE CD-ROM drives, it is now possible to boot your PC from a CD and load an operating system without a floppy or hard drive. The problem is in obtaining bootable CDs to begin with. Many new computers are

Creating A Bootable CD 159

If no SCSI hard drives are in the system, the SCSI adapter’s on-board BIOS ROM can usually be disabled. Being sold with a “system disc,” which can boot and load an operating system, but it is rare for users to bring in their bootable CDs with the system when service is required. If you have a CD-R drive and some readily available software tools, you can actually make a bootable CD yourself. This part of the chapter covers the procedure used to create a bootable CD. Before you can create a bootable CD, you will need a system (or access to a system) with the following hardware and software tools:

- An “El Torito-capable” IDE or SCSI CD-ROM drive (with their standard IDE/SCSI interfaces).
- An “El Torito-capable” motherboard or SCSI adapter BIOS that supports booting from bootable CDs.
- A hexadecimal editor utility. If you have Norton Utilities (version 8.0 or Windows 95), the DISKEDIT.EXE utility is preferred.
- A bootable floppy disk (MS-DOS 6.2x or DOS 7.0 of Windows 95). You might also use a bootable hard drive.
- A hard-disk drive with ample speed and space to hold an ISO 9660 image file for the bootable CD. A SCSI disk is preferred, but a fast EIDE hard drive will also work. At least 650MB of free space should be on the HDD for the image file.
- A CD-R drive (almost always SCSI).
- Any CD-R software that can make an ISO 9660 image file. For example, you could use Adaptec’s Easy CD Pro for Windows 95.
- A blank CD-R disc (you can’t make a multisession CD bootable).

160 CD-ROM and CD-R Drives

Troubleshooting CD-ROM Drives Although the vast majority of CD-ROM problems are caused by software or setup problems, the drives themselves are delicate and unforgiving

devices. Considering that their prices have plummeted over the last few years (and still continue to drop), there is little economic sense in attempting a lengthy repair. When a fault occurs in the drive or in its adapter board, your best course is typically to replace the defective drive outright.

Symptom 7-1. The drive has trouble accepting or rejecting a CD This problem is typical of motorized CD-ROM drives, where the disc is accepted into a slot or placed in a motorized tray. Before performing any disassembly, check the assembly through the CD slot for any obvious obstructions. If nothing is obvious, expose the assembly and check each linkage and motor drive gear very carefully. Carefully remove or free any obstruction. Be gentle when working around the load/unload assembly. Notice how it is shock mounted in four places.

Disconnect the geared dc motor assembly and try moving the load/unload mechanism by hand. If you feel any resistance or obstruction, you should track it down by eye and by feel. Replace any worn or damaged part of the mechanism, or replace the entire load/unload assembly. Also check the geared motor for any damage or obstruction. Broken or slipping gear teeth can interfere with the transfer of force from motor to mechanism. Replace any damaged gears or replace the entire geared assembly. You might also simply replace the CD-ROM drive mechanism outright.

Symptom 7-2. The optical read head does not seek An optical head is used to identify pits and lands along a CD-ROM, and to track the spiral data pattern as the head moves across the disk. The optical head must move very slowly and smoothly to ensure accurate tracking. Head movement is accomplished using a linear stepping motor (or lin-

If you like the idea of creating your own bootable CDs, but don't like the idea of editing hex code manually, try the following utilities on the Companion CD: MKBTCD1.ZIP,

The companion CD contains a number of CD-ROM testing/caching utilities. Check out ear actuator) to shift the optical assembly in microscopic increments—head travel appears perfectly smooth to the unaided eye. Check the drive for any damaged parts of obstructions.

When the optical head fails to seek, the easiest and fastest fix is simply to replace the CD-ROM mechanism outright.

Symptom 7-3. The disc cannot be read This type of problem might result in a DOS level sector not found" or "drive not ready" error. Before you reach for your tools, however, check the CD itself to ensure that it is the right format, inserted properly, and physically clean. Cleanliness is very important to a CD. Although the laser will often "look past" any surface defects in a disc, the presence of dust or debris on a disc surface can produce serious tracking (and read) errors. Try a different disc to confirm the problem. If a new or different disc reads properly, the trouble might indeed be in (or on) the original disc itself. Not only the disc must be clean, but the head optics must also be clear. Gently dust or clean the head optics, as suggested by your drive's particular manufacturer.

If read problems persist, check the physical interface cable between the drive and its adapter board. Be sure that the cable is connected correctly and completely. Many CD drives use SCSI interfaces—if you are using multiple SCSI devices from the same controller card and other SCSI devices are operating properly, the SCSI controller board is probably intact. If other SCSI devices are also malfunctioning, try a new SCSI host controller board. At this point, either the drive's optical head or electronics are defective.

Your best course here is to replace the drive. If problems persist on a drive with a proprietary interface, replace the adapter board.

Symptom 7-4. The disc does not turn The disc must turn at a *Constant Linear Velocity (CLV)* that is directed and regulated by the spindle. If the disc is not spinning during access, check to be sure that the disc is seated properly, and is not jammed or obstructed. Before beginning a repair, review your drive installation and setup carefully to ensure that the drive is properly configured for operation. If the drive's BUSY LED comes on when drive access is attempted (you might also see a corresponding DOS error message), the drive spindle system is probably defective. If the computer does not recognize the CD drive (i.e., "invalid drive specification"), there might be a setup or configuration problem (either the low-level device driver or MSCDEX might not have loaded properly). If your particular drive provides you with instructions for cleaning the optical head aperture, perform that cleaning operation and try the drive again. A fouled optical head can sometimes upset spindle operation. If operation does not improve, replace the CD-ROM drive mechanism.

Symptom 7-5. The optical head cannot focus its laser beam As you saw earlier in this chapter, a CD-ROM drive must focus its laser beam to microscopic precision to properly read the pits and lands of a disk. To compensate for the minute fluctuations in disc flatness, the optical head mounts its objective lens into a small focusing mechanism, which is little more than a miniature voice-coil actuator—the lens does not have to move very much at all to maintain precise focus. If focus is out or not well maintained, the laser detector might produce erroneous signals. This might result in DOS drive error messages. If random, but consistent, DOS errors appear, check the disc to be sure that it is optically clean—dust and fingerprints can result in serious access problems. Try another disc. If a new disc continues to perform badly, try cleaning the optical aperture with

Symptom 7-3. The disc cannot be read This type of problem might result in a DOS level "sector not found" or "drive not ready" error. Before you reach for your tools, however, check the CD itself to ensure that it is the right format, inserted properly, and physically clean. Cleanliness is very important to a CD. Although the laser will often "look past" any surface defects in a disc, the presence of dust or debris on a disc surface can produce serious tracking (and read) errors. Try a different disc to confirm the problem. If a new or different disc reads properly, the trouble might indeed be in (or on) the original disc itself. Not only the disc must be clean, but the head optics must also be clear. Gently dust or clean the head optics, as suggested by your drive's particular manufacturer.

If read problems persist, check the physical interface cable between the drive and its adapter board. Be sure that the cable is connected correctly and completely. Many CD drives use SCSI interfaces—if you are using multiple SCSI devices from the same controller card and other SCSI devices are operating properly, the SCSI controller board is probably intact. If other SCSI devices are also malfunctioning, try a new SCSI host controller board. At this point, either the drive's optical head or electronics are defective. Your best course here is to replace the drive. If problems persist on a drive with a proprietary interface, replace the adapter board.

Symptom 7-4. The disc does not turn The disc must turn at a *Constant Linear Velocity (CLV)* that is directed and regulated by the spindle. If the disc is not spinning during access, check to be sure that the disc is seated properly, and is not jammed or obstructed.

Before beginning a repair, review your drive installation and setup carefully to ensure that the drive is properly configured for operation. If the drive's BUSY LED comes on when drive access is attempted (you might also see a corresponding DOS error message), the drive spindle system is probably defective. If the computer does not recognize the CD drive (i.e., "invalid drive specification"), there might be a setup or configuration problem (either the low-level device driver or MSCDEX might not have loaded properly). If your particular drive provides you with instructions for cleaning the optical head aperture, perform that cleaning operation and try the drive again. A fouled optical head can sometimes upset spindle operation. If operation does not improve, replace the CD-ROM drive mechanism.

Symptom 7-29. You cannot change the CD-ROM drive letter under Windows 95 You need to change the drive's settings under the *Device manager*:

- Open the *Control panel* and select the *System* icon.
- Once the *System properties* dialog opens, click on the *Device manager* page.
- Locate the entry for the CD-ROM. Click on the + sign to expand the list of CD-ROM device.
- Doubleclick on the desired CD-ROM.
- Once the CD-ROM drive's *Properties* dialog appears, choose the *Settings* page.
- Locate the current drive letter assignment box and enter the new drive designation.

Multiple letters are needed only when a SCSI device is implementing LUN addressing (i.e., multidisc changers).

- Click on the *OK* button to save your changes.
- Click on the *OK* button to close the *Device manager*.
- A *System settings change* window should appear. Click on the *Yes* button to reboot the system so that the changes can take effect, or click on the *No* button so that you can make more changes to other CD-ROMs before rebooting system. Changes will not become effective until the system is rebooted.

Week10

This Week Learning Outcome To Understand:

➤ Keyboard Failure – Symptoms and Troubleshooting

Introduction

Keyboards (Fig. 20-1) are the classic input device. By manipulating a matrix of individual electrical switches, commands, and instructions can be entered into the computer one character at a time. If you've used computers or typewriters to any extent, you already have an excellent grasp of keyboard handling. However, keyboards are not without their share of drawbacks and limitations. Although today's keyboard switches are not mechanically complex, there are a number of important moving parts. When you multiply this number of moving parts times the 80 to 100+ keys on a typical keyboard, you are faced with a substantial number of moving parts. A jam or failure in any one of these many mechanical parts results in a keyboard problem. Most keyboard failures are hardly catastrophic, but they can certainly be inconvenient. This chapter gives you the information needed to understand and repair computer keyboards.

Keyboard Cleaning and Maintenance

Keyboards are perhaps the most abused part of any computer, yet they are often ignored until serious problems develop. With some regular cleaning and maintenance, however, a keyboard can easily last for the lifetime of a computer. This part of the chapter shows you some practical techniques for keyboard service.

Correcting Problem Keyboards

Virtually all computer keyboards are open to the air. Over time, everyday dust, pet hair, air vapor, cigar/cigarette smoke, and debris from hands and ordinary use will settle into the keyboard. Eventually, accumulations of this foreign matter will cause keys to stick, or will prevent keys from making proper contact (i.e., a key does not work every time it is pressed).

In either case, keyboard problems will develop. Fortunately, correcting a finicky keyboard is a relatively straightforward process. Start by removing the key caps of the offending keys. Be sure to note where each key is placed before starting your disassembly especially if the keyboard is a DVORAK-type or unusual ergonomic design. To remove a key cap, bend an ordinary paper clip into the shape of a narrow "U", and bend-in small tabs at the tip of the "U" shape. Slip the small tabs under the key cap and pull up gently. Do not struggle with the key cap. If a cap will not come off, remove one or more adjacent caps. If there is a substantial accumulation of foreign matter in the keyboard, you should consider removing all of the key caps for a thorough cleaning, but this requires more time

Flip the keyboard upside down and rap gently on the case. This will loosen and dislodge any larger, heavier foreign matter, and allow it to fall out of the keyboard. A soft-bristled brush will help loosen the debris. Return the keyboard to an upright position. Use a can of compressed air (available from almost any electronics or photography store) to blow out the remainder of foreign matter. Because this tends to blow dust and debris in all directions, you might wish to use the compressed air outside or in an area away from your workbench. A medium- or firm-bristled brush will help loosen any stubborn debris.

Now that the keyboard is cleaned out, squirt a small amount of good-quality electronicsgrade contact cleaner (also available from almost any electronics store) into each key contact, and work the key to distribute the cleaner evenly. Allow a few minutes for the contact cleaner to dry completely and test the keyboard again before reinstalling the key caps. If the problems persist, the keyboard might be damaged or the individual key(s) might simply be worn out beyond recovery. In such an event, replace the keyboard outright.

Vacuum Cleaners And Keyboards

There is an ongoing debate as to the safety of vacuum cleaners with computer equipment. The problem is static discharge. Many vacuum cleaners—especially small, inexpensive models—use cheap plastic and synthetic fabrics in their construction. When a fast air flow passes over those materials, a static charge is developed (just like combing your hair with a plastic comb). If the charged vacuum touches the keyboard, a static discharge might have enough potential to damage the keyboard-controller IC, or even travel back into the motherboard for more serious damage.

670 Keyboards

Avoid removing the <Space Bar> unless it is absolutely necessary because the space bar is often much more difficult to replace than ordinary keys. If you do choose to use a vacuum for keyboard cleaning, take these two steps to prevent damage. First, be sure that the computer is powered down and disconnect the keyboard from the computer before starting service. If a static discharge does occur, the most that would be damaged is the keyboard itself. Second, use a vacuum cleaner that is made for electronics work and certified as “static-safe.” Third, try working on an anti-static mat (such as the mat in Fig. 20-7), which is properly grounded. This will tend to “bleed-off” static charges before they can enter the keyboard or PC.

Replacing The <Space Bar>

Of all the keys on the keyboard, replacing the <Space Bar> is probably the most difficult. The <Space Bar> is kept even by a metal wire that is inserted into slots on each leg of the plastic bar key. However, you have to get the wire into the slots without pressing the wire.

If you push the wire down, you compress the wire and installation becomes impossible.

As a general rule, do not remove the <Space Bar> unless absolutely necessary. If you must remove the <Space Bar>, remove several surrounding key caps also. This will let you get some tools under the <Space Bar> wire later on. Once the <Space Bar> is re-inserted, you can easily replace any of the other key caps.

Preventing The Problems

Keyboard problems do not happen suddenly (unless the keyboard is dropped or physically abused). The accumulation of dust and debris is a slow process that can take months (sometimes years) to produce serious, repetitive keyboard problems. By following a regimen of regular cleaning, you can stop problems before they manifest themselves in your keyboard. In normal office environments, keyboards should be cleaned once every four months. Keyboards in home environments should be cleaned every two months. Keyboards in harsh or industrial environments should be cleaned even more frequently.

Turn your keyboard upside-down and use a soft-bristled brush to clean between the keys. This prevents debris that might already be on the keys from entering the keyboard. Next, run the long, thin nozzle of your compressed air can between the key spaces to blow

Keyboard Cleaning And Maintenance 671

FIGURE 20-7 A Curtis

Anti-Static Keyboard Mat. Curtis, a division of Rolodex, Secaucus, NJ 07094 out any accumulations of dust. Because compressed air will tend to blow dust in all directions, you might consider “blowing down” the keyboard outside, or in an area away from your workbench. Instead of compressed air, you might use a “static-safe” vacuum cleaner to remove dust and debris.

Dealing With Large Objects

Staples and paper clips pose a clear and present danger to keyboards. Although the odds of a staple or paper clip finding its way into a keyboard are generally slight, foreign objects can jam the key or short it out. If the keyboard is moved, the object can wind up in the keyboard’s circuitry where serious damage can occur. When a foreign object falls into the keyboard, do not move the keyboard. Power down the PC, then locate the object and find the nearest key. Use a paper clip bent in a “U” shape with the ends of the “U” angled inward to remove the nearest key cap. Use a pair of non-conductive tweezers or needle nose pliers to remove the object. Replace the key cap.

Dealing With Spills

Accidental spills are probably the most serious and dangerous keyboard problem. Coffee, soda pop, and even tap water is highly conductive (even corrosive). Your keyboard will almost certainly short circuit. Immediately shut down your computer (you might be able to exit your application using a mouse) and disconnect the keyboard. The popular tactic is to simply let the liquid dry. The problem with this tactic is that most liquids contain minerals and materials that are corrosive to metals—your keyboard will never be the same unless the offending liquid is removed before it dries. Also, liquids tend to turn any dust and smoke

film into a sticky glue that will just jam the keys when dry (not even considering the sticky sugar in most soda pop).

Disassemble the keyboard's main housings and remove the keyboard printed-circuit assembly. As quickly as you can after the incident, rinse the assembly thoroughly in clean, room-temperature, de-mineralized water (available from any pharmacy for contact lens maintenance). You can clean the plastic housings separately. Do not use tap water. Let the assembly drip dry in air. Do not attempt to accelerate the drying process with a hair dryer or other such heat source. The de-mineralized water should dry clean without mineral deposits or any sticky, conductive residue. Once the assembly is dry, you might wish to squirt a small amount of good-quality, electronics-grade contact cleaner into each key switch to ensure that no residue is on the contacts. Assuming that the keyboard's circuitry was not damaged by the initial spill, you should be able to reassemble the keyboard and continue using it without problems. If the keyboard behaves erratically (or not at all), replace the keyboard outright.

Disabling A Keyboard

Keyboards are an essential peripheral for all computers, except servers. In many cases, network administrators would prefer to restrict direct access to the server, and prevent potential tampering. Traditional PCs did not allow you disable the keyboard, but newer systems do offer a CMOS setup entry that can enable or disable the keyboard. When the keyboard is disabled through CMOS, the PC will boot without suffering "Keyboard not found" errors. Before starting service on a server, it might be necessary to reattach and reenable the keyboard.

Keyboard Troubleshooting

Although their appearance might seem daunting at first glance, keyboard systems are not terribly difficult to troubleshoot. This ease is primarily because of the keyboard's modularity— if all else fails, it's a simple matter to replace a keyboard outright. The keyboard's great weakness, however, is its vulnerability to the elements. Spills, dust, and any other foreign matter that finds its way between the key caps can easily ruin a keyboard. The keyboard's PC board is also a likely candidate to be damaged by impacts or other physical abuse. The following procedures address many of the most troublesome keyboard problems.

Symptom 20-1. During initialization, an error message indicates that no keyboard is connected. Check your keyboard cable and see that it is inserted properly and completely into the PC connector. Remember that you will have to reboot your system to clear this error message. Try another compatible keyboard. If a new keyboard assembly works properly, there is probably a wiring fault in the original keyboard. Given the very low price of new keyboards, it is usually most economical to simply replace a defective keyboard. If you're working on a file or network server, see that the CMOS setup has enabled the keyboard.

If a known-good keyboard fails to function, try the original keyboard on a known-good PC to verify that the keyboard itself is indeed operational. If so, your trouble now lies in the

PC. Check the wiring between the PC keyboard connector and the motherboard. Check the connector pins to be sure that none of them have been bent or pushed in (resulting in a bad connection).

You might also want to check the soldering connections where the keyboard connector attaches to the motherboard. Repeated removals and insertions of the keyboard might have fatigued the solder joints. Reheat any defective solder joints. If the keyboard connector is intact, it is likely that the keyboard controller IC (KBC) has failed. Try booting the PC with a POST board installed (as covered in Chapter 15). A KBC failure will usually be indicated by the system stopping on the appropriate POST code. You can attempt to replace the KBC or replace the motherboard outright. If a POST board indicates a fault other than a KBC (such as the programmable interrupt controller, which manages the KBC's interrupt), you can attempt to replace that component, or simply exchange the motherboard anyway.

Symptom 20-2. During initialization, an error message indicates that the keyboard lock is on. In many cases, the detection of a locked keyboard will halt system initialization. Be sure that the keyboard lock switch is set completely to the "unlocked" position. If the switch is unlocked, but the system detects it as locked. The switch might be defective. Turn off and unplug the system, then use a multimeter to measure continuity across the lock switch (you might need to disconnect the lock switch cable from the motherboard. In one position, the switch should measure as an open circuit. In the opposing position, the switch should measure as a short circuit. If this is not the case, the lock switch is probably bad and should be replaced. If the switch measures properly, there is probably a logic fault on the motherboard (perhaps the keyboard controller). Your best course is to try another motherboard.

Symptom 20-3. The keyboard is completely dead—no keys appear to function at all other computer operations are normal. In this symptom, it is assumed that your computer initializes and boots to its DOS prompt or other operating system as expected, but the keyboard does not respond when touched. Keyboard-status LEDs might not be working properly. Your first step in such a situation is to try a known-good keyboard in the system. Notice that you should reboot the system when a keyboard is replaced.

If a known-good keyboard works, the fault is probably on the keyboard-interface IC. You can attempt to replace this IC if you wish, but it is often most economical to simply replace the keyboard outright.

If another keyboard fails to correct the problem, use a multimeter and check the +5-V supply at the keyboard connector (refer to Fig. 20-5). If the +5-V signal is missing, the female connector might be broken. Check the connector's soldering junctions on the motherboard. Reheat any connectors that appear fatigued or intermittent. Many motherboards also use a "pico-fuse" to protect the +5-V supply feeding the keyboard connector.

If your +5 V is lost, locate and check the keyboard-connector fuse. If problems continue, replace the motherboard.

Symptom 20-4. The keyboard is acting erratically One or more keys appear to work intermittently, or it is inoperative. The computer operates normally and most keys work just fine, but one or more keys do not respond when pressed. Extra force or repeated strike might be needed to operate the key. This type of problem can usually range from a minor nuisance to a major headache. Chances are that your key contacts are dirty. Sooner or later, dust and debris works into all key switches. Electrical contacts eventually become coated and fail to make contact reliably. This symptom is typical of older keyboards, or keyboards that have been in service for prolonged periods of time. In many cases, you need only vacuum the keyboard and clean the suspect contacts with a good-quality electronic contact cleaner.

Begin by disconnecting the keyboard. Use a static-safe, fine-tipped vacuum to remove any accumulations of dust or debris that might have accumulated on the keyboard PC board. You might wish to vacuum your keyboard regularly as preventive maintenance.

Once the keyboard is clean, gently remove the plastic key cap from the offending key(s). The use of a keycap-removal tool is highly recommended, but you might also use a modified set of blunt-ended tweezers with their flat ends (just the tips) bent inward. Grasp the key cap and pull up evenly. You can expect the cap to slide off with little resistance. Do not rip the key cap off—you stand a good chance of marring the cap and causing permanent key switch damage.

Use a can of good-quality electronics-grade contact cleaner and spray a little bit of cleaner into the switch assembly. When spraying, attach the long, narrow tube to the spray nozzle—this directs cleaner into the switch. Work the switch in and out to distribute the cleaner. Repeat this maintenance once or twice to clean the switch thoroughly. Allow residual cleaner to dry thoroughly before re-testing the keyboard. Never use harsh cleaners or solvents. Industrial-strength chemicals can easily ruin plastic components and housings.

Reapply power and retest the system. If the suspect key(s) respond normally again, install the removed key caps and return the system to service. As a preventive measure, you might wish to go through the process of cleaning every key.

Membrane keys must be cleaned somewhat differently from mechanical keys. It is necessary for you to remove the rubber or plastic boot to clean the PC board contacts. Depending on the design of your particular membrane switch, this might not be an easy task. If you are

Week11

This Week Learning Outcome

To Understand:

➤ Mouse Failure – Symptoms and Troubleshooting

Introduction

As software packages evolved beyond simple menus and began to make use of the powerful graphics systems coming into popular use during the mid-1980s (i.e., EGA and VGA graphics), ever-larger amounts of information were presented in the display. Simple, multi-layered text menus were aggressively replaced with striking graphic user interfaces (GUIs). System options and selections were soon represented with symbols (graphic “buttons” or “icons”), instead of plain text. Using a keyboard to maneuver through such visual software soon became a cumbersome (if not impossible) chore.

Peripherals designers responded to this situation by developing a family of *pointing devices*. Pointing devices use a combination of hardware and software to produce and control a graphical screen *cursor*. A software device driver generates the cursor and reports its position. As the pointing device is moved around, hardware signals from the pointing device are interpreted by the device driver, which moves the cursor in a similar manner. By positioning the cursor over a graphic symbol and activating one, two, or three of the buttons on the pointing device, it is now possible to select (i.e., “click” or “doubleclick”) and manipulate (i.e., “drag”) options in the application program instead of using a keyboard.

Three factors are needed to make pointing devices work: the physical signal-generating hardware itself, a software driver (the “device driver”), and the application program must be written to make use of the device driver. If any of these three items are missing, the pointing device will not work. This chapter looks at the technology, maintenance, and troubleshooting of two popular pointing devices: the mouse and the trackball.

The Mouse

Although the development of computer pointing devices has been ongoing since the early 1970s, the first commercial pointing devices for IBM-compatible systems were widely introduced in the early 1980s. The device was small enough to be held under your palm, and your fingertips rested on its button(s). A small, thin cord connected the device to its host computer. The device’s small size, long tail-like cord, and quick scurrying movements immediately earned it the label of *mouse*. Every mouse needs at least one button. By pressing the button, you indicate that a selection is being made at the current cursor location. Many mouse-compatible software packages only use a single mouse button even to this day. A two-button mouse is more popular (reflecting the endurance of the mouse design) because a second button can add more flexibility to the mouse. For example, one

button can work to “select” an item; the second button can be used to “deselect” that item again or to activate other menus and options.

A few mouse designs use three buttons, but the third button is rarely supported by application programs, aside from CAD or high-end art applications.

Mouse Gestures

The first mouse “gesture” is called *clicking*, which is little more than a single momentary press of the left mouse button (on a two-button mouse). Clicking is the primary means of making a selection in the particular application program. The second common gesture is *doubleclicking*, which is simply two single clicks in immediate succession. A doubleclick also represents selection, but its exact use depends upon the application program. The third type of mouse gesture is the *drag*, where a graphical item can literally be moved around the display. Dragging is almost always accomplished by pressing the left mouse button over the desired item, then (without releasing the button) moving the item to its new location. When the item moved to its new position, releasing the left mouse button will “drop” the item in that location.

It is interesting that pen gestures are interpreted by the computer’s operating system, but mouse movements and button conditions are handled by the actual application program (such as a word processor or game). Thus, the same mouse gestures can be made to represent different actions, depending on which program is executing.

Cleaning a Pointing Device

Pointing devices are perhaps the simplest peripheral available for your computer. Although they are reasonably forgiving to wear and tear, trackballs and mice can easily be fouled by dust, debris, and foreign matter introduced from the ball. Contamination of this sort is almost never damaging, but it can cause some maddening problems when using the pointing device. A regimen of routine cleaning will help to prevent contamination problems.

You can use pre-fabricated mouse cleaning kits (Fig. 25-5) to speed the cleaning process. Turn your small-computer off before performing any cleaning procedures:

- *Remove the ball* A ball is held in place by a retaining ring. For a mouse, the retaining ring is on the bottom. For a trackball, the ring is in the top. Rotate the ring and remove it gently—the ball will fall out. Place the retaining ring in a safe place.
- *Clean the ball* Wash the ball in warm, soapy water, then dry it thoroughly with a clean, lint-free towel. Place the ball in a safe place.
- *Blow out the dust* Use a can of photography-grade compressed air to blow out any dust or debris that has accumulated inside the pointing device. You might want to do this in an open or outdoor area.
- *Clean the rollers* Notice that the mouse has three rollers: an X roller, a Y roller, and a small pressure roller that keeps the ball pressed against the X and Y rollers. Use a

- cotton swab dipped in isopropyl alcohol to clean off any layers of gunk that might have accumulated on the rollers.
- *Reassemble and test* Allow everything to dry completely, then replace the ball and retaining ring. Then test the pointing device to be sure that it is performing as expected.

Troubleshooting a Pointing Device

The weakest link in a pointing system is the peripheral pointing device itself. Few peripheral devices are subjected to the wear and general abuse seen by trackballs or mice. They are dropped, yanked, and moved constantly from place to place. Damage to the device's PC board, cabling, and connector is extremely common because of abuse. Accumulations of dust and debris can easily work into the housing and create havoc with the rubber ball, tracks, and rollers. Hardware conflicts and driver-configuration issues can also result in limitless problems. This part of the chapter guides you through some simple troubleshooting techniques for your trackball and mouse.

Mouse/Trackball Interfaces

From time to time, you might need to check the physical interface on a mouse or trackball. At its core, the mouse uses a simple serial device—that is, it can pass serial data back and forth with the host computer using communication protocols managed by the mouse driver. Three types of mouse interfaces are common in the field: serial mice, bus mice, and PS/2 mice. This part of the chapter highlights the pinouts for each interface type.

Serial mice A “serial” mouse connects to an existing RS232 serial port at the PC (usually COM1 or COM2) using a standard DB-9F (9-pin female) or DB-25F (25-pin female) connector. Table 25-1 lists the pinout for a Logitech Type M, V, or W serial mouse connector.

Bus mice In many circumstances, it is not possible to use a serial mouse on an open COM port, and the PC is not fitted with a PS/2 port. In this case, it might be necessary to use a “bus mouse,” which basically involves using a stand-alone mouse-controller board (a bus mouse controller) and a mouse fitted with a bus mouse connector—usually a male sub-miniature “D”-type connector or a miniature male DIN (circular) connector. Be careful not to mistake the 9-pin DIN connector of a bus mouse for the 6-pin circular connector of a PS/2 mouse.

Symptoms

Symptom 25-1. The mouse cursor appears, but it only moves erratically as the ball moves (if at all) This symptom might occur in either the horizontal or vertical axis. This symptom suggests that an intermittent condition is occurring somewhere in the pointing device. You should not have to disassemble your computer during this procedure. Start your investigation by powering down the computer. Check the device's cable connector at the computer. Be sure that the connector is tight and inserted properly. If you are in the habit of continually plugging and unplugging the mouse/trackball, excessive wear can develop in the connector pins over time. If the connector does not seem to fit tightly in the computer, try a new pointing device.

More likely, the device's rollers are not turning, or are turning only intermittently. In most cases, roller stall is caused by a dirty or damaged ball, or an accumulation of dirt blocking one or both sensors. Clean the ball and blow out any dust or debris that might have settled into the mouse/trackball housing. Refer to the preceding section on cleaning and attempt to clean the device thoroughly. Never use harsh solvents or chemicals to clean the housings or ball.

If you have the mouse connected to a standard serial communication port (a COM port), you should check that no other devices are using the same interrupt (IRQ). For example, COM1 and COM3 use the same IRQ, while COM2 and COM4 share another IRQ. If you have a mouse on COM1 and a modem on COM3, there will almost invariably be a hardware conflict. If possible, switch the mouse (or conflicting device) to another port and try the system again.

844 Mice And Trackballs

FIGURE 25-7 Configuring MouseKeys operation.

If no hardware conflict occurs, and cleaning does not correct an intermittent condition, remove the device's upper housing to expose the PC board, and use your multimeter to check continuity across each wire in the connecting cable. Because you probably will not know which connector pins correspond to which wires at the sensor PC board, place one meter probe on a device's wire and "ring-out" each connector pin until you find continuity. Make a wiring chart as you go. Each time you find a wire path, wiggle the cable to stimulate any possible intermittent wiring. Repair any intermittent wiring, if possible. If you cannot find continuity or repair faulty wiring, simply replace the pointing device.

Symptom 25-2. One or both buttons function erratically (if at all) Buttons are prone to problems from dust accumulation and general contact corrosion. Your first step should be power down your computer and disconnect the pointing device. Remove the ball and upper housing to expose the PC board and switches. Spray a small amount of electronics- grade contact cleaner into each switch, then work each switch to circulate the cleaner.

If cleaning does not improve intermittent switch contacts, you might wish to check continuity across the connecting cable. With the ball and housing cover removed, use your multimeter to check continuity across each wire in the connecting cable. Because you probably do not know which connector pins correspond to which wires at the device, place one meter lead on a device wire and "ring-out" each connector pin until you find continuity.

Once you find continuity, wiggle the cable to stimulate any possible intermittent wiring. Repair any intermittent wiring if you can, or simply replace the pointing device.

Symptom 25-3. The screen cursor appears on the display, but it does not move If the cursor appears, the device driver has loaded correctly and the application program is communicating with the driver. Your first step should be to suspect the serial connection. If there is no serial connection, however, no pulses will modify the cursor's position. If you

find a bad connection, power down your computer before reattaching the device's serial connector, then restore power and allow the system to reinitialize.

If the device is attached correctly to its proper serial port, the problem probably exists in the pointing device's wiring. Remove the ball and upper housing to expose the PC board, then use your multimeter to check continuity across each wire in the connecting cable. Because you probably do not know which connector pins correspond to which wires in the device, place one meter lead on a device wire and "ring-out" each connector pin until you find continuity.

Once you find continuity, wiggle the cable to stimulate any possible intermittent wiring. Repair any intermittent or open wiring if you can, or simply replace the pointing device.

Symptom 25-4. The mouse/trackball device driver fails to load The device driver is a short program that allows an application program to access information from a pointing device. Most computer users prefer to load their device drivers during system initialization by invoking the drivers in the CONFIG.SYS or AUTOEXEC.BAT files. Most drivers are written to check for the presence of their respective device first—if the expected device does not respond, the driver will not be loaded into memory. Other drivers load blindly, regardless of whether the expected device is present or not.

If the device driver fails to load during initialization, your pointing device might not have been detected. Power down your computer and check the connection of your pointing device. Ensure the device is securely plugged into the proper serial port (or other

Troubleshooting A Pointing Device 845

Mouse port). If the device is missing or incorrectly inserted, install or re-secure the pointing device and allow the system to re-initialize. If you see a "File not found" error message displayed at the point your device driver was supposed to load, the driver might have been accidentally erased, might be corrupted, or might be located in a sub-directory where the CONFIG.SYS or AUTOEXEC.BAT files are not looking. Try re-installing a valid copy of your mouse device driver and ensure that the driver is located where your calling batch file can access it. Reboot your system.

Most well-designed application programs check for the presence of a pointing device through the device driver during initial program execution. If the application program aborts or fails to execute because of a "No mouse found" or "No mouse driver" error, return to the preceding paragraphs and recheck the device and driver installation.

Symptom 25-5. You see a "General protection fault" after installing a new mouse and driver under Windows First, this is probably not a hardware fault (although it would be helpful to check any mouse driver command line switches in CONFIG.SYS or AUTOEXEC.BAT). It is more likely that the new mouse driver is conflicting with one or more applications. Try several different applications—most will probably work just fine. Check with the mouse manufacturer to see if there are any other reported problems, and find if any patches are planned. If you have an older version of the mouse driver available,

try replacing that one. An older driver might not work as well as a newer one, but it might not suffer from this kind of compatibility problem. If no patches or older drivers are available, you might be forced to change the mouse and mouse driver to something completely different to eliminate the problem.

Symptom 25-6. You see an error: “This pointer device requires a newer version” In virtually all cases, you have the wrong driver installed on the system for your driver. Check the driver and be sure that the driver you are using is appropriate for the particular mouse. For example, a Logitech or Genius mouse selected in Windows setup can cause this kind of problem if you have a Microsoft mouse on the system. Change the mouse type under Windows. Under Windows 95, you’ll need to remove the old mouse reference from the *Device manager*, then use the *Add new hardware* wizard to install the new mouse manually.

Symptom 25-7. You see an error: “Mouse port disabled or mouse not present” This is almost always a connection or setup problem. Check the signal connector first. Be sure the mouse cable is not cut or damaged anywhere, and see that it is attached securely to the serial or PS/2 port. Many newer system BIOS versions now provide an option in the CMOS setup for a mouse port. Check the CMOS setup and see that any entries for your mouse are enabled properly.

Symptom 25-8. The mouse works for a few minutes, then stops When the computer is rebooted, the mouse starts working again. This problem often plagues cutprice mice, and is almost always caused by buildups of static in the mouse. The static charges are interfering with the mouse circuitry, causing the mouse to stop responding (though charges are not enough to actually damage the mouse). There are generally three ways to resolve the problem: (1) spray the surrounding carpet and upholstery with a very dilute fabric softener to dissipate static buildup, (2) hire an electrician to ensure that the

846 Mice And Trackballs

Computer and house wiring are grounded properly, or (3) replace the mouse with a more static-resistant model.

Symptom 25-9. You attempt a doubleclick but get quadrupleclick, or you attempt a singleclick and get a doubleclick This is a phenomenon called “button bounce,” and is the result of a hardware defect (broken or poorly buffered mouse buttons).

You might be able to clean the mouse buttons by spraying in some good-quality electronic-grade contact cleaner. Otherwise, you’ll need to replace the mouse outright.

Symptom 25-10. A single mouse click works, but doubleclick doesn’t When this problem occurs, it is almost always because the “doubleclick speed” is set too high in the Windows 95 mouse control panel. Try setting it lower. Click *Start*, select *Settings*, then open the *Control panel*. Doubleclick the *Mouse* icon and adjust the *Doubleclick speed* slider under the *Buttons* tab.

Symptom 25-11. A PS/2 mouse is not detected by a notebook PC under Windows 95 There is a known problem with PS/2 mouse detection on a Toshiba portable computer under Windows 95. You can usually correct the problem by taking the following steps:

1. Shut down the computer entirely and physically disconnect the PS/2 mouse from the PS/2 port.
2. Restart the PC to the DOS mode and create backup copies of your CONFIG.SYS and AUTOEXEC.BAT files.
3. Restart Windows 95 (reboot the PC, if necessary).
4. Click *Start*, select *Settings*, open the *Control panel*, and doubleclick on the *System* icon.
5. Select the *Device manager* tab and doubleclick the *Mouse* entry.
6. Select the mouse entry that is not being detected (i.e., “Toshiba AccuPoint”), and click *Remove*.
7. Select and remove any other mouse entries.
8. Shut down the computer and reconnect the mouse, then turn the PC back on.
9. When the system reboots, it should detect the mouse and attempt to reinstall the appropriate drivers. If this doesn’t fix the problem, a hardware issue could exist. Try a different PS/2 mouse (preferably from a manufacturer different than the current one). If a different make and model PS/2 mouse does not work, the PS/2 port might require service.

Symptom 25-12. Mouse pointer options are not saved This is a known problem when you use the “extra points” features in the Mouse Manager program included with the Microsoft Mouse driver. The pointer options are not saved or written to the MOUSE.INI file when you are running a virus-protection program, such as Microsoft Anti-Virus (MSAV) or Norton Anti-Virus (NAV). To correct this problem, remove the CHKLIST.MS or CHKLIST.CPS file in the directory, which contains the mouse files. To determine the location of that directory, type “set” at the MS-DOS command prompt—it will return a list of locations of various files and memory strings. Look for the MOUSE=

Troubleshooting A Pointing Device 847

Line, then go to that directory and delete the CHKLIST.MS or CHKLIST.CPS file. Reboot the system and try saving options again.

Symptom 25-13. Clicking the right mouse button doesn’t start the default context menus of Windows 95 If the Mouse Manager software you’re running is using an assignment set for the right button, this assignment will override the Windows 95 default setting of “context menus.” Open the Mouse Management software utility and change the assignment for the right button to “Unassigned.” Save your changes. The right mouse button will now access the default context menus.

Symptom 25-14. The modem won’t start after installing new mouse software For example, this is a known problem when installing Logitech’s MouseWare 6.60 (or later) under Windows 95. Sometimes the mouse drivers might detect the modem as a second mouse and try to initialize it. This can cause the modem to go into a busy state. However, you can prevent the mouse drivers from searching the serial port that the modem is using:

1. Download the current mouse driver for Windows 95.
2. Edit the Windows 95 registry by clicking on the *Start* menu and selecting *Run*.
3. Type "C:.EXE" on the *Open* line.
4. Click *OK*. The Registry Editor program will start.
5. Doubleclick on the *HKEY_LOCAL_MACHINE* folder.
6. Doubleclick on the *Software* folder.
7. Doubleclick on the manufacturer's folder (i.e., Logitech).
8. Doubleclick on the manufacturer's driver folder (i.e., MouseWare).
9. Doubleclick on the *CurrentVersion* folder.
10. Click on the *Global* folder.
11. Let's assume the mouse is on COM1 and the modem is on COM2. On the right side of the screen will be a list of value data strings. Doubleclick on the *PortSearchOrder* string. An *Edit string* dialogue box will appear. The *Value data* line will read: COM1, COM2
12. Remove the space, the comma, and "COM2," so the line reads: COM1
13. If you only plan to use one mouse on the system, change the *Maximum Devices* value data line to "1" using the same steps. This will tell the driver to stop searching for additional mice after the primary mouse has been found.
14. Click *OK*, and the values under the data value section on the right side of the screen should change. Exit the registry editor (saving is automatic). Shut down the computer and reboot from a cold start so that your changes can take effect.

If you are not using a serial mouse, remove "Serial" from the "SearchOrder" value data line so that no serial devices are searched for at all. In general, remove any reference to the port that the modem is using.

Symptom 25-15. A two-button "First Mouse" refuses to work on a Packard Bell system. The pointer doesn't move, but Windows 95 did not report any problem detecting the mouse. This is a known problem with some Packard Bell computers and the two-button "First Mouse" serial version (M/N: M34). It might be possible to work around the problem by pressing <Ctrl>+<Esc> to open the *Start* menu. Using the arrow keys, highlight *Settings*, then *Control panel*, and press the <Enter> key. Select the *Mouse* icon with the arrow keys, and press the <Enter> key. This will open the *Mouse properties* dialog box. "Tab over" to the *Quick setup* tab. Then, (using the right arrow key) open the *Devices* tab. Once on the *Devices* tab, "Tab over" to the *Add mouse* button and press the <Enter> key. The mouse-control software should now detect the two-button serial mouse, and the pointer should now move properly. Unfortunately, you'll need to perform this procedure each time you restart the system. Otherwise, you should try disabling the built-in serial port and install a different serial card.

You might also exchange the serial version for a PS/2 version, if your system has a dedicated PS/2 style mouse port (be sure to uninstall the mouse software if you plan to exchange the mouse). Go to the Windows 95 *Control panel* and launch the *Add/remove programs* icon. Select the mouse product (i.e., "Logitech MouseWare") and click on the *Add/remove* button. When the message "Uninstall Completed" appears, reboot the system.

Symptom 25-16. A Logitech three-button mouse refuses to work on a Packard Bell computer. You install a Logitech three-button mouse on a Packard Bell computer, and when you open the *Enhanced mouse control center* on the *Devices* tab, it states: "Pointing device on unknown port." It also shows only a two-button mouse. In virtually all cases, you'll need to tweak the Registry:

1. Click on the *Start* menu and select *Run*.
2. Type "C:.\EXE" on the *Open* line.
3. Click *OK*. The *Registry editor* program will start.
4. Open the *Hkey_Local_Machinennnn*> folder (where <nnnn> is an incremental fourdigit number starting at 0000).
5. Click on each folder under the *Mouse* folder and delete them until no 000X folders remain.
6. Exit the Registry (saving is automatic) and reboot the system from a cold start.
7. Open the *Enhanced mouse control center* to verify the correct detection of the pointing device.

Symptom 25-17. The mouse pointer moves only vertically. The mouse is connected to a PS/2 port under Windows 95. If the mouse works along one axis but not the other, it's usually because of a hardware problem—either the mouse needs to be cleaned or repaired. However, in some cases a software-configuration problem can occur when the mouse driver (i.e., Mouse Power v9.5) is installed on a system with Plug-and-Play BIOS running Windows 95, and the mouse is connected to the PS/2-style mouse port. As soon as you touch the mouse, the pointer darts over the right edge of the screen, and then will move only up and down.

1. To regain control over your computer, reboot in *Safe* mode.
2. Click *Start*, then *Run*, then type "REGEDIT" and press <Enter>.
3. Open the *HKEY_LOCAL_MACHINE* folder and see if "BIOS" is listed under Enum. If it is, then you know the software configuration is causing the problem.
4. Open *HKEY_LOCAL_MACHINE\PNP0F13*, and look for a key (usually "05" or "07") under "*PNP0F13." Click on this key to highlight it. The key under "*PNP0F13" should now be highlighted, and the corresponding values should be displayed on the right side of the window. Notice that "string values" have an "ab" icon next to them and "binary values" have a "011" icon next to them.
5. Compare your values to those shown. Edit your entries until all your values shown on the screen match these values:
6. Open *HKEY_LOCAL_MACHINE*. There should be multiple keys under *Mouse* (such as "0000" and "0001"). All but one are to be deleted. Carefully determine which one pertains to your current mouse (by looking at the values associated with each key), and delete all keys under *Mouse*, except the related one.
7. Be sure that the one remaining key under *Mouse* is labelled "0000" (rename it, if necessary).
8. Click on the *X* box in the far upper-right corner of the Registry editor to close it.
9. Reboot the computer from a cold start. The computer should reboot in normal mode, and the problem with the mouse and keyboard should be gone.

Week12

This Week Learning Outcome To Understand:

➤ Display System Failure

Display System failure– Symptoms and Troubleshooting

Introduction

From their humble beginnings as basic monochrome text displays, the *monitor* (Fig. 27-1) has grown to provide real-time photo-realistic images of unprecedented quality and color.

Monitors have allowed real-time video playback, stunning graphics, and information filled illustrations to replace the generic “command line” user interface of just a few years ago. In effect, monitors have become our “virtual window” into the modern computer.

With many millions of computers now in service, the economical maintenance and repair of computer monitors represents a serious challenge to technicians and hobbyists alike. Fortunately, the basic principles and operations of a computer monitor have changed very little since the days of “terminal displays.” This chapter explains the basic concepts behind today’s computer monitors, and provides a cross-section of troubleshooting procedures.

Pixels And Resolution

The picture element (or pixel) is the very smallest point that can be controlled on a CRT. For monochrome displays, a pixel can simply be turned on or off. For a color display, a pixel could assume any of a number of different colors. Pixels are combined in the form of an array (rows and columns). The size of the pixel array defines the display’s resolution. Thus, resolution is the total number of pixels in width by the total number of pixels in height. For example, a typical EGA resolution is 640 pixels wide by 350 pixels high (a total of 224,000 pixels), and a typical VGA resolution is 640 pixels wide by 480 pixels high (a

total of 307,200 pixels). Typical Super VGA (SVGA) resolution is 800 pixels wide by 600 pixels high. Resolution is important for computer monitors because higher resolutions allow finer image detail.

Troubleshooting a CRT

In spite of its age, the *Cathode-Ray Tube (CRT)* continues to play an important role in modern computer monitors. There are some very important reasons for this longevity.

First, the CRT is relatively inexpensive to make, and it requires only simple circuitry. Second, the CRT is extremely reliable. Typical working lives can extend to 10 years or longer. This combination of low-cost, ease of operation, and long-term reliability has allowed the CRT to keep pace with today's personal computers. However, CRTs are certainly not perfect devices—the delicate assemblies within the CRT used to generate and direct electron beams can eventually open, short-circuit, or wear out. Like most classic vacuum tubes, CRT failures often occur slowly over a period of weeks or months. This part of the chapter shows you the assemblies in a typical color CRT, explains the faults that often occur, and offer some alternatives for dealing with CRT problems.

Inside The CRT

Before reading about CRT problems, you should have an understanding of the color CRT itself. Figure 27-11 shows a cross-section of a typical color CRT. To produce an image, electron beams are generated, concentrated, and directed across a phosphor-coated face.

When electron beams (which are invisible) strike phosphor, light is liberated—this is the light you see from the CRT. The color of light is determined by the particular phosphor chemistry. Notice that there are three electron “guns” in the color CRT: a beam for red, a beam for green, and a beam for blue.

Electron beams start with a heater wire. When energized, the heater becomes extremely hot (this is the glow you see in the CRT neck). The heat from a heater warms its corresponding cathode, and a barium tip on the cathode begins “boiling off” electrons. Ordinarily, electrons would simply boil off into a big, clumsy cloud. But because electrons are negatively charged, they will be attracted to any large positive potential. A moderate positive potential (+500 V or so) on the screen grid starts accelerating the electrons down the CRT's neck, while the control grid voltage limits the electrons—effectively forcing the unruly cloud into a beam. Once electrons pass the screen grid, a high positive potential on the CRT anode (anywhere from 15 to 30 kV) rockets the electrons toward the CRT face.

The beam is still rather wide, so a focus grid applies another potential that concentrates the beam. All this is very effective at generating narrow, high-velocity electron beams. But unless you want to watch a big, bright spot in the middle of the CRT, there has to be some method of tracing the beams around the CRT face. *Beam tracing* is accomplished through the use of deflection magnets placed around the CRT neck—these magnets (actually electromagnets) are heavy coils of wire where the CRT funnel meets the neck. Four electromagnets are in this “deflection assembly”: two opposing electromagnets direct the beam in the vertical direction, and another set of opposing magnets direct the beam in the horizontal direction.

Using electrical signals from the monitor's raster circuits, an electron beam can trace across the entire CRT face. Another element of the CRT that you should understand is called the *shadow mask*. A shadow mask is basically a thin metal sheet with a series of small holes punched into it. Some CRTs use a mask of rectangular openings referred to as an *aperture grille* or *slot mask*. Both types of mask perform the same purpose—to ensure that electron beams strike only the color phosphors of the intended pixel. This is a vital element of a color monitor.

In a monochrome monitor, the CRT is coated with a single homogeneous layer of phosphor— if stray electrons strike nearby phosphor particles, a letter or line might simply appear to be a bit out of focus. For a color CRT, however, stray electrons can cause incorrect colors to appear on nearby pixels. Masks help to preserve color purity. Color purity is also aided by a *purity magnet*, which helps correct fine beam positioning. A *convergence magnet* helps ensure that all three electron beams meet (or converge) at the shadow mask.

Of course, grids, heaters, and cathodes are all located inside the glass CRT vessel. Electrical connections are made through a circular arrangement of sealed pins in the neck. Table 27-2 explains the designations for each pin. Remember that the high-voltage anode is attached directly to the CRT in the top right part of the glass funnel. Also remember that some CRT designs might use additional pins.

Identifying CRT Problems

CRTs enjoy a long, reliable working life because there are really no moving parts—merely a set of stationary metal elements. However, the arrangement of grids and cathodes are located in very close proximity to one another. Physical shocks can dislodge elements and cause sudden short circuits. Eventually, regular use will alter the physical dimensions of cathodes and grids (resulting in the development of a slower, more gradual short-circuit).

The stress of regular wear can also cause open circuits in the heater, cathode, or grid. When considering a CRT replacement, you should remember that the CRT is typically the most expensive part of the monitor. For larger monitors, the CRT becomes an even larger percentage of the monitor's overall cost. In many cases, the cost for a replacement CRT approaches the original cost of the entire monitor. As a consequence, you should carefully evaluate the economics of replacing the CRT versus buying a new monitor outright.

Symptom 27-1. Heater opens in the CRT Each time the heater runs, it expands. When the CRT turns off, the heater cools and contracts again. This regular thermal expansion and contraction might eventually fatigue the heater and cause it to open. You will see this as a complete loss of the corresponding color. Because heaters are all tied together electrically, there is no way to measure a particular heater directly, but you might see only two glowing heaters in the CRT neck, instead of three. An open heater cannot be recovered, and the only available alternative is to replace the CRT itself.

Symptom 27-2. Heater shorts to a cathode in the CRT This is not as strange as it might seem at first. To heat a cathode effectively, the heater must be extremely close to the cathode—especially to the barium element that actually liberates the electrons.

Over time, the heater might develop accumulations of corrosion, which might eventually cause the heater to contact the cathode. In theory, this should never happen because the inert low-pressure gasses inside the CRT should prevent this. But in actuality, some small amount of oxygen will still be present in the CRT, and oxidation might occur. A shorted heater will cause the electron gun to fire at full power—in effect, the electron gun will be stuck “on.” The image will appear saturated with the color of the defective electron gun.

For example, if the blue heater shorts to the cathode, the image will appear to be saturated with blue. You will also likely see visible retrace lines in the image. You can verify this problem by removing all power from the monitor, removing the video drive board from the CRT’s neck, and measuring the resistance between a heater wire and the suspect cathode. For the CRT pinout listed in Table 27-2, you could check the blue cathode by measuring resistance between the KB and H1 (or H2) pins. Ideally, an infinite resistance should be between the heaters and cathodes. If there is measurable resistance (or a direct short-circuit), you have found the problem. If the resistance measures infinity, as expected, you might have a defect on the video drive board.

Symptom 27-3. Cathode shorts to the control grid in the CRT A cathode can also short-circuit to the control grid. Often, corrosion flakes off the cathode and contacts the control grid. When this happens, the control grid loses its effectiveness, and the corresponding color will appear saturated. This symptom will appear very much like a heater short. Fortunately, you should be able to verify this problem with your meter by measuring resistance between the control grid and the suspect cathode. Ideally, an infinite resistance should be between the control grid and all cathodes. If you read a measurable resistance (or a direct short-circuit), chances are good that you’re facing a cathode-to-control grid short.

Symptom 27-4. One or more colors appear weak This is a common symptom in many older CRTs. Over time, the barium emitter in your cathodes will wear out or develop a layer of ions (referred to as *cathode poisoning*), which inhibit the release of electrons.

In either case, the afflicted cathode will lose efficiency, resulting in weakened screen colors. Typically, you might expect all three cathodes to degrade evenly over time—and they will—but by the time the problem becomes serious enough for service, you will usually notice one color weaker than the others. Try increasing the gain of the afflicted signal on the video drive board. If the cathode is indeed afflicted, increasing signal gain should not have a substantial effect on the color brightness, and you should consider replacing the CRT.

Symptom 27-5. CRT phosphors appear aged or worn *Phosphors* are specially formulated chemicals that glow in a particular color when excited by a high-energy electron beam. Typically, phosphors will last for the lifetime of the monitor, but age and normal use will eventually reduce the sensitivity of the phosphors—for old CRTs, you might see this as

dull, low-contrast colors. Perhaps a more dramatic problem occurs with “phosphor burn,” which occurs when a monitor is left on displaying the same image for a very long period of time. If you turn the monitor off, you can see the latent image burned onto the CRT as a dark shadow. In both cases, there is no way to rejuvenate phosphors, so the CRT will have to be replaced. You can advise customers to prolong the life of their CRT by keeping the brightness at a minimum and using a screen-saver utility, if an image will sit unchanging for a long time.

Symptom 27-6. The CRT suffers from bad cutoff (a.k.a. bad gamma) On a CRT, color linearity is a function of the cathode’s ability to adjust the level of electron emission—in other words, beam intensity must be linear across the entire range of the

924 Monitor Troubleshooting

Video signal (e.g., 0 to 20 V or 0 to 50 V). As cathodes age, however, they tend to become non-linear. When this happens, images tend to be too “black and white,” rather than display a smooth transition of colors. Technicians often refer to this as a “gassy” CRT, which is actually a CRT gamma problem. In addition to cathode wear, control grid failure can adversely affect beam intensity. Symptom 27-7. The control grid in the CRT is open The control grid is used to limit the beam intensity produced by a cathode by applying a potential on the grid. Occasionally, you will find that a control grid might open. In that case, there is no longer a potential available to control the beam intensity, and the beam will fire at full intensity. At first glance, you might think this is a cathode-to-control grid short or a heater-to-cathode short. But if you can’t find a short with your multimeter, the control grid is probably open, and the CRT will have to be replaced.

Symptom 27-8. The CRT screen grid is open The screen grid plays an important role in image brightness by accelerating the electron beam toward the CRT phosphors. If the screen grid opens, no potential will be available to begin accelerating the beam. This will result in a very dark image—even with the screen voltage at maximum. You might think this is a control-to-screen grid short, but if you can’t find the short with your multimeter, the screen grid is probably open, and the CRT will have to be replaced.

Symptom 27-9. The CRT focus grid is open A focus grid assembly concentrates electron beams into narrow pinpoints by the time the beam reaches the shadow mask.

Typically, a focus control is located around the flyback transformer. If the focus grid fails, the image will appear highly distorted, and the focus adjustment will have no effect. When a focus grid fails, the entire CRT will have to be replaced.

Symptom 27-10. The control grid shorts to the screen grid in the CRT The same flakes of oxidation that can short a cathode to the control grid can also short the control grid to the screen grid. The screen grid starts accelerating the electrons toward the CRT face. If the screen grid is shorted, it will reduce the energy imparted to the electrons—in effect, a shorted screen grid will significantly reduce the overall image brightness (even with the brightness at maximum). In extreme cases, the image might disappear entirely. You can

measure the screen grid voltage at G2, which typically runs from 250 to 750 V in normal operation. If the voltage is low (even with the screen grid control at maximum), power down the monitor, remove the video drive board from the monitor's neck, restart the monitor, and measure the screen voltage again. If the screen voltage returns to normal, you can be confident that the screen grid is shorted. If screen voltage remains low, you might have a fault in the screen voltage circuit. You can also verify a short between the control and screen grids by powering down the monitor and measuring resistance between the G1 and G2 pins on the CRT neck. Ideally, it should be an infinite resistance.

Troubleshooting a Color Monitor

Any chapter about monitor troubleshooting must start with a reminder of the dangers involved. Computer monitors use very high voltages for proper operation. Potentially lethal shock hazards exist within the monitor assembly—both from ordinary ac line voltage, as well as from the CRT anode voltage developed by the flyback transformer. You must use extreme caution whenever a monitor's outer housings are removed. If you are uncomfortable with the idea of working around high voltages, defer your troubleshooting to an experienced technician.

Symptom 27-35. The image appears to flip or scroll vertically. A synchronization problem is in your vertical raster circuit. Begin by checking the video cable to be sure that it is installed and connected securely. Cables that behave intermittently (or that appear frayed or nicked) should be replaced. If the cable is intact, suspect that the problem is in your vertical circuit. If a vertical-sync (or "vertical hold") adjustment is on the raster board, adjust it in small increments until the image snaps back into sync. If no such adjustment is on your particular monitor, try resoldering all of the connections in the vertical-processing circuit. If the problem persists, replace the vertical oscillator IC or replace the entire raster board.

Symptom 27-36. The image appears to shake or oscillate in size. This might occur in bursts, but it typically occurs constantly. In most cases, this is caused by a fault in the power supply—usually the 135-V (B+) output. Try measuring your power-supply outputs with an oscilloscope and see if an output is varying along with the screen-size changes. If you locate such an output, the filtering portion of that output might be malfunctioning.

Track the output back into the supply and replace any defective components. If you are unable to isolate a faulty component, replace the power supply. If the power supply is integrated onto the raster board, you might have to replace the raster board entirely.

If the outputs from your power supply appear to be stable, you should suspect that a weak capacitor is in your horizontal circuit. Try resoldering the FBT, HOT, and other horizontal circuit components to eliminate the possibility of a soldering problem. If the problem remains, you will have to systematically replace the capacitors in the horizontal circuit. If you do not have the time or inclination to replace individual components, replace the raster board outright.

Here's an unusual problem. The shaking you see might be related to a problem in the degaussing coil located around the CRT funnel. Ordinarily, the degaussing coil should unleash the most of its energy in the initial moments after monitor power is turned on. Thermistors (or posistors) in the power supply quickly diminish coil voltage—effectively cutting off the degaussing coil's operation. A fault in the degaussing-coil circuit (in the power supply) might continue to allow enough power to the coil to affect the image's stability.

Try disconnecting the degaussing coil. If the problem remains, the degaussing coil is probably operating properly. If the problem disappears, a fault is in the degaussing-coil circuit.

Symptom 27-27. The fine detail of high-resolution graphic images appears a bit fuzzy. At best, this kind of symptom might not appear noticeable without careful inspection, but it might signal a serious problem in the video amplifier circuit.

High resolutions demand high bandwidth—a video amplifier must respond quickly to the rapid variations between pixels. If a weakness in the video amplifier(s) occurs, it can limit bandwidth and degrade video performance at high resolutions. The problem will likely disappear at lower resolutions.

The particular problem with this symptom is that it is almost impossible to isolate a defective component—the video amplifier board is working. As a result, your best course of action is to first check all connectors for secure installation. Nicked or frayed video cables can also contribute to the problem. If the problem remains, replace the video amplifier board.

Symptom 27-28. The display changes color, flickers, or cuts out when the video cable is moved. Check the video cable's connection to the video adapter at the PC—a loose connection will almost certainly result in such intermittent problems. If the connection is secure, an intermittent connection is in the video cable. Before replacing the cable, check its connections within the monitor itself. If connections are intact, replace the intermittent video cable outright. Do not bother cutting or splicing the cable—any breaks in the signal shielding will cause crosstalk, which will result in color bleeding.

Symptom 27-29. The image expands in the horizontal direction when the monitor gets warm. One or more components in the horizontal retrace circuit are weak—and changing value a bit once the monitor gets warm. Turn off and unplug the monitor. You should inspect any capacitors located around the *Horizontal Output Transistor (HOT)*. The problem is that thermal problems, such as this, can be extremely difficult to isolate because you can't measure capacitor values while the monitor is running; after the monitor is turned off, the parts will cool too quickly to catch a thermal problem.

It is often most effective to simply replace several of the key capacitors around the HOT outright. If you don't want to bother with individual components, replace the raster board.

Symptom 27-30. The image shrinks in the horizontal direction when the monitor gets warm. This is another thermal-related problem that indicates either a weakness in one or more components or a mild soldering-related problem. Turn off and unplug the monitor. Start by checking for a poor solder connection—especially around the horizontal deflection yoke wiring, the *Horizontal Output Transistor (HOT)*, and the flyback transformer. If nothing appears obvious, consider resoldering all of the components in the HOT area of the raster board. If problems continue, suspect that a failure is in the HOT itself. Semiconductors rarely become marginal—they either work or they don't. Still, semiconductor junctions can become unstable when temperatures change, and result in circuit characteristic changes. You could also try replacing the HOT outright. It is also possible that one or more mid-range power-supply outputs (i.e., 12 or 20 V) are sagging when the monitor warms up. Use a voltmeter and measure the outputs from your power supply. If the 12- or 20-V outputs appear to drop a little once the monitor has been running for a bit, you should troubleshoot the power supply.

934 Monitor Troubleshooting

Symptom 27-31. High-voltage fails after the monitor is warm. A large number of possible causes are behind this problem, but no matter what permutation you find, you will likely be dealing with soldering problems or thermal-related failures. Turn off and unplug the monitor. Inspect the HOT's heatsink assembly—a bad solder connection might be on the heatsink ground. An open solder connection might be on one or more of the flyback transformer pins. If you cannot locate a faulty soldering connection, you might simply choose to re-solder all of the connections in the flyback area.

If the problem persists, suspect that either your HOT or flyback transformer is failing under load (after the monitor warms up). One possible means of isolating the problem is to measure pulses from the HOT output with your oscilloscope. If the pulses stop at the same time your high-voltage fails, you can suspect that the problem is with your HOT or other horizontal components. Try replacing the HOT. If high-voltage fails but the HOT pulses remain, your flyback transformer has likely failed. Replace the flyback transformer.

If you do not have an oscilloscope, try replacing the HOT first because that is the least-expensive part, then replace the flyback transformer, if necessary.

In the unlikely event that both a new HOT and flyback transformer do not correct the problem, carefully inspect the capacitors in the HOT circuit. One or more might be failing. Unfortunately, it is very difficult to identify a marginal capacitor (especially one that is suffering from a thermal failure). You might try replacing the major capacitors in the HOT circuit or replace the raster board entirely.

Symptom 27-32. The image blooms intermittently. The amount of high voltage driving the CRT is varying intermittently. Because high voltage is related to the HOT circuit and flyback transformer, concentrate your search in those two areas of the raster board.

Examine the soldering of your HOT and FBT connections—especially the ground connections, if you can identify them. You might try resoldering all of the connections in

those areas (remember to turn off and unplug the monitor before soldering). A ground problem might also be on the video amplifier board, which allows all three color signals to vary in amplitude. If this happens, the overall brightness of the image changes, and the image might grow or shrink a bit in response. Try resoldering connections on the video amplifier board.

If the problem remains (even after soldering), your FBT might be failing—probably because of an age-related internal short. High-end test equipment, such as Sencore's monitor test station provides the instrumentation to test a flyback transformer. If you do not have access to such dedicated test equipment, however, try replacing the FBT assembly.

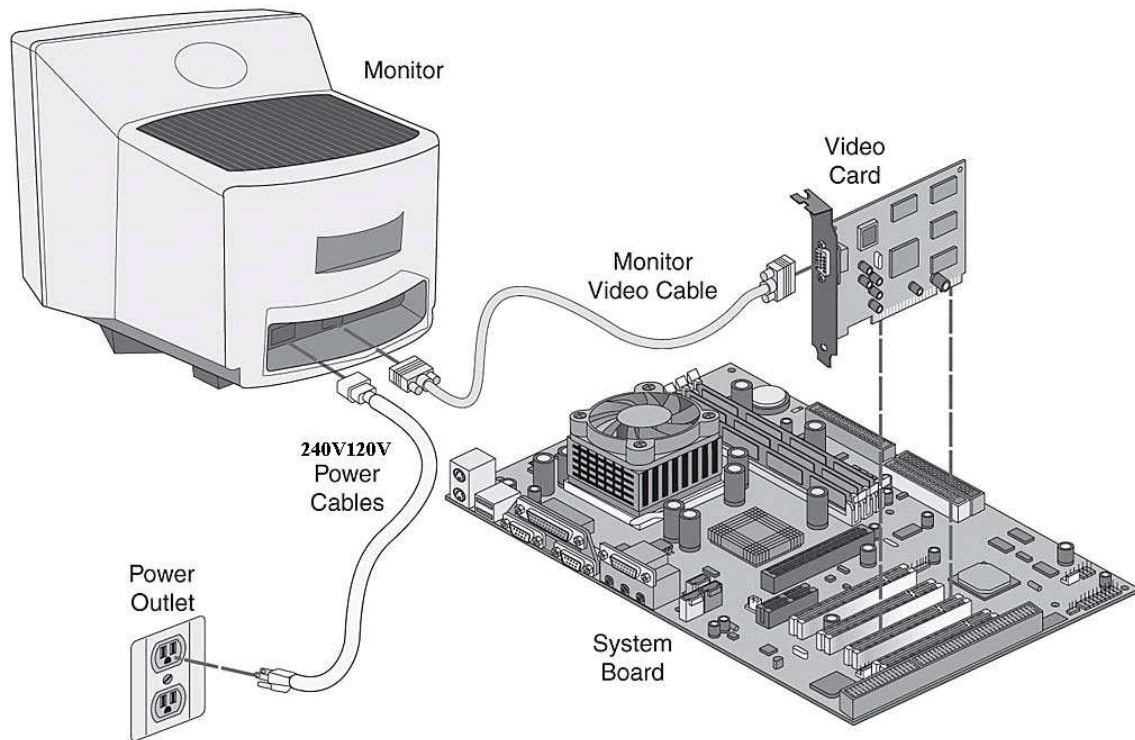
If you do not have the time or inclination to deal with component replacement, replace the raster board outright. In the unlikely event that your problem persists, suspect a fault in the CRT itself. If you have access to a CRT tester/rejuvenator, you can check the CRT's operation.

Some weaknesses in the CRT might be corrected (at least temporarily) by rejuvenation. If the fault cannot be corrected, you might have to replace the CRT.

Symptom 27-33. The image appears out of focus Before suspecting a component failure, try adjusting the focus control. In most cases, the focus control is located adjacent to the flyback transformer. Remember that the focus control should be adjusted with brightness and contrast set to optimum values—excessively bright images might lose focus naturally. If the focus control is unable to restore a proper image, check the CRT focus voltage. In Fig. 27-9, you can find the focus voltage off a flyback transformer tap. If the focus voltage is low (often combined with a dim image), you might have a failing FBT.

It is possible to test the FBT if you have the specialized test instrumentation; otherwise, you should just replace the FBT outright. If you lack the time or inclination to replace the FBT, you can simply replace the raster board.

If a new FBT does not resolve your focus problem, suspect that a fault is in the CRT—probably in the focus grid. You can use a CRT tester/rejuvenator to examine the CRT, and it might be possible to restore normal operation (at least temporarily). If you do not have such equipment, you will simply have to try a new CRT. Symptom 27-34. The image appears to flip or scroll horizontally A synchronization problem is in your horizontal raster circuit. Begin by checking the video cable to be sure that it is installed and connected securely. Cables that behave intermittently (or that appear frayed or nicked) should be replaced. If the cable is intact, suspect a problem in your horizontal circuit. If a horizontal-sync (or “horizontal hold”) adjustment is on the raster board, adjust it in small increments until the image snaps back into sync. If no such adjustment is on your particular monitor, try resoldering all of the connections in the horizontal-processing circuit. If the problem persists, replace the horizontal oscillator IC or replace the entire raster board.



If the monitor appears to be totally dead, then make sure that the monitor is plugged in and turned on, and see if it has power.

Check for a power-on indicator on the front of the monitor, and check to see if the monitor warms up.

Select the appropriate general failure troubleshooting procedure outlined below, based on whether or not the monitor appears to have power.

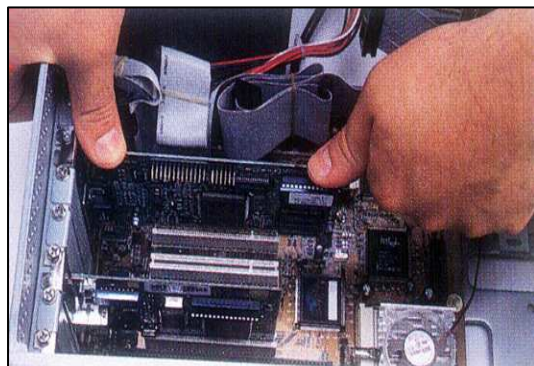
Symptom	Remedy
<p>The monitor appears not to be working at all. There are no indications that the monitor has any power</p>	<ul style="list-style-type: none"> • Make sure that the electrical outlet is working, by trying another appliance in the socket and seeing if it works. If the socket does not work, you will need to consult an electrician to have it fixed. • Check any power protection devices that the monitor might be plugged into, to ensure that they are working. Troubleshoot any problems here. • Make sure the power cable is connected securely and is undamaged. Try replacing the cable with another one. • If the monitor has a switch to select between 110 volt and 220 volt operation, make sure it is set to the correct value. This switch will normally be on the outside of the monitor at the back, near where the power cord connects.
<p>The display makes a squealing or other loud noise</p>	<ul style="list-style-type: none"> • The fan on the graphics card may need to be cleaned or it may be failing. The fan on most cards is not replaceable.
<p>The screen is black and completely blank</p>	<ul style="list-style-type: none"> • Check that the monitor is turned on. Most have a light to indicate power and another to indicate that it is receiving a signal from the PC. • Check that the video cable's connectors are securely and properly fastened to the graphics card and on some models to the monitor. • Check that no pins are bent or missing from the connector. • Unplug the PC and make sure the graphics card is securely and properly installed into its slot.
<p>The display doesn't fit properly on my monitor</p> <p>OR</p> <p>The text or resolution is the wrong size</p>	<ul style="list-style-type: none"> • The resolution is not set correctly in Windows. Go into the display settings in the Control Panel, and change the resolution settings. • The monitor may have controls that allow you to adjust the size and position of the display. Use the monitor's controls to move or resize the display. • You may need to install a different or updated driver for your graphics card and/or monitor.

Symptom	Remedy
The display seems to flicker	<ul style="list-style-type: none"> Reset the display's refresh rate in the Windows Control Panel. Do not use a refresh rate that is not supported by your monitor or damage may result.
The colors don't look right	<ul style="list-style-type: none"> The color depth is not set correctly in Windows. Go into the display settings in the Control Panel, and change the resolution settings. You may need to install a different or updated driver for your graphics card and/or monitor.
The display is completely unreadable	<ul style="list-style-type: none"> The color depth and/or resolution is not set correctly in Windows. Go into the display settings in the Control Panel, and change the resolution settings. You may need to install a different or updated driver for your graphics card and/or monitor

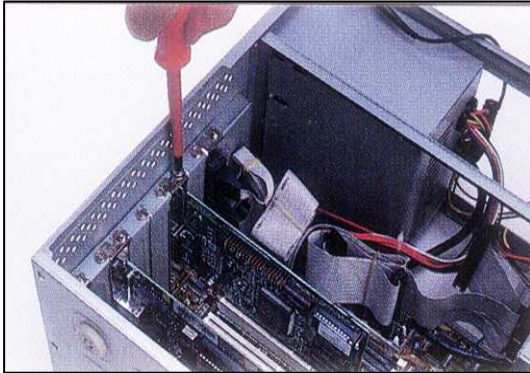
Replacing a Graphics card

Once the graphics card is suspected to be defective, it is always better to replace the card with an identical one. The procedure for replacing a graphics card is given below :

1. Unplug the PC
2. Remove the cover
3. Identify the slot where the graphics card is mounted. In most cases it will be the larger (AGP) slot closest to the CPU.
4. Replace the graphics card as shown in the figure. Align the card over the slot with the video connection facing toward the outside of the PC
5. Set the card into the slot and press down firmly. Make sure the mounting bracket is properly aligned with any slot that might be present. It may be necessary to gently rock the card from end to end to secure it in the slot. The gold contacts at the bottom of the card should nearly or completely disappear into the slot. The card should be level and straight.
6. Secure the graphics adapter mounting bracket to the case with a screw as shown in the figure.



7. Replace the cover
8. Connect the video connector from your monitor to the connector on the graphics card
9. Plug in the PC



Follow the manufacturer's instructions for installing the software. Windows will detect the graphics adapter and start the hardware wizard; simply follow the prompts.

After everything is working, you can go back into the Windows Control Panel and reset the resolution and refresh as recommended by the manufacturer of the monitor.

Week13

This Week Learning Outcome To Understand:

➤ Windows Display Properties

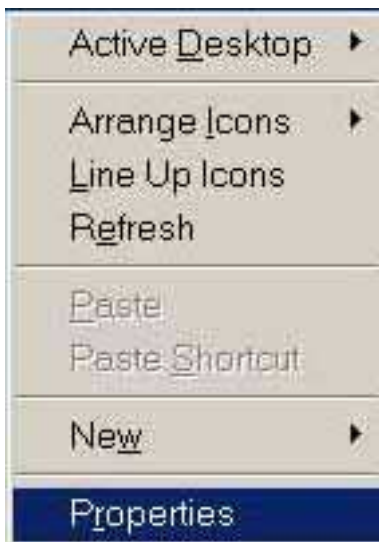
Windows Display Properties

Microsoft Windows has a built in feature allowing you a wide range of control over the visual display. This feature is called the Display Properties Panel. Once you have learned how to manage the Display Properties Panel, you will be able to shrink or enlarge text, modify system colors and fonts, or even change the resolution of the display itself. Let's start by familiarizing ourselves with the ways to actually summon up the panel.

Opening the Display Properties Panel

There are two basic ways to open the panel. The first is to click on the start button, then select Settings > Control Panel. When the control panel window opens on the screen, find and then double-click the "Display" button.

The second, faster way to open the panel is to right mouse click on any empty portion of the desktop and then select "Properties" from the drop-down menu.

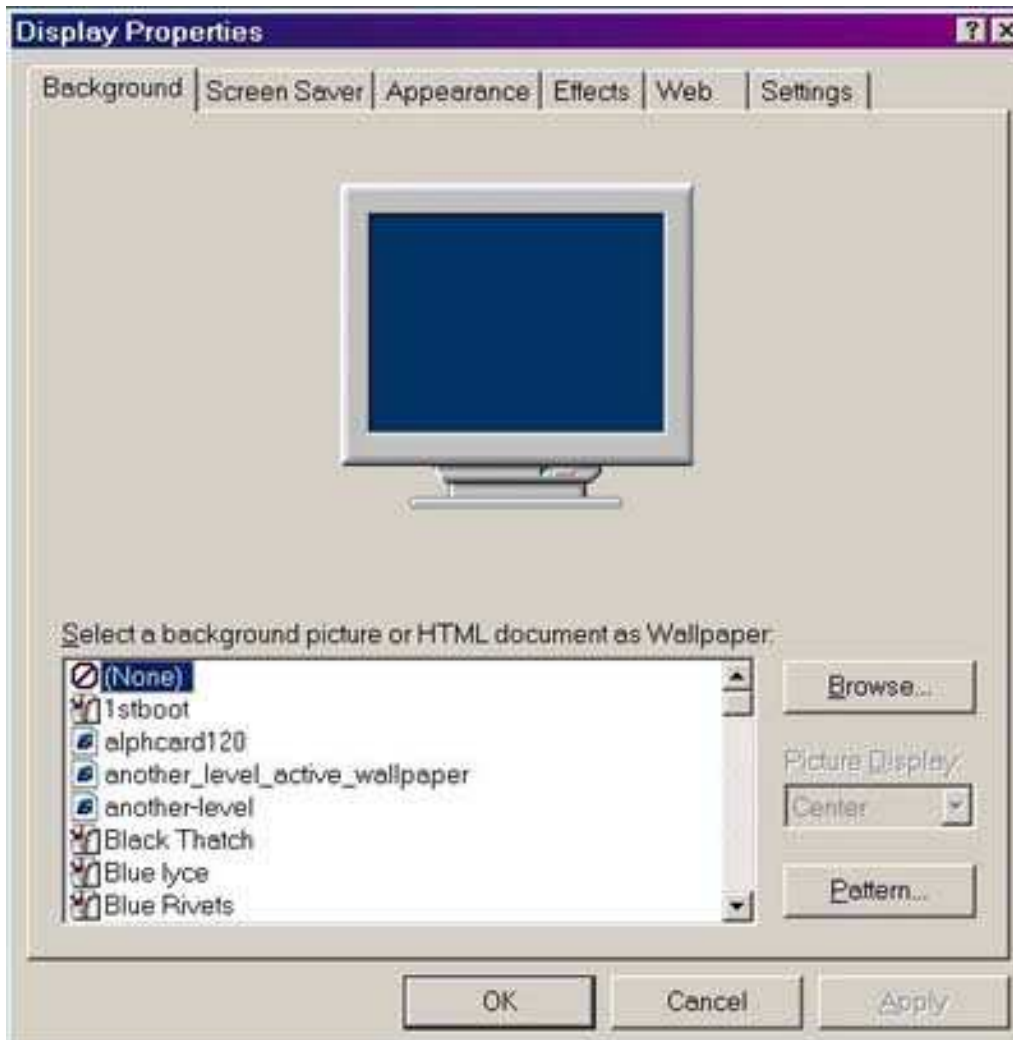


The Layout of the Panel

When you have successfully opened the display properties panel, you should see a variety of options on the panel and six "tabs" across the top: background, screen saver, appearance, effects, web & settings.(for windows ME. The number and name of the tabs may vary slightly with other versions of windows.)

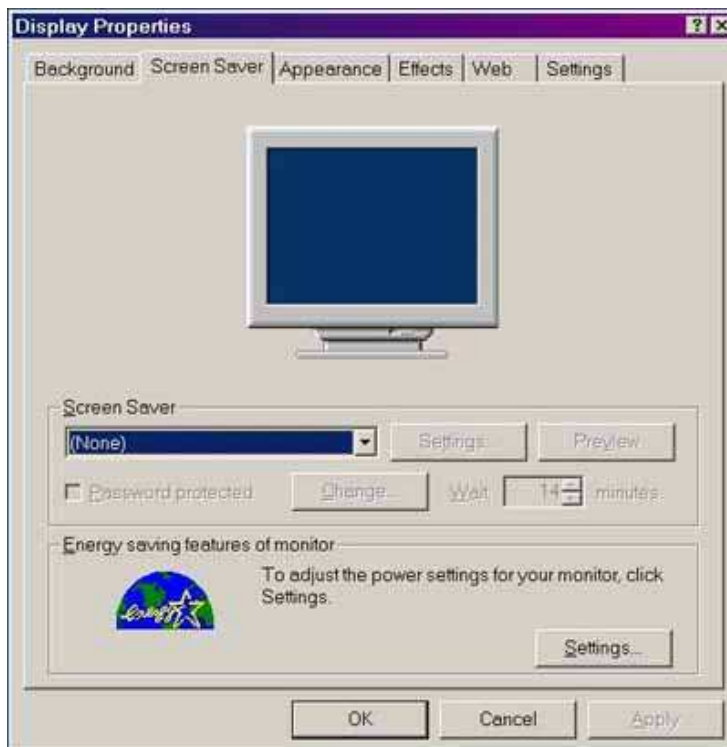
Background

In the background tab, which is the default when you first open the panel, you have the ability to set a background image or pattern for the windows desktop. You may select an image from the list on the left or, if you have a favorite image which does not appear on the list, you may select an image from anywhere else in storage by using the "browse" feature. Once you have selected an image, you can use the pull-down menu on the right to select whether you would prefer for it to float in the center of the display, be stretched so as to fill the entire display, or be tiled to cover the display area. If you would rather have your desktop background be a solid color than an image, select "none" from the list. You will soon learn how to change the color.



Screen Saver

This tab allows you to select what your computer will do when it has been idle for a certain amount of time. You can choose from the list of installed screensavers in the pull-down menu. Each screensaver has it's own settings menu which you should feel free to explore and experiment with, but generally you do not need to change the settings.



The preview button will allow you to see how your screen saver looks without waiting for it to turn on. The second line of controls for the screen saver allow you to set the wait time before the screen saver is activated and allows you to specify whether or not a password will be required to re-activate the computer from screen saver mode. Chances are the "password protected" checkbox will be empty when you open the panel, if you check it then the button labeled "Change" will no longer be grayed out and can be used to set the password. For most computers, screen saver passwords are not necessary unless security is a large concern. If you do choose to set a screen saver password, it is recommended that you choose a reasonably long wait period(15 minutes or more). If you have a monitor with energy saving features then there will be a second section of the screen saver tab with options specific to your monitor. Generally, there is no reason to change these options.

Appearance

The appearance tab provides significant control for Windows users looking for large text, high contrast or other accessibility fixes. In this tab you can choose from a large number of pre-defined schemes as well as changing the size and color of many windows features individually. The top portion of the panel consists of a mock-display (preview) showing the way in which Windows will appear if the changes are applied.

The first actual option on this tab is the pull-down menu labeled "schemes". There are many, many schemes to choose from, but let's focus on a few that are particularly useful from an accessibility perspective. First, you will notice near the top of the list several different high contrast color schemes, all available in normal, large and extra-large size. Also, if you need large font and buttons but prefer the standard Windows colors, you will find a set of schemes at the bottom of the list called Windows Standard in normal, large and extra-large. Once you have chosen a base scheme (or opted to continue using the current one), you can tweak each individual feature of the windows display using the controls below the "schemes" menu.

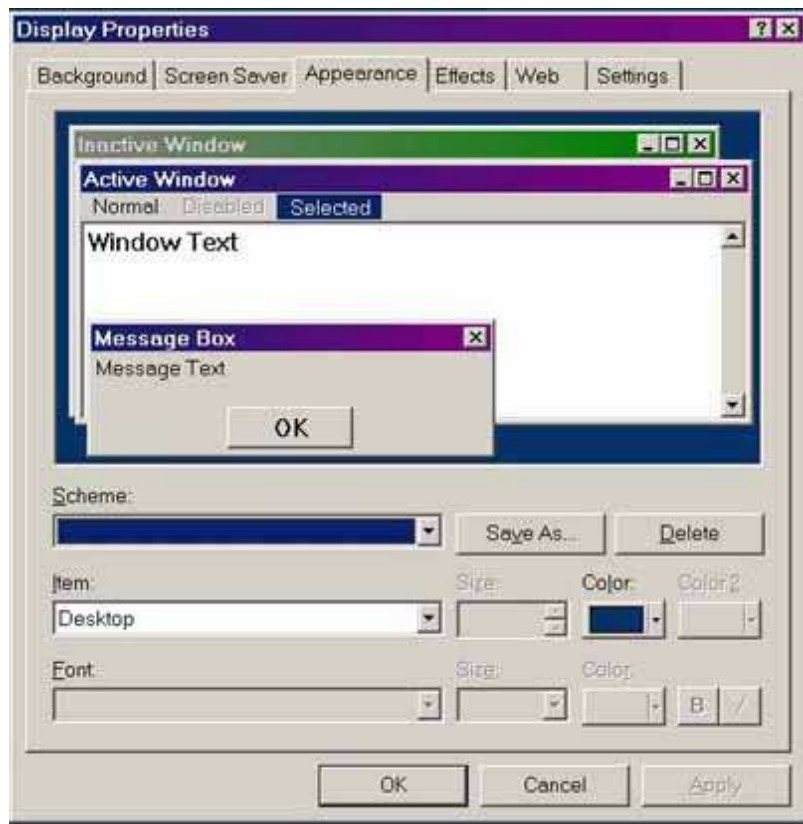
Immediately below the "schemes" drop-down menu is another menu labeled "item". In this menu you will find all of the customizable appearance features of the windows desktop.

If you select an item, you will notice that some of the other menus and options will become available. These are the individual features that can be modified for each desktop item: Size, color, color 2, font, font size, font color and bold/italic.

Each of these features can be modified through a drop-down menu, by typing in a new value, or by clicking on the color box to open the Windows color picker.

Changes will be reflected as you make them in the preview window at the top of the panel and can always be reverted to the original settings by clicking the "cancel" button. You can tweak the items as much as you want, and when you are content with them, simply click the "apply" button.

If you are particularly fond of the scheme you have created, or if you want to keep this scheme available but switch back and forth with one or more others, you can save your work by clicking the "save as" button immediately next to the "schemes" pull-down menu.



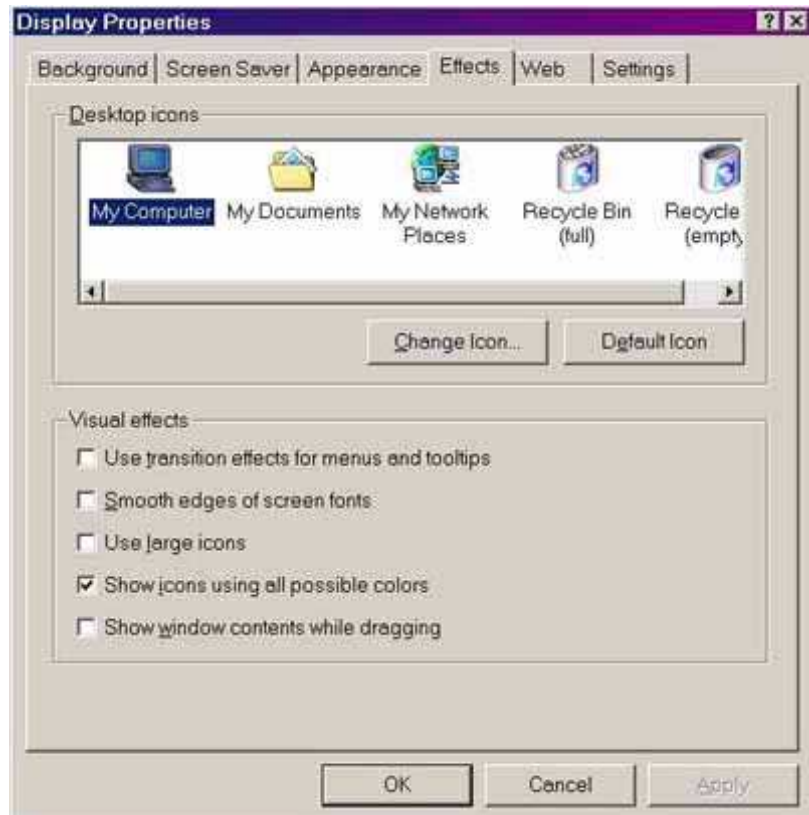
You will be prompted to give your new scheme a name and then, after you have saved it, it will appear in the "schemes" pull-down menu alongside all the pre-defined ones. If you ever feel that you've gotten in over your head in the Appearance tab, remember that you can always call up the "Windows Standard" scheme to get out of trouble.

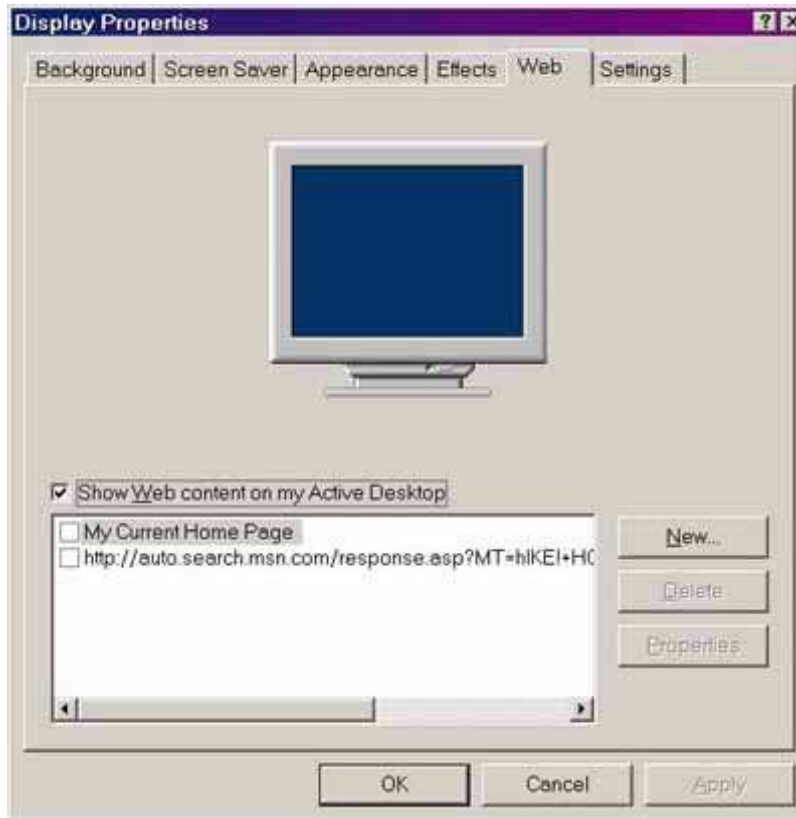
Effects

Of the options in the Effects tab, there is only one that are of particular importance. In the lower portion of the panel there will be several checkboxes. The third should say "Use large icons". Checking this box will enlarge the icons on the Windows desktop. Note that, if you feel so inclined, you can create a very similar effect by modifying the "icon" item in the Appearance tab.

Web

The Web tab contains allows you to install and manage "active desktop" items, such as animated backgrounds and real-time stock tickers. The use of these features is beyond the scope of this tutorial, but keep in mind that active desktop items are rarely accessible.

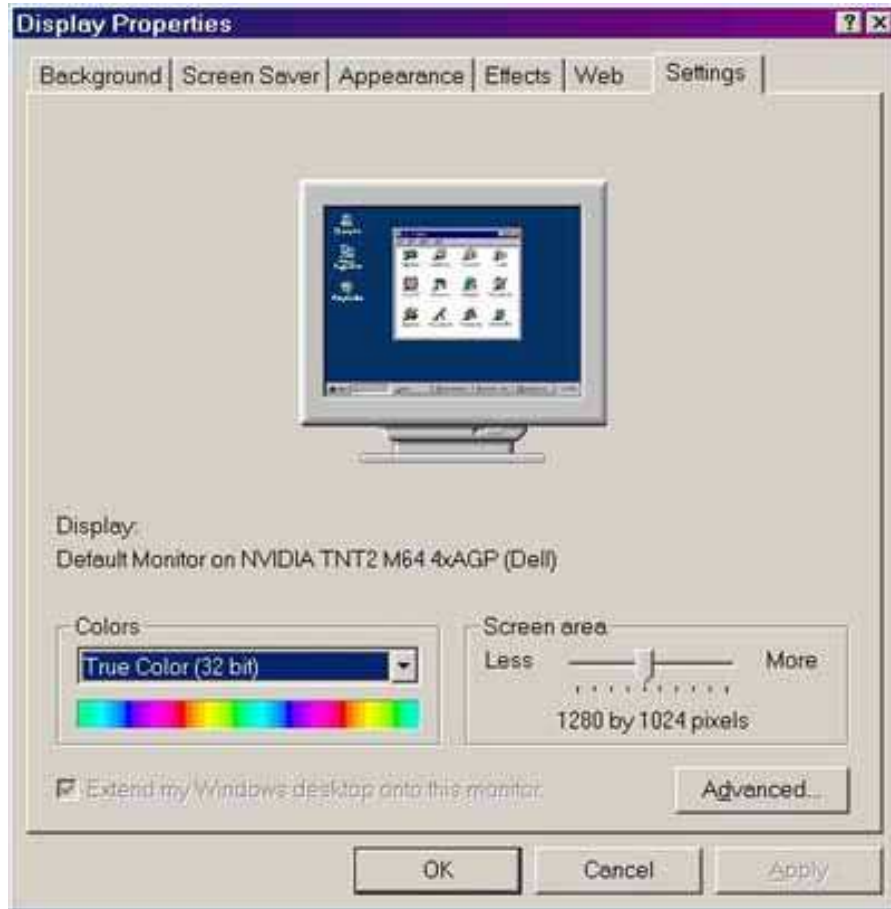




Settings

The Settings tab allows you to change features related directly to the performance of the actual monitor and video card hardware. The top portion of the panel should be a preview window. Immediately below the preview window there will be a short blurb describing what particular monitor and video card is being used. Below that, there will be a "colors" pull-down menu, a "screen area" slide bar and an "advanced" button. The only option in the settings tab of particular use from an accessibility standpoint is the "screen area" option, often referred to as the resolution. Lowering the screen area will cause the screen to be broken up into fewer individual pixels. This has the result of making every feature, from text to buttons to menus to icons, appear larger. The side effect is that to those accustomed to using a higher resolution, the display will appear blocky. Most modern computers use resolutions of 1024x768 or 1200x1024, however it is common for people with vision impairments to prefer to use a computer running at 640x480 or 800x600. In order to change the resolution, simply slide to pointer in the "screen area" option box until the desired resolution is displayed and then click the apply button to test the resolution. A dialog box will appear explaining that the screen will now go dark and attempt to resize itself. The dialog box will further explain that if the resolution change is unsuccessful then the original resolution will be restored after 15 seconds. You should press to "ok" button to dismiss the dialog box. If the resolution change is successful then you can press either "ok" to keep the new resolution or "cancel" to revert to your original resolution (note that even if the change is successful, the original resolution will return after fifteen seconds if you click neither button). If the change is unsuccessful and the display either remains dark or appears

garbled, simply sit tight and wait for fifteen seconds. As long as you do not press any buttons on the keyboard or mouse the original display settings will return.



Week14

This Week Learning Outcome

To Understand:

➤ Sound Failure Symptoms

Sound Failure Symptoms

Sound is an area of the PC that has been largely overlooked in early systems. Aside from a simple, oscillator-driven speaker, the early PCs were mute. Driven largely by the demand for better PC games, designers developed stand-alone sound boards that could read sound data recorded in separate files, then reconstruct those files into basic sound, music, and speech. Since the beginning of the decade, those early sound boards have blossomed into an array of powerful, high-fidelity sound products, capable of duplicating voice, orchestral soundtracks, and real-life sounds with uncanny realism (Fig. 41-1). Not only have sound products helped the game industry to mature, but they have been instrumental in the development of multimedia technology (the integration of sound and picture), as well as Internet Web phones and other communication tools. This chapter is intended to explain the essential ideas and operations of a contemporary sound board, and show you how to isolate a defective sound board when problems arise.

Understanding Sound Boards

Before you attempt to troubleshoot a problem with a sound board, you should have an understanding of how the board works and what it must accomplish. This type of background helps you when recommending a sound board to a customer or choosing a compatible card as a replacement. If you already have a strong background in digital sound concepts and software, feel free to skip directly to the troubleshooting portion of this chapter.

The Recording Process

All sound starts as *pressure variations* traveling through the air. Sound can come from almost anywhere—a barking dog, a laughing child, a fire engine's siren, a person speaking. You get the idea. The process of recording sound to a hard drive requires sound to be carried through several manipulations (Fig. 41-2). First, sound must be translated from pressure variations in the air to analog electrical signals. This is accomplished by a microphone. These analog signals are amplified by the sound card, then digitized (converted to a series of representative digital words each taken at a fixed time interval). The resulting stream of data is processed and organized through the use of software, which places the data (as well as any overhead or housekeeping data) into a standard file format. The file is saved to the drive of choice (typically, a hard drive).

The Playback Process

Simply speaking, the playback process is virtually the reverse of recording (Fig. 41-3). A software application opens a sound file on the hard drive, then passes the digital data back

to the sound card. Data is translated back into equivalent analog levels—ideally, the reconstructed shape of the analog signal closely mimics the original digitized signal. The analog signal is amplified, then passed to a speaker. If the sound was recorded in stereo, the data is divided into two channels that are separately converted back to analog signals, amplified, and sent to their corresponding speakers. Speakers convert the analog signal back into traveling pressure waves that you can hear.

The Concept of “Sampling”

To appreciate the intricacies of a sound card’s operation, you must understand the concept of *digitization* (otherwise known as *sampling*). In principle, sampling is a very straightforward concept; an analog signal is measured periodically, and its voltage at each point in

1194 Sound Boards

Sound

Mic Analog signal

Digital signal

Software driver

Storage device (hard drive)

Sound board hardware

FIGURE 41-2 The sound-board recording process.

Software driver

Storage device (hard drive)

Analog signal

Digital signal L

spkr. R

spkr. Sound board hardware

FIGURE 41-3 The sound-board playback process.

Time is converted to a digital number. The device that performs this conversion is known as an *Analog-to-Digital Converter (ADC)*. It sounds simple enough in principle, but it has some important wrinkles.

The problem with sampling is that a digitizer circuit has to capture enough points of an analog waveform to reproduce it faithfully. The example in Fig. 41-4 illustrates the importance of sampling rate. Waveforms A and B represent the same original signal. Waveform A is sampled at a relatively slow rate—only a few samples are taken. The problem comes when the signal is reconstructed with a *Digital-to-Analog Converter (DAC)*. As you see, there are not enough sample points to reconstruct the original signal. As a result, some of the information in the original signal is lost. This form of distortion is known as *aliasing*.

Waveform B is the same signal, but it is sampled at a much higher rate. When that data is reconstructed, the resulting signal is a much more faithful reproduction of the original.

As a rule, a signal should be sampled at least twice as fast as the highest frequency contained in the signal—this is known as *Nyquist's Sampling Theorem*. The lowest standard sampling rate used with today's sound boards is 11kHz—this allows fair reproduction of normal speech and vocalization (up to about 5.5kHz). However, most low-end sound boards can digitize signals up to 22kHz. Unfortunately, the human range of hearing is about 22kHz. To capture sounds reasonably well throughout the entire range of hearing, you would need a sampling rate of 44kHz—often known as *CD-quality sampling* because it is the same rate used to record audio on CDs. The disadvantage to high sampling rates is disk space (and sound file size). Each sample is a piece of data, so the more samples taken each second, the larger and faster a file grows. If 8 bits are used for each sample, 256 discrete levels can be supported. But the most popular configuration is 16-bit conversion, which allows a sample to be represented by one of 65,536 levels. At that level of resolution, samples form a very close replica of the original signal. Many of today's sound boards are 16-bit.

Troubleshooting a Sound Board

Traditionally, sound boards use many of the same chipsets and basic components, but because each board is designed a bit differently, it is very difficult for commercial diagnostic products to identify failed IC functions. For the most part, commercial and shareware diagnostics can only identify whether a brand-compatible board is responding or not. As a result, this chapter will take the sub-assembly replacement approach. When a sound board is judged to be defective, it should be replaced outright. This part of the chapter reviews the problems and solutions for sound boards under both DOS and Windows. The following tips might help you nail down a sound problem most efficiently:

- Check to see that your speakers are connected, powered, and turned on.
- Check that the speaker volume and sound card master volume are turned up.
- Check to see that the mixer volume and master volume are set properly.
- Be sure that the music or sound file(s) are installed properly.
- Check that all sound card and multimedia drivers are installed.
- Be sure that the drivers are up to date.
- Check for resource conflicts between the sound card and other devices in the system.
- Be sure that the sound card is selected and configured properly (especially for DOS apps).
- The sound device should be enabled and configured under CMOS (for sound functions incorporated on the motherboard).

Sound device is not configured properly If you cannot play any .WAV files in Windows 95 (or if .WAV files are not played at the proper volume), you might not have a sound device selected or the sound device that you have selected might not be configured properly. To select and configure a sound device in Windows 95:

- Open the *Control panel* and doubleclick the *Multimedia* icon.

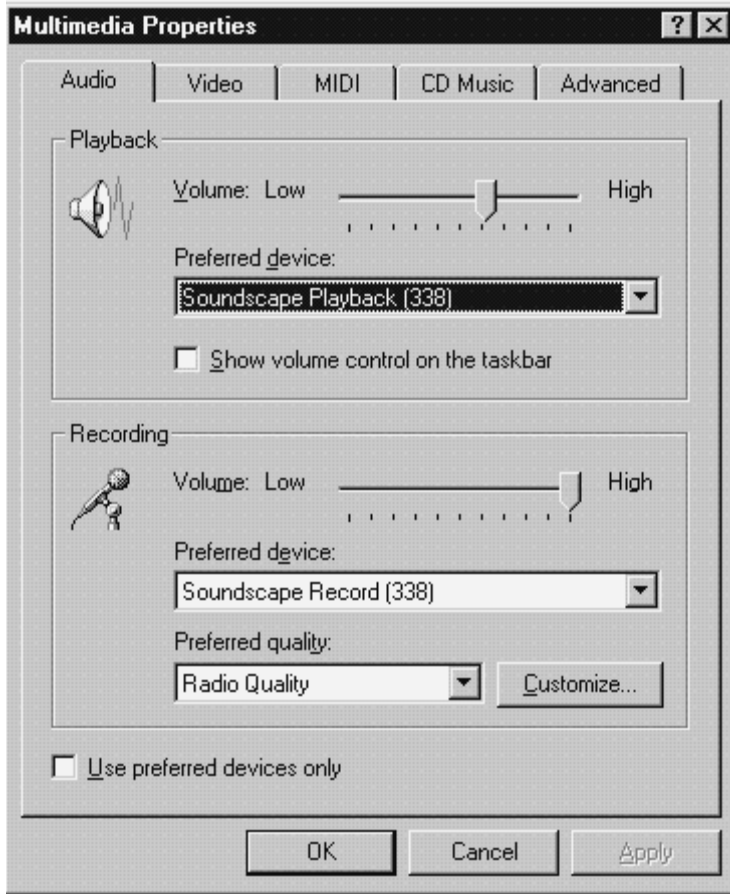
- In the *Playback* area under the *Audio* tab (Fig. 41-8), click the playback device that you want to use in the *Preferred device* list, then move the *Volume* slider to the value you want (usually 50 to 75% volume is adequate).
- In the *Recording* area under the *Audio* tab, click the playback device that you want to use in the *Preferred device* list, then move the *Volume* slider to the value you want.
- Be sure that the speakers are properly connected to the sound card and that the speakers are turned on.

Symptoms

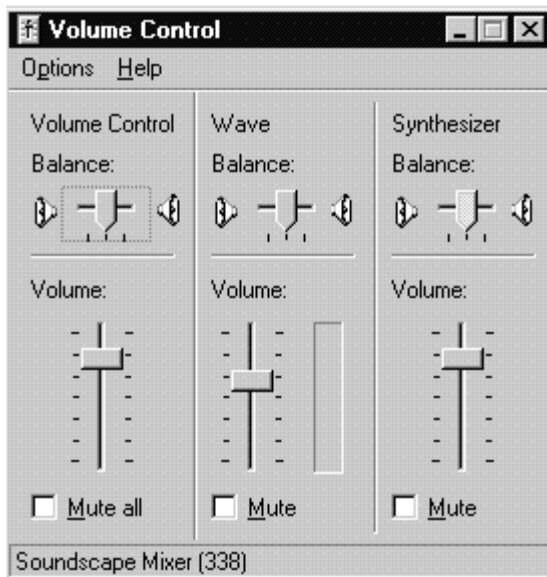
Symptom 41-1. A noticeable buzz or hum is being produced in one or both speakers. Low-cost speakers use unshielded cables. Unfortunately, strong signals from ac cords and other signal-carrying conductors can easily induce interference in the speaker wires. Try rerouting speaker cables clear of other cables in the system. If problems persist, try using higher-quality speakers with shielded cables and enclosures. In most cases, that should resolve everyday noise problems. If the noise continues, regardless of what you do, the fault might be in the sound-board amplifier. Try moving the sound board to another bus slot away from other boards or the power supply. If that does not resolve the problem, try a new sound board.

Symptom 41-2. No sound is produced by the speaker(s). The lack of sound from a sound board can be caused by any one of a wide range of potential problems. If the sound board works with some applications, but not with others, it is likely that the problem is caused by an improperly installed or configured application. See that the offending application is set up properly (and be sure it is even capable of using the sound card). Also check that the proper sound driver files (if any) are loaded into CONFIG.SYS and AUTOEXEC.BAT, as required. In many cases, one or two sound-related environment variables that are set in AUTOEXEC.BAT. Be sure that your startup files are configured properly.

Check your speakers next. See that they are turned on and set to a normal volume level. The speakers should be receiving adequate power and should be plugged properly into the correct output jack—if speakers have been plugged into the wrong jack, no sound will be



Multimedia properties media dialog



Multimedia volume control applet

produced. If the cable is broken or questionable, try a new set of speakers. Also see that the master volume control on the sound board is turned up most (or all) of the way.

If problems continue, a resource conflict might be occurring between the sound board and another device in the system. Examine the IRQ, DMA, and I/O settings of each device in the system. Be sure that no two devices are using the same resources. You might like to use the PC Configuration Form at the end of this book to record your settings. If problems persist, and no conflict is present, try another sound board.

Symptom 41-3. CD audio will not play through the sound card This problem can occur under both DOS and Windows. First, be sure that the sound board is actually capable of playing CD audio (older boards might not be compatible). If the sound card is playing sound files, but is not playing CD audio, check several things. First, open the PC and be sure that the CD-audio cable (a thin, 4-wire cable) is attached from the CD-ROM drive to the sound board. If this cable is broken, disconnected, or absent, CD audio will not be passed to the sound board. If the cable is intact, be sure that the CD audio player is configured properly for the sound board you are using, and check the startup files to see that any drivers and environment variables needed by CONFIG.SYS and AUTOEXEC.BAT are available. If CD audio fails to play under Windows, be sure that an *MCI (Multimedia Control Interface)* CD Audio driver is included in the *Drivers* dialog box under Windows *Control panel*.

Symptom 41-4. An error, such as “No interrupt vector available” appears The DOS interrupt vectors used by the sound board’s setup drivers (usually INT 80h to BFh) are being used by one or more other drivers in the system. As a consequence, there is a software conflict. Try disabling other drivers in the system one at a time until you see the conflict disappear. Once you have isolated the offending driver(s), you can leave them disabled, or (if possible) alter their command-line settings so that they no longer conflict with the sound board’s software.

Symptom 41-5. It has no MIDI output Be sure that the file you are trying to play is a valid MIDI file (usually with a .MID extension). In most cases, you will find that the *MIDI mapper* under Windows is not set up properly for the sound board. Load the Windows *MIDI mapper* applet from the *Control panel*, and set it properly to accommodate your sound board.

Symptom 41-6. Sound play is jerky Choppy or jerky sound playback is typically the result of a hard drive problem—more specifically, the drive cannot read the sound file to a buffer fast enough. In most cases, the reason for this slow drive performance is excessive disk fragmentation. Under DOS, the sound file(s) might be highly fragmented.

Under Windows, the permanent or temporary swap files might be highly fragmented. In either case, use a reliable DOS defragmenter, such as PC Tools or Norton Utilities (leave Windows before defragmenting the disk), and defragment the disk thoroughly.

Symptom 41-7. An error, such as “Out of environment space” appears. The system is out of environment space. You will need to increase the system’s environment space by adding the following line to your CONFIG.SYS file: `shell=c:.com /E:512 /P`

Troubleshooting A Sound Board 1207

This command line sets the environment space to 512 bytes. If you still encounter the error message, change the E entry to 1024.

Symptom 41-8. Regular “clicks,” “stutters,” or “hiccups” occur during the playback of speech. This might also be heard as a “garbled” sound in speech or sound effects. In virtually all cases, the system CPU is simply not fast enough to permit buffering without dropping sound data. Systems with i286 and slower i386 CPUs typically suffer with this kind of problem. This is often compounded by insufficient memory (especially under Windows), which automatically resorts to virtual memory. Because virtual memory is delivered by the hard drive and the hard drive is much slower than RAM anyway, the hard drive simply can’t provide data fast enough. Unfortunately, little can be done in this kind of situation (aside from adding RAM, upgrading the CPU, or changing the motherboard). If it is possible to shut off various sound features (i.e., music, voice, effects, etc.), try shutting down any extra sound features that you can live without. Be sure that no TSRs or other applications are running in the background.

Symptom 41-9. The joystick is not working or is not working properly on all systems. This problem only applies to sound boards with a multi-function MIDI/joystick port being used in the joystick mode. Chances are that the joystick is conflicting with another joystick port in the system. Disable the original joystick port or the new joystick port—only one joystick port (game adapter) can be active at any one time in the system.

Because joystick performance depends on CPU speed, the CPU might actually be too fast for the joystick port. Disable the joystick port or try slowing the CPU down.

Symptom 41-10. The sound board is installed and everything works properly, but now the printer does not seem to work. An interrupt conflict is between the sound board and an IRQ line used by the printer. Although parallel printers are often polled, they can also be driven by an IRQ line (IRQ5 or IRQ7). If the sound board is using either one of these interrupts, try changing to an alternative IRQ line. When changing an IRQ line, be sure to reflect the changes in any sound board files called by CONFIG.SYS or AUTOEXEC.BAT.

Symptom 41-11. The following error message appears: “Error MMSYSTEM 337: The specified MIDI device is already in use” This problem often occurs with high-end sound boards, such as the Creative Labs AWE64. This error is often caused by having the sound board’s mixer display on with the wavetable synthesizer selected (i.e., the LED display in the Creative Mixer turned on and Creative Wave Synthesizer selected as the MIDI playback device). You can usually correct the problem by turning the mixer display off.

Symptom 41-12. The following error message appears: “Error: Wave device already in use when trying to play wave files while a MIDI file is playing” This problem often occurs

with high-end sound boards, such as the Creative Labs AWE64, and it is usually the result of a device configuration problem. If “full-duplex” is turned on and you try to play a .WAV file and a MIDI file at the same time with the wavetable synthesizer (e.g., the Creative Wave Synthesizer) selected as the MIDI play- 1208 SOUND BOARDS back device, an error will occur. To resolve this problem, you need to turn off the full-duplex mode:

- Hold down <Alt>key and doubleclick on *My computer*.
- Select the *Device manager* tab. A listing for *Sound, video, game controllers* should be included in the *Device manager*, doubleclick on the listing to expand it.
- You should now see a listing for the sound board (e.g., Creative AWE32 16-Bit Audio). Doubleclick on the listing, then select the *Settings* tab. Un-check the box labeled *Allow full-duplex operation*. Click *OK* until you are back to the *Control panel*.
- Now try to play a .WAV and MIDI file at the same time.

Symptom 41-13. You hear “pops” and “clicks” when recording sound under Windows 95 Cache is insufficient to adequately support the recording process (or cache is improperly configured). Try the following procedure to alter the way cache is allocated:

- Open *Notepad* and load SYSTEM.INI
- Locate the area of SYSTEM.INI labeled [vcache].
- Add the following line [vcache]: maxfilecache=2048
- Save your changes to the SYSTEM.INI file.
- From the desktop, right-click on *My computer*, then select *Properties*.
- Select the *Performance* page, then click on *File system*.
- Find the slider marked *Read-ahead optimization*, then pull the slider to *None*.
- Save your changes and restart Windows 95.

Symptom 41-14. You notice high frequency distortion in one or possibly in both channels In many cases, the AT bus clock is set faster than 8MHz and data is being randomly lost. This problem usually occurs in very fast systems using an ISA sound board. Enter the system’s CMOS setup and check the AT bus clock under the *Advanced chipset setup* area. See that the bus clock is set as close as possible to 8MHz. If the bus clock is derived as a divisor of the CPU clock, you might see an entry, such as /4. Be sure that divisor results in a clock speed as close to 8MHz as possible. If problems still persist, try increasing the divisor to drop the bus speed below 8MHz (this might have an adverse effect on other ISA peripherals).

Symptom 41-15. You hear “pops” and “clicks” when playing back prerecorded files under Windows 95 An excessive processing load is on the system, which is often caused by virtual memory and/or 32-bit access. Start by disabling virtual memory: Open the *Control panel* and doubleclick on the *System* icon. Select the *Performance* page and click on *Virtual memory*. Set the swap file to *None* and save your changes. Try the file playback again. If problems persist, try disabling 32-bit file access.

If that still does not resolve the problem, try disabling 32-bit disk access.

Symptom 41-16. “Pops” and “clicks” are audible on new recordings only, pre-existing files sound clean This is often caused by issues with software caching.

Troubleshooting A Sound Board 1209

If you are using DOS or Windows 3.1, disable SmartDrive from both CONFIG.SYS and AUTOEXEC.BAT, then restart the computer for your changes to take effect. If problems continue (or you are using Windows 95), an excessive processing load on the system might be caused by virtual memory or 32-bit access. Follow the recommendations under Symptom 41-15.

Symptom 41-17. “Pops” and “clicks” occur when playing back or recording any sound file In most cases, there is a wiring problem with the speaker system. Check all of your cabling between the sound board and speakers. If the speakers are powered by ac, be sure that the power jack is inserted properly. If the speakers are powered by battery, be sure that the batteries are fresh. Check for loose connections. If you cannot resolve the problem, try some new speakers. If the problem persists, replace the sound board.

Symptom 41-18. The sound board plays back fine, but it will not record The board probably records fine in DOS, but not in Windows. If the sound board is using 16-bit DMA transfer (typical under Windows), two DMA channels are in use. Chances are that one of those two DMA channels are conflicting with another device in the system.

Determine the DMA channels being used under Windows, then check other devices for DMA conflicts. If you are using Windows 95, check the *Device manager* and look for entries marked with a yellow icon.

Symptom 41-19. A DMA error is produced when using a sound board with an Adaptec 2842 controller in the system This is a known problem with the Digital Audio Labs “DOC” product and the Adaptec 2842. You will need to alter the controller’s FIFO buffer. Go in the controller’s Setup by hitting <Ctrl>+<A> Open prompted during system startup. Select the *Advanced Configuration* option, then select the FIFO threshold—chances are that it will be set to 100%. Try setting the FIFO threshold to 0% and see if this makes a difference.

Symptom 41-20. A DMA error is produced when using a sound board with an Adaptec 1542 controller in the system This is a known problem with the Digital Audio Labs “DOC” sound product and the Adaptec 1542. The problem can usually be resolved by rearranging the DMA channels. Place the Adaptec controller on DMA 7, then place the sound board on DMA 5 for playback and DMA 6 for recording.

Symptom 41-21. The sound card will not play or record—the system just locks up when either is attempted The board will probably not play in either DOS or Windows, but might run fine on other systems. This is a problem that has been identified with some sound boards and ATI video boards. ATI video boards use unusual address ranges, which sometimes overlap the I/O address used by the sound board. Change the sound board to another I/O address.

Symptom 41-22. The sound card will record, but will not playback Assuming that the sound board and its drivers are installed and configured properly, chances are that a playback oscillator on the sound board has failed. Try replacing the sound board outright.

1210 Sound Boards

Symptom 41-23. The sound application or editor produces a significant number of DMA errors This type of problem is known to occur frequently when using the standard VGA driver that accompanies Windows—the driver is poorly written and cannot keep up with screen draws. Try updating your video driver to a later, more efficient version. If the driver is known to contain bugs, try using a generic video driver that is written for the video board's chipset.

Symptom 41-24. The sound board will not record in DOS Several possible problems can account for this behavior. First, suspect a hardware conflict between the sound board and other devices in the system. Be sure that the IRQs, DMA channels, and I/O port addresses used by the sound board are not used by other devices.

If the hardware setup appears correct, suspect a problem between DOS drivers. Try a clean boot of the system (with no CONFIG.SYS or AUTOEXEC.BAT). If sound can be run properly now, there is a driver conflict. Examine your entries in CONFIG.SYS or AUTOEXEC. BAT for possible conflicts or for older drivers that might still be loading to support hardware that is no longer in the system.

Finally, suspect the hard-drive controller. Try setting up a RAM drive with RAMDRIVE. SYS. You can install a RAMdrive on your system by adding the line: device=c:.sys /e 8000 The 8000 is for 8MB worth of RAM—be sure that enough RAM is in the PC. Once the RAMdrive is setup, try recording and playing from the RAMdrive (you might have to specify a new path in the sound-recorder program). If that works, the hard-drive controller might simply be too slow to support the sound board, and you might need to consider upgrading the drive system.

Symptom 41-25. When recording sound, the system locks up if a key other than the recorder's "hot-keys" are pushed This is a frequent problem under Windows 3.1x. The system sounds (generated under Windows) might be interfering with the sound recorder. Try turning off system sounds. Go to the *Main* icon, choose the *Control panel*, then select *Sounds*. A box will appear in the lower left corner marked *Enable system sounds*. Click on this box to remove the check mark, then click *OK*.

Symptom 41-26. After the sound-board driver is loaded, Windows locks up when starting or exiting In virtually all cases, you have a hardware conflict between the sound board and another device in the system. Be sure that the IRQs, DMA channels, and I/O port addressed used by the sound board are not used by other devices.

Symptom 41-27. When using Windows sound-editing software, the sound board refuses to enter the "digital" mode—always switching back to the analog mode Generally speaking,

this is a software-configuration issue. Be sure that your editing (or other sound) software is set for the correct type of sound board (i.e., an AWE32 instead of a Sound Blaster 16/Pro). If problems persist, the issue is with your sound drivers. Check the [drivers] section of the Windows SYSTEM.INI file for your TROUBLESHOOTING A SOUND

Week15

This Week Learning Outcome

To Understand:

➤ Device Conflicts in Device Manager

Introduction

The incredible acceptance and popularity of the PC largely results from the use of an “open architecture.” An open architecture allows any manufacturer to develop new devices (e.g., video boards, modems, sound boards, etc.) that will work in conjunction with the PC. When a new expansion board is added to the PC, the board uses of various system resources in order to obtain CPU time and transfer data across the expansion bus. Ultimately, each board that is added to the system requires unique resources. No two devices can use the same resources—otherwise, a hardware conflict will result. Low-level software (such as device drivers and TSRs) that uses system resources can also conflict with one another during normal operation. This chapter explains system resources, then shows you how to detect and correct conflicts that can arise in both hardware and software.

Understanding System Resources

The key to understanding and eliminating conflicts is to understand the importance of each system resource that is available to you. PCs provide three types of resources: interrupts, DMA channels, and I/O areas. Many controllers and network devices also utilize BIOS, which requires memory space. Do not underestimate the importance of these areas—conflicts can occur anywhere, and carry dire consequences for a system.

Interrupts

An interrupt is probably the most well-known and understood type of resource. Interrupts are used to demand attention from the CPU. This allows a device or sub-system to work in the background until a particular event occurs that requires system processing. Such an event might include receiving a character at the serial port, striking a key on the keyboard, or any number of other real-world situations. An interrupt is invoked by asserting a logic level on one of the physical interrupt request (IRQ) lines that are accessible through any of the motherboard’s expansion bus slots. AT-compatible PCs provide 16 IRQ lines (noted IRQ 0 to IRQ 15). Table 10-1 illustrates the IRQ assignments for classic XT and current AT systems.

These lines run from pins on the expansion bus connector or key ICs on the motherboard to Programmable Interrupt Controllers (PICs) on the motherboard. The output signals generated by a PIC triggers the CPU interrupt. Keep in mind that Table 10-1 covers hardware interrupts only. There are also a proliferation of processor and software-generated interrupts.

The use of IRQ 2 in an AT system deserves a bit of explanation. An AT uses IRQ 2 right on the motherboard, which means that the expansion bus pin for IRQ 2 is now empty. Instead of leaving this pin unused, IRQ 9 from the AT extended slot is wired to the pin previously occupied by IRQ 2. In other words, IRQ 9 is being redirected to IRQ 2. Any AT expansion device set to use IRQ 2 is actually using IRQ 9. Of course, the vector interrupt table is adjusted to compensate for this slight of hand.

After an interrupt is triggered, an interrupt-handling routine saves the current CPU register states to a small area of memory (called the *stack*), then directs the CPU to the interrupt vector table. The interrupt vector table is a list of program locations that correspond to each interrupt. When an interrupt occurs, the CPU will jump to the interrupt handler routine at the location specified in the interrupt vector table and execute the routine. In most cases, the interrupt handler is a device driver associated with the board generating the interrupt.

For example, an IRQ from a network card will likely call a network device driver to operate the card. For a hard-disk controller, an IRQ calls the BIOS ROM code that operates the drive. When the handling routine is finished, the CPU's original register contents are "popped" from the stack, and the CPU picks up from where it left off without interruption. As a technician, it is not vital that you understand precisely how interrupts are initialized and enabled, but you should know the basic terminology. The term *assigned* simply means that a device is set to produce a particular IRQ signal. For example, a typical hard drive controller board is assigned to IRQ 14. Assignments are usually made with one or more jumpers or DIP switches, or are configured automatically through the use of Plug and Play (PnP). Next, interrupts can be selectively enabled or disabled under software control. An "enabled" interrupt is an interrupt where the PIC has been programmed to pass on an IRQ to the CPU. Just because an interrupt is enabled does not mean that there are any devices assigned to it. Finally, an "active" interrupt is a line where real IRQs are being generated. Notice that *active* does not mean assigned or enabled.

Interrupts are an effective and reliable means of signaling the CPU, but the conventional ISA bus architecture—used in virtually all PCs—does not provide a means of determining which slot contains the board that called the interrupt. As a result, interrupts cannot be shared by multiple devices. In other words, no two devices can be actively generating interrupt requests on the same IRQ line at the same time. If more than one device is assigned to the same interrupt line, a hardware conflict can occur. In most circumstances, a conflict will prevent the newly installed board (or other previously installed boards) from working. In some cases, a hardware conflict can hang up the entire

Recognizing and Dealing with Conflicts

Fortunately, conflicts are almost always the result of a PC upgrade gone awry. Thus, a technician can be alerted to the possibility of a system conflict by applying the Last Upgrade rule. The rule consists of three parts:

- 1 A piece of hardware and/or software has been added to the system very recently.
- 2 The trouble occurred after a piece of hardware and/or software was added to the system.
- 3 The system was working fine before the hardware and/or software was added.

If all three of these common-sense factors are true, chances are very good that you are faced with a hardware or software conflict. Unlike most other types of PC problems, which tend to be specific to the faulty sub-assembly, conflicts usually manifest themselves as much more general and perplexing problems. The following symptoms are typical of serious hardware or software conflicts:

- The system locks up during initialization.
- The system locks up during a particular application.
- The system locks up when a particular device (e.g., a TWAIN scanner) is used.
- The system locks up randomly or without warning regardless of the application.
- The system might not crash, but the device that was added might not function (even though it seems properly configured). Devices that were in the system previously might still work correctly.
- The system might not crash, but a device or application that was working previously no longer seems to function. The newly added device (and accompanying software) might not work properly.

What makes these problems so generic is that the severity and frequency of a fault, as well as the point at which the fault occurs, depends on such factors as the particular de-

Dealing With Software Conflicts

Two types of software can cause conflicts in a typical PC: TSRs and device drivers. TSRs (sometimes called “popup utilities”) load into memory, usually during initialization, and wait until a system event (e.g., a modem ring or a keyboard “hot key” combination). There are no DOS or system rules that define how such utilities should be written. As a result, many tend to conflict with application programs (and even with DOS itself). If you suspect that such a popup utility is causing the problem, find its reference in the AUTOEXEC. BAT file and disable it by placing the command REM in front of its command line (e.g., REM C:\UTILS\NEWMENU.EXE /A:360 /D:3). The REM command turns the line into a “REMark,” which can easily be removed later if you choose to restore the line.

Remember to reboot the computer so that your changes will take effect. Device drivers present another potential problem. Most hardware upgrades require the addition of one or more device drivers. Such drivers are called from the CONFIG.SYS file during system initialization (or loaded with Windows), and use a series of command-line parameters to specify the system resources that are being used. This is often necessary to ensure that the driver operates its associated hardware properly. If the command line options used for the device driver do not match the hardware settings (or overlap the settings of another device driver), system problems can result. If you suspect that a device driver is causing the problem, find its reference in the CONFIG.SYS file and disable it by placing the command REM in front of its command line (e.g., REM DEVICE = C:\DRIVERS NEWDRIVE.SYS /A360 /I:5). The REM command turns the line into a “REMark,” which can easily be removed later if you choose to restore the line. Remember that disabling the device driver in this fashion will prevent the associated hardware from working,

Dealing With Hardware Conflicts

A PC user recently added a CD-ROM and adapter board to their system. The installation went flawlessly using the defaults—a 10-minute job. Several days later, when attempting to backup the system, the user noticed that the parallel port tape backup did not respond (although the printer that had been connected to the parallel port was working fine). The user tried booting the system from a “clean” bootable floppy disk (no CONFIG.SYS or AUTOEXEC.BAT files to eliminate the device drivers), but the problem remained. After a bit of consideration, the user powered down the system, removed the CD-ROM adapter board, and booted the system from a “clean” bootable floppy disk. Sure enough, the parallel port tape backup started working again.

Stories such as this remind technicians that hardware conflicts are not always the monstrous, system-smashing mistakes that they are made out to be. In many cases, conflicts have subtle, non-catastrophic consequences. Because the CD-ROM was the last device to be added, it was the first to be removed. It took about 5 minutes to realize and remove the problem. However, removing the problem is only part of conflict troubleshooting—re-installing the device without a conflict is the real challenge.

Ideally, the way to correct a conflict would be to alter the conflicting setting. That’s dynamite in theory, but another thing in real life. The trick is that you need to know what resources are in use and which ones are free. Unfortunately, there are only two ways to find out. On one hand, you can track down the user manual for every board in the system, then inspect each board individually to find the settings, then work accordingly. This will work (assuming that you have the documentation), but it is cumbersome and time consuming.

As an alternative, you can use a resource testing tool, such as the Discovery Card by AllMicro, Inc. The Discovery Card plugs into a 16-bit ISA slot and uses a series of LEDs to display each IRQ and DMA channel in use. Any LED not illuminated is an available resource.

It is then simply a matter of setting your expansion hardware to an IRQ and DMA channel that is not illuminated. Remember that you might have to alter the command line switches of any device drivers. The only resources not illustrated by the Discovery Card are I/O addresses, but because most I/O ports are reserved for particular functions (as you saw in Tables 10-3 to 10-5), you can typically locate an unused I/O port with a minimum of effort.

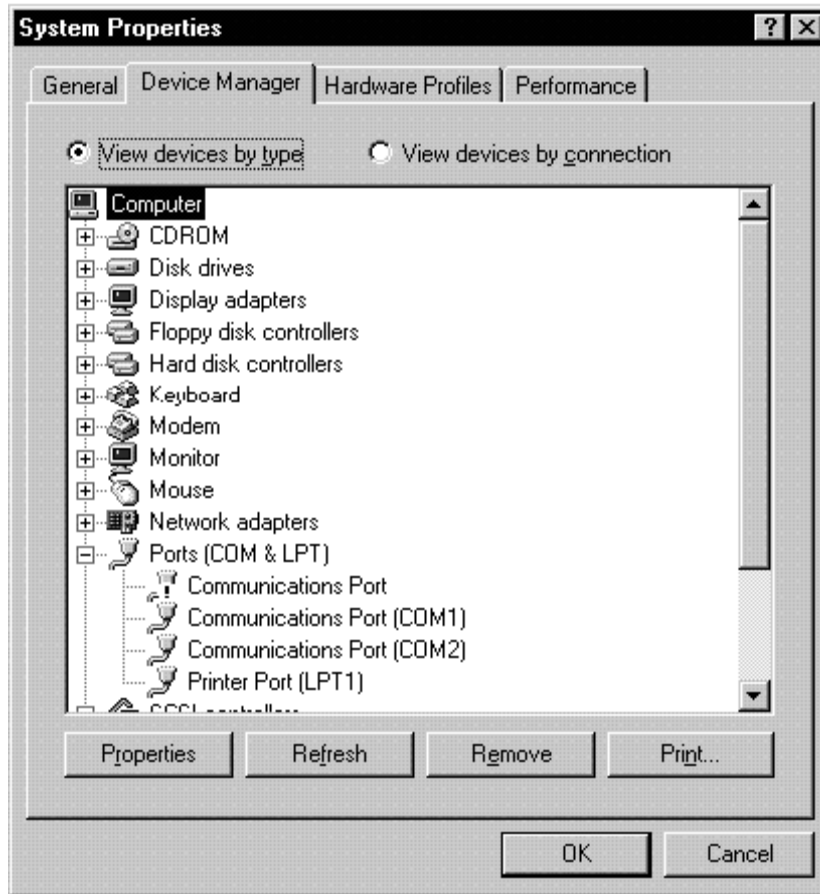
CONFLICT TROUBLESHOOTING WITH WINDOWS 95

One of the biggest problems with conflict troubleshooting is that every conflict situation is a bit different. Variations in PC equipment and available resources often reduce conflict troubleshooting to a “hit or miss” process. Fortunately, conflict troubleshooting can be accomplished quickly and easily using the tools provided by Windows 95 (namely the Device Manager). This part of the chapter provides a step-by-step process that you can use for conflict resolution under Windows 95.

Step 1: Getting started Start the Device Manager in Windows 95:

1 Click the *Start* button, then click *Settings*, then select *Control panel*.

- 2 Double-click the *System* icon, then click on the *Device manager* tab (Fig. 10-1).
- 3 Be sure that *View devices by type* is selected.



Windows Device Manager

Determine if the device was installed twice. Is the device you were installing (or that suffers from the conflict) listed twice in *Device manager*?

- If the device is listed only once, go to Step 2.
- If the device is listed twice and there is only supposed to be one such device in the system, go to Step 3.
- If the device is listed twice, but there are supposed to be two such devices in the system go to Step 2.

Step 2: Device listed only once View the resource settings for the conflicting device:

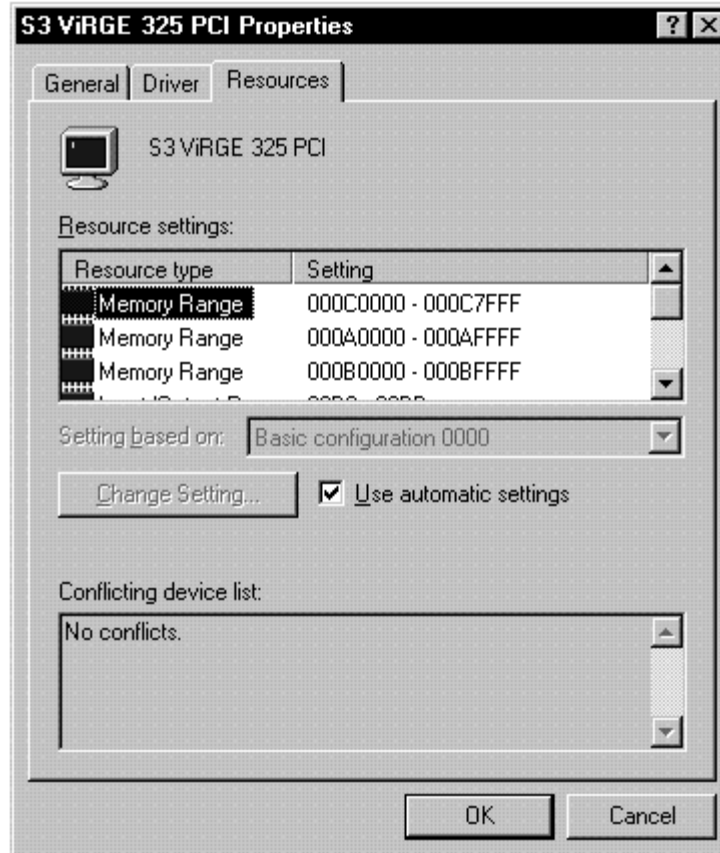
1. Double-click on the hardware that shows a conflict.
2. In the *Device usage* area (such as Fig. 10-2), be sure that there is a check in the box next to the configuration marked “Current.” If the box isn’t checked, check the box now.
3. Click the *Resources* tab.

Do you see a box with resource settings (as in Fig. 10-3)?

- If the box with resource settings appears, go to Step 4.
- If the *Set configuration manually* button appears instead, go to Step 5.
- If the device doesn't have a Resources tab, go to Step 6.



Device properties highlighting the Device Usage.



Device properties highlighting Resource Settings.

Step 3: Device listed twice Remove all of the duplicated device(s), and install again:

1. Remove each duplicate item from the hardware list. Click its name, and then click *Remove*. When you are finished, no instances of the conflicting hardware should be listed.
2. Click *OK*.
3. Now (while still within the *Control panel*), double-click on the *Add new hardware* icon. If you see a message that you already have a wizard open, click *Finish* in that wizard, and then click the button in this step to start a new wizard.
4. Click *Next*.
5. Click the option to automatically detect your hardware, and then click *Next*. Continue until you finish the wizard.

Did this fix the problem?

- If the conflict no longer appears, this should correct the problem, and you should be done. Exit the *Control panel* and restart Windows 95.
- If the conflict still appears, go to Step 2.

Step 4: Resource settings appear Identify exactly which resources are causing the conflict:

1. In the *Conflicting device list* box, identify the hardware that is using conflicting resources.
Is more than one resource conflict listed?
 - If more than one resource conflict is listed, go to Step 7.
 - If only one conflict is listed, go to Step 8.
 - If no conflicts are listed, or if one or more indications show *System reserved* as the conflict, go to Step 9.

Step 5: Manual button appears Determine why the resources are not displayed:

1. When the *Resources* tab shows a *Set configuration manually* button, it is either because the device has a conflict or other problem and is disabled, or because the resource settings used by this device are working properly, but they don't match any of the known configurations.
2. You can tell which situation applies by reading the text above the button.
Which text message do you see?
 - If you see a message that says; "The device is conflicting, or the device is not currently enabled or has a problem," then go to Step 10.
 - If you see a message that says; "The resource settings don't match any known configurations," there is no further solution to the problem. You should probably remove the conflicting device.

Step 6: There is no Resources tab You have probably chosen the wrong device.

Select the correct device:

1. Click *Cancel* to return to the hardware list.
2. Carefully double-click the hardware that has a conflict.
3. In the *Device usage* area, be sure that there is a check in the box next to the configuration marked "Current." If the box isn't checked, check it now.
4. Click the *Resources* tab.

Do you see a box with resource settings now?

- If the box with resource settings now appears, go to Step 4.
- If you see a *Set configuration manually* button, go to Step 5.
- If the resource settings still do not appear, there is no further solution to the problem.

You should probably remove the conflicting device.

Step 7: More than one conflict is listed At this point, you should determine just how many devices are listed as being conflicting.

- If you only see one device causing all the conflicts, go to Step 11.
- If more than one device is causing the conflicts, go to Step 12.

274 Conflict Troubleshooting

Step 8: Only one conflict is listed Look for a resource setting that doesn't conflict:

1. In the *Resource settings* box, double-click the icon next to the resource setting that is conflicting. If you see a message that says "You must clear the Use Automatic Settings box before you can change a resource setting," click *OK* to close the message, and then clear the *Use automatic settings* box.
2. Scroll through the available resource settings.
3. For each setting, look at the *Conflicting device list* box to see if it conflicts with any other hardware.
4. If you find a free setting, click *OK*.

Did you find a setting that doesn't conflict with any other hardware?

- If you can find a setting which does not conflict, go to Step 13.
- If you cannot find a setting that does not conflict, go to Step 14.
- If you see a message stating that the resource setting cannot be modified, go to Step 1

Step 9: No conflicts are listed If there are no conflicts listed in the *Conflicting device list* box, either you are not viewing resources for the correct device, or the conflict has already been resolved (you need to restart your computer to allow Windows 95 to configure the hardware). Look at the top of the dialog box to see if you are viewing resources for the correct device.

There is no further solution to this problem. If restarting Windows 95 does not clear the problem, you might simply need to remove the conflicting device.

Step 10: The device is conflicting Now you need to identify which hardware is conflicting:

1. Click *Set configuration manually*.
2. In the *Conflicting device list* box, identify the other hardware that is using the conflicting resources.

Is more than one resource conflict listed?

- If more than one resource conflict is listed, go to Step 16.
- If only one resource conflict is listed, go to Step 17.
- If no conflicts are listed, go to Step 9.

Step 11: Only one device is conflicting Do you want to disable the device that is causing all the conflicts?

- If you wish to disable the conflicting device, go to Step 18.
- If you must use the hardware that is causing the conflicts, go to Step 17.

Step 12: More than one device is conflicting Look for resource settings that don't conflict:

1. In the *Resource settings* box, double-click the icon next to a resource setting that is conflicting. If you see a message that says "You must clear the Use Automatic Settings box

Recognizing And Dealing With Conflicts 275

Before you can change a resource setting,” click *OK* to close the message, and then clear the *Use automatic settings* box.

2. Scroll through the available resource setting.
3. For each setting, look in the *Conflicting device list* box to see if it conflicts with any other hardware.
4. When you find a free setting, click *OK*.
5. Repeat steps 1 through 4 for each conflicting resource.

Did you find a free setting for each conflicting resource?

- If you do find free settings for each conflicting resource, go to Step 19.
- If some (or all) resources are still conflicting, go to Step 20.
- If you see a message indicating that the resource setting cannot be modified, go to

Step 13: There is a free setting When a free setting is available, change the configuration:

- 1 Enter the new setting value.
- 2 Make a note of the old and new settings to refer to later.
- 3 Click *OK*. If you see a message prompting you to restart your computer, click *No*.

Restart your computer:

1. Click *OK*.
2. You might see a message prompting you to restart your computer. Click *No*.
3. Click the *Start* button, click *Shut down*, then click *Yes*.
4. When Windows says it is safe to do so, turn off your computer so that you can configure the hardware devices that you’ve changed.

This should correct the problem, and the hardware conflict should now be resolved once the PC is restarted.

Step 14: All other settings conflict Identify hardware you no longer need:

- 1 Scroll through the available resource settings.
- 2 When a conflict appears in the *Conflicting device list* box, determine whether you still need to use the device that is causing the conflict. Can you identify a hardware device that you no longer need to use?

276 Conflict Troubleshooting

Depending on the type of hardware you have, you might have to change the jumpers on your hardware card to match the new setting(s) or you might have to run a configuration utility provided by your hardware manufacturer. If the jumper settings on your card aren’t set properly, your hardware will not work—even if you resolved the conflict correctly. Refer to your hardware documentation for instructions on changing jumpers.

- If you can disable the conflicting device, go to Step 21.
- If you cannot disable the conflicting device, go to Step 22.

Step 15: Resource settings cannot be modified View the resources for the other device:

1. In the *Conflicting device list* box, make a note of which device is using the resource that cannot be modified.
2. Click *Cancel*.
3. In the hardware list, find and double-click the device that is using the resource.

Does this device have a Resources tab?

- If a *Resources* tab is available, go to Step 23.
- If a *Resources* tab is not available, go to Step 24.

Step 16: There is more than one conflict How many devices are listed as conflicting?

- If only one device is causing the conflicts, go to Step 11.
- If more than one device is causing the conflicts, go to Step 12.

Step 17: There is only one conflict Look for a resource setting that doesn't conflict:

1. In the *Resource settings* box, double-click the icon next to the resource setting that is conflicting. If you see a message that says "You must clear the Use Automatic Settings box before you can change a resource setting," click *OK* to close the message, then clear the *Use automatic settings* box.
 2. Scroll through the available resource settings.
 3. For each setting, look in the *Conflicting device list* box to see if it conflicts with any other hardware.
 4. If you find a free setting, click *OK*. Did you find a setting that doesn't conflict with any other hardware?
- If you manage to find a setting that does not conflict, go to Step 13.
 - If you see a message indicating that the resource setting cannot be modified, go to

Step 15.

- If all other settings conflict with other hardware, there is no further solution to the problem, and you should probably remove the conflicting device.

Step 18: Disable conflicting hardware Determine how to best disable the conflicting hardware:

1. On the hardware list, double-click the hardware that you want to disable. If you do not see the hardware list, click *Cancel* until you return to it.

Recognizing and Dealing With Conflicts 277

2. In the *Device usage* area, click the box next to the configuration marked "Current" to remove the check mark.
3. Click the *Resources* tab. If there is a *Set configuration manually* button, Windows 95 can disable and free up resources used by this hardware without your removing its card from your computer.

Do you see a *Set configuration manually* button?

- If the button exists, you can effectively disable the device, so go to Step 19.

- If the button is not available, go to Step 25.

Step 19: Resources now set without conflicts Print out a report for each device you changed:

1. In the hardware list, click a device whose resource settings you changed while resolving the conflict. If you do not see the hardware list, click *OK* until you return to it.
2. Click *Print*.
3. Click the second option to print the selected class or device.
4. Click *OK*.
5. Repeat steps 1 through 4 for each device that you changed during this troubleshooting process.

This should correct the problem, and you should be done.

Step 20: Some resources are still conflicting Set resources to conflict with only one device:

1. Double-click a resource that is still conflicting. If you see a message that says “You must clear the *Use automatic settings* box before you can change a resource setting,” click *OK* to close the message, then clear the *Use automatic settings* box.
2. Scroll through the available resource settings. For each value, write down the setting and the name of the hardware it conflicts with. Then click *Cancel*.
3. Repeat steps 1 and 2 for each conflicting resource.
4. Looking at the list, see if you can change the resource settings so that they conflict with only one device—preferably one you could disable.

Are all conflicts with one device?

- If all the conflicts are with only one device, go to Step 11.
- If resources still conflict with more than one device, there is no further solution to the problem, and you should probably remove the conflicting device.

Step 21: Disable the unneeded device Determine whether the hardware you want to disable is Plug-and-Play:

1. Select each resource setting that conflicts with the hardware you will disable, and then click *OK*.
2. When the message appears saying the setting conflicts with another device, click *Yes* to continue.

278 Conflict Troubleshooting

3. Click *OK* until you return to the hardware list.
4. Click the plus sign (+) next to the type of hardware that you want to disable.
5. Double-click the hardware that you want to disable.
6. In the *Device usage* area, click the box next to the configuration marked “Current” to remove the check mark.
7. Click the *Resources* tab.
8. If there is a *Set configuration manually* button, Windows 95 can disable and free up resources used by this hardware without your removing its card from your computer.

Do you see a *Set configuration manually* button?

- If the button exists, you can effectively disable the device, so go to Step 19.
- If the button is not available, go to Step 25.

Step 22: All devices are in use Write down a list of all devices using resources:

1. Scroll through the resource settings. On a piece of paper, write down the name of each piece of conflicting hardware and its setting.
2. Click *Cancel* until you return to the hardware list.

Rearrange resource settings for conflicting hardware:

1. On the hardware list, click the plus sign (+) next to the hardware type for the first item on your written list.
2. Double-click the hardware.
3. Click the *Resources* tab.
4. Double-click the resource setting that you wrote down. If you see a message that says

“You must clear the *Use automatic settings* box before you can change a resource setting,” click *OK* to close the message, then clear the *Use automatic settings* box.

5. Scroll through the available resource settings. For each setting, look in the *Conflicting device list* box to see if it conflicts with any other hardware.
6. If you find a free setting other than the one you wrote down, write down the new values, and continue.
7. If you do not find a free setting, repeat steps 1 through 5 until you run out of hardware to try or you find a free setting.

Did you find a free resource setting?

- If you found free resources, go to Step 26.
- If you could not locate free resources, go to Step 27.

Step 23: Resource information is available Check to see if the device can use a different resource:

1. Click the *Resources* tab.
2. In the *Resource settings* box, double-click the resource setting that you need to free for the other device. If you see a message that says “You must clear the Use Automatic Settings box before you can change a resource setting,” click *OK* to close the message, then clear the *Use automatic settings* box.

Recognizing And Dealing With Conflicts 279

3. Scroll through the available resource settings.
4. For each setting, look in the *Conflicting device list* box to see if it conflicts with any other hardware.
5. If you find a free setting, click *OK*. If you see a message prompting you to restart your computer, click *No*.

Did you find a free resource setting?

- If *Yes*, go to Step 28.

- If *No* (or the settings cannot be modified), go to Step 29.

Step 24: Resource information is not available Decide which device you should disable. Because both devices need to use the same resource setting, you must decide which device you want to use. You must disable and/or remove the other device.

It probably is easier to remove the device that had the original conflict. If you choose to remove the other device, you might see a message stating that you still have a conflict after completing the procedure. Just restart the procedure and continue resolving the conflict. Which device would you like to disable?

- If you'd rather disable the original device, go to Step 30.
- If you'd rather disable the other conflicting device, go to Step 31.

Step 25: Manual button not available Disable the conflicting hardware by removing it:

1. On the hardware list, click the plus sign (+) next to the type of hardware that you want to disable. If you do not see the hardware list, click *Cancel* until you return to it.
2. Click the hardware you want to disable.
3. Click *Remove*.

Go to Step 19.

Step 26: Free resources found Change the resource settings to utilize the free resources:

1. Save the new setting by clicking *OK*, then clicking *OK* again.
2. If you see a message about restarting your computer, click *No*.
3. Double-click the hardware that first had the conflict.
4. Click the *Resources* tab.
5. Double-click the resource that is conflicting. If you see a message that says "You must clear the Use Automatic Settings box before you can change a resource setting," click *OK* to close the message, then clear the *Use automatic settings* box.
6. Change the resource setting to the value you just freed. The *Conflicting device list* box might show a conflict with the other hardware that you just changed.
7. Click *OK*. If you see a message, click *Yes* to continue.

Go to Step 19.

280 Conflict Troubleshooting

Step 27: No free resources available You must disable some hardware to relieve the conflict. Do you want to disable the hardware that caused the original conflict?

- If you want to disable the hardware that originally caused the conflict, go to Step 18.
- If you must use all of the hardware in the system, there is no further solution to the problem because the conflict cannot be resolved.

Step 28: Free setting found Determine whether there are any remaining conflicts:

1. Click *OK* to return to the hardware list.
2. Double-click the device that had the original conflict.
3. Click the *Resources* tab.
4. See if there are any remaining conflicts listed in the *Conflicting device list* box.

Are there still conflicts listed?

- If all the resources are now set without any conflicts, go to Step 19.
- If some or all of the resources are still conflicting, go to Step 20.

Step 29: No free setting found You must decide which device to disable. Because both devices need to use the same resource setting, you must decide which device you want to use. You must disable and remove the other device.

It probably is easier to remove the device that had the original conflict at this point. If you choose to remove the other device, you might see a message telling you that you still have a conflict after you finish and restart your computer. Just restart this procedure and continue resolving the conflict.

Which device would you like to disable?

- If you choose to disable the device with the original conflict, go to Step 30.
- If you choose disable the other device that it is conflicting with, go to Step 31.

Step 30: Disable original conflicting device Determine whether you have to remove the card to disable the hardware:

1. On the hardware list, double-click the hardware that you want to disable. If you do not see the hardware list, click *Cancel* until you return to it.
2. In the *Device usage* area, be sure that there is a check in the box next to the configuration marked "Current." If the box isn't checked, check it now.
3. Click the *Resources* tab. If there is a *Set configuration manually* button, Windows 95 can free up resources for this hardware without your removing its card from your computer.

Recognizing And Dealing With Conflicts 281

If the conflict you just resolved is listed, you can ignore it. It will no longer conflict after you restart your computer later.

When you see a *Set configuration manually* button: If you do see that button, and there are no resource settings listed in the box, you'll need to restart your computer.

1. Click *OK*, then click *OK* again.
2. You might be prompted to restart your computer. Click *Yes*.

When you don't see a *Set configuration manually* button: if no button is available, you'll need to disable the physical hardware by removing it from the system.

1. On the hardware list, click the plus sign (+) next to the type of hardware that you want to disable. If you do not see the hardware list, click *Cancel* until you return to it.
2. Click the hardware you want to disable.
3. Click *Remove*, then click *OK*.

4. You might be prompted to restart your computer. You will have to remove the card for this hardware from your computer, so you need to shut down instead of restarting. Click *No*.
5. Click the *Start* button, click *Shut down*, then click *Yes*. When the message says it is safe to do so, turn off your computer and remove the card from your computer.
6. Restart your PC and check if your problem has been resolved.

This should correct the conflict and complete your troubleshooting procedure.

Step 31: Disable other conflicting device Determine whether you have to remove the card to disable the hardware:

1. On the hardware list, double-click the hardware that you want to disable. If you do not see the hardware list, click *Cancel* until you return to it.
2. In the *Device usage* area, click the box next to the configuration marked “Current” to remove the check mark.
3. Click the *Resources* tab. If there is a *Set configuration manually* button, Windows 95 can free up resources for this hardware without your removing its card from your computer.

Do you see a *Set configuration manually* button?

- If you see the button, go to Step 32.
- If you don't see the button, go to Step 33.

Step 32: Disable the other device Determine whether there are any remaining conflicts:

1. Click *OK* to return to the hardware list.
2. Double-click the device that had the original conflict.
3. Click the *Resources* tab.
4. See if there are any remaining conflicts listed in the *Conflicting device list* box. If the conflict you just resolved is listed, you can ignore it. It will no longer conflict after you restart your computer later. Are there still conflicts listed?

282 Conflict Troubleshooting

- If there are no further conflicts, go to Step 19.
- If one or more conflicts are still listed, go to Step 34.

Step 33: Remove the other device Disable hardware by removing it:

- 1 On the hardware list, click the plus sign (+) next to the type of hardware that you want to disable. If you do not see the hardware list, click *Cancel* until you return to it.
- 2 Click the hardware you want to disable.
- 3 Click *Remove*.

Go to Step 19.

Step 34: There are still some conflicts Try setting resources to conflict with only one device:

- 1.. Double-click a resource that is still conflicting. If you see a message that says “You

- must clear the *Use automatic settings* box before you can change a resource setting,” click *OK* to close the message, then clear the *Use automatic settings* box.
2. Scroll through the available resource settings. For each value, write down the setting and the name of the hardware it conflicts with, then click *Cancel*.
 3. Repeat steps 1 and 2 for each conflicting resource.
 4. Looking at the list, see if you can change the resource settings so that they conflict with only one device—preferably one you could disable.

Are all conflicts now with one device?

- When all the conflicts are with only one device, go to Step 11.
- If the resources still conflict with more than one device (or cannot be changed), there is no further solution to this problem, and you should probably remove the conflicting device.

The Role Of Plug-And-Play (Pnp)

Traditional PCs used devices that required manual configuration—each IRQ, DMA, I/O port, and memory address space had to be specifically set through jumpers on the particular device. If you accidentally configured two or more devices to use the same resource, a conflict would result. This would require you to isolate the offending device(s), identify available resources, and reconfigure the offending device(s) manually. Taken together, this was often a cumbersome and time-consuming process.

In the early 1990s, PC designers realized that it was possible to automate the process of resource allocation each time the system initializes. This way, a device needs only to be installed, and the system would handle its configuration without the assistance or intervention of the installer. This concept became known as “Plug-and-Play” (PnP), and it is now standard in the PC arena. PnP systems require three elements to function:

- PnP-compliant devices (such as video boards, modems, drive controllers, and so on).
- PnP-compliant BIOS (now used in all Pentium-class systems).
- PnP-compliant operating systems (like Windows 95).

Recognizing And Dealing With Conflicts 283

When the PnP system works properly, a PnP device can be installed in an available expansion slot on a PnP-supported motherboard (with a PnP BIOS). When Windows 95 starts, it recognizes the new PnP device, assigns resources, then attempts to install the proper protected-mode driver (which could be installed from manufacturer’s floppy disk or a Windows 95 installation CD). Thereafter, the system “remembers” the new device and reconfigures it each time the system starts. Ideally, if the PnP device is ever removed, Windows 95 would automatically clear the device from its “system,” and free the resources for other devices. However, if any of these elements are missing, devices will not be “auto-configured.” For example, PnP won’t work under DOS (though there are DOS PnP drivers that can be used to initialize PnP devices). Older, jumper-configured devices (called *legacy devices*) also won’t support PnP, and resources need to be reserved for legacy devices to prevent the PnP system from ignoring them entirely.

