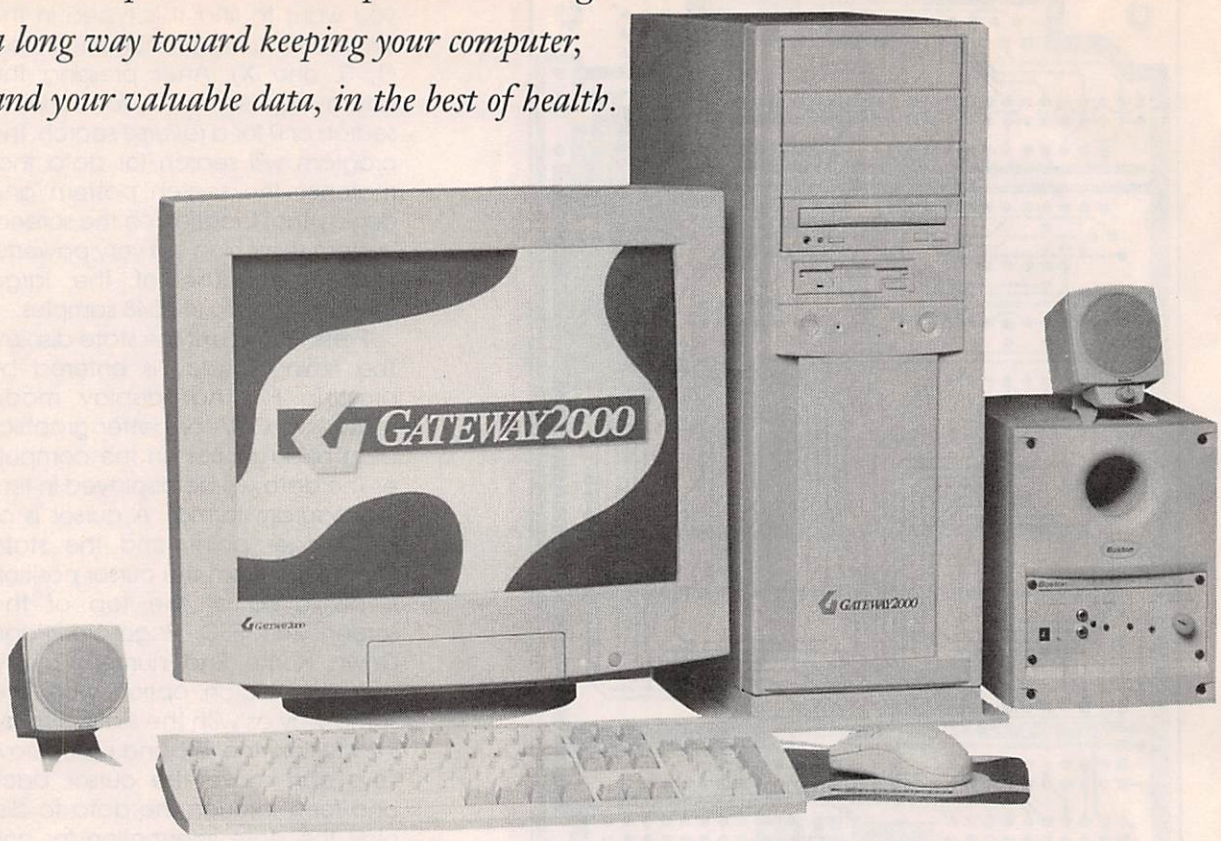
These simple maintenance procedures can go a long way toward keeping your computer, and your valuable data, in the best of health.



MAINTAINING YOUR OWN PC

STEPHEN J. BIGELOW

For most of us, the purchase of a personal computer, or PC, is a substantial investment of both time and money. But after the money is spent and the PC is in our home or office, few PC users ever take the time to properly maintain their PC. That's unfortunate, as routine maintenance is an important part of PC ownership and can go a long way toward keeping your computer's hardware and software error-free. Proper routine maintenance, following the schedule outlined in Table 1, can also help to avoid costly visits to your local repair shop; in the U.S., labor alone can run $50-$70/hour. That's where this article comes in: In the pages that follow we will provide you with a comprehensive, step-by-step procedure for protecting and maintaining your personal-computer investment.

Protecting Your Data. It's interesting to note that the data recorded on a computer's hard drive is often far more valuable than the drive itself. But if the drive fails, your precious data is usually lost along with the hardware. Months (perhaps years) of records and data could be irretrievably lost. It goes without saying then that one of the first steps in any routine maintenance plan is to make regular backups of your system's contents—as well as the system's configuration. Backups ensure that you can recover from any hardware glitch, accidental file erasure, or virus attack.

File backups are important for all types of PC users from major corporations to occasional home users. By creating a "copy" of your system files (or even just a part of them), you can restore the copy and continue working in the event of a disaster. Before you proceed with any type of system checks, consider performing a file backup.

You're going to need two items in order to backup your files; a "backup drive" and backup software. The actual choice of backup drive is really quite open. Tape drives such as the Iomega Ditto drive (www.iomega.com) or the MicroSolutions 8000t 8GB "Backpack" drive (www.micro-solutions.com) are the traditional choice, but other high-volume removable media drives like Iomega's 100MB Zip drive, their 1GB Jaz drive, or the SyQuest 1.5GB SyJet drive (www.syquest.com) are also very popular. Most drives are available in both internal and external configurations. One advantage of an external drive, particularly one that interfaces to your PC via its parallel port, is that it is portable—it can be shared between many PCs.

You'll also need some backup

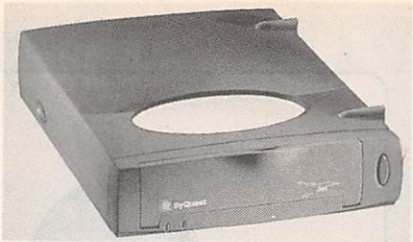
software to format the media, and handle your backup and restore operations. If you're using Windows 95, try the native Backup applet (click on *Start, Programs, Accessories, System Tools,* and *Backup*). If Backup doesn't suit your needs, many drives ship with a backup utility on diskette. Just make sure that the backup drive and backup software are compatible with one another.

Backups generally fall into two categories; incremental and complete. Both types of backups offer unique advantages and disadvantages. An incremental backup only records the "differences" from the last backup. That usually results in a faster backup procedure and uses less tape (or other media), but restores take longer because you need to walk through each "increment" in order. A complete backup records the drive's full contents. That takes much longer and uses a lot more media, but restores are easier. Many PC users use a combination of complete and incremental backups. For example, you might start with a complete backup on January 1, then make incremental backups each week until the end of February. By March 1, you'd make another complete backup and start the incremental backup process again.

Perhaps the most overlooked issue with backups is the frequency—how often should backups be performed? The answer to that question is not always a simple one, because everyone's needs are different. Major corporations with busy order-entry systems may backup several times each day, while individual home users may not even consider backups to be necessary. The standard that I use is this; can you afford to lose the data on this drive? if the answer is "no," it's time to back up.

Regardless of how you choose to handle file backups, there are some tips that will help you get the most from your backup efforts:

- Keep the backup(s) in a secure location (such as a fire-proof safe or cabinet).
- Keep the backup(s) in a different location than the original PC.



High-volume removable media, like this SyQuest 1.5GB SyJet drive, can make the job of backing up your data easier.

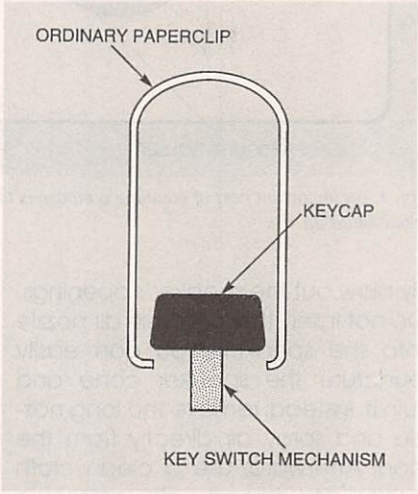


Fig. 1. To get at a sticky or unresponsive key switch, you can use an ordinary paper clip, bent as shown, to remove the keycap.

- Back up consistently—backups are useless if they are out of date.
- If time is a factor, start with a complete backup, and then use incremental backups.
- Use a parallel port tape drive (or other "backup" drive) for maximum portability between PCs.

CMOS Backups. All PCs use a sophisticated set of configuration settings (everything from "Date" and "Time" to "Video Palette Snoop" and "Memory Hole") that defines how the system should be operated. Those settings are stored in a small amount of very low power memory called CMOS RAM. Each time the PC starts, motherboard BIOS reads the CMOS RAM, and copies the contents into low system memory (the BIOS Data Area). While system power is off, CMOS RAM contents are maintained with a small battery. If that battery goes dead, CMOS contents can be lost. In most cases, that will prevent the system from even starting until you reconfigure the CMOS setup from scratch. By making a backup of the CMOS setup, you can restore lost settings in a matter of minutes. CMOS backups are simply printed screens of your CMOS setup pages.

From the above, it is obvious that the one item that you'll need to perform a CMOS backup is a printer—it really doesn't matter what kind of printer (*i.e.* dot-matrix, ink jet, or laser). The printer should be attached to the PC's parallel port. After starting the CMOS setup routine, visit each page of the setup, and use the <Print Screen> key to "capture" each page to the printer. Since every BIOS is written differently, be sure to check for submenus that might be buried under each main menu option.

CMOS backups are quick and simple, but you'll get the most benefit from a CMOS backup by following these pointers:

- Make it a point to print out *every* CMOS Setup page.
- Keep the printed pages taped to the PC's housing or with the system's original documentation.
- You should back up the CMOS setup whenever you make a change to the system's configuration.

Cleaning. Now that you've backed up the system's vital information, you can proceed with the actual maintenance procedures. The first set of procedures involves exterior cleaning. That hardly sounds like a glamorous process, but you'd be surprised how quickly dust, pet hair, and other debris can accumulate around a computer. You'll need four items for cleaning; a supply of Windex or another mild ammonia-based cleaner (a little ammonia in water will work just as well), a supply of paper towels or clean lint-free cloths, a canister of electronics-grade compressed air (which can be obtained from any electronics store), and a small static-safe vacuum cleaner.

Note: Avoid the use of ordinary household vacuum cleaners. The rush of air tends to generate significant amounts of static electricity along plastic hoses and tubes, which can accidentally damage the sensitive electronics in a PC. Also, *never*

use harsh or industrial-grade cleaners around a PC. Harsh cleaners often contain chemicals that could damage the finish of (or even melt) the plastics used in PC housings. Use a highly diluted ammonia solution *only*.

As a rule, exterior cleaning should be performed every four months (three times per year) or as required. If the PC is operating in dusty, industrial, or other adverse environments, you may need to clean the system more frequently. Systems operating in clean office environments may only need to be cleaned once or twice each year. Always remember to turn off the computer, and unplug the AC cord from the wall outlet before cleaning.

To clean the case, use a clean cloth lightly dampened with ammonia cleaner to remove dust, dirt, or stains from the exterior of the PC. Start at the top and work down. Add a little bit of extra cleaner to remove stubborn stains. You'll find that the housing base is typically the dirtiest (especially for tower systems). When cleaning, be careful not to accidentally alter the CD-ROM volume or sound-card master-volume controls. Also do not dislodge any cables or connectors behind the PC.

Note: Always dampen a clean towel with cleaner—*never* spray cleaner directly onto any part of the computer.

While cleaning the case, pay particular attention to the air intake(s), usually located in the front (or front sides) of the housing. Check for accumulations of dust or debris around the intakes or caught in an intake filter. Clean away any accumulations from the intake area, and then use your static-safe vacuum to clean the intake filter if possible—you might need to remove the intake filter for better access. If the intake filter is washable, you might choose to rinse the filter in simple soap and water for the best cleaning (remember to dry the filter thoroughly before replacing it). Of course, if there is no intake filter, simply clean around the intake area.

Multimedia speakers offer a countless number of ridges and openings that are just perfect for accumulating dust and debris. Use your can of compressed air to gently blow out the speaker's openings. Do not insert the long, thin air nozzle into the speaker—you can easily puncture the speaker cone and ruin it. Instead, remove the long nozzle and spray air directly from the can. Afterward, use a clean cloth lightly dampened with ammonia solution to remove any dirt or stains from the speaker housings.

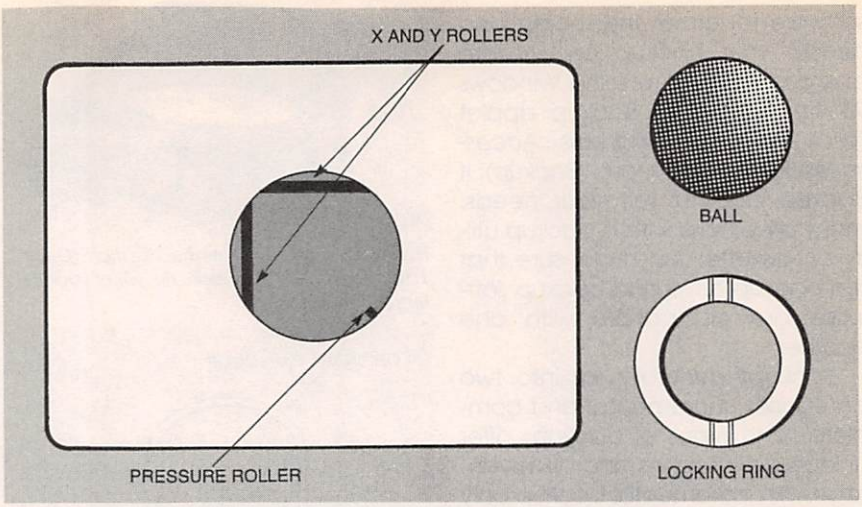


Fig. 2. An important part of cleaning a mouse is to make sure the internal rollers are free of dirt and grime build up.

Keyboards are open to the environment, so dust and debris readily settle between the keys. Over time, those accumulations can jam keys or cause repeated keystrokes. Attach the long thin nozzle to your can of compressed air, and use the air to blow through the horizontal gaps between key rows. Be careful—this will kick up a lot of dust—so keep the keyboard away from your face. Afterward, use a clean cloth lightly dampened with ammonia solution to remove dirt or stains from the keys and keyboard housing. If any keys seem unresponsive or "sticky," you can remove the corresponding keycap (see Fig. 1) and spray a bit of good-quality electronic contact cleaner into the key assembly; then gently replace the keycap.

Note: Do not remove the <Enter> key or <Space Bar>. Those keys are held in place by metal brackets that are *extremely* difficult to re-attach once the key is removed. Only the most experienced technicians should work with these keys.

There are several important areas to deal with when cleaning a monitor: ventilation, case, and CRT. Monitors rely on vent openings for proper cooling. Use your vacuum cleaner, and carefully remove any accumulations of dust and debris from the vents underneath the case, as well as those on top of the case. Make sure that none of the vent openings are blocked by paper or other objects (that can restrict ventilation and force the monitor to run hot).

Next, use a clean cloth lightly dampened with ammonia solution to clean the monitor's plastic case. There is active circuitry directly under the top vents, so under no circumstances should you spray cleaner directly onto the monitor housings. Do *not* use ammonia or *any* chemicals to clean the CRT face. The CRT is often treated with anti-glare and other coatings, and even mild chemicals can react with some coatings. Instead, use clean tap water only to clean the CRT face. Be sure to dry the CRT face completely.

Like the keyboard, a mouse is particularly susceptible to dust and

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debris, which are carried from the mouse pad up into the mouse ball and rollers. When enough foreign matter has accumulated, you'll find that the mouse cursor hesitates or refuses to move completely. Loosen the retaining ring and remove the mouse ball. Clean the mouse ball using a clean cloth and an ammonia solution. Dry the mouse ball thoroughly, and set it aside with the retaining ring. Next, locate three rollers inside the mouse (an "X" roller, a "Y" roller, and a small "pressure" roller as shown in Fig. 2). Use a clean cloth dampened with ammonia solution to clean all of the rollers completely. Use your can of compressed air to blow out any remaining dust or debris that may still be inside the mouse. Finally, replace the mouse ball, and secure it into place with its retaining ring.

Checking Cables and Connections. Now that the system is clean, it's time to perform a few practical checks of the system interconnections. There are a myriad of external cables interconnecting the computer to its peripheral devices. You should examine each cable and verify that it is securely connected. If the cable can be secured to its connector with screws, make sure that the cable is secured properly. As a minimum, check the following cables:

- AC power cable for the PC
- AC power cable for the monitor
- AC power cable for the printer
- AC/DC power pack for an external modem (if used)
- Keyboard cable
- Mouse cable
- Joystick cable (if used)
- Video cable to the monitor
- Speaker cable(s) from the sound board
- Microphone cable to the sound board (if used)
- Serial-port cable to external modem (if used)
- Parallel-port cable to printer
- RJ11 telephone-line cable to internal or external modem (if used)

Cleaning Drives. In spite of their age, floppy disks remain a reliable and highly-standardized media, and

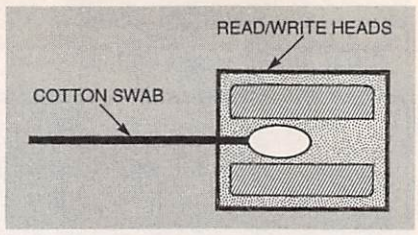

Fig. 3. If you don't have a drive-cleaning kit, use an electronics-grade swab dampened with isopropyl alcohol to scrub between the read/write heads. Note that the view here is looking into the drive from the floppy door.

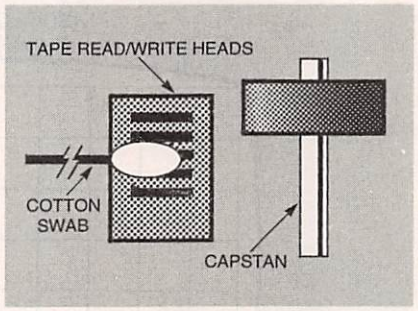

Fig. 4. You can also use an isopropyl-alcohol-dampened swab to clean the tape heads and capstan in a tape drive. Again, this view is looking into the drive from the tape door.

every new PC sold today still carries a 3.5-inch 1.44MB floppy drive. However, floppy disks are a "contact" media—the read/write heads of the floppy drive actually come into contact with the floppy disk. That contact transfers some of the magnetic oxides from the floppy disk to the drive's read/write heads. Eventually, enough oxides can accumulate on the read/write heads to cause reading or writing problems with the floppy drive. You should periodically clean the floppy drive to remove any excess oxides.

Cleaning can be accomplished in several ways: you can use a prepackaged "cleaning kit", or swab the read/write heads with fresh isopropyl alcohol. You can obtain prepackaged cleaning kits from almost any store with a computer or consumer-electronics department. With a cleaning kit, you simply dampen a mildly abrasive "cleaning diskette" with cleaning solution (typically alcohol-based), and then run the cleaning diskette in the drive for 15-30 seconds. You can often get 10 to 20 cleanings from a cleaning diskette before discarding it.

If you don't have a cleaning kit handy, you can use a long, thin, electronics-grade fabric swab dampened in fresh isopropyl alcohol, and gently scrub between the read/write heads (see Fig. 3). Remember to turn off and unplug the PC before attempting a manual cleaning. Repeat the scrubbing with several fresh swabs, and then use a dry swab to gently dry the heads. Allow several minutes for any residual alcohol to dry before turning the PC back on.

As with floppy drives, tape drives are also a "contact" media, and the tape head is in constant contact with the moving tape. That causes oxides from the tape to transfer to the tape head and capstans, and that can ultimately result in reading or writing errors from the tape drive. If a tape drive is present with your system, you should periodically clean the tape head(s) and capstans to remove any dust and excess oxides. You might be able to find a pre-packaged drive cleaning kit for your particular tape drive. Otherwise, you'll need to clean the tape drive manually.

Turn off and unplug the PC. As with the floppy drive, use an electronics-grade swab dampened in fresh isopropyl alcohol to gently scrub the tape head(s) and capstan (see Fig. 4). Repeat the scrubbing with several fresh swabs, then use a dry swab to gently dry the tape head(s). Allow several minutes for any residual alcohol to dry before turning the computer back on.

Miscellaneous Checks. Most CD-ROM drives operate using a "tray" to hold the CD. Try ejecting and closing the tray several times—make sure that the motion is smooth, and that there is no hesitation or grinding that might suggest a problem with the drive mechanism. While the tray is open, check for any accumulations of dust, pet hair, or other debris in the tray that might interfere with a CD. Clean the tray with a cloth lightly dampened in water (only). Be sure that the tray is completely dry before closing it again. Do not use ammonia or ammonia-based cleaners around the CD-ROM—prolonged exposure to ammonia vapors could damage a CD.

Next, you should make sure that your sound system is set properly.

Begin by playing an ordinary audio CD in the CD-ROM drive. Check the sound board itself, and locate the master volume control (not all sound boards have a physical volume knob). Make sure that the master volume is set at 75% or higher. If not, you might need to keep the speaker volume abnormally high, and that can result in a hum or other noise in the speakers. If the sound board does not have a master volume control, check the board's "mixer" applet (see Fig. 5), and see that the master volume is set properly. Once the sound board is set, you can adjust the speaker volume to achieve the best sound quality.

Note: Speakers are magnetic devices that can interfere with the color purity of a monitor. Keep unshielded speakers at least 6 inches away from your monitor.

Here's more on that topic: Color monitors use a fine metal screen located just behind the CRT face in order to isolate the individual color pixels in the display. That ensures that stray electrons don't strike adjacent phosphors and cause incorrect colors. If part or all of that metal screen becomes magnetized, it will deflect the electron beams and cause color distortion. Normally, a color CRT is demagnetized (or "degaussed") each time the monitor is turned on. That is accomplished through a "degaussing coil" located around the perimeter of the CRT face. However, if the CRT is subjected to external magnetic fields (such as unshielded speakers, motors, or other strong magnets), it may cause color problems across the entire CRT or in small localized areas as shown in Fig. 6.

Check the CRT for color purity by displaying an image of a known color (preferably white). Examine the image for discoloration or discolored areas. For example, if you display an image that you know is white, and it appears bluish (or there are bluish patches), chances are that you've got color purity problems.

There are three ways to correct color-purity problems. First, try moving anything that might be magnetic (such as speakers) away from the monitor. Second, try degaussing the monitor by turning it off, waiting 30 seconds, and then turning it on again. That allows the monitor's built-in degaussing coil to cycle. If the problem persists, wait 20-30 minutes and try cycling the monitor again. Finally, if the image is still discolored, you should take the monitor to a technician who can use a hand-held degaussing coil.

Fig. 5. If the sound board does not have a master volume control, check the board's "mixer" applet and make sure that the master volume is set properly.

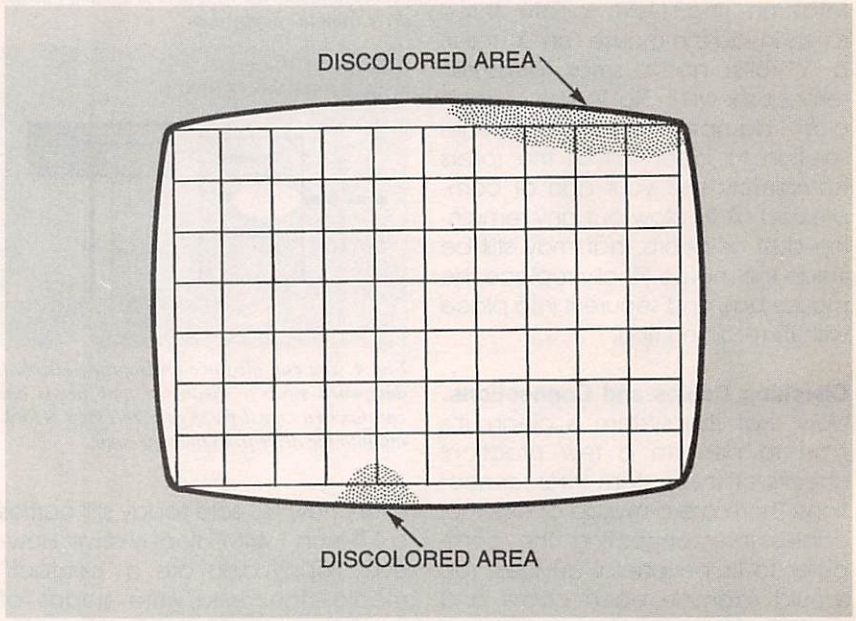

Fig. 6. Color purity problems, which are often caused by external magnetic fields like those generated by improperly shielded speakers, show up as discolored areas.

Internal Checks. At this point, we can move into the PC itself and perform some internal checks to verify that critical parts and cables are secure and that all cooling systems are working. Internal checks should usually be performed every six months (twice per year). Gather a small Philips screwdriver and an anti-static wrist strap. Use your screwdriver to unbolt the outer cover. Remove the outer cover (careful for sharp edges), and set it aside. Attach the wrist strap from your wrist to a good earth ground; that allows you to work safely inside the PC without the risk of accidental damage from electrostatic discharge (or ESD).

If you don't have a wrist strap, here's what and what not to do: Avoid wearing clothes made of synthetic materials or silk; cotton or cotton-blend clothing is better. Also, do not wear rubber-soled shoes. Keep some part of your skin in good contact with the PC's bare-metal frame, both before and while you are working inside the machine; that keeps both you and the circuitry (especially the $500 CPU) at the same electrical potential. The best way to meet that last requirement is to either grab the frame with one hand as you work or to roll up your sleeve and lean on the frame with your forearm.

PCs tend to generate a substantial amount of heat during normal operation, and that heat must be ventilated with fans. If one or more fans fail, excess heat can build up in the PC enclosure and result in system crashes or premature system

TABLE 1—PC MAINTENANCE SCHEDULE

Procedure	Frequency
File Backup	Whenever important data cannot be recreated Order Entry—daily Business/Art/Multimedia—weekly SOHO/Accounting—bi-weekly or monthly Home Use—every several months
CMOS Backup	Whenever changes are made to the system's configuration
Cleaning	Every 4 months, or as required Vacuum-clear accumulations of dust and debris as required
External Check	Every 4 months
CRT Degauss	Only if necessary
Internal Check	Every 6 months
Drive Check	Monthly, or when major files are added/deleted from the system
Boot Disk	Update disk whenever hardware changes are made to the system

failures. Now that the cover is off, your first check should be to see that all the fans are running. As a minimum, check the power-supply fan, the case-exhaust fan (both usually located at the rear of the enclosure), and the CPU heat sink/fan. Some PCs, such as those housed in full-sized tower enclosures, could sport even more fans. If any fans are not running, they should be replaced—or the system should be serviced by an experienced technician who can replace defective fans.

Pay particular attention to the CPU heat sink/fan. Virtually all Intel Pentium/Pentium MMX/Pentium II, AMD K5/K6, and Cyrix 6x86/M2 CPUs are fitted with a heat sink/fan. That fan *must* be running, or the CPU runs a very real risk of overheating and failing. If you notice that the fan has stopped, you should have the heat sink/fan assembly replaced *as soon as possible*.

Now for the cleaning: Turn off and unplug the PC, and then examine the fans and exhaust filters for accumulations of dust or other debris. Use your static-safe vacuum to clean the fan blades. Clean away any accumulations from the exhaust area, and then clean the exhaust filter if possible—you may need to remove the exhaust filter for better access. If the exhaust filter is washable, you may choose to rinse the filter in simple soap and water for best cleaning (remember to dry the filter thoroughly before replacing it). Of course, if there is no exhaust filter, simply clean around the exhaust area. Also vacuum away any other accumulations of dust that you might find on the motherboard or around the drives, but be very careful to avoid vacuuming up the little jumpers on the motherboard!

Note: Remember that PC electronics are *extremely* sensitive to ESD (electrostatic discharge), so make sure to use a static-safe vacuum inside the PC.

Most PCs use several expansion boards that are plugged into expansion slots on the motherboard. Internal modems, video boards, SCSI adapters, and network cards are just a few types of expansion boards. Each expansion board must be inserted completely into its corresponding slot, and the metal mounting bracket on the board should be secured to the chassis with a single screw. Make sure that every board is installed evenly and completely, and see that the mounting bolts are good and tight.

You'll notice that there are a large number of cables inside the PC. Each cable must be installed securely—especially the wide ribbon cable connectors that can easily be tugged off. Take a moment to check any wiring between the case and the motherboard such as the keyboard connector, power LED, on/off switch, drive activity LED, turbo switch, turbo LED, and so on. Next, check the following cables:

- Motherboard power connector(s)
- All four-pin drive-power cables
- Floppy-drive ribbon cable
- Hard-drive ribbon cable
- CD-ROM ribbon cable (usually separate from the hard-drive cable)
- CD four-wire audio cable (between the CD-ROM and sound board)
- SCSI ribbon cable (if used)
- SCSI terminating resistors (if used)

Memory is most often provided in the form of SIMMs (single in-line memory modules), which simply clip into sockets on the motherboard. Loose SIMMs can cause serious startup problems for the PC. Examine each SIMM—verify that they are inserted properly into each socket and that both ends of each SIMM are clipped into place. Some newer PCs use DIMMs (dual in-line memory modules) instead of SIMMs; those should also be checked as outlined above.

The CPU is the single largest IC on the motherboard and it is usually installed into a ZIF (zero insertion force) socket for easy replacement or upgrade. Examine the CPU, and see that it is inserted evenly into its socket. The ZIF socket lever should be in the "closed" position and locked down at the socket itself. Check the placement of the CPU's heat sink/fan next—it should sit flush against the top of the CPU. It should not slide around or be loose. If it is, the heat sink/fan should be secured

or replaced.

The final step in your internal check should be to inspect the drive mountings. Each drive should be mounted in place with four screws—the use of fewer screws could allow excessive vibration in the drive, which could lead to premature failure. Make sure that each drive has four mounting screws, and use your Philips screwdriver to tighten each bolt.

Note: Do not overtighten the bolts. That can actually warp the drive frame and cause errors or drive failure.

Checking the Hard Drive. After the PC has been cleaned and checked inside and out, it's time to test the hard drive for potential problems. That 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. For those using Windows 95, those utilities are already built into the operating system so you can reboot the PC and use those utilities directly. If you are not running Windows 95 or are more comfortable with running those utilities from DOS, create a "startup disk" (more on that in a moment) and boot from that; then run ScanDisk and Defrag right from the startup disk. As a rule, you should perform the drive check very regularly—once a month is usually recommended; or whenever you make major additions or deletions from your system.

Your PC should always have a boot disk that can start the system from a floppy drive in the event of an emergency. Windows 95 has the ability to create a "startup disk" automatically. 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 DOS A: prompt.

The ScanDisk utility is designed to check your drive for file problems (such as lost or cross-linked clusters) and then correct those problems. If you're running from the startup disk, start ScanDisk by typing:

A:\> scandisk<Enter>

If you're running from Windows 95, click *Start, Programs, Accessories, System Tools,* and *ScanDisk.* Select the drive to be tested, and start the test cycle. ScanDisk will report any problems and give you the option of repairing the problems.

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. That 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 file clusters to be relocated together. If you're running from the Startup Disk, start Defrag by typing:

A:\> defrag<Enter>

If you're running from Windows 95, click *Start, Programs, Accessories, System Tools,* and *Disk Defragmenter.* Select the drive to be tested, and start the cycle. Defrag will relocate every file on the disk so that all their clusters are together.

Note: You can run Defrag any time, but you do not *need* to run Defrag until your disk is more than 10% fragmented.

Conclusion. That concludes the maintenance procedure for your PC. Now you can replace the outer cover and bolt it back into place (be careful of sharp edges). After the enclosure is secure, reboot the system and perform a final test of some of the major applications—the system should perform exactly the same as it did before. By performing this routine maintenance, you can keep your PC running longer and save on expensive down-time or trips to the shop. Ω

LOGIC ANALYZER

(continued from page 43)

had to be met (with bit 0 at 0).

Experiment with the different clock rates, trigger modes, and trigger values. Also be sure to use all of the probes on signal Q7 in order to verify that all of the channels on the analyzer are working. One final note concerning the "A" then "B" trigger mode: only the lower 4 bits (0-3) of each trigger value are valid. Once you have tried all the options, you are ready to use the logic analyzer on other circuits.

A logic analyzer is a very valuable tool for working with digital logic. It can be used to verify timing relationships or for troubleshooting digital logic. The author welcomes any questions, comments, or suggestions on this project. He can be contacted by e-mail at alta@gutbang.com, by telephone at (860) 489-8003, or by visiting the Alta Engineering Web site at www.gutbang.com/alta.