SERVICE DIAGNOSTICS

Professional PC Diagnostic User's Manual

LANDMARK
RESEARCH INTERNATIONAL CORPORATION

Service Diagnostics™

Advanced PC Diagnostics

User's Manual

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Congratulations!

You are now among the ranks of thousands of successful technicians and advanced end-users that rely on the solid performance of Service Diagnostics. Large manufacturers, OEMs, distributors, and dealers around the world agree that Service Diagnostics is a power-packed product that delivers results with stunning accuracy! We encourage you to read further to see why Service Diagnostics earned the distinction of *PC Magazine* Editor's Choice!

A Short History Lesson

The roots of Service Diagnostics can be traced to the days when CP/M dinosaurs walked the earth. As you know, the dinosaurs died out years ago, but Service Diagnostics has evolved to take on the special needs of today's IBM-compatible machines, regardless of the operating system. For over 10 years, our engineering team has been working hard to tweak compatibility and add exciting new features to ensure that Service Diagnostics will continue to reliably meet your exacting specifications.

System Requirements

Service Diagnostics is not demanding of your system resources, however, there are a few fundamental requirements:

- IBM PC, XT, AT-286, AT-386, AT-486, PS/2, or 100% compatible
- System base memory - 128K (XT), 256K (AT)
- Not operating-system dependent (DOS version requires DOS v2.1 or later)
- One floppy drive - 360K 5¼ inch, or 720K 3½ inch

Who Can Benefit?

Everyone! - Service Diagnostics was designed from the ground up to handle the needs of sophisticated service technicians. System testing, burn-in, and configuration has never been easier. However, manufacturers, distributors, dealers, educators, and end users have needs for which Service Diagnostics is the ideal tool.

• **Service Technicians** - Many diagnostics on the market are *subdued* in order to maintain compatibility with the industry's broad machine types. Service Diagnostics, however, is available in modules that are *specific* to the various platforms currently in existence. Each module offers *serious* tools that help get machines back online quickly. After work is completed, Service Diagnostics will ensure that repairs are sound and have not affected other areas of the machine.

• **Manufacturers** - Service Diagnostics is the ideal tool for a burn-in procedure as new machines or devices come off the line. When units are repaired under manufacturer warranty, Service Diagnostics will help to efficiently complete the repair. Reports can be generated by Service Diagnostics to boost credibility with distributors because Quality Control is often the standard by which manufacturers are measured.

• **Distributors** - When evaluating new products to distribute, Service Diagnostics can provide a picture as to the extent of "IBM-compatibility." Reports can be generated by Service Diagnostics for shipment with the product to dealers.

• **Dealers** - Nothing upsets a client more than getting a new or newly-repaired unit home and having it fail shortly thereafter. By using Service Diagnostics to configure and burn-in units before they go out the door, dealers can reduce returns.

• **Educators** - As a utility for CMOS setup editing, low-level formatting, partition table editing, and bad-sector mapping, Service Diagnostics can help students learn the fundamentals of building a system from scratch. Advanced courses in troubleshooting are supported by Service Diagnostics' ability to test memory, DMA and Interrupt Controllers, timers, CMOS RAM, RTC, and other board-level components.

• **End Users** - For the curious, Service Diagnostics exposes the innermost facets of today's IBM compatibles. Maybe you feel that you are being overcharged for service of your computer. Service Diagnostics can pinpoint the problem before the technician looks at your system!

First Things To Do

• **Inspect the package** - Although Landmark makes every attempt to provide complete packages, from time to time an item might be overlooked. If you find that an item is missing, a quick call to our Customer Service Department will rectify the situation.

All modules include:

- This manual,
- Registration card,
- 25-pin parallel loopback plug (female),
- 25-pin serial loopback plug (male),
- 9-pin serial loopback plug (male).

The Kit versions include:

- 3½ inch and 5¼ inch calibrated alignment disks,
- AT ROM POST,
- XT ROM POST.

Software - To accommodate new platforms or variations on existing platforms, the actual program disks may vary in content. You can be assured, however, that the modules purchased will be present on a combination of 3½ inch and 5¼ inch disks. If this is not the case, check the items against your invoice and call Customer Service if you believe that an item might be missing.

Note: Any other variance previously agreed upon with your Product Consultant will be reflected on the invoice.

• **Register Your Product** - As noted above, you should have received a registration card. In order to ensure continued support from Landmark, please complete *and* mail the registration card. The serial number can be found on the bottom of the vinyl case. Your warranty, of course, is still valid without the registration card.

• **Backup, Backup, Backup!** - As of v2.12, Service Diagnostics can be backed up using an image copy such as "*DISKCOPY*". All disks eventually wear out, especially when they are used frequently, as is the case with diagnostic software. Our warranty provides for the replacement of disks that expire prematurely, but a backup will ensure you of uninterrupted service.

If the Unexpected Happens...

• **Customer Service** - If your package is missing a component, a component is found to be defective, or a component fails within the warranty period, and the product was purchased directly from Landmark, please contact our Customer Service Department. They will be happy to service your needs. If the product was obtained through a distributor or dealer, please contact the distributor or dealer for support.

• **Technical Support** - Sometimes additional information is required to better apply Service Diagnostics to a particular case. If you are in need of information beyond that which is presented here, please feel free to contact your supplier's Technical Support Department. If the product was purchased directly from Landmark, you will find that our Technical Support is unsurpassed.

• **RMA Procedures** - If it is necessary to return your product for any reason (ie. exchange, replacement, repair), *first* contact your supplier's Technical Support Department. A Technical Support Agent will provide instructions for packaging, marking, and shipping your product to a factory-authorized repair facility. Additionally, an *RMA number* will be provided to ensure proper handling of your package. If Landmark is your direct supplier, please contact Landmark's Technical Support Department directly at:

- (800) 683-0854 (continental U.S.)
- (813) 443-1331 (outside U.S.)
- Hours: 9AM - 6PM EST

References - For more detailed information concerning PC maintenance and repair, we recommend the titles in Table 1:

Table 1. References for Additional Study

Publication	Author	Publisher	Date
Computer Troubleshooting and Maintenance	Walter J. McBride	San Diego, CA: Harcourt Brace Jovanovich	1988
The Computer Glossary	Alan Freedman	New York, NY: Amacom	1991
Inside the IBM PC	Peter Norton	New York, NY: Simon and Schuster	1987
Upgrading and Repairing PCs	Scott Mueller	Carmel, IN: Que Corporation	1988
Installing a Personal Computer System	William E. Perry	Wellesley, MA: QED Information Sciences	1989
Starting Out Right (video tape)	Colin Mick	Stanford, CA: Understanding Personal Computers	1983
The Brady Guide to Microcomputer Troubleshooting	Henry F. Beechold	New York, NY: Prentice Hall Press	1986
The Complete Computer Maintenance Handbook	David Bellin	New York, NY: Harper & Row	1986
The Complete IBM Personal Computer	Novogrodsky, Seth, et alia	New York, NY: Simon and Schuster	1986
The PC Configuration Handbook	John Woram	New York, NY: Bantam Books	1987
Towards a New Concept of Computer Hardware	Louis Grail	Paris, France: Organization for Economic Co-operation	1982
Webster's New World Dictionary of Computer Terms	Webster's	New York, NY: Prentice Hall	1988

Starting Service Diagnostics

To start Service Diagnostics, insert the key diskette into drive A: and reboot the system. There are two types of Service Diagnostics, DOS based and stand-alone (bootable). When using a DOS version of Service Diagnostics, boot DOS from a clean system disk (that is, one which does not install terminate-and-stay-resident programs or device drivers other than LIM/EMS/expanded-memory drivers and uses as simple a CONFIG.SYS as possible). If you have an AT, type:

C> ATSERV

If you have a PC or XT, type:

C> XTSERV

If you have a PS/2 Model 20, 25, or 30, type:

C> 30SERV

If you have a MicroChannel PS/2, type:

C> MCSERV

In addition, the standard input of Service Diagnostics can be redirected. This means that you may enter the intended keystrokes into a DOS file (such as REDIRECT) and list that file on the command line preceded by a less-than character:

C> ATSERV < REDIRECT

If this is done, all input for Service diagnostics will be read from file REDIRECT.

To start the stand-alone (bootable) Service Diagnostics, insert the program diskette into drive A: and reboot the system. This version will work with non-DOS based PC's (Unix, Xenix, and certain file servers, for instance). Because the stand-alone version does not know what operating system is normally loaded on your computer, it cannot use standard input redirection the way the DOS version does. If the booting process is working, the boot sector is loaded (sector 0, head 0, track 0), then a series of dots is displayed, one for each track that is loaded.

If you do not see these dots, or if the dots do not finish, then the loading process died. If the dots end in a two-digit (hexadecimal) number, then that number is a floppy error code. Please refer to Table 2:

Table 2. Self-Boot Floppy Error Codes

Code	Description
01	Invalid diskette parameter or bad command
02	Address Mark not found
04	Sector not found
06	Diskette was removed
08	DMA overrun on previous operation
09	Attempt to cross 64K boundary during DMA
0C	Media type was not found
10	CRC or ECC error on disk read (Bad sector)
20	Controller failed
40	Seek failed
80	Drive timed out, assumed not ready

If at least one dot appeared, but the system hung, suspect that low memory is bad (between 0K and 64K.) Try the Landmark ROM POST at this point. Any errors returned by the floppy controller will be displayed as a two digit number.

When Service Diagnostics executes successfully, the following screen will appear:

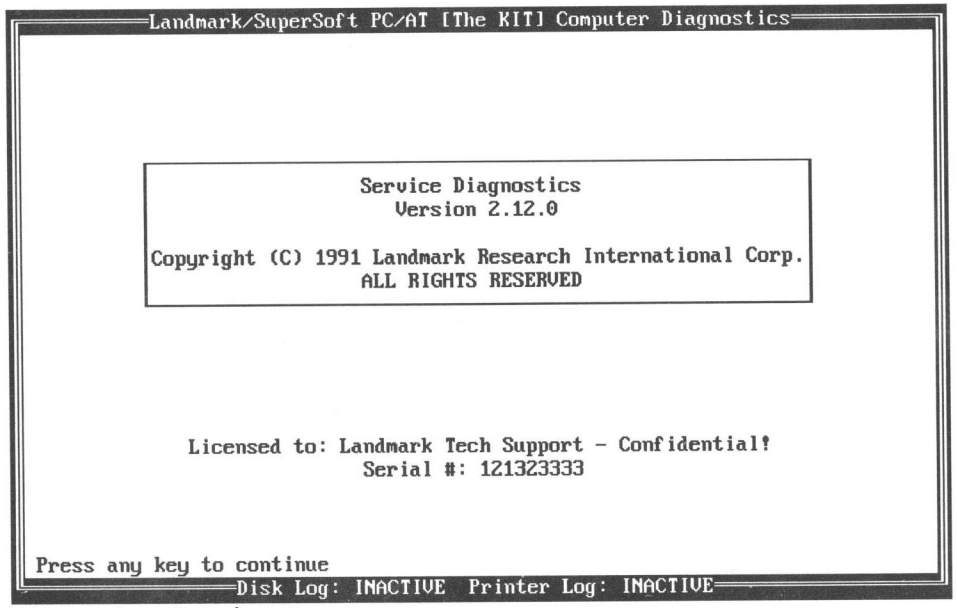


Figure 1. Opening Screen

Your system's configuration will be verified to ensure that the appropriate tests are run for your system. If an abnormal or unrecognized setup is detected, a screen will be displayed indicating the last item checked. Please contact Landmark Technical Support if this happens on your system.

Next, depending upon your system's current graphics mode (as well as whether a graphics adapter is installed), the following questions will be asked:

Is a monitor attached to both Adapters? Yes No

Is an Enhanced Graphics Display attached? Yes No

Is a color monitor attached to the Graphics Adapter? Yes No

Next, a screen similar to this will be displayed:

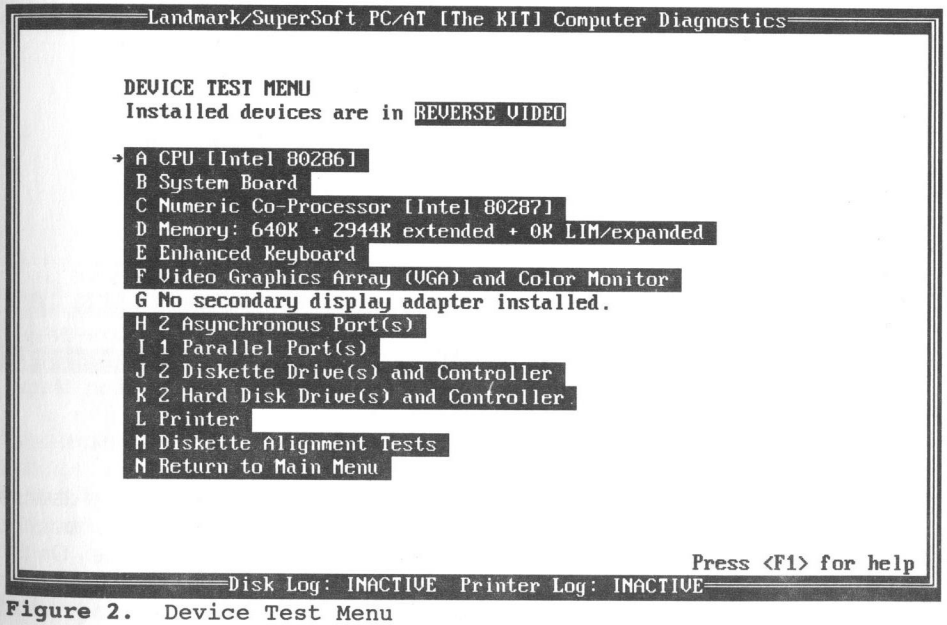


Figure 2. Device Test Menu

Tests can be run for any or all highlighted devices. All of your installed devices should be highlighted. If any are not highlighted, they are not installed correctly, or are malfunctioning.

Enter <Y> if the list is correct and proceed to the Test Selection Menu. Most screens, when prompting for input to proceed, will accept an <ENTER> as a "*Yes*" response. Enter <N> if there are any differences between devices listed on the screen and your system devices. This screen is displayed:

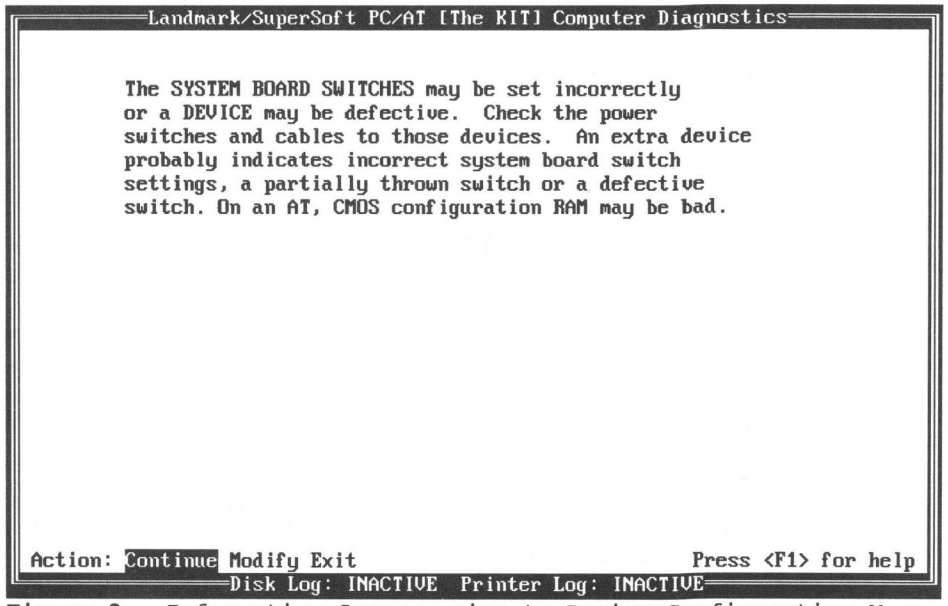


Figure 3. Information Screen prior to Device Configuration Menu

Check the power on all devices. Then check the cables which connect these devices to your computer. If this does not help, refer to your Operations Guide to check the switch setting on the devices. Check the installation instructions for the device. On the AT, the system board configuration CMOS RAM may be defective or the battery which powers this RAM may be bad. On a PS/2 the CMOS RAM, battery, or device setup hardware may be bad.

There are devices (hard/floppy disks, monitors, and so on.) that are attached to your system, but are not compatible with standard devices. These devices require special device drivers, and cannot be detected by the device-detection algorithms, and cannot be tested.

Finally, you may try modifying the device list, using the Modify option from the Main Menu. The screen appears as follows:

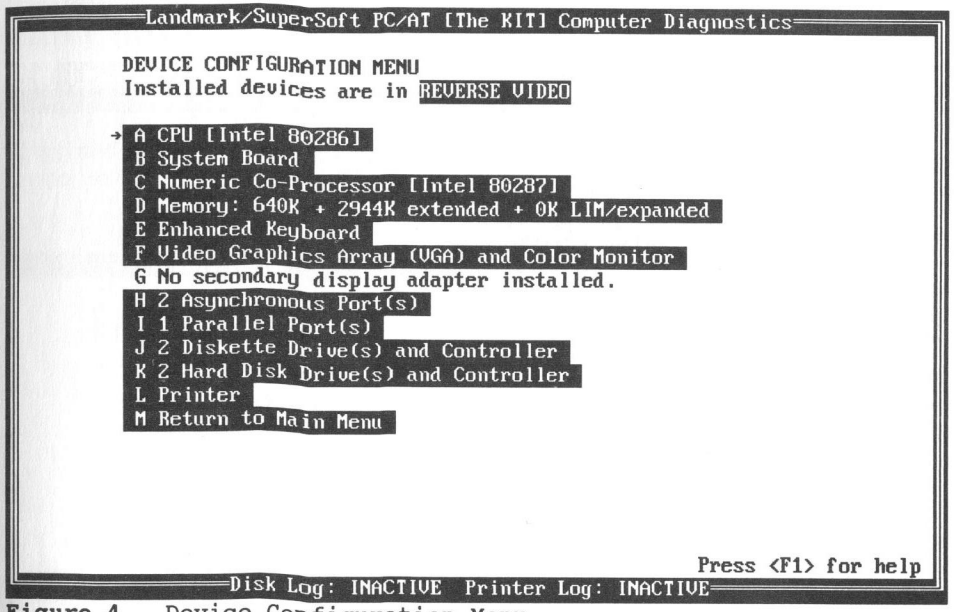


Figure 4. Device Configuration Menu

If you enable certain devices, a sub-menu will appear at the bottom of the screen. For instance, if you request additional diskette drives, then you are asked to select the diskette type. If you request additional memory, then the division of base and extended is requested. Expanded memory must be automatically located and sized.

Enabling certain non-existent devices may cause erratic behavior by Service Diagnostics and may cause your system to lock. Some systems are unable to report which type of keyboard is installed. You may change item D if you wish to *force* the keyboard type.

Selecting Tests

Once the device list has been correctly specified, the Main Menu will be displayed as follows:

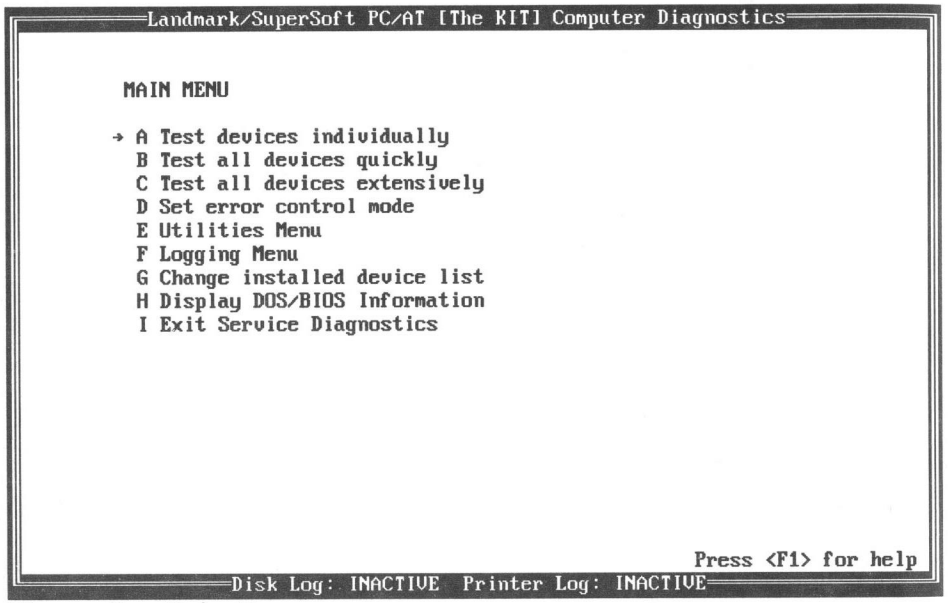


Figure 5. Main Menu

Throughout Service Diagnostics, the menus work as follows: <TAB>, <SPACE>, or the right or down arrow keys may be used to move the pointer down to the next item. <BACK TAB>, <BACKSPACE>, or the left or up arrows will move the pointer up to the previous item. Menu items may also be selected directly by pressing the appropriate letter key. Multiple choice questions such as "*Yes Menu Repeat*" will highlight the current choice; <SPACE>, <BACKSPACE>, and so on will work in a similar manner as the menus. Pressing the first letter of the choice (such as <Y>, <M>, or <R>) will directly select that option. Pressing <ESC> will return you up one level of menu unless you are at this menu, in which case <ESC> will have no effect.

Choose one of these options to run the tests (options A, B, C, and H), set diagnostic options (option D, E, and F), modify the device list (option G), or exit to the DOS prompt (option I). The tests and diagnostic options are described in detail below.

Option A: Test Devices Individually

This option allows the testing of a single device. If you desire to test devices not highlighted, you may modify the device list. Also if you wish to test only certain devices but not others, you may delete the undesired items from the installed devices list.

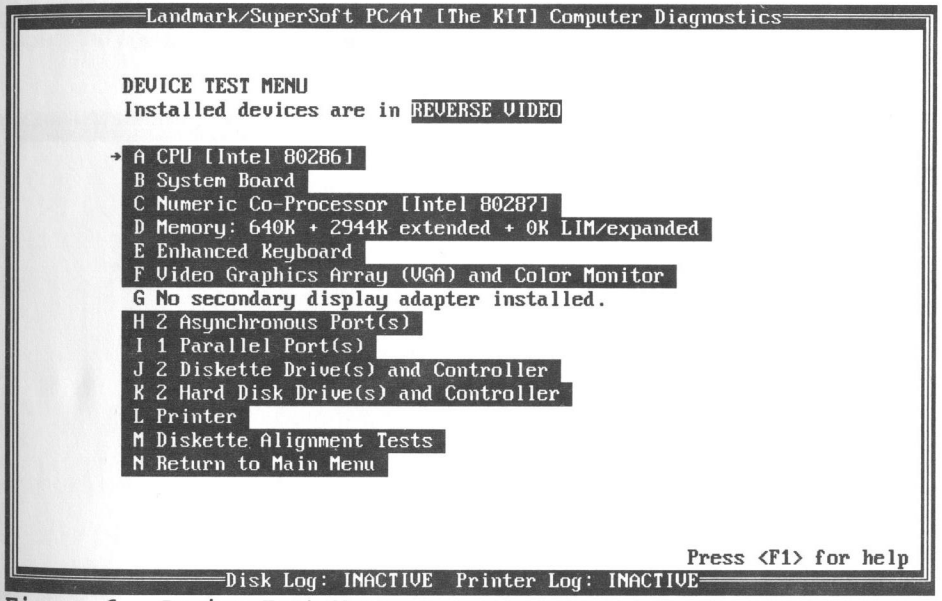


Figure 6. Device Test Menu

Choosing one of the selections from this menu will begin the tests for that device. The individual tests are described in sections below. When the test is completed, Service Diagnostics will return to this device list, to await another selection. You may return to the Main Menu by typing <N> or by hitting <ESC>.

Option B: Test All Devices Quickly

This option does a quick test of all devices except the keyboard and monitor (which require extensive operator interaction). When this test is run it will prompt you for the number of iterations:

> **Number of iterations to run tests**
> **(-1 for continuous testing)?**

The quick test will then display a screen showing the devices to be tested and run quick tests on all of them. The device that is currently being tested will be shown in blinking text. Note that some tests such as memory tests take longer than others.

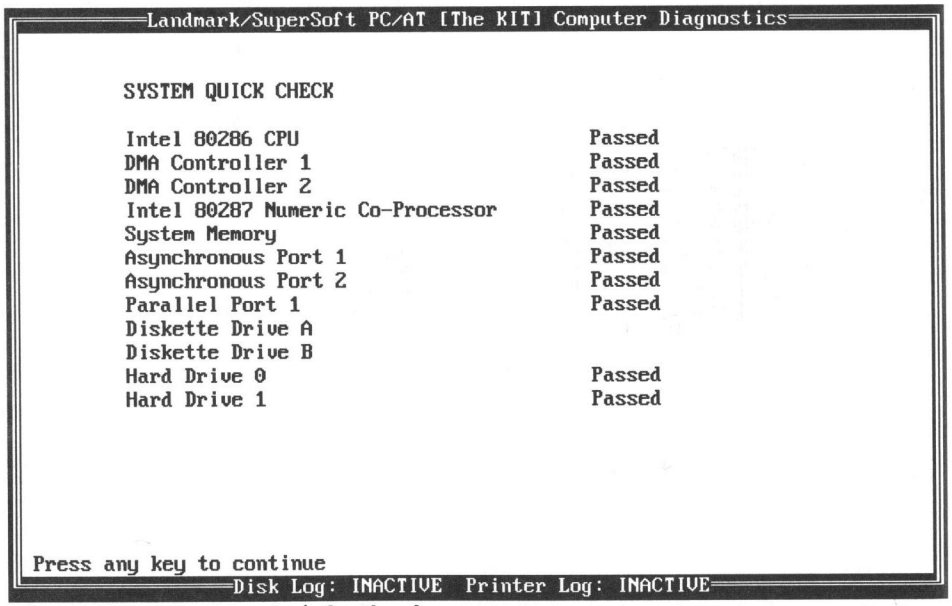


Figure 7. System Quick Check

If logging is activated, errors will be reported to the disk or printer log, whichever is active. The individual quick tests take differing amounts of time to complete. For instance, the memory and hard disk tests take longer than the rest of the tests. You will not need to enter any input while the quick test is running. Pressing <ESC> or <Control-C> will abort the test; there might be a delay between pressing <ESC> or <Control-C> and the time when the test actually stops.

Option C: Test All Devices Extensively

This test allows you to extensively test any or all of the installed devices; it allows selecting the number of iterations per device, as well as the number of iterations to repeat the entire test cycle. When this option is selected, the following menu will appear:

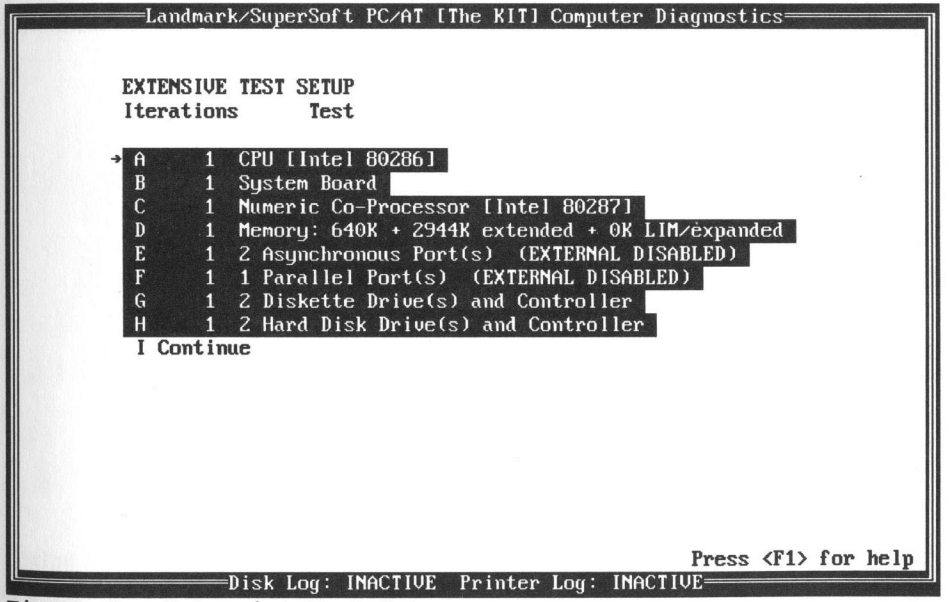


Figure 8. Extensive Test Setup

Selecting one of the devices will allow you to enter an iteration count for that device and, in the case of asynchronous and parallel ports, to specify whether or not external loopback plugs are installed. Selecting the "*Continue*" option will then prompt for the number of iterations to run the total test cycle. After that, the devices will be tested in the order presented. During each test, errors will be reported to the screen and they will also be sent to the log if active. This test also does not require operator intervention while running and is useful for total system burn-in. Landmark also sells diagnostics designed specifically for burn-in.

Option D: Set Error Control Mode

Selecting Option D will display the following screen:

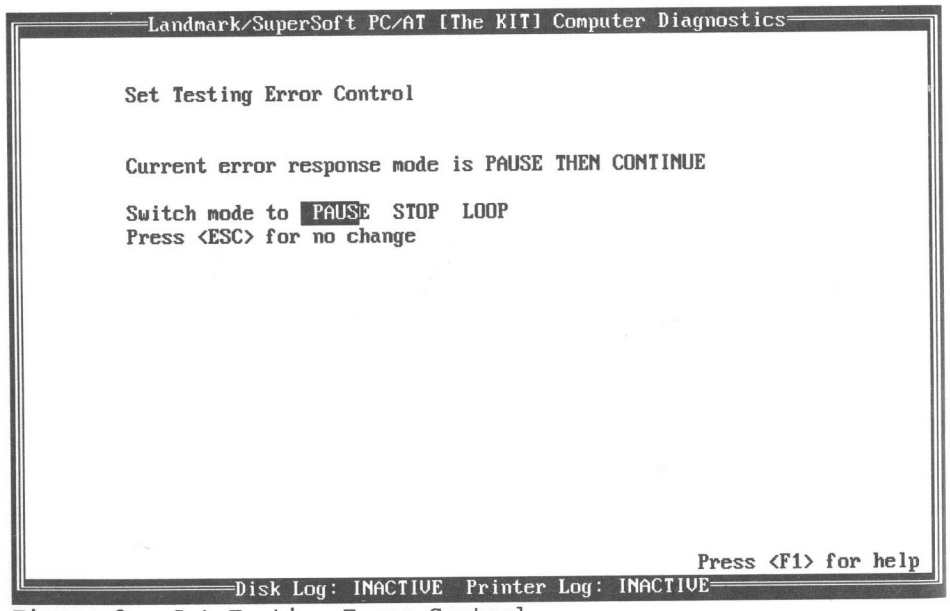


Figure 9. Set Testing Error Control

The default mode, *PAUSE*, will cause Service Diagnostics to pause for a few seconds, then continue, when an error occurs. Setting *STOP* will make Service Diagnostics stop on error and wait for your response before continuing. This option will also allow you to abort the test and return to the testing menu. Setting *LOOP* will cause Service Diagnostics to repeat the test a number of times when an error occurs; the following question will be asked:

Iteration limit per error (-1 for no limit)?

Enter the maximum number of times to retry a test after an error.

Option E: Utilities Menu

The Utilities Menu offers several useful utilities to display/set system time, copy/format disk, backup/verify/restore a mirror image of the hard drive, and park the hard drive heads. When Option E is selected from the Main Menu, the following screen is displayed:

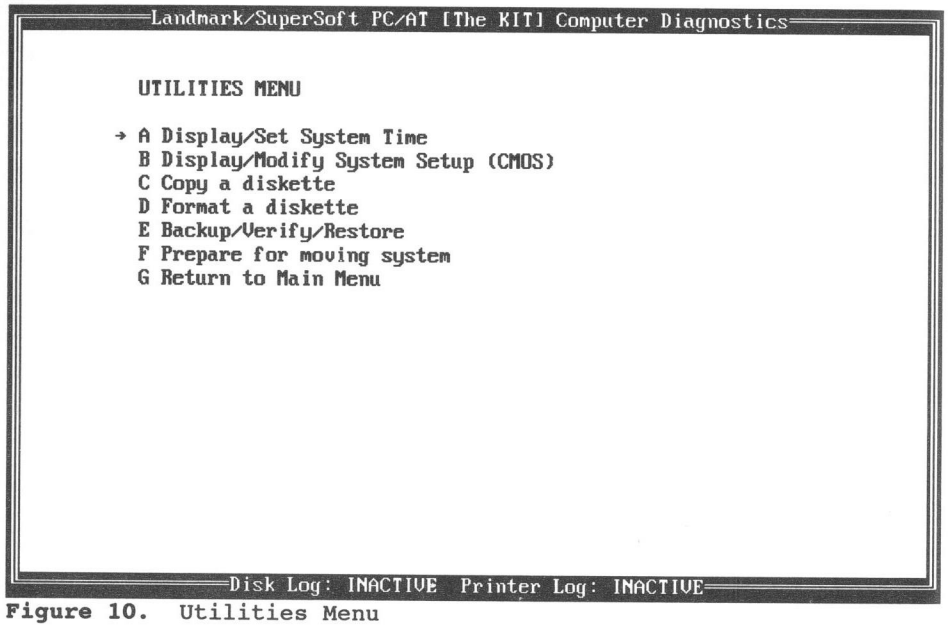


Figure 10. Utilities Menu

- **Display/Set System Time**

The option for displaying and setting the system time affects the time maintained by all AT and PS/2 compatible computers in non-volatile CMOS RAM. The year can be set between approximately 1980 and 2099. The time is set in 24-hour military format. <ESC> will abort any changes.

The System Date/Time option screen looks like this:

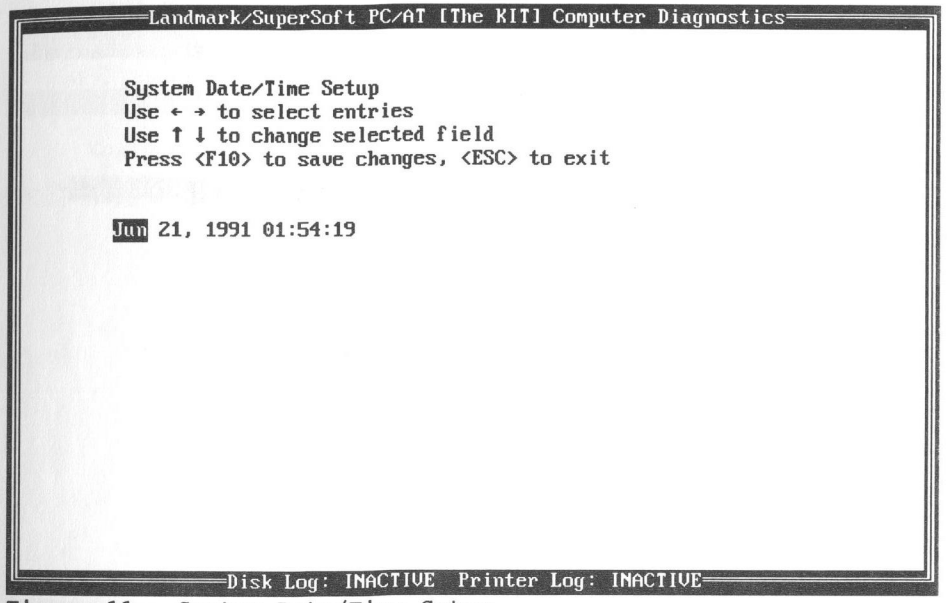


Figure 11. System Date/Time Setup

- **Display/Modify System Setup (CMOS)**

The utilities for displaying and modifying the CMOS system configuration are for the 80286, 80386, and 80486 ATs, in addition to PS/2 models 20, 25, and 30.

> **Note:** Since there is no CMOS in PC or XT compatibles, and PS/2 compatible machines (models 50 and up) require the use of a special reference diskette for configuring the system setup, Service Diagnostics will not allow this operation on those machine types.

This option allows you to display the system configuration as stored in the CMOS RAM and, if desired, make changes to that configuration.

After selecting the Display/Modify System Setup option, the following screen is displayed:

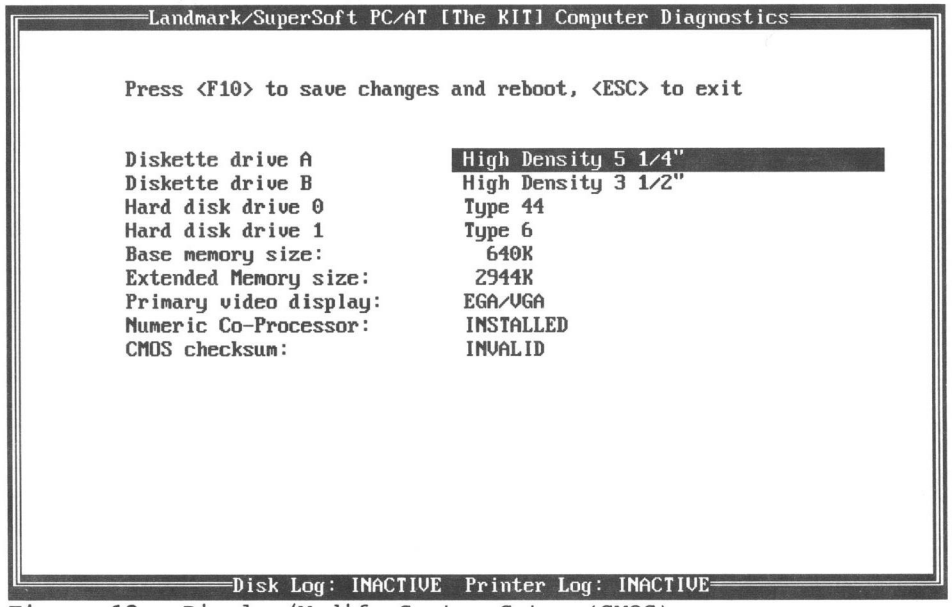


Figure 12. Display/Modify System Setup (CMOS)

These options will be able to support non-standard definitions of the CMOS RAM that may be used by the BIOS installed in certain systems. If the CMOS RAM becomes badly corrupted (perhaps by setting up options that are not appropriate for your computer), you may have to remove the CMOS battery (check the system board, or the sides of the case for this battery) and short the battery terminals for several seconds. This will initialize the CMOS RAM. Then, reinstall the battery and boot the machine. At that point, the BIOS should allow you to edit the CMOS settings. If your BIOS does not have a built-in CMOS editor, use Service Diagnostics's CMOS editing facilities described above.

- **Copy a Diskette**

Service Diagnostics also has facilities to allow a diskette to be copied. The option to Copy a Diskette will display the following screen:

Figure 13. Copy a Diskette

Note: The copy facility will make an image copy of the source diskette onto the target diskette. The copy facility cannot copy diskettes that are copy-protected.

- **Format a Diskette**

The format facility will format a diskette, but will not transfer an operating system.

> **WARNING:** Formatting destroys data. Remove any diskette from the drive with information that you want to save, including the Service Diagnostics disk!

The option to format a diskette will display the following screen:

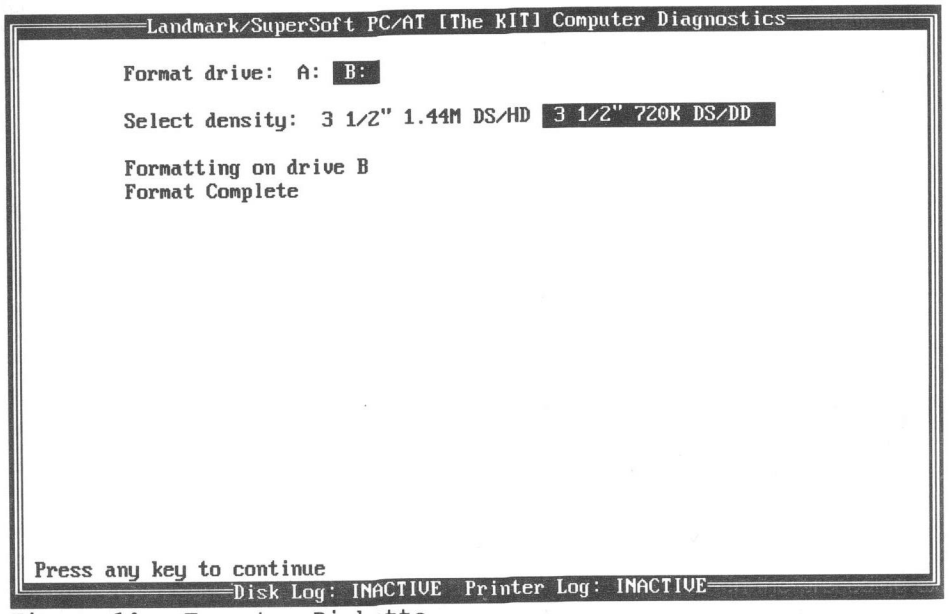


Figure 14. Format a Diskette

If there is no diskette in the drive, the diskette is write protected, or the diskette is bad, you will see a message such as the following:

TRACK 0 FAILURE
DISCARD DISKETTE

- **Backup/Verify/Restore**

The Backup/Verify/Restore option allows a partition or entire hard drive to be backed up, verified for accuracy, and restored at a later date. An example of the backup screen is displayed below:

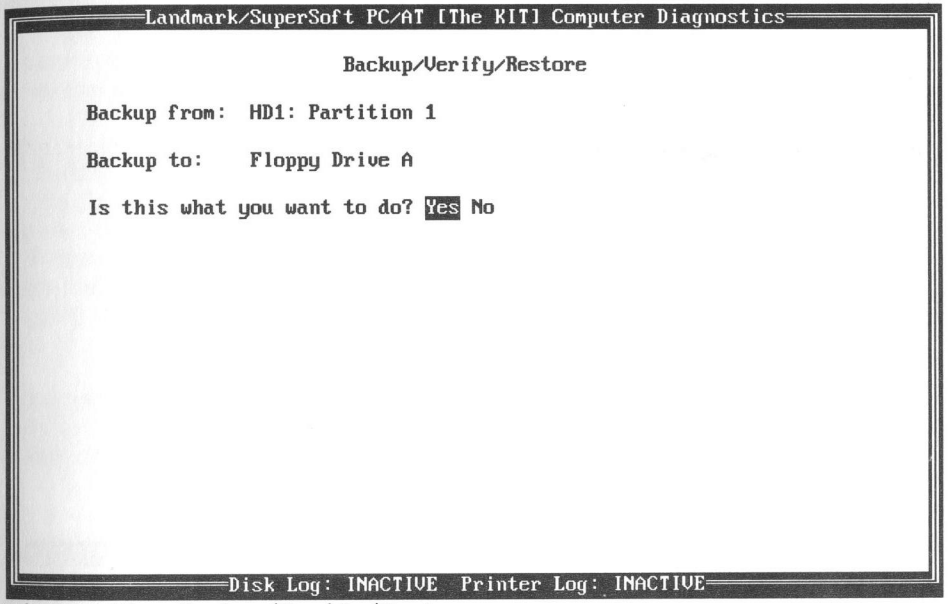


Figure 15. Backup/Verify/Restore

In the preceding example, partition 1 of hard drive 1 was selected to be backed up to floppy drive A:. It is just as easy to select an entire drive. The verify and restore features are driven by a similar selection process.

- Prepare System for Moving

Parking the heads on the hard drive is a simple task. This option will park the heads on all hard drives found in your system. Here is the screen:

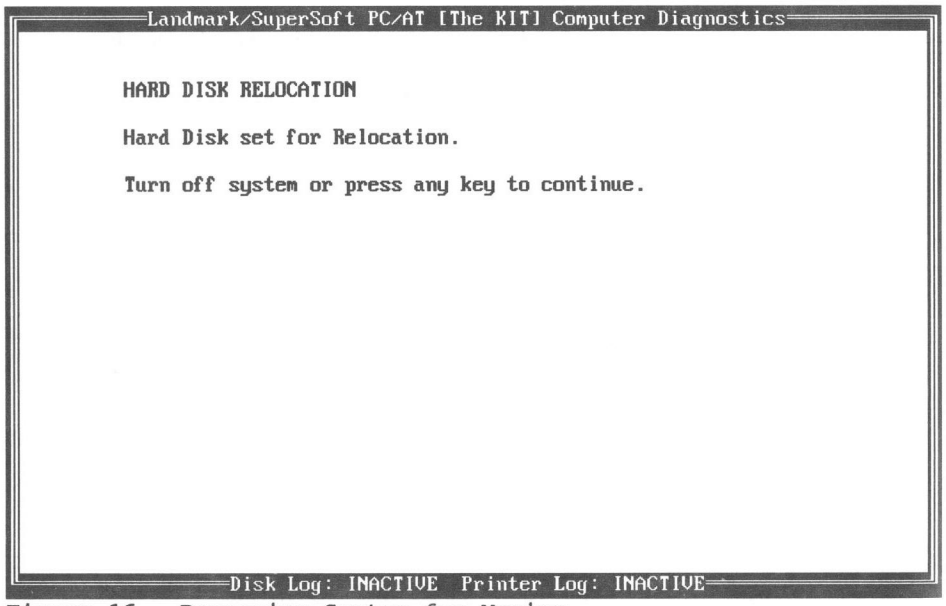


Figure 16. Preparing System for Moving

At this point, you may power down your machine, or hit any key to resume your diagnostic session.

> **Note:** For the curious, the heads are actually moved to a cylinder beyond the last usable cylinder on your hard drive. In case your drive receives any form of shock or vibration, the heads will *bounce* on an area of the disk that does not contain any data. This area of the disk is often referred to as the Landing Zone. On some older drives, the last cylinder is not reserved, but may be formatted and contain data. However, this last cylinder is still the safest to use as a Landing Zone because it is least likely to actually contain data.

Option F: Logging Menu

The disk log allows you to retain a copy of the error reports generated by a test for future reference. While this option is useful when you are running tests on your system in person, it is of greatest value when used in conjunction with the automatic testing mode for unattended testing of your system. Each time you run a test using the log option, an entry is made into the log. If the log is not present on disk, it will be created. Note, however, that I/O errors will occur if disk logging is selected and there is insufficient disk space to log the results of a test. Hence, you must use care in specifying this option for tests that are to be run unattended.

In the stand-alone version of Service Diagnostics, the disk log will be placed on the back of the Service Diagnostics diskette; therefore, it must stay in drive A: while logging is active. The Service Diagnostics diskette may be removed, however, during the floppy disk test and the alignment tests. It should be re-inserted when the tests are complete. Note that logging to another drive is the preferred method over switching in and out the logging disk. The disk log will always be written to the Service Diagnostics diskette.

This menu allows maintenance of the disk log file. The log may be started or stopped, sent to the printer or to a disk file, reviewed on screen, annotated, or truncated. The action on error (error control) can also be set.

When you choose Option F, the following screen will be displayed:

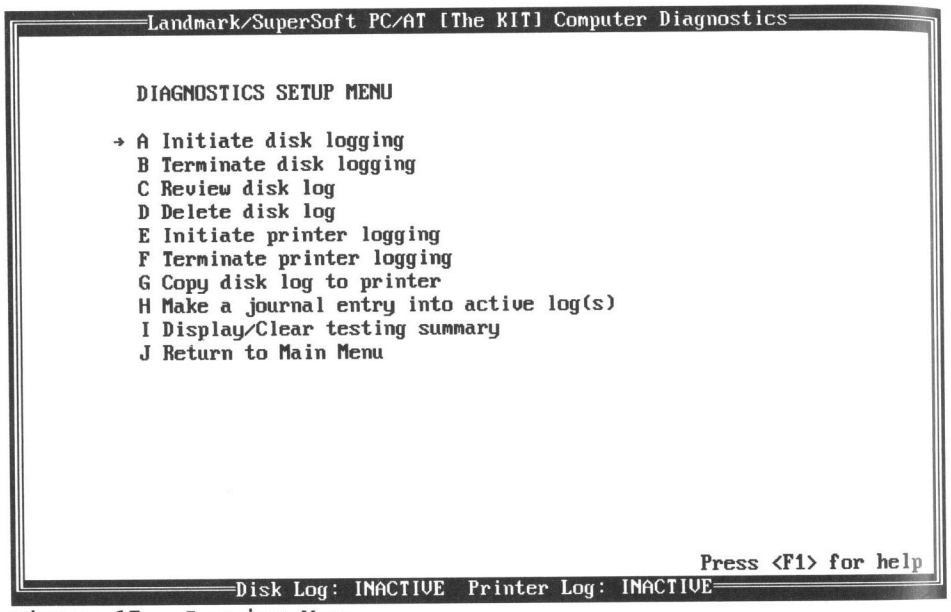


Figure 17. Logging Menu

- **Initiate Disk Logging**

This option starts the disk log. Any tests initiated after this point will post their results to the disk log. Test results will continue to be displayed on your video monitor.

> **Note:** The video monitor, keyboard, and printer tests only post a "*pass or fail*" indication because the results are of no value unless the entire test is under close observation.

With the DOS version of Service Diagnostics, you can choose to log the test output to a disk in any one of the drives recognized on your system. This option requests a drive letter on which to open the log file. The log file is opened as *DIAG.LOG*. Only one disk log file may be opened at once, however, printer logging may be active simultaneously. The disk drive should be carefully selected if you are going to run the floppy disk test because the disk can't be removed while logging is active. A similar caveat applies to logging to any device that is going to be tested (including RAM drives if RAM is to be tested). Stand-alone versions of Service Diagnostics will always write the log to the Service Diagnostics disk. If the log is being initiated, the following question is asked if using a DOS version of Service Diagnostics:

> **Which disk drive [default is A]?**

Type the desired drive specification or <ENTER> to accept the default drive. After your selection has been made, Service Diagnostics will display your choice for verification. For instance:

> **OUTPUT WILL BE LOGGED TO A:DIAG.LOG**

Type any character to return to the Logging Menu. The log disk must stay in the drive while testing, except during the floppy and alignment tests. After the floppy and/or alignment tests complete, the log disk should be re-inserted.

- **Terminate Disk Logging**

This option stops all logging activity. In other words, it prevents the results of any further testing from being appended to the disk log file.

> **More for the curious:** Disk logging is terminated automatically upon a normal exit to DOS. If the machine hangs, loses power, or Service Diagnostics is terminated in any other abnormal way, the disk log file may be lost. It is for this reason that you are given the option to terminate logging at any time prior to exiting Service Diagnostics.

- **Review Disk Log**

You may review the disk log at any time, even while logging is currently active. This option allows you to scroll through a comprehensive list of test results.

- **Delete Disk Log**

This feature closes the disk file if logging is active, and promptly deletes the entire log file from your disk.

- **Initiate Printer Logging**

When printer logging is initiated, all test results are output to the printer. The format is identical to the disk log.

- **Terminate Printer Logging**

Just like its disk counterpart, terminating logging to the printer closes the I/O stream to the printer. The results of any further testing are displayed only on the video monitor until a log file is again initiated.

- **Copy Disk Log to Printer**

This option dumps the *DIAG.LOG* disk file to the printer. Since all results posted to the disk log are in ASCII format, even daisy-wheel printers should not have any difficulty.

- **Make a Journal Entry into Active Log(s)**

If, for some reason, you would like to try your hand at technical writing, or if you would like to add your own comments to the results log, this is the option for you! Upon selecting this option, you will be placed in an ASCII text editor, where you are free to add comments of unlimited length. When you are satisfied with your entry, hit <CONTROL-G> and the entry will be appended immediately to the active log.

- Display/Clear Testing Summary

Separate from the active disk/printer log is a summary log. Individual devices are tracked by number of passes and/or failures. This cumulative summary log looks like this:

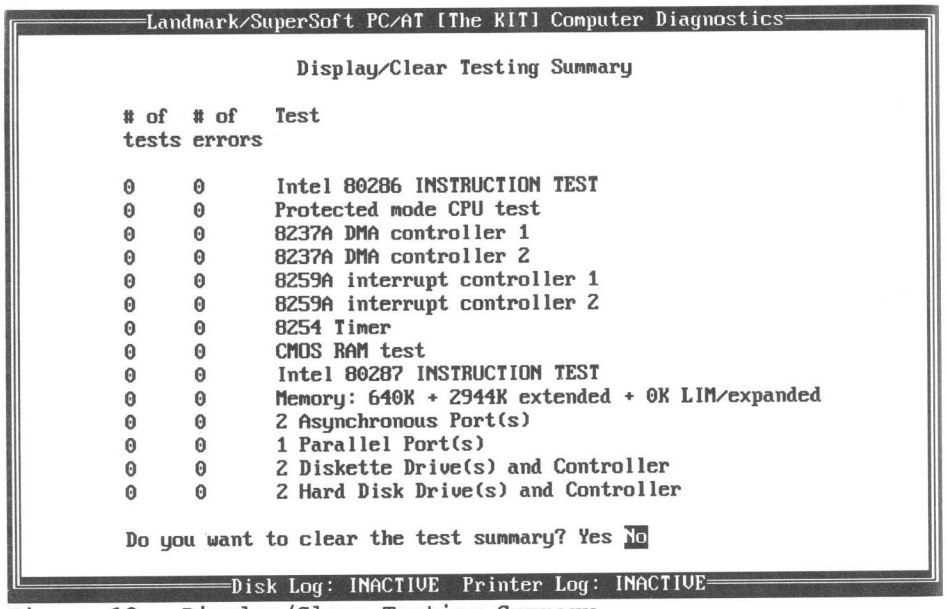


Figure 18. Display/Clear Testing Summary

Notice that each time you review this summary, you are given the option to clear or reset the results (passes and failures all set to zero).

Option G: Change Installed Device List

This menu allows the list of installed devices to be modified. A screen similar to the device list is presented. The effect of selecting a device is to toggle it from present to not present, or vice versa, except for memory or multiple devices, where you will be prompted for the proper quantity. Changing the floppy drives will also allow you to select drive types. Notice the following screen:

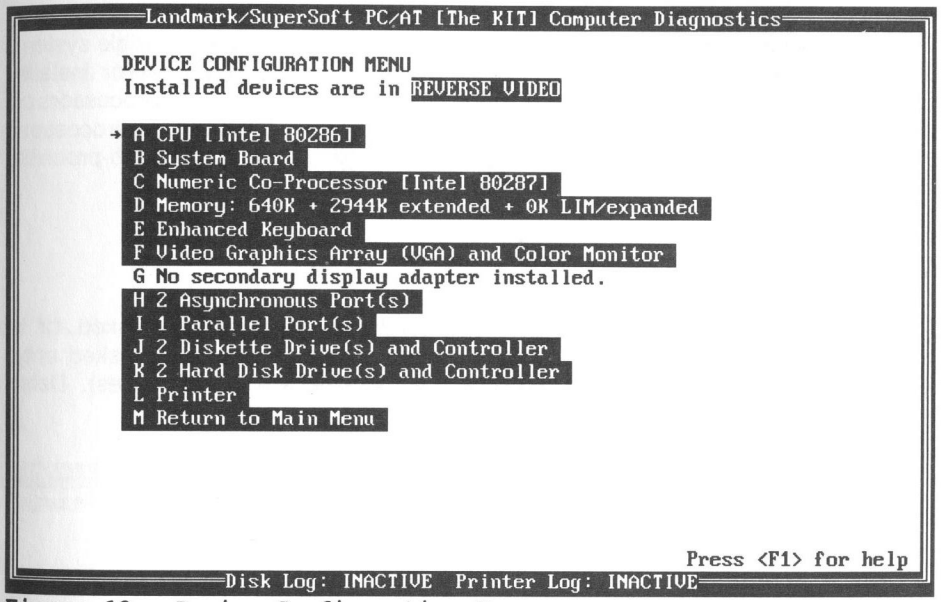


Figure 19. Device Configuration Menu

- **CPU**

The CPU type may be changed. It may appear strange that one option for CPU type is NONE. This option would be selected if you wish to skip the CPU during a batch test such as the System Quick Check. Optionally, an 80486 may be configured as an 80386 or 80286 in order to bypass testing of the advanced memory management/protection features of the 486.

- **Numeric Co-Processor**

There are various types of numeric co-processors available for PC compatible systems. Service Diagnostics attempts to detect the type of numeric co-processor installed, however, you can change the type of numeric co-processor. Numeric co-processors can be from Intel, IIT, Cyrix and so forth. Proper selection of the numeric co-processor is necessary for Service Diagnostics to report correctly on the numeric co-processor instruction tests.

- **Memory**

When making changes to the memory configuration, you will first be asked for the amount of base memory. Size of extended and expanded memory will asked only if Service Diagnostics detects its presence. All memory sizes are in K (Kilobytes). Default memory sizes can be accepted by hitting <ENTER>.

- **Asynchronous Ports**

Selection of the COM: ports can be done with the Asynchronous Port option of this menu. If you elect to change the Asynchronous Ports, you will see the following:

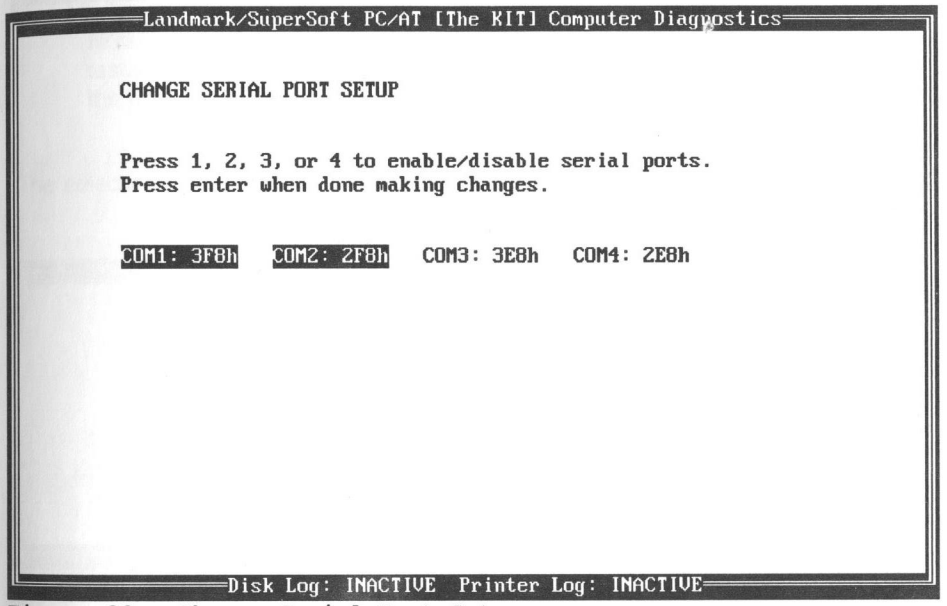


Figure 20. Change Serial Port Setup

- Parallel Ports

The LPT: or parallel ports may be change as well. The screen appears as shown:

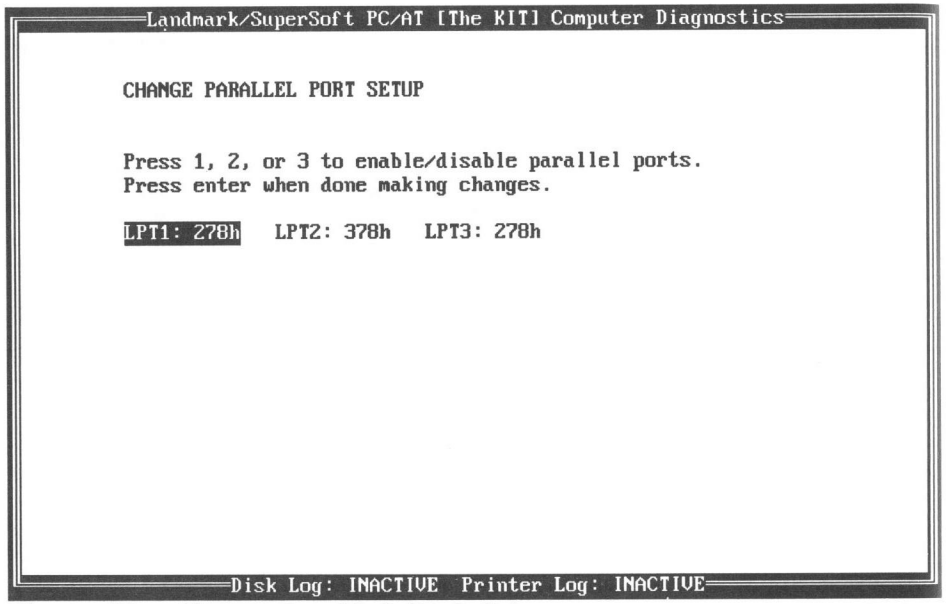


Figure 21. Change Parallel Port Setup

- Diskette Drive(s) and Controller

When making changes to the floppy drives, a drive type menu will be displayed after entering the number of floppy drives. Simply highlight the correct drive type using the cursor keys.

> **Note:** Your floppy drives must be configured properly in order to be properly tested. In all but the rarest case, Service Diagnostics will automatically determine the floppy drive type(s).

The selection screen for the floppy drive types appears as:

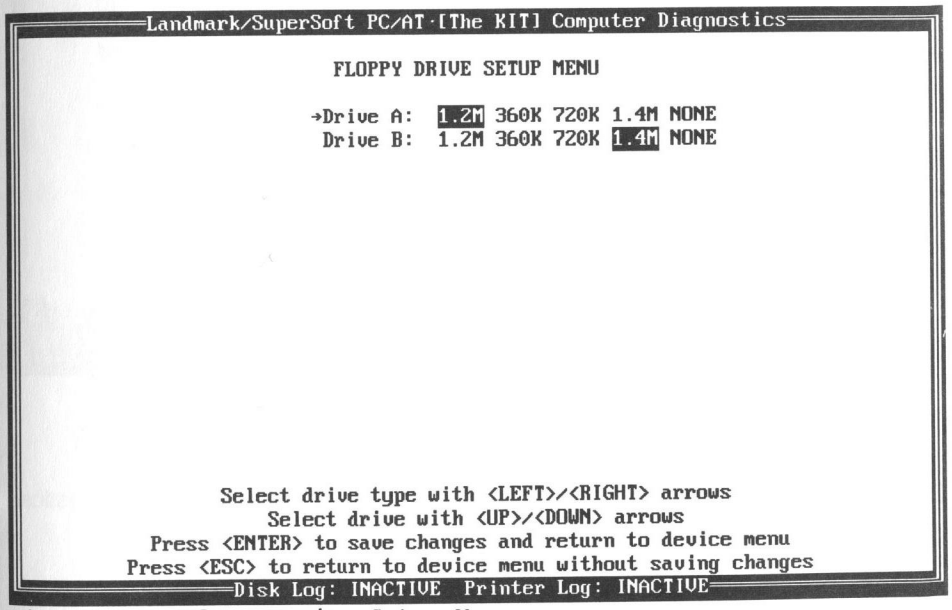


Figure 22. Floppy Drive Setup Menu

Option H: Display DOS/BIOS Information

This option displays various configuration and environmental information about your system. The following screen is displayed:

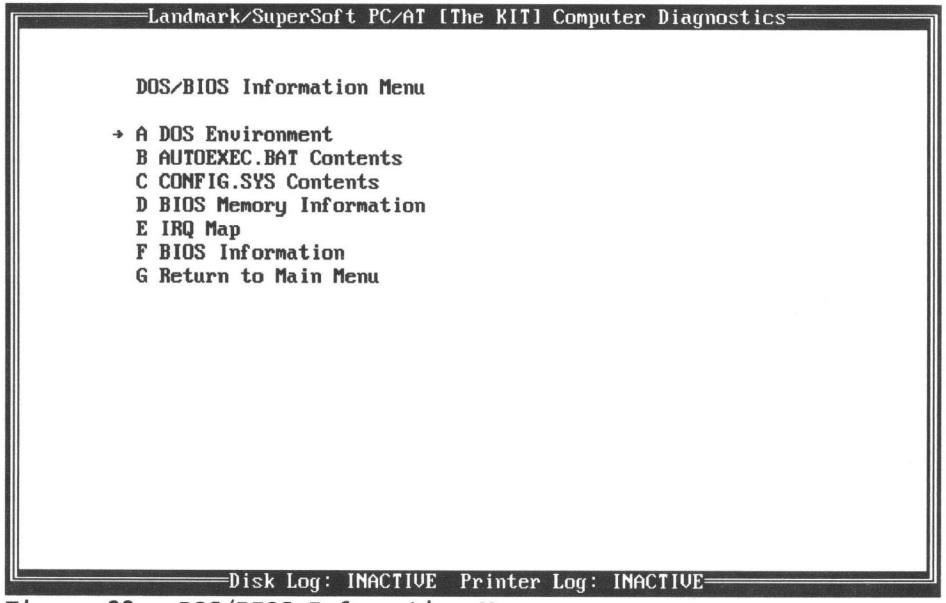


Figure 23. DOS/BIOS Information Menu

Options A, B, and C are not available in the self-booting version of Service Diagnostics.

- **DOS Environment**

This option displays the DOS environment variables. These variables are examined by DOS programs.

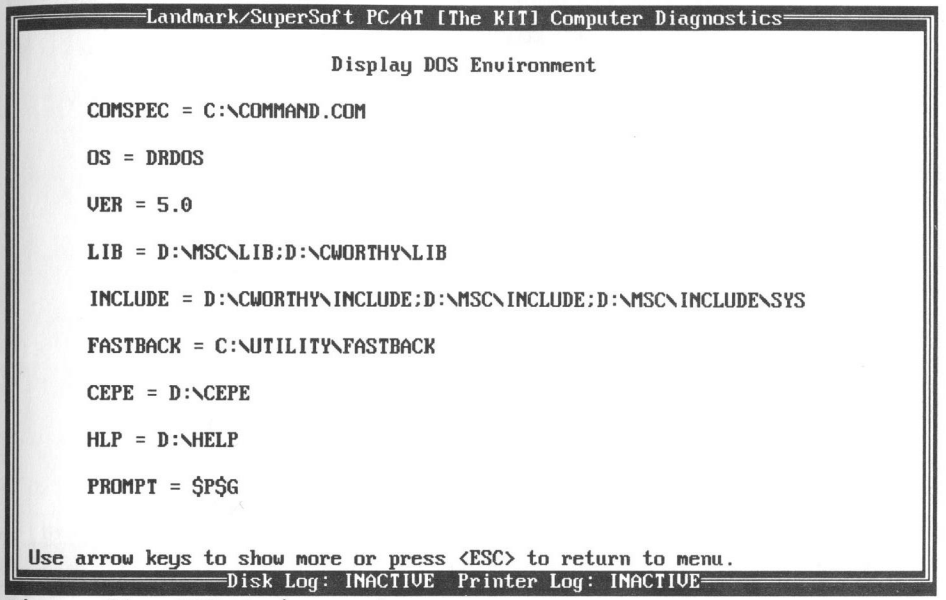


Figure 24. DOS Environment

Note: See your DOS manual for more information.

- AUTOEXEC.BAT Contents

Selection of this option prints the DOS AUTOEXEC.BAT file. Here is an example:

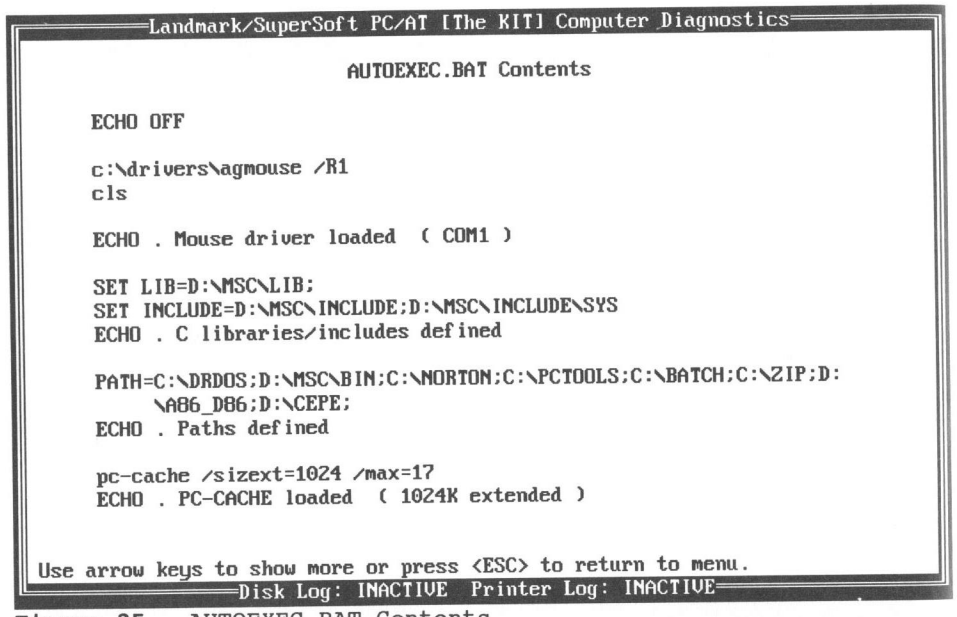


Figure 25. AUTOEXEC.BAT Contents

This file initializes and customizes your system. This batch file is run on power up, so its contents affect the behavior of your system at all times, including when Service Diagnostics is run. Especially important in AUTOEXEC.BAT are lines that execute TSR's and device drivers. TSR's and device drivers can interfere with Service Diagnostics and visa versa. For instance, any disk caching TSR should be disabled when running the Service Diagnostics memory test.

Note: See your DOS manual for more information.

- CONFIG.SYS Contents

This option displays the contents of the DOS CONFIG.SYS file:

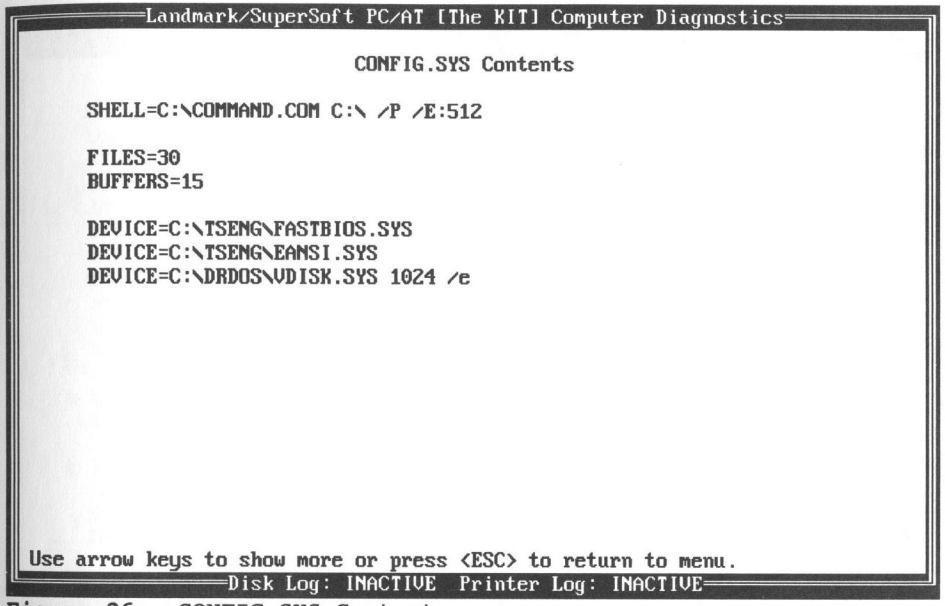


Figure 26. CONFIG.SYS Contents

This file also initializes and customizes your system, so its contents affect the behavior of your system at all times, including when Service Diagnostics is run. Especially important in the file are lines that declare device drivers (lines starting with *DEVICE=*). Device drivers can interfere with Service Diagnostics and vice versa. For instance, expanded memory drivers must be included for Service Diagnostics to test expanded memory.

Note: See your DOS manual for more information.

- **BIOS Memory Information**

The BIOS Memory Information screens display the BIOS Data Segment at 0040:00xx. Your first screen might appear as follows:

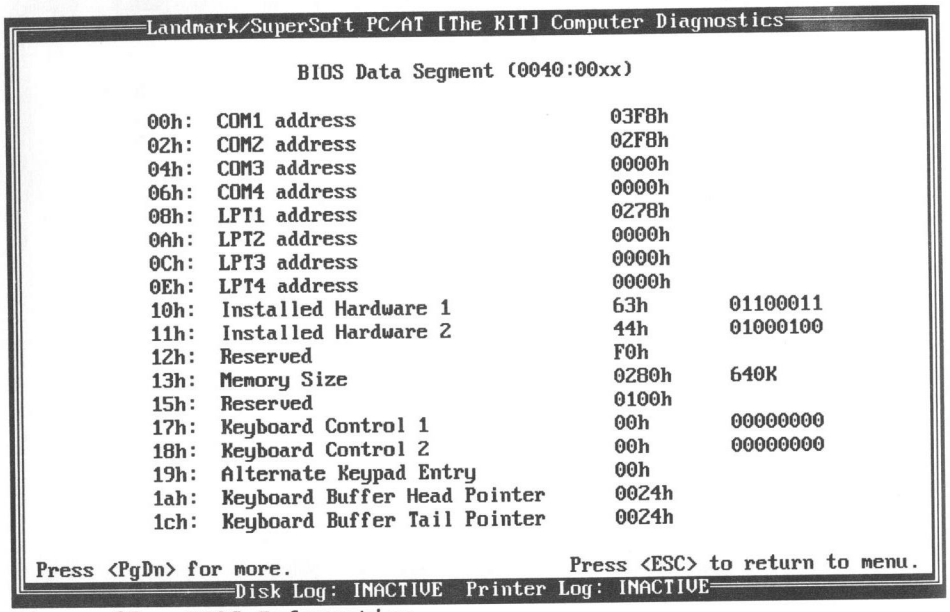


Figure 27. BIOS Information

In this data segment, the BIOS stores information about your system, which is determined when the machine is booting up. Notice that base addresses for COM: and LPT: ports as well as other important information can be found using this feature.

- **IRQ Map**

The IRQ Map displays the interrupt vector, description, and owner of all software interrupt vectors. The following screen appears:

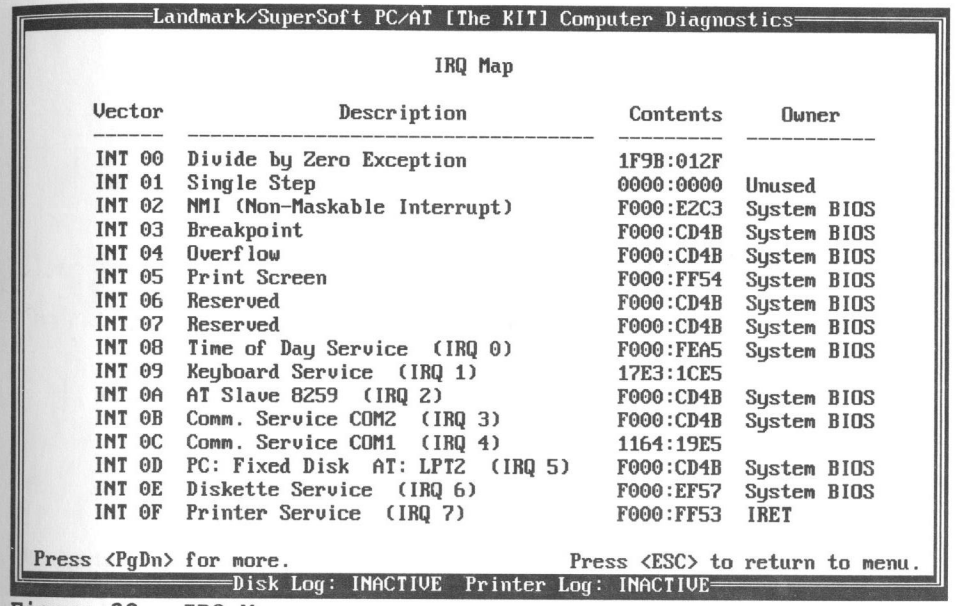


Figure 28. IRQ Map

- BIOS Information

The BIOS Information option scans high memory (from 640KB to 1MB), noting any video, device, or system BIOSes found.

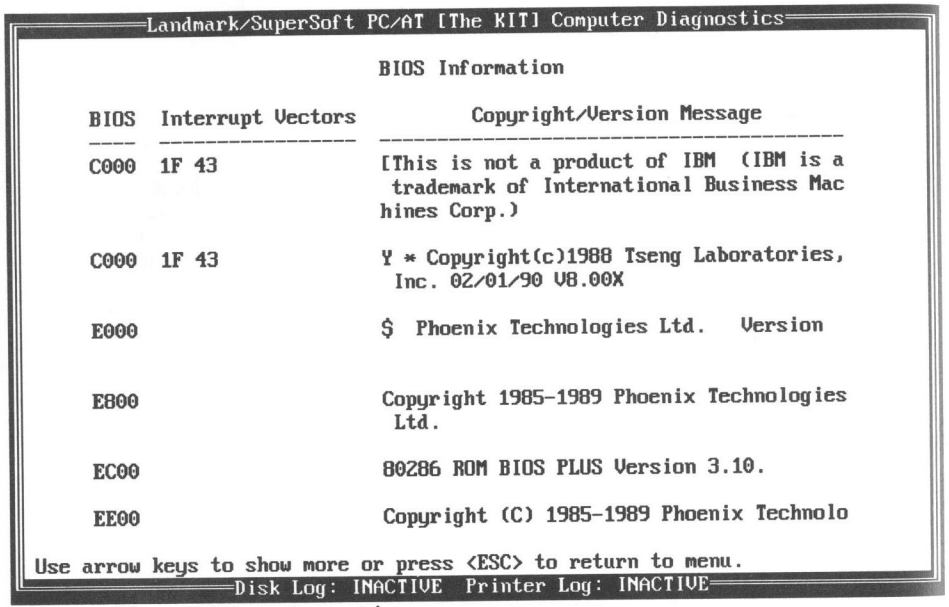


Figure 29. BIOS Information

CPU Test

When you run the CPU Test, the screen below is displayed:

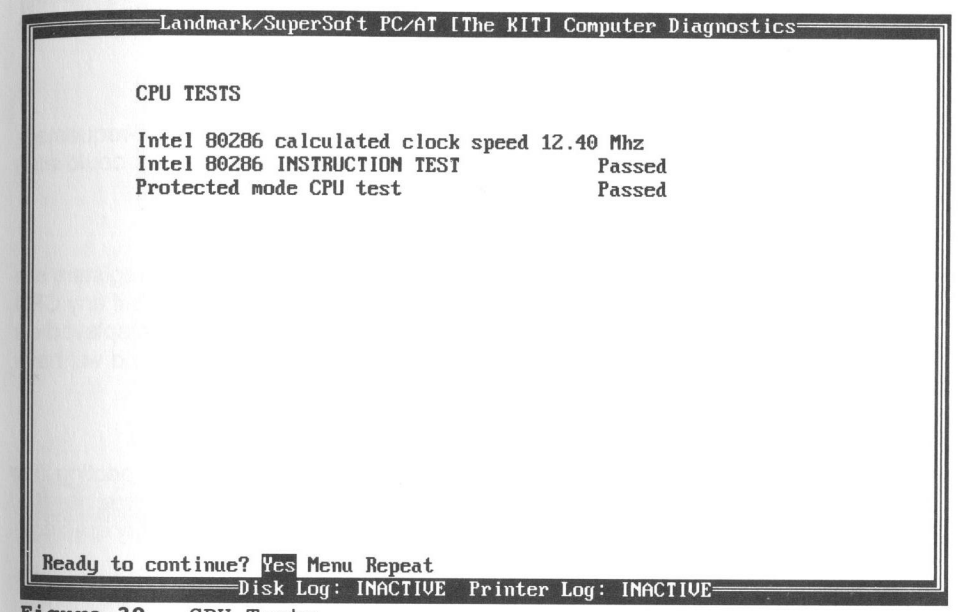


Figure 30. CPU Tests

The speed test causes the CPU to execute a series of instructions that take a known number of cycles. The time to completion is measured. The apparent clock rate (speed) in Mhz is displayed.

If it is close or over what you expect then there is no problem. Note that the above screen shows 12.40 Mhz. This CPU is rated at 12 Mhz, so there is no problem. There are several reasons that the speed is not shown as exactly 12 Mhz. One is that the speed test attempts to compensate for memory refresh. If memory refresh is less intrusive than an IBM AT, then the CPU could have rated above 12 Mhz. Perhaps memory refresh is slightly more intrusive than on an IBM AT. Another factor is the number of wait states that are added to the CPU's memory access cycle.

Another factor is non-maskable interrupts that are happening during the test. The test does not generate non-maskable interrupts, so this is probably a failure in the computer. This number should correspond roughly to the expected speed. If it is grossly off then your system has a problem. Check to see if there is a software selectable CPU speed option on your computer. This could be a keyboard combination such as <Control-Alt--+> or a front panel button. It could be an extended CMOS RAM setup option. Sometimes there is a "*turbo*" light on the front panel to indicate whether or not the system is running in slow mode.

Other problems could be memory refresh happening too often, wild (non-requested) DMA activity that is monopoiizing the memory bus. Memory parity errors could also cause this.

As each of the CPU's instructions are executed, the contents of all the CPU registers are saved in memory and then compared against an expected state table to see if any CPU registers fail to match the expected values. All mismatches errors will be displayed on this screen. Any error at all in this test is indication that the CPU is faulty and will have to be replaced.

> **Note:** If your CPU is not the same as what Service Diagnostics is expecting (for instance, testing a V20 CPU with the 8088 version of Service Diagnostics), it WILL fail the CPU test, due to different instruction execution times and other characteristics.

If your system is an 80286, 80386, or 80486 system, then the protected mode CPU test will be performed. This test verifies that the additional registers used as descriptor table pointers for protected mode are functional. It also tests the ability of protected mode to correctly load the task register and to perform task and context switching. For 80386 and 80486 CPU's, a test of virtual memory paging available when running in protected mode is also performed.

> **Believe it or not:** In systems with 80386 or 80486 CPUs, tests are performed to determine if the CPU fails multiply instructions that are a problem with many of the early revisions of these processors. Again, the problem is inherent in the CPU, not your system as a whole.

System Board Test

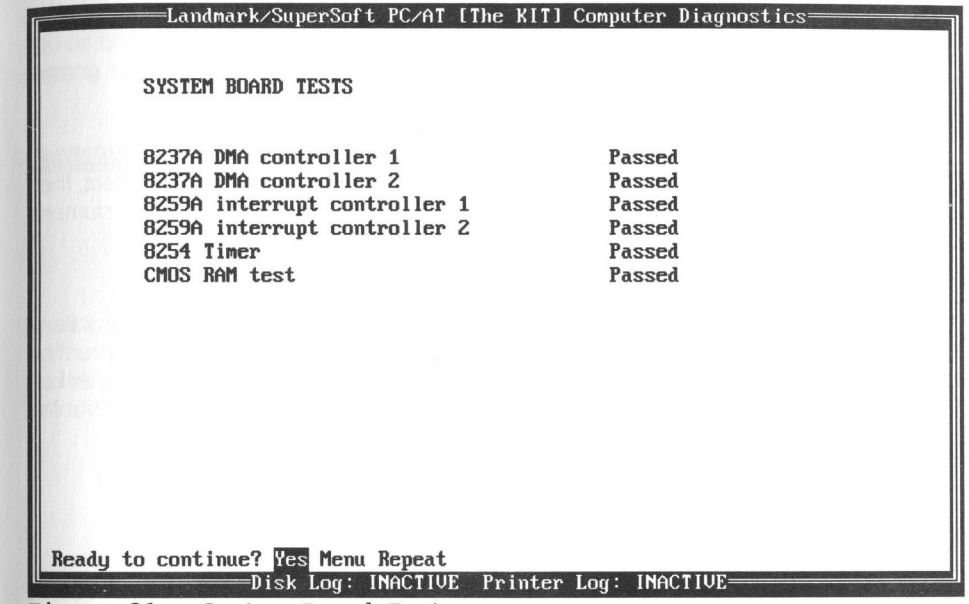


Figure 31. System Board Tests

The System Board diagnostics perform tests on the DMA controller(s) installed in the system, the interrupt controllers, and the timer chip. Each of these components is tested for correct operation and for the ability to write and read the internal registers on the respective chips.

The CMOS RAM test verifies that the CMOS RAM can be correctly accessed and updated, so that the correct system configuration can be maintained in the system. This test is only performed on AT compatible and PS/2's with CMOS RAM.

Numeric Co-Processor Test

The screens for the Numeric Co-Processor Test are similar to the CPU test except that the numeric co-processor name (8087, 80287, 80C287, 80387, 80c387, Cyrix, and so on) is substituted for CPU. Service Diagnostics will automatically detect and test the correct numeric co-processor according to which is installed.

If you believe that the automatically detected numeric co-processor type is incorrect, then you may go to the Change Installed Devices Menu to select the correct numeric co-processor.

The register tests cause the numeric co-processor to execute most of its instructions both in integer mathematics and IEEE floating point mathematics. After each instruction is executed, the stack of data registers, and the control and status registers are checked against an expected state table to determine if the numeric co-processor is functioning properly.

Memory Tests

The Memory Tests option is used to test base, extended, and expanded memory. When this option is selected, Service Diagnostics loads a separate memory diagnostics module. The first screen to appear is the following Memory Tests Menu:

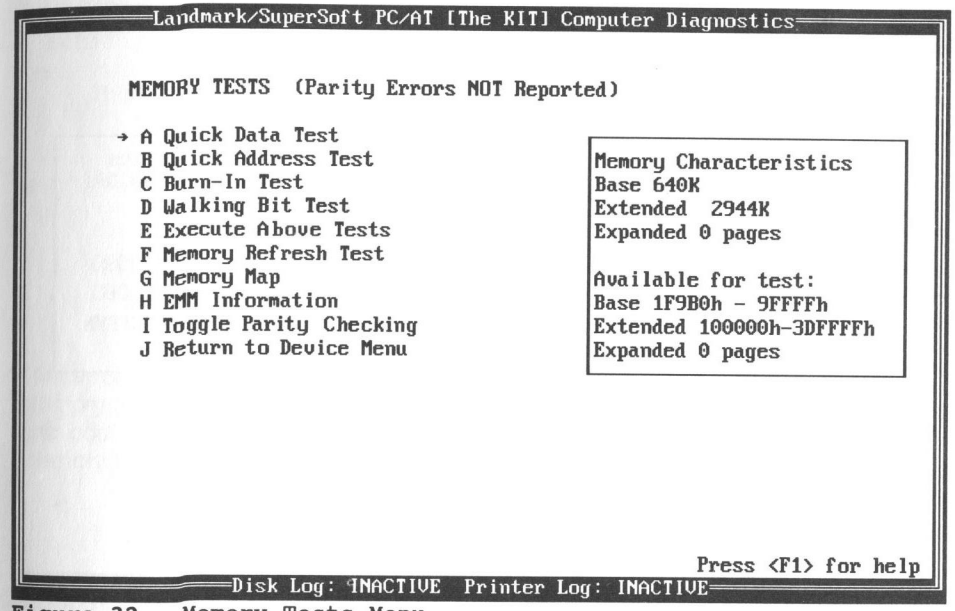


Figure 32. Memory Tests Menu

• **Quick Data Test**

The Quick Data Test writes a pattern to memory and then reads that pattern back to see if any anomalies occur. Any errors are logged. The memory address being tested is periodically updated as the test runs. The test prompts for starting and ending addresses in hexadecimal notation:

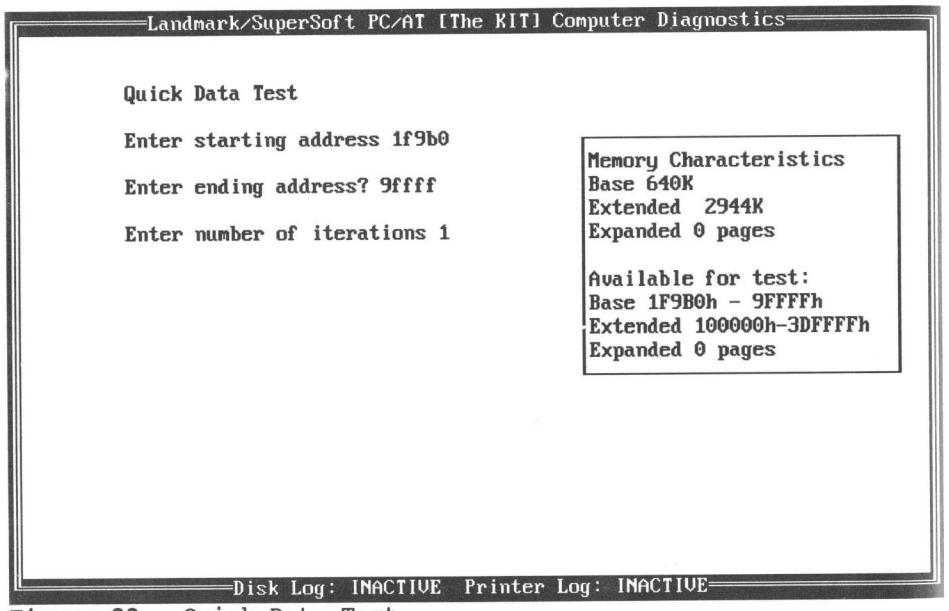


Figure 33. Quick Data Test

The test will show the test status as it is running. Errors that occur will be listed in the following format:

Memory Error Location	Data Written	Data Read
111111H	FFH	F0H
122222H	FFH	FEH

This will be followed by a bit map summary of the errors in the following format:

Address		Bits
		7 6 5 4 3 2 1 0
090000	E	0017 0000 0000 0000 0012 0023 0000 0000
090000	O	0017 0000 0000 0000 0012 0023 0000 0000

This error reporting format is also used in the Walking Bit Test and the Burn-in Test. Memory addresses are reported in 16K increments, with separate summaries for even and odd addresses. A detailed description of the interpretation of the results of the memory tests is included in the Technical Information section later in this manual.

• Quick Address Test

The Quick Address Test ensures that memory addressing is not overlapping. This tests both the addressing lines and logic controlling the memory chips as well as the internal addressing within the memory chips. This test accomplishes the same objectives as the Walking Bit Test. This alternate test is not as comprehensive as the Walking Bit Test, but it is incredibly faster.

This test will complete in one to ten minutes depending on the amount of memory installed in the system and the speed of the CPU. The display looks like this:

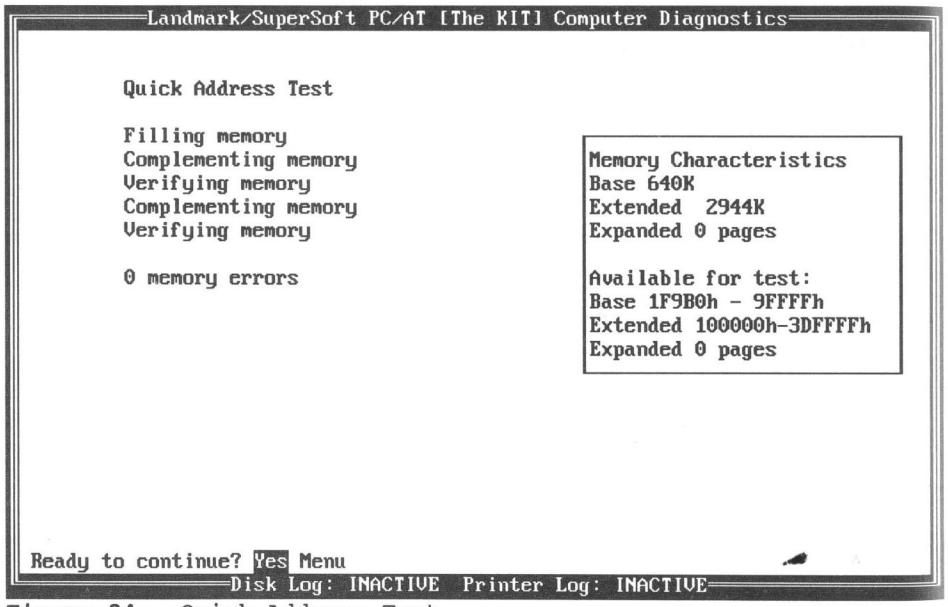


Figure 34. Quick Address Test

Memory is filled with a pattern, then complemented (all bits reversed), verified, complemented a second time, then again verified.

• **Burn-in and Walking Bit Tests**

The screens and format of the Burn-In Test and the Walking Bit Test are similar to those of the Quick Data Test. The same format will be used for error summary of each of these tests.

The longer the tests run, the greater the chance of detecting any errors; it may be advisable to allow them to run an extended period of time such as overnight. All errors will be logged if logging is enabled. An explanation of each test and its purpose appears in the Technical Information later in this manual.

• **Memory Refresh Test**

The Memory Refresh Test checks the ability of memory to maintain a known pattern in memory. If the test fails, but the other memory tests do not, then it is likely that there is a partial refresh failure in the system. One of the ways in which the test might fail would be if critical code in Service Diagnostics or your operating system was not refreshed, therefore becoming corrupted. The Landmark ROM POSTs have a more extensive memory refresh test, which is able to detect chips with marginal chip persistence problems.

- **Memory Map**

The Memory Map displays the current memory usage in the computer, in order to aid in visualizing the regions of memory. The Memory Map will vary according to the amount of memory in your system and whether or not it is equipped with extended/expanded memory. The map looks like this:

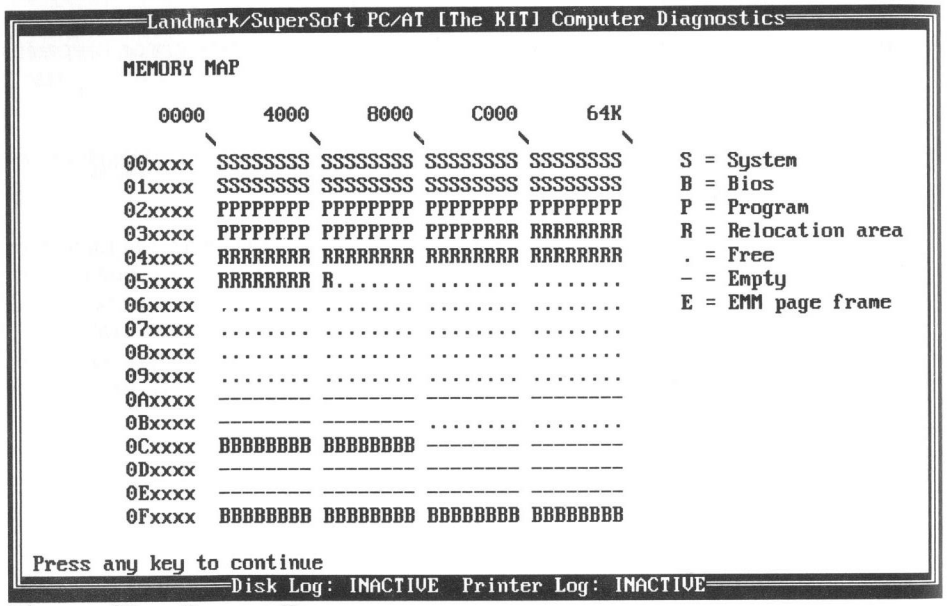


Figure 35. Memory Map

Each character in the map represents the usage for each 2K of address space memory in your system. For instance in the above screen, the first S above indicates the (System) region addressed from 000000 to 00A000h hexadecimal. Each 2K region marked with an "*S*" is memory in use by the BIOS and/or operating system. Each area represented by a "*P*" is memory in use by Service Diagnostics, although any memory test can test this region because Service Diagnostics is self-relocating.

Memory marked as "*R*" is available to be used as the relocation area if the "*P*" region is being tested. The areas represented by a "." are available for testing and are not reserved for the program or for relocation. BIOS memory, indicated by a "*B*", is ROM memory of adapters or the system board. They are detected only if they conform to IBM device BIOS standards. Empty memory, indicated by a "-", is a region without any memory in it.

If your computer has extended or expanded memory, then multiple screens will be displayed. After base memory (memory below 1M) is displayed, extended memory maps are displayed (if present), then expanded memory screens are displayed (if present). Expanded memory will show as pseudo-addresses above the total of conventional and extended memory installed. The expanded memory I/O ports will be shown to the left of the pseudo-addresses.

Note: See the Technical Information section for an explanation of how to use the memory map in your diagnostic session.

Keyboard Test

The Keyboard Test checks that all keys send the correct key codes to the system. As you press each key on the keyboard, the corresponding position on the display changes to show the interpretation of that key by the system. Pressing shifted characters will cause them to appear above the unshifted characters. As each character is pressed, the scan code for the character is shown. This is the code sent from the keyboard to the system board whenever a key is pressed or released. Assuming that you have a standard keyboard, all the keys should match your keyboard. If you have an enhanced keyboard, you can change the device list to use an enhanced keyboard test.

Press the <Y> key and then <ENTER> to move to the next screen. When you continue, this message is displayed:

Does your screen display correspond
to the keys pressed? Yes No

Entering <Y> will proceed to the next test. Otherwise you get the message:

KEYBOARD FAILED TEST
Ready to continue? Yes Menu Repeat

Asynchronous Port Test

This test checks all of the asynchronous ports' status and I/O registers. The test attempts to initialize the port; any errors that occur will be reported. The test then sets the port's internal loopback mode, sends characters, and compares the received values with the transmitted values. Afterwards, the internal loopback is shut off and, if the user has specified the external test, the test will repeat the character send/receive test assuming the serial loopback plug is installed.

Note: There are two external serial loopback plugs: a 25-pin female (for PC, XT or PS/2 computers) and a 9-pin (for AT computers).

When you run the Asynchronous Port Test, the following screen is displayed:

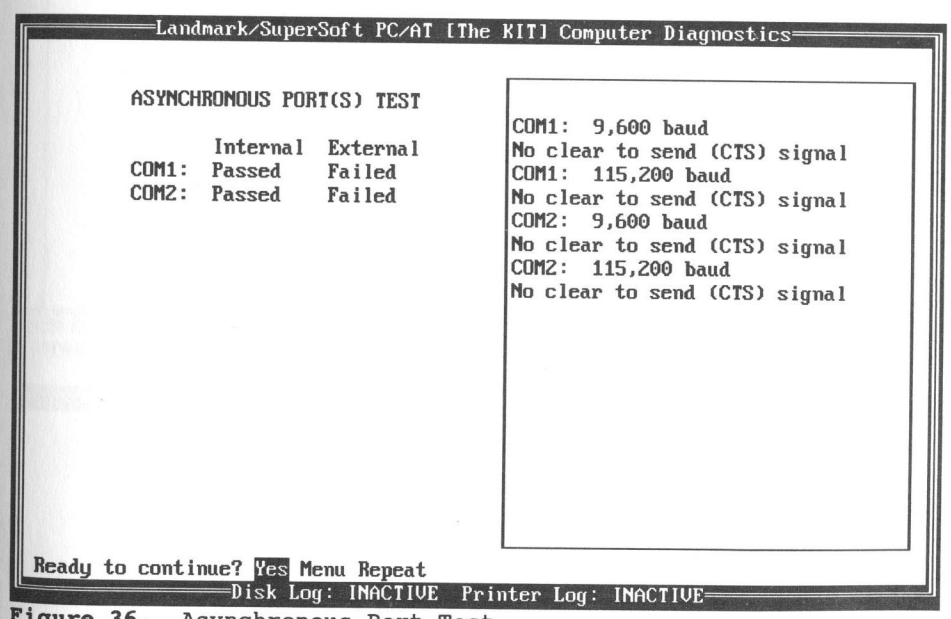


Figure 36. Asynchronous Port Test

Parallel Port Test

This test writes characters from 0 to 255 decimal to the parallel port and then checks the status registers. An error indicates that there is a problem somewhere between, or in, the CPU and port.

When you run the Parallel Port Test, this screen is displayed:

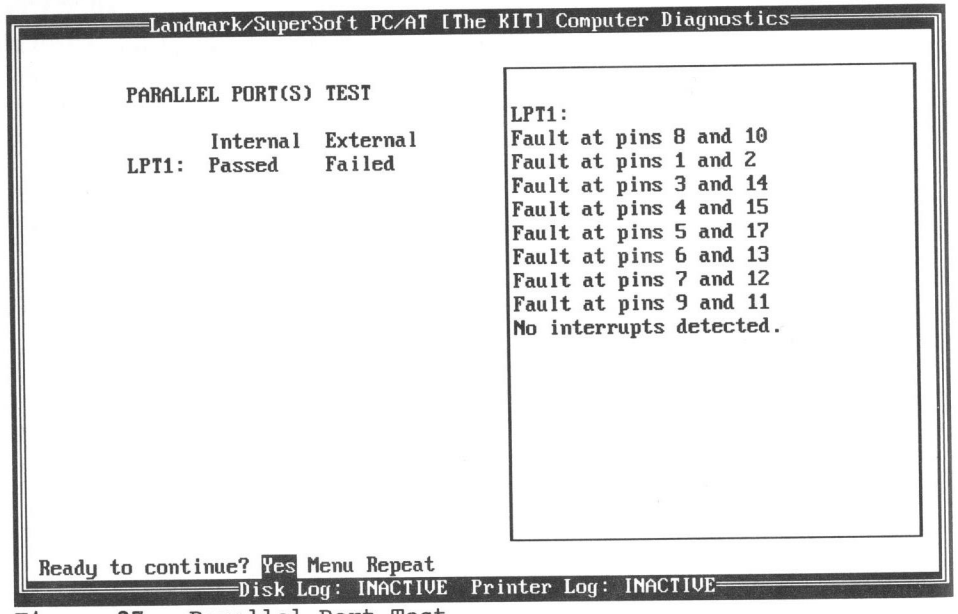


Figure 37. Parallel Port Test

Video Adapter Tests

Service Diagnostics is capable of testing all major video adapters. Your installed adapter type can be modified using the Device Configuration Menu, which can be accessed from the Main Menu. The following screen shows adapters that are currently supported:

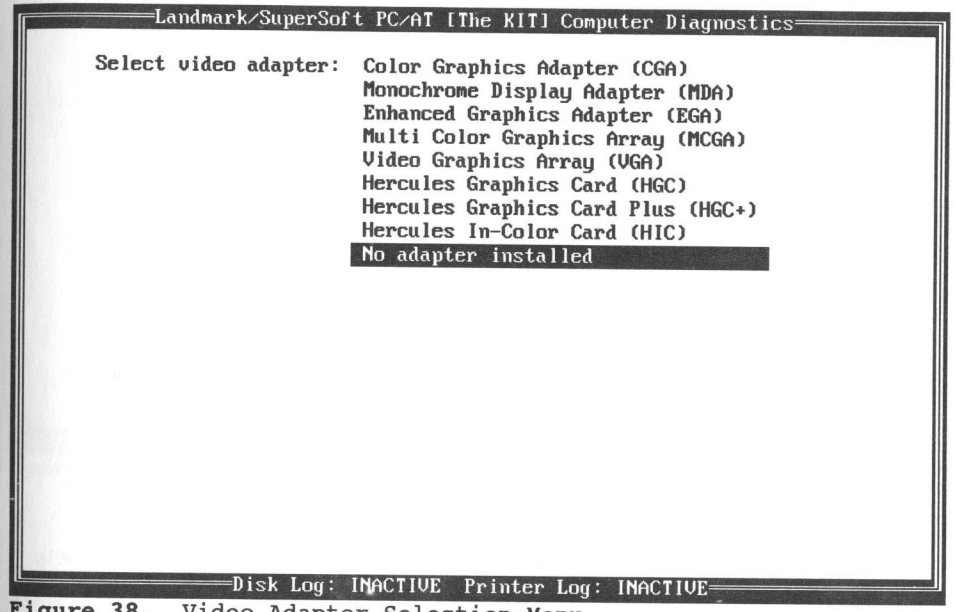


Figure 38. Video Adapter Selection Menu

Monitor and Adapter Test

This test consists of up to six parts: the Display Test, the Diamond Test, the Grid Test, the Raster Purity Test, the Video Adapter Memory Test, and the Circle Test for color adapters. The monochrome menu appears as follows:

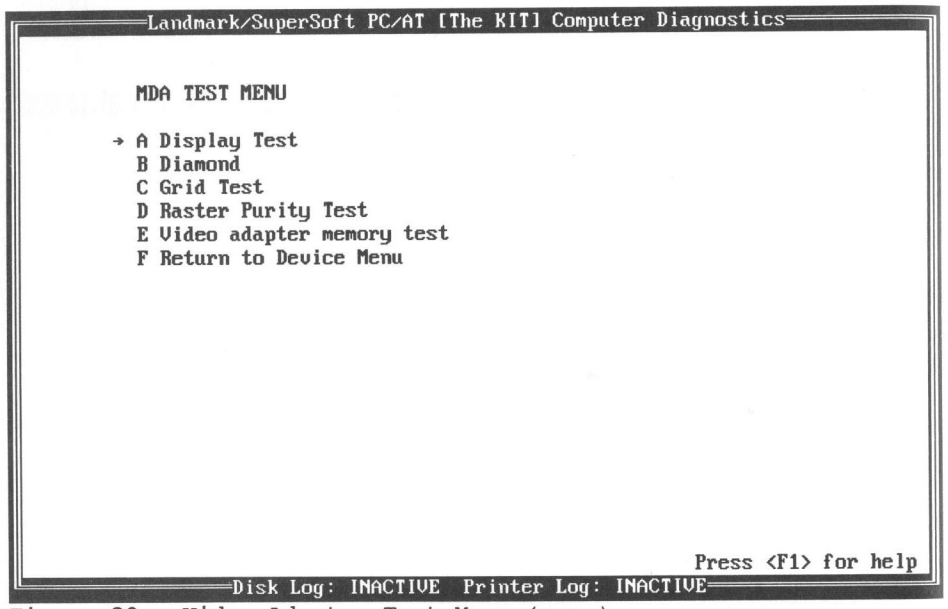


Figure 39. Video Adapter Test Menu (mono)

The menu for testing color adapters is shown below:

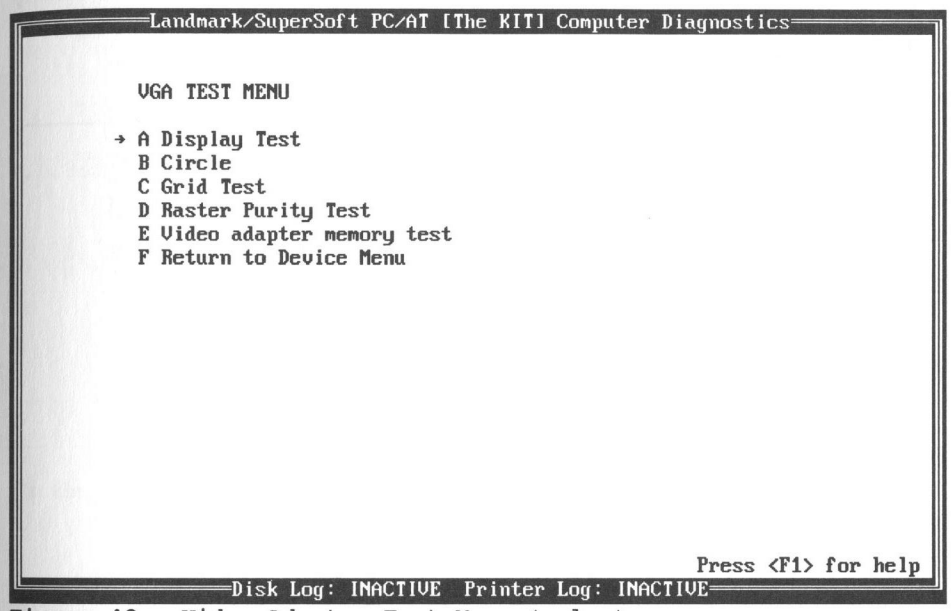


Figure 40. Video Adapter Test Menu (color)

Note: The headings for all menus will reflect the actual adapter type under test (ie. CGA, MDA, EGA, MCGA, VGA, HGC, HGC+, or HIC). Differences between monochrome and color test screens will be noted along the way.

- **Display Test**

This selection will perform attribute, ASCII character, barber pole, and graphics display tests. The first screen for monochrome adapters shows available video attributes and looks like this:

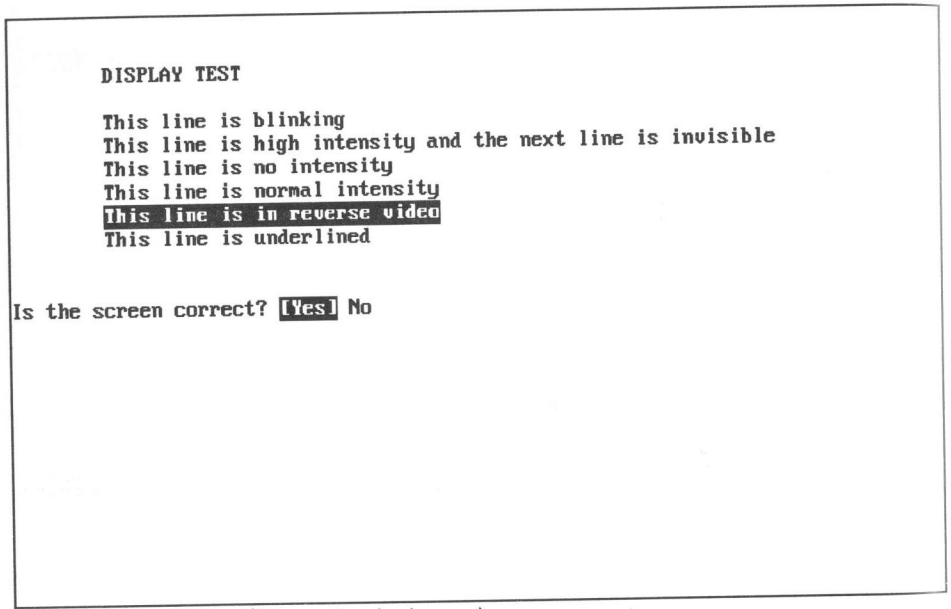


Figure 41. Attribute Test (mono)

Note: If you notice a discrepancy and tell Service Diagnostics that the screen is not correct, advice will be given in an attempt to correct the problem.

The first screen for color adapters looks like this:

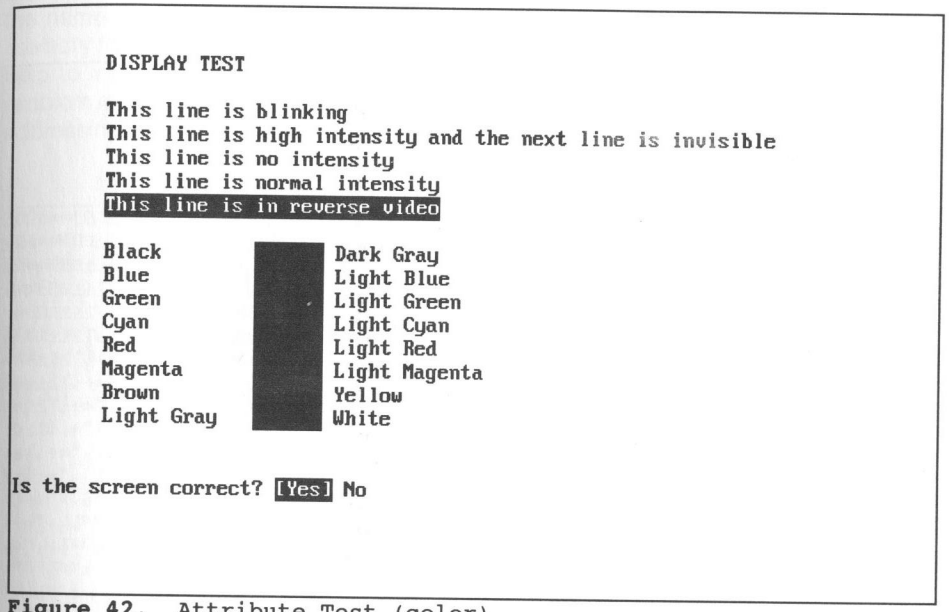


Figure 42. Attribute Test (color)

Note: In addition to video attributes, color adapter users are asked to verify that color attributes are correct.

The next screen displays a grid of available ASCII characters. The ASCII code for any character displayed in the grid may be found by adding the values above and beside the appropriate character. The following screen appears for mono and color users:

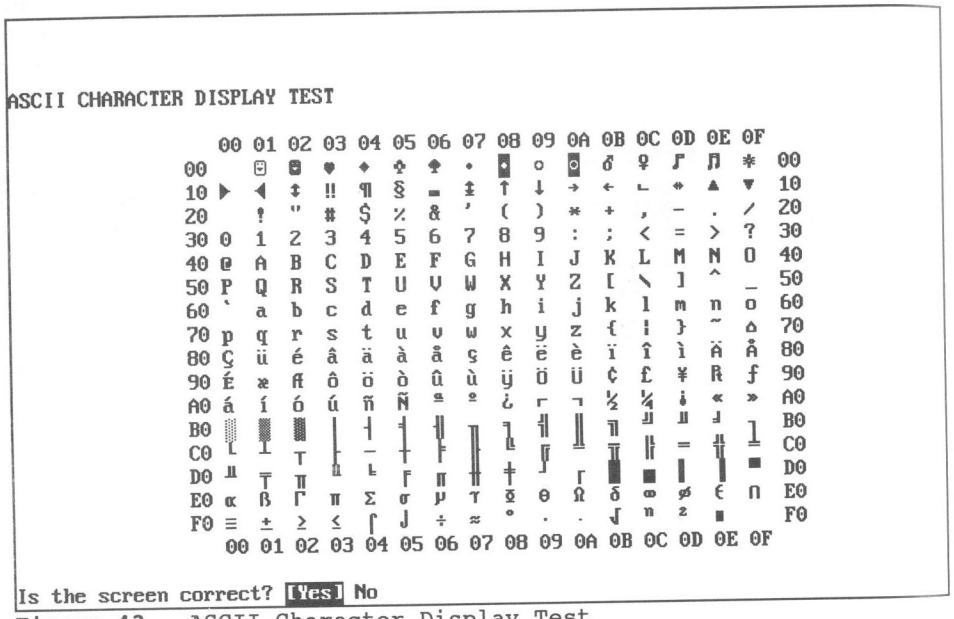


Figure 43. ASCII Character Display Test

Note: Characters that are misformed, distorted, or entirely missing indicate a problem with the character generator on the video adapter itself. If only one or more characters are corrupted, suspect the video RAM. See the Barber Pole Test for more information.

Next is the Barber Pole Test. A series of printable characters is displayed on a line, with the first character cycling in following lines as the screen scrolls. On color adapters, the character color also cycles. The obvious diagonal stripes that appear are the basis for the name of this test. Errors at a fixed position in the display indicate that the video memory is defective at that position. Flickering characters that have a pattern to them help to indicate which bit is failing. For instance, "*A's*" that become "*B's*" suggest a problem in the lower-order bit of that position. Errors that scroll with the display indicate addressing problems. The screen, for mono and color, appears as follows:

Figure 44. Barber Pole Test

The Graphics Display Test checks the colors or gray shades displayed by your monitor. This test is performed twice in 320 x 200 screen resolution (once for each color palette set, which are numbered set 1 and set 2) and once in 640 x 200 screen resolution. If you have a color monitor, the first two screens are displayed in color and the final screen is displayed in shades of gray. If you have a monochrome monitor, the three screens are displayed in shades of gray.

The second part displays the same graphics format for color set number 2. The third part tests the 640 x 200 pixel graphics set by drawing vertical stripes in the front and rear boxes to effect gray shading.

The messages from the second and third portions of the test are the same as the first graphics test. If an EGA or a VGA is being tested, additional graphics screens corresponding to the available video modes will be shown. Here is a screen from a monochrome adapter:

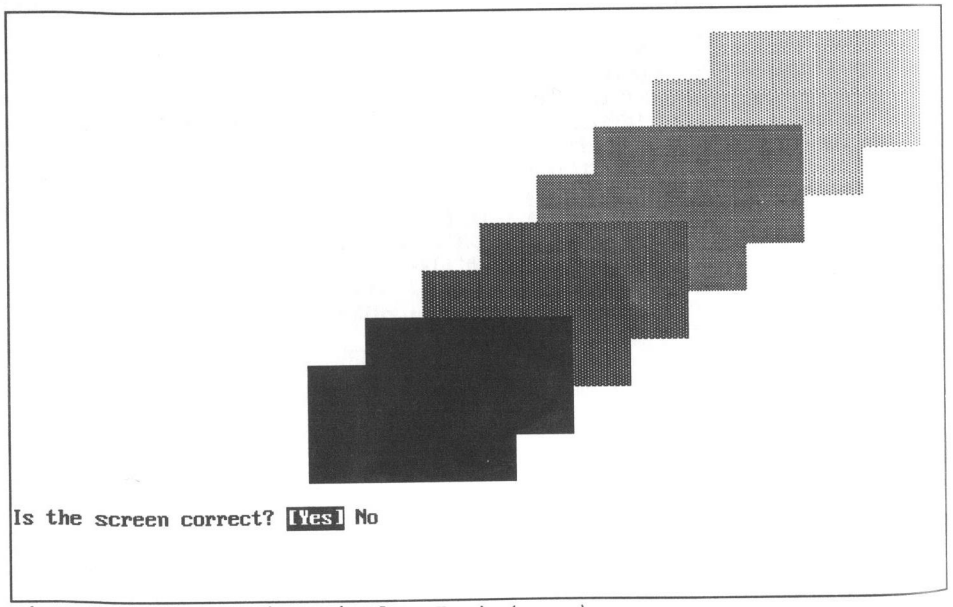


Figure 45. Graphics Display Test (mono)

Here is a screen from a color adapter:

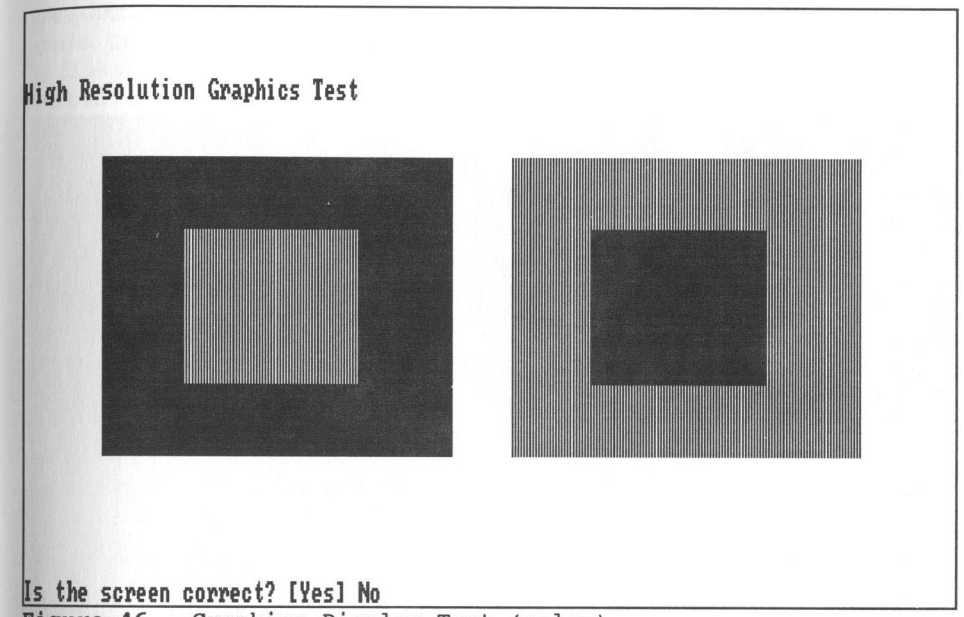


Figure 46. Graphics Display Test (color)

Service Diagnostics also offers a unique test for color adapters, in which every available color in several palettes is displayed side by side in every combination possible. All testing occurs in EGA mode. Look closely for colors bleeding into another color. All separations of color should be distinct. The following screen appears:

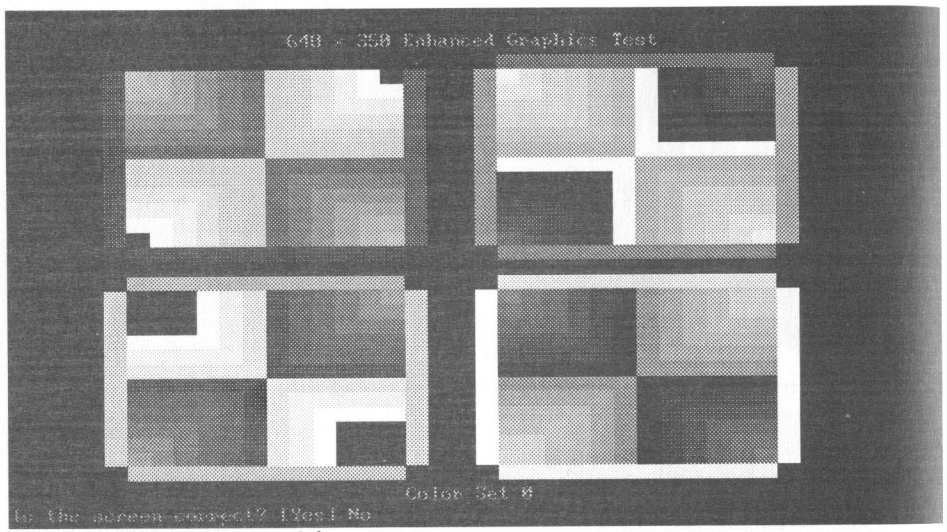
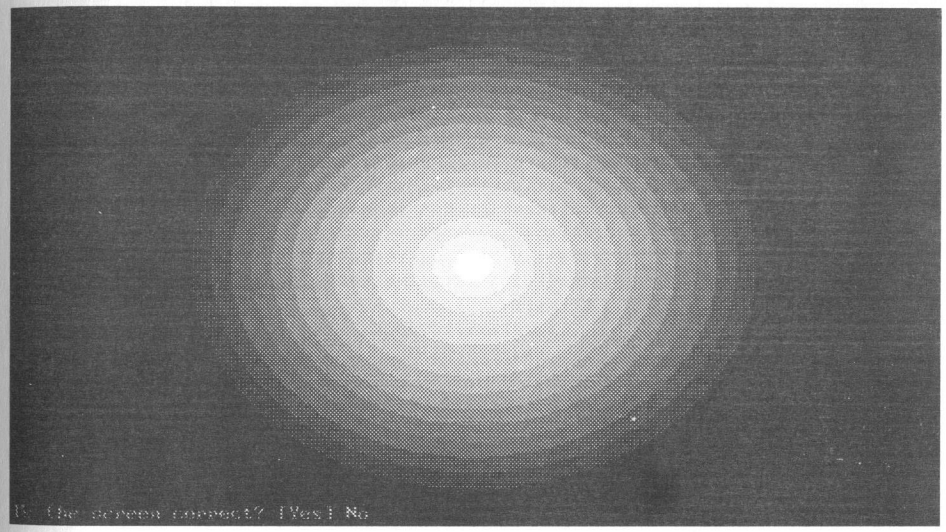


Figure 47. EGA Graphics Test

- **Circle Test**

The Circle Test is only available on color adapters. This test will draw three concentric circles on the screen if the adapter is a CGA. Up to 15 circles are drawn if the adapter is EGA or VGA, the largest of which should border the top and bottom of the screen. As each circle is drawn, it will be filled in. The circles should appear round. If the circle is elliptical, it may be an indication of a problem with your monitor. It is at least an indication that software which expects a square aspect ratio will not draw geometric shapes as expected. If the circles are not complete or are not filled in entirely, it is an indication that the graphics adapter may be defective. The screen appears as follows:



- Diamond Test

The Diamond Test displays a diamond covering most of the screen. Individual blocks compose the diamond, of which all blocks should be same size. Pay careful attention to the extremities of the diamond. The test screen appears as follows:

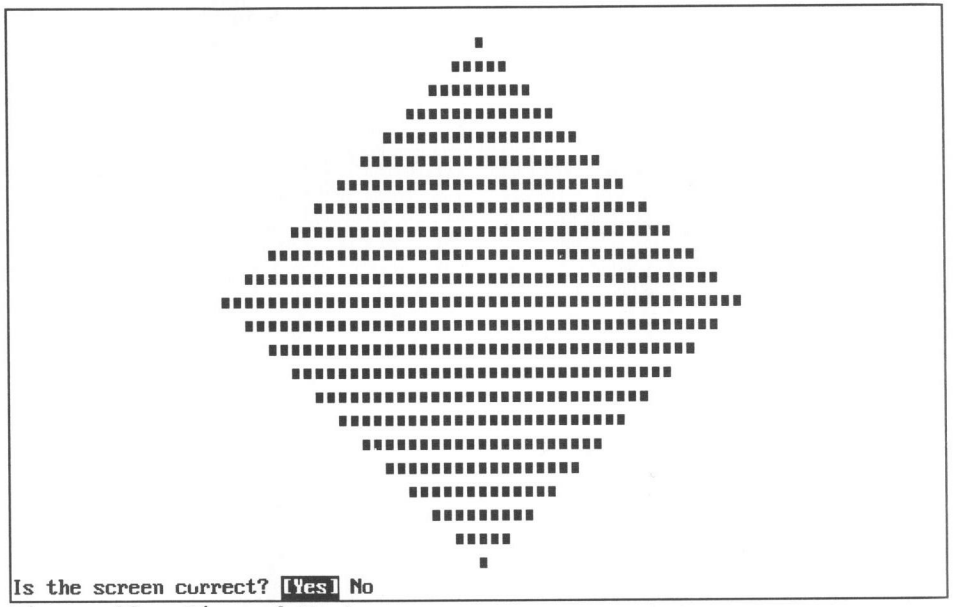


Figure 49. Diamond Test

- Grid Test

The Grid Test will display a grid covering the entire display area. All sections of the grid should be the same size, with no stretching or distortion of any kind at the edges. Look, too, for clipping or missing borders at the top, bottom, left, and right edges. The following screen appears:

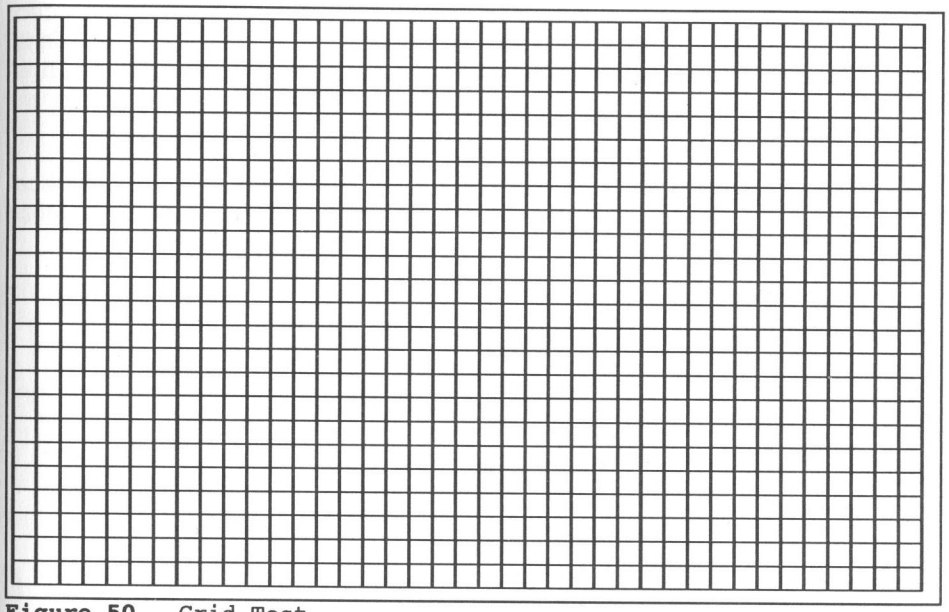


Figure 50. Grid Test

- **Raster Purity Test**

This test will light every pixel in the display area. The result should be a well-defined, solid box. No lines, patches, or individual pixels should stand out.

- **Video Adapter Memory Test**

The Video Adapter Memory Test will indicate whether or not the memory on the video adapter is able to hold specific bit patterns. During the course of the test, it is completely normal to see patterns on the display, as well as a total lack of display. This should only last for a brief period.

> **Note:** For more information concerning faults discovered while using Service Diagnostics' suite of video tests, see the Technical Information section of this manual.

Floppy Disk Test

The Floppy Disk Test can verify the correct operation of any normal floppy drive, as it directly accesses the floppy disk controller. It tests the controller ROM code, the controller itself, and the recording media. If the errors occur in the drive itself, the Alignment Test Menu can be used to pinpoint the problem in the drive.

The floppy drive types must be properly set before using the Floppy Disk Test Menu. If you are unsure, use option "*G*" (Change installed device list) from the Main Menu, then select option "*J*" to specify the drive types.

> **Note:** Service Diagnostics supports 360K 5¼ inch, 720K 3½ inch, 1.2M 5¼ inch, and 1.44M 3½ inch floppy drives. Other drives that require a special device driver (check the CONFIG.SYS file on your boot disk for a line starting with "*DEVICE=*") and probably cannot be tested. This includes RAM disks, alternate disk format drivers, 8 inch floppy drives, and other such devices. Sometimes even though a 3½ inch or a 5¼ inch disk drive requires a driver, it can still be tested by Service Diagnostics.

Upon entering the Floppy Disk Test, the following screen will appear:

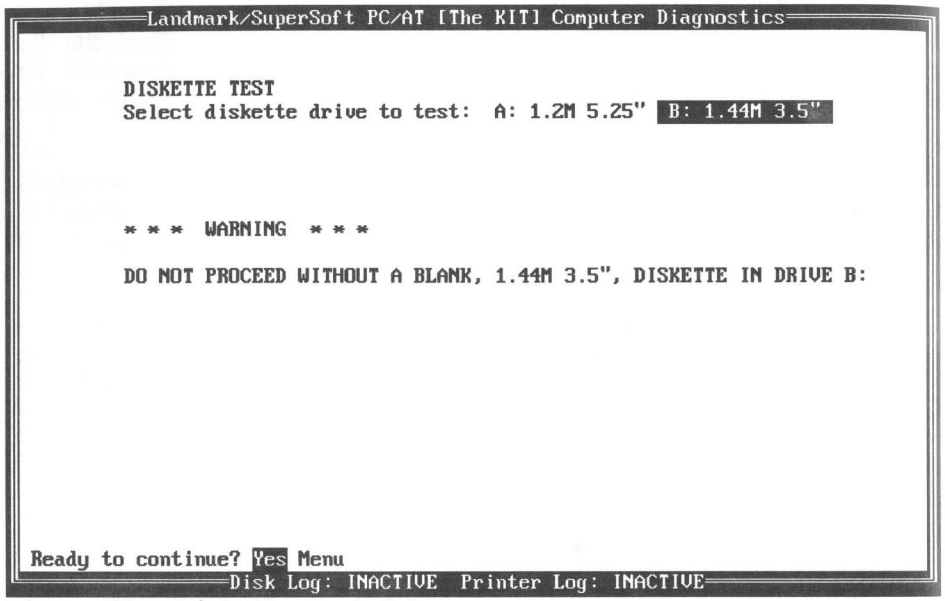


Figure 51. Diskette Test Setup

Service Diagnostics will detect if the disk in the drive is a Service Diagnostics diskette; if so, it will reject it and allow the user to insert a blank disk. During testing, the disk will be formatted, verified, written, read, and seeked at random. A summary of recoverable and unrecoverable errors will conclude the testing.

Here is an actual screen taken at the end of diskette testing:

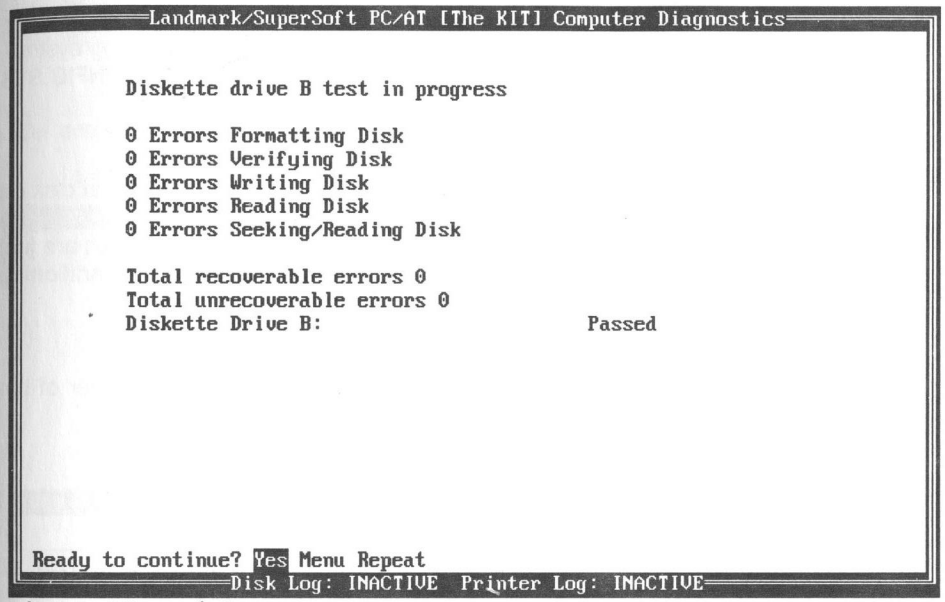


Figure 52. Diskette Test

Hard Disk Test

The Hard Disk Test will test any standard hard drive; as with the Floppy Disk Test, Service Diagnostics directly accesses the controller, bypassing the operating system. The drive(s) to be tested must not require special device drivers (see the CONFIG.SYS file on the system).

The hard disk test is performed on disk 0 or disk 1. Disk 0 is the PHYSICAL first disk on your system. Disk 1 is the PHYSICAL second disk on your system. Under DOS, these disks may or may not be your disk C: or disk D:. Sometimes disks C: and D: are just partitions of disk 0. Use DOS's "*FDISK*" or similar program to determine the partitioning of your disk.

On entering the hard disk tests, the user will be prompted to enter the number of the drive to be tested. The following is the Hard Disk Test Menu:

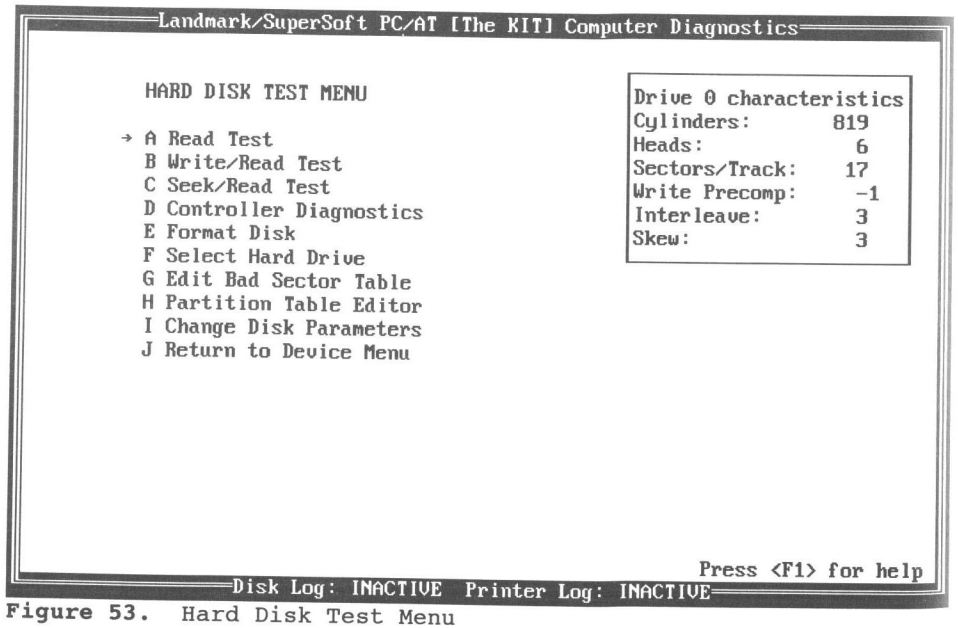


Figure 53. Hard Disk Test Menu

• Read Test

The Read Test allows the user to scan the entire hard disk, or any portion thereof. See the Technical Information section for a discussion of the errors reported by this test. The hard disk and the hard disk adapter are usually replaceable items.

After entering the Read Test, the user will be prompted for the following:

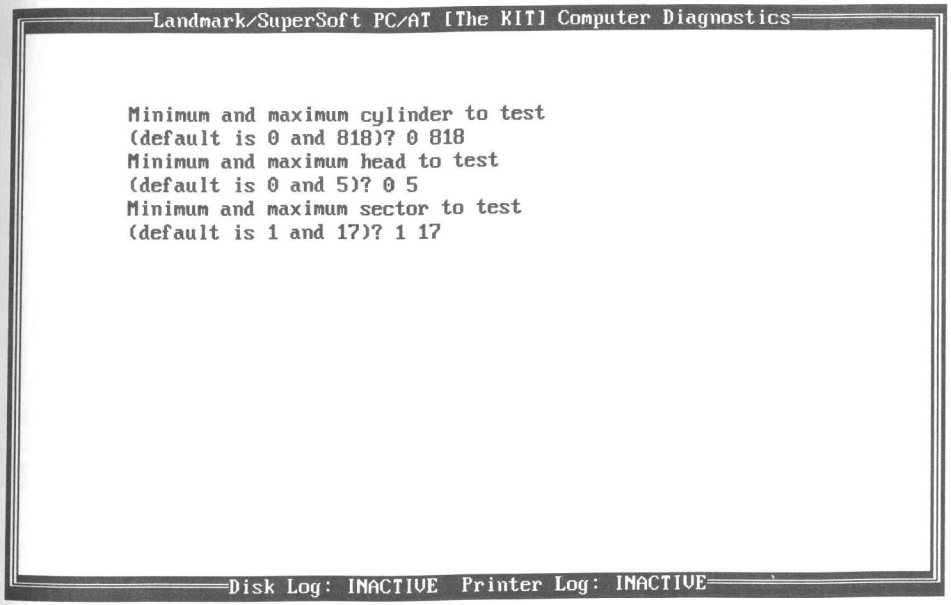


Figure 54. Read Test Setup

When entering two values for any of the above items, enter the first number, followed by a space, then the second number, and press <ENTER>. After entering the parameters, the test will start, and the following screen will be displayed:

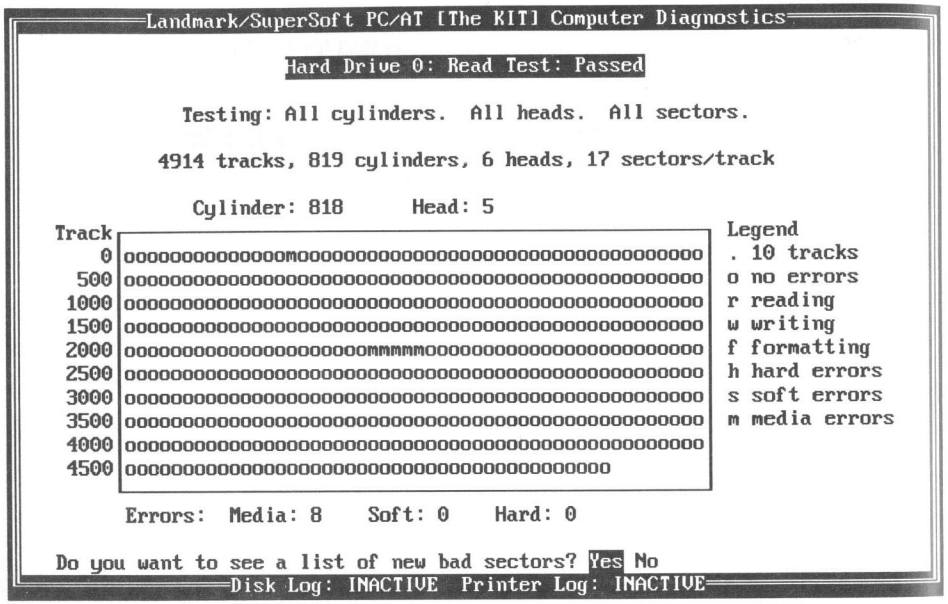


Figure 55. Read Test

The Read Test will begin reporting the current cylinder, head, and sector being tested as well as errors as they occur.

Immediately following the Read Test, you are given the option to review the new Bad Sector Table. The following is an example:

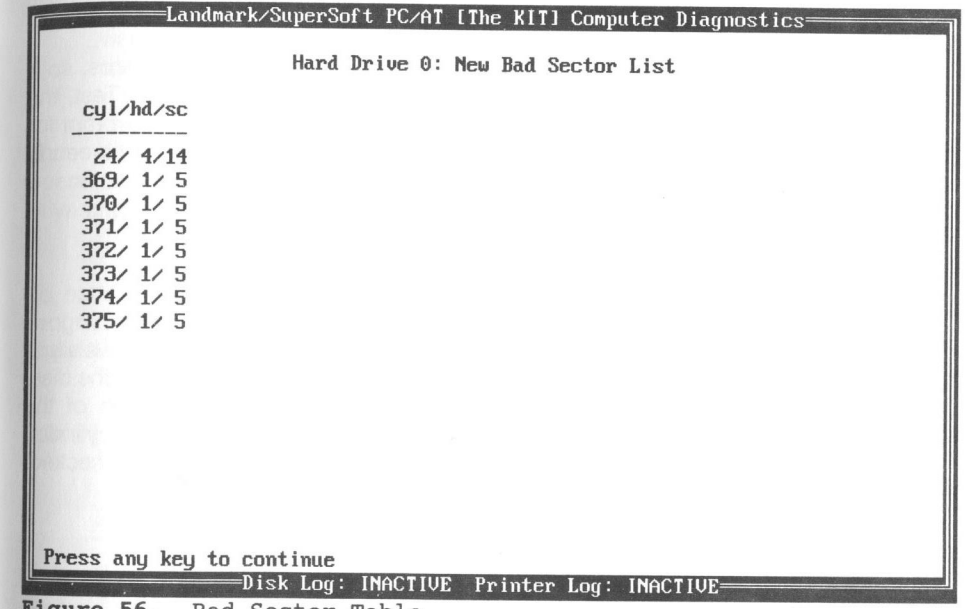


Figure 56. Bad Sector Table

The list of sectors will include any media, soft, or hard errors found during testing.

Note: Any sectors added to this table by Service Diagnostics are NOT removed from service or marked as bad as far as your disk operating system is concerned. In other words, Service Diagnostics DOES NOT make any attempt to move or salvage data from these sectors; the reason is to maintain compatibility across many different operating systems. Only during a low-level format is the Bad Sector Table used or allowed to affect availability of particular sectors.

- **Write/Read Test**

The Write/Read Test works much like the Read Test, except that it writes a unique test pattern onto each of the specified sectors before reading them.

> **WARNING!!!** This test WILL DESTROY any data on the specified sectors, so it should be used with EXTREME care. After specifying the Write/Read Test, the user will be warned, and given a chance to abort. Then the test will prompt for the minimum and maximum cylinder, head, and sector. This entry screen is identical to the Read Test Setup screen.

- **Seek/Read Test**

The Seek/Read Test assesses the drive's ability to properly position the heads. It starts by seeking to cylinder 0, head 0, sector 1, then seeks to the highest cylinder on the disk, using head 0 and sector 1. Then it checks the same cylinders with each of the remaining heads. Afterwards, it seeks to cylinder 1, then to the next-to-last cylinder, again checking each head. The test progresses until all cylinders have been checked. Errors are shown as they occur.

The test screen looks like the screen in the Read test. See the Technical information section for a discussion of the meanings of specific error messages.

- **Controller Diagnostics**

This option tests the controller's electronics and buffer memory. It will report whether the controller passed or failed the test.

- **Format Disk**

This option performs a low-level format, which writes addressing information onto the disk. This information is the sector, head, and cylinder header information per sector that is required by the controller in order to communicate with the hard disk. Hard disks that are readable do not need to be low-level formatted. If, however, your hard disk is starting to get soft errors, then it may be time to do a low-level format.

Before Service Diagnostics allows a drive to be low-level formatted, an unmistakable warning is displayed.

> **WARNING!!!** This option WILL ERASE ALL DATA on the disk! The user will be warned and given the option to return to the Hard Disk Test Menu instead of continuing.

This option will not partition the disk, nor will it perform a high-level (file system) format operation. See your operating system manual for more information on partitioning the drive and performing a high-level (file system) format operation.

To partition the drive, use the DOS "*FDISK*" command, or the equivalent partitioning program supplied with the operating system installed on your computer. For the high-level format, the DOS "*FORMAT*" or equivalent program must be used.

When formatting the disk, the user will be prompted as follows:

> **Enter interleave factor [between 1 and 16]?**
>
> **Enter skew factor [between 0 and 16]?**
>
> **Attempt to reformat bad tracks? Yes No**

The user may choose whether or not Service Diagnostics should attempt to reformat tracks that have previously been marked as bad. Choosing to reformat such tracks may increase the capacity of the drive, however you run the risk of allowing marginal sectors to be used by the operating system. Choose this option only if you are reformatting a drive that was previously used with this controller, because before a sector is formatted, it is read. If the controller does not see any information, it cannot correctly detect tracks previously marked as bad.

The previous bad sector information can be used during the format. This information might be listed on the drive itself, or on a document supplied with the drive. Using this information is a good idea, since the controller may format a marginal sector just by chance, but during use the sector will go bad. That is, if a sector was ever detected as bad, it is probably not a good idea to ever reformat it as good.

In addition, the following question is asked:

Will the bad media data be entered as Bytes from Index? Yes No

The defect list can be entered as bytes from index or as sectors from index. This depends on the format of the listed bad sector table. This is the prompt for bytes from index:

Enter cylinder, head, and bytes from index

or <Enter> to continue

This is the prompt for sectors from index:

Enter cylinder, head, and sectors from index

or <Enter> to continue

The test screen looks like the screen in the Read Test. See the Technical information section for a discussion of the meaning of error messages.

- **Select Hard Drive**

This option allows the user to select another hard drive for testing.

- **Change Drive Parameters**

This option allows the user to specify the number of cylinders, heads, sectors for the drive to be tested, and the cylinder on which to start write precompensation. The screen appears as follows:

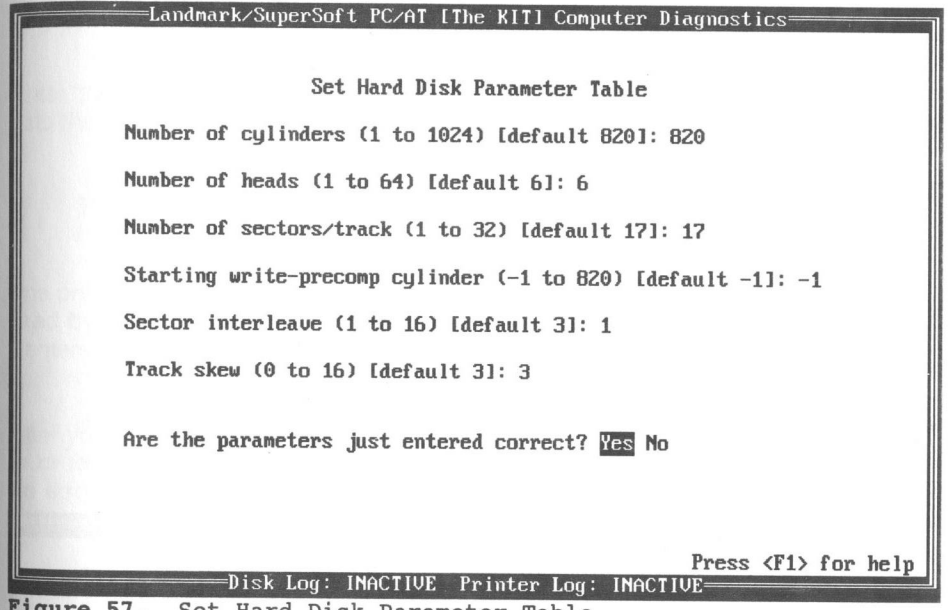


Figure 57. Set Hard Disk Parameter Table

WARNING!!! Do not change the drive parameters arbitrarily. Consult your disk drive manual for additional information.

Printer Test

The first screen of the printer test is the menu. It is displayed as follows:

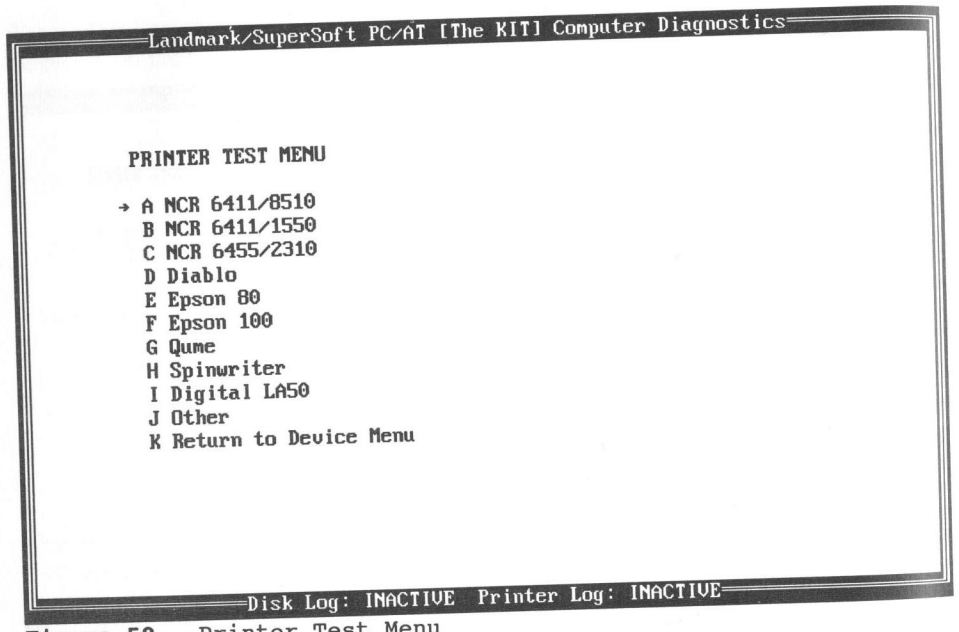


Figure 58. Printer Test Menu

Type the number corresponding to your printer. After selecting your printer type, you will then be prompted for some configuration information. The diagnostic will first prompt you asking if your printer is connected to a serial or parallel port. Then the diagnostics will prompt you for the number of that port. You should enter a 1, 2, or 3 corresponding to the port such as COM1: or LPT2:.

If your printer is attached to a serial port, then the diagnostic will prompt for some additional information regarding the port configuration. First the diagnostic will ask for the baud rate, the possible responses are 9600, 4800, 2400, 1200, 600, 300, 150, and 110 baud. Second, the diagnostic will prompt for the word length. Here the possible responses are 7 or 8 bits.

Next, you will be prompted for the type of parity used. Respond with a "*N*" for no parity, a "*O*" for odd parity, or a "*E*" for even parity. Finally, the diagnostic will prompt for the number of stop bits to use. The possibilities are either 1 or 2 stop bits.

If your printer is not listed and you enter <J>, you will be prompted as follows:

Enter width in columns:

Enter "*132*" if your printer can print 132 columns; otherwise just press <ENTER>, which sets the width to the default value of 80 columns.

Enter number of nulls to pad carriage motion (<ENTER>=1):

The printer and the computer may occasionally get out of synchronization; this can be fixed by sending a null character or two at the end of a line. Two is enough for most printers.

After you have selected your printer (or specified the above information after selecting <J> for *Other*), the printer test will begin. As with the video monitor and adapter tests, no error logging is done to the file. After a few seconds, this message appears:

Press any key to stop the Printer Test. Turn the

printer off and back on to clear the printer buffer.

Diskette Alignment Test

The alignment tests work with a Digital Diagnostic Diskette, which contains precise timing and alignment information.

The alignment tests work directly on the floppy disk controller. These tests will not work on non-standard drives that require a DOS driver. The driver is either a "*DEVICE=*" line in CONFIG.SYS, or a TSR (possibly a .COM file) in AUTOEXEC.BAT.

The data obtained from each test is compared against built-in tables of expected operating ranges to determine the condition of your disk drive. The interpretation and use of these tests is described in the Technical Information section of this manual.

- **Spindle Speed Test**

The Spindle Speed Test evaluates the revolutions per minute of the disk. A drive rotating at a rate different from which it was designed may lead to potential read/write errors. If the spindle speed of your drive is not within the acceptable range, there is an increased possibility of read/write errors. The spindle speed of most diskette drives can be adjusted to the correct rate.

- **Centering Test**

The Centering Test checks the spindle bearings and the mechanical clamping mechanism of the diskette drive. This mechanism engages each time the door of the drive is closed. This test checks to see that the mechanism is seating and holding the floppy disk properly in the diskette drive.

The test repeatedly recalibrates the diskette drive read/write head position and then reads a designated track on each side of the Digital Diagnostic Disk. If all sectors are read successfully, the centering mechanisms of the diskette drive pass the test. A cumulative count of track and sector read errors is maintained throughout the test.

If any sector cannot be read successfully, you should try reseating the diskette by reinserting it, then attempting the test again. You might also try cleaning the read/write head(s) of the diskette drive with a head cleaning diskette coated with the proper cleaning solvent. Contact Landmark if you are in need of a good floppy diskette cleaning kit.

Repeated failures indicate the need for repair or replacement. Possible problem areas include the spindle bearings and the diskette clamping mechanism of the diskette drive. This diskette drive should not be used to record anything of value as it may not be able to be retrieve the data.

- **Index to Data Timing Test**

The Index to Data Timing Test checks the timing from the issuance of a read command to the response by the diskette drive. If this operation is not performed within the expected time limit, the drive fails this test.

A failing diskette drive should have its read/write head(s) cleaned using a diskette read/write head cleaning kit (available from Landmark). If errors persist, adjust diskette drive timing.

- **Track to Track Seek Test**

The Track to Track Seek Test checks the ability of the diskette drive to move from one track on the diskette to another. This is done by requesting a series of seeks, then by verifying (via a read) the actual track under the read/write head. Any errors in reading will be reported as failure of the test.

At the end of testing, a cumulative error message is issued, indicating the number of read errors for each read/write head.

- **Head Positioner Hysteresis Test**

The Head Positioner Hysteresis Test checks the seek accuracy of the diskette drive when moving from one track on the diskette to another. This is done by seeking first to track 0, then to the test track determining the track alignment. Then the test seeks to the innermost track, followed by a seek to the test track. Finally, the alignment difference between the two reads of the test track is determined. The result is expressed in milli-inches whether the drive is reading towards (positive result) or away (negative result) from the spindle as a result of seeking inaccuracy.

- **Head Positioner Linearity Test**

The Head Positioner Linearity Test displays the relative alignment of the diskette drive being tested at an inner track, a middle track, and an outer track. The results indicate the degree of misalignment of the drive at each of the three positions. A negative result indicates misalignment away from the spindle; a positive result indicates misalignment towards the spindle.

To pass the test, the alignment at each of the three positions must be within one unit of difference of the measurements of the other two positions. This test can also be used to do a side 0/side 1 comparison for double sided diskette drives.

- **Radial Alignment Test**

The Radial Alignment Test attempts to read specially designed tracks of the diskette to determine if the read/write heads are reading symmetrical to the nominal center of the track. First, the heads read a track with each sector alternately offset from each side of the center of the track. Next, a track with the sectors progressively offset is read.

If the diskette drive can read each track up to ± 10 milli-inches, then the radial alignment is good. If it can read only up to ± 9 milli-inches, then it will be considered fair. Any result less than ± 9 milli-inches will be reported as poor.

Failure of this test indicates a serious need for adjustment of the diskette drive and a high probability of losing data written by the drive. Even diskette drives reported as marginal should not be trusted with critical data. The diskette drive should be serviced as soon as possible.

- **Azimuth Alignment Test**

The Azimuth Alignment Test checks to see if the read/write head is adversely skewed relative to the radius of the data track. This is accomplished by reading a track that has been written by a skewed head with various degrees of skewing, in both directions. If errors do not occur symmetrically with respect to each direction, then the read/write head may not be correctly aligned.

Note: This test is not available for 3½ inch floppy drives.

Failure of this test indicates a serious diskette drive alignment problem or dirty read/write heads. This test (as well as most of the other tests such as the radial alignment test) can fail due to a weak read or write signal, caused by excessive oxide build-up on the read/write head. In addition, because diskettes have the oxide aligned for one azimuth, the diskette drive may not even be able to read data that it wrote. If any of these tests fail, use Landmark's head cleaning kit on the diskette drive and rerun the test. Repeated failure rules out a dirty read/write head.

Bad alignment is a problem that can only get worse. This diskette drive may not be able to read data written by other diskette drives and vice versa. Thus the chance for losing data is high; the drive should not be used until it has been repaired. If the diskette drive is reported as marginal, the diskette drive may still be writing data readable by itself, but unreadable by another diskette drive. In this case, no critical data should be saved to this drive; the diskette drive should be serviced as soon as possible.

- **Analog Alignment Aids**

The Analog Alignment Aids are provided for use in aligning a diskette drive with the aid of an oscilloscope and for use in diskette head cleaning (contact your Product Consultant for information concerning head-cleaning kits). An alignment done with the Digital Diagnostic Diskette (DDD) is accurate to ± 0.5 milli-inch, which is more than sufficient for evaluation of diskette drive performance, determination of which drives are failing because of alignment problems, and correction thereof.

The more conventional method of diskette drive alignment using an oscilloscope may be desirable when making adjustments to a misaligned drive. This aid is provided for use with an Analog Alignment Diskette (AAD). You may move the drive's read/write head to the correct track on the AAD, and to cause a head load so that the alignment can be determined and adjusted. In order to clean the read/write head(s) of the diskette drive, insert a head cleaning diskette coated with the proper cleaning solvent during this test. Cleaning kits are available from Landmark.

> **Note:** For the average technician, the Analog Alignment Aids can be disregarded. This is due to the familiarity that is needed with an oscilloscope to effectively utilize these alignment features. For more information regarding the setup of your oscilloscope, and for specific information about patterns that should be seen on your oscilloscope when using an Analog Alignment Diskette, see the manuals accompanying your oscilloscope and AAD.

Overview

Service Diagnostics is an executable software program that helps diagnose hardware problems with IBM PC, PC/XT, AT 2/3/486, PS/2, and 100% compatible computers. Other items such as screw drivers (3/16 inch and 1/8 inch flat, number 1 and number 0 Phillips are recommended), nut drivers (1/4 inch and 3/16 inch are recommended), integrated circuit inserter/pullers, tweezers, parts retrievers, anti-static parts tubes, memory chips (64K [200 nanosecond or less], 256K [150 nanosecond or less], 1024K [100 nanoseconds or less] are recommended), and an oscilloscope are also useful for more advanced repair.

Service Diagnostics consists of two programs that call each other, **xxSERV.EXE** and **xxMEM.EXE**, and the help file, **SERVDIAG.DAT**. **XTSERV.EXE** will run in 128K on a PC, PC/XT, or PS/2 Model 25 or 30 compatible; the program is overlaid. **ATSERV.EXE** will run in 256K on an AT compatible or a PS/2 Model 50, 50SX, 60, 70, or 80; the program is not overlaid. **xxMEM.EXE** will run in 64K on either type of computer. The standalone version uses a similar arrangement, but the programs are stored in a special proprietary format.

The following sections will detail the procedures involved in each diagnostics test and discuss the possible results. It is important to keep in mind that due to the complexity and inter-relationships of microcomputer components, it may not always be possible to correctly identify the actual fault in the system.

Independent tests have shown 95% fault detection for Service Diagnostics. That is, if the diagnostics will run at all but an application program or operating system will fail, Service Diagnostics will indicate failure.

The engineers at Landmark are constantly updating Service Diagnostics in order to test the latest CPUs, numeric co-processors, and peripherals.

Version numbers for Service Diagnostics are in the format: **vX.YY.ZZ**. A change in the **X** field indicates a significant revision, such as the addition of several revolutionary features. The **YY** field signifies the addition of testing routines for new devices such as CPUs, numeric co-processors, and peripherals. A change in the **ZZ** field indicates a minor bug fix, or revision in the testing routines for currently supported devices.

CPU Test

The CPU Test is intended to exercise and diagnose faults in the CPU. Throughout Service Diagnostics, the test routines are written in standard C with one extension; **#asm/#endasm** directives are included for in-line assembly code. This allows the test routines to access those functions of the processor that are not available from C.

The test is divided into two parts. The first part of the test causes the processor to execute a repeated loop of CPU instructions. This loop of instructions is timed if a timer is present. It is used to determine the correctness of the speed of operation of the CPU.

> **Note:** See the CPU test section for a discussion of reasons for an apparent incorrect CPU speed.

In order to determine the rated CPU speed, you can do several things. The most reliable is to look for the CPU crystal. This will be a shiny metal encased part on the system board. It will usually be rectangular, and be physically located near the CPU. There will probably be more than one crystal on the board if the system is not a 4.77 Mhz PC or a 6 Mhz AT. One crystal supplies the bus clock and another crystal (usually faster) supplies the CPU timing. The crystals are usually rectangular.

The second part of the test checks the CPU for correct execution of its instruction set. The CPU is requested to execute nearly all of the instructions available to it. This is accomplished by running the processor in the single-step mode and saving the state of the processor (that is, all of the registers) after the execution of each instruction. The saved state is checked against a table containing the correct state for a nominal CPU. The instruction sequence of the test is devised so that full use of the CPU's registers is made, along with at least one instruction that uses each of the register stack addressing modes available. The accumulator registers AX, BX, CX, and DX are compared byte by byte. That is, the AH (high byte of the AX register) is compared against the expected results for the AH register. This is done because the accumulators may be addressed as byte registers as well as word registers. The index registers, the segment registers, and the flags are all compared on a word basis.

If errors are detected, they are reported in the following format:

CPU Failed Test
Error count 11H
Instruction sequence was 00000000H
Register AX contains FFH
but should contain 10H
Register value before instruction
sequence was FFH
Instruction test number 0DH

Repeated errors by the CPU are an indication of a faulty CPU. The test detects problems such as moving the contents of the SI register to the AX effecting the BX register, as well as detecting erroneous results of arithmetic operations. Since the processor is socketed, replace the processor and rerun the test. If the test still fails, then the socket itself should be suspected, along with all connections to the processor chip and all support chips.

When burning in a CPU, it is best to repeatedly run the CPU Test under both normal and high-stress conditions, such as high temperature, humidity, and operating frequency. It should also be run under lower- and higher-than-normal power supply voltages.

Some 80386 CPUs have a bug in the 16-bit and 32-bit multiply hardware; multiplying the accumulator with a number containing a byte of 0E8h sometimes yields inaccurate results. The CPU Test for the 80386 CPU will test these multiply instructions. The test will distinguish between 16-bit and 32-bit failures. CPUs that fail only 32-bit instructions may be used in 16-bit (8086, and 80286) software, however we do not recommend this. CPUs that fail 32-bit multiplies may cause crashes or yield erroneous results when used with programs or operating environments that use 80386-dependent code. CPUs that fail 16-bit multiplies are useless and should be discarded.

Some 80486 CPU's have a bug in the floating point multiply hardware. These CPU's should not be used in floating point tasks. DOS, UNIX, and NOVELL as well as most file servers do not use floating point in the operating system, so if your application tasks do not use floating point, then there will be no problem.

Memory Test

The memory tests read and write a region of memory using a particular algorithm in order to help determine the working state of the memory. The DOS version of Service Diagnostics does not test over the operating system (including the interrupt vector area), although it can test over itself via a relocation method. The relocation is done automatically whenever you choose to test all available memory. The test has provisions for expanded (banked/LIM/EMS/EEMS) memory. To test the operating system memory, use the standalone version of the Diagnostics, the Landmark ROM POST, or physically move memory chips and boards.

Note: Device memory (typically memory between 640K and 1M) can be tested also, but should only be tested if it is known that writing to it will not confuse the device or destroy valuable data on the device.

During the course of memory testing, the hardware system for detecting parity errors is disabled by default, so that the test will retain control of the system even if a parity error condition should occur. At your option, you may choose to enable the parity-checking circuitry by selecting option **I** from the Memory Tests Menu.

The memory test is not just one test, but a battery of six different tests: a memory map for verification of available memory, the Quick Data Test, the Quick Address Test, the Walking Bit Test, the Burn-In Test, and the Memory Refresh Test.

The algorithms have provisions to test dynamic as well as static memories. The algorithms test for addressing and data failures. You must select which of these tests you wish to perform each time you run the memory tests. These tests can only be performed one at a time. To perform all tests in sequence, you must re-enter all parameters and select the next test. Errors that occur during testing are reported in a common format to be described later.

- **Standard Output of Memory Tests**

The Memory Test will produce the following output if the region being tested is good at the end of each pass:

1 pass(es) completed, 0 data errors

This message indicates that the selected memory test completed one pass, and that no errors were encountered. When all of the requested iterations are completed, the test will return to the Memory Tests Menu.

For each error that is detected, the following is displayed:

Memory Error Location	Data Written	Data Read
111111H	FFH	F0H
122222H	FF0H	FEH

Location refers to the actual memory address where the failure occurred. **Data Written** refers to the byte that the test tried to write to that location. **Data Read** refers to the byte that the test read back.

The error report will continue as long as errors are discovered. This means that transient errors will produce only sporadic output, whereas dead memory will produce constant output. If logging is active, all errors will be recorded. Also each pass displays a cumulative error count. Even if you do not see errors on the screen, the count will tell you that they have occurred.

When you abort the test by pressing <Esc>, or the test is finished, you will be given a summary of all errors bit by bit. The cumulative error report is issued so that you can let the test run for a long time, say overnight, without having to watch the display. For example:

Address	Bits							
	7	6	5	4	3	2	1	0
018000 E	0000	0000	0000	0000	0000	0000	0000	0001
018000 O	0003	0000	0000	0002	0013	0008	0001	0000
04C000 E	0000	0000	0019	0000	0000	0000	0000	0000
04C000 O	0017	0000	0000	0000	0012	0023	0000	0000

The address column indicates the 16K memory region tested. In the columns under each bit number you will see a four digit hexadecimal number representing the total number of errors that occurred in that bit position within the 16K region indicated. Regions which have no errors are not listed. Separate summaries are given for even and odd addresses, with **E** representing even addresses and **O** for odd addresses.

Here, we see that 17 errors occurred in bit 7, 12 in bit 3, and 23 in bit 2 in odd address locations in the region 04C000h to 04FFFFh. Since memory is usually organized by bits, this is useful in determining the exact memory chip that failed.

To determine which chip or chips has failed based on the addresses reported, a few simple calculations must be made. To begin, determine the type of each bank of chips in the computer. The chips will be 16K, 64K, 128K, 256K, 1024K, or 4096K in size.

Note: Only the oldest computers will use 16K, such as the original IBM PC. This computer had four banks of 16K chips on the system board to comprise the lowest 64K of RAM. Only the original IBM AT will have 128K chips. These chips can be found easily, because they are actually two chips piggy-backed (soldered) together.

Unless the computer has 16K chips, the first two digits starting at left are the significant digits in locating a failing chip; the other digits are provided for determination of addressing problems, especially during the walking bit test.

The first digit will be 0 for all memory that makes up the 640K of conventional RAM in the computer. If the first digit is non-zero, then the failing memory is located on expanded (bank switched) memory, or for 80286, 80386, or 80486 computers, it is extended memory with addresses starting above 1M.

The second digit will identify which bank contains the failing chip for the region under test. The value of the second digit of the number is equivalent to a 64K segment of memory, with the first segment starting at 0. The determination of this address is going to vary according to the arrangement of the banks of memory.

> **Note:** If every bit in the memory tests as bad, perhaps you are testing locations that do not have memory in them (ie. ROM between 640K and 1M).

8088 CPU's typically have memory arranged in byte banks. For example, if the address of the error is 009000h, then the error occurred in the first bank. If the address of the failing memory is 030101h, then some calculations must be performed. The **'3'** indicates that the error is in the fourth 64K of memory in the computer (remember that **'0'** was the first 64K in the computer). If 64K chips comprise the first four banks, then the error is in the fourth bank. However, if the system board is filled with 128K chips, then the error would be found in the second bank, since the first bank of chips would be the first and second 64K segments in the computer and the second bank would be the third and fourth 64K segments in the computer.

If the computer is populated with 256K chips, the error would be in the first bank, since this would comprise the first four 64K segments of memory.

If the computer is populated with 1024K chips, the error would be in the first bank, since this would comprise the first sixteen 64K segments of memory.

If the computer is populated with 4096K chips, the error would be in the first bank, since this would comprise the first sixty-four 64K segments of memory.

The failing chip can then be found be counting from the first chip in the bank which would be bit **'0'**, the second chip being bit **'1'**, and so on, until the failing bit is reached.

All computer with 80386SX, 80286, 80186, V30, and 8086 processors have 16 data lines. The banks of memory are arranged in words. For PC compatibles, this arrangement may be true only for the system board.

Memory boards on the I/O bus with two edge connectors (16-bit) use word arrangement, while those with only one edge connector are byte banked.

> **Note:** Memory on the IBM PC bus (add-on memory) is *always* byte banked, since the PC only has an 8-bit bus.

Machines with 80386 CPU's (except the 80386SX) and 80486 CPU's use 32 data lines for memory on the system board or memory that plugs into special connectors on the system board (memory bus). These CPU's are likely to have memory arranged in double word (32-bit, or 4-byte) banks. The memory size of each bank would be four times the size of the chips in that bank.

To determine the failing chip in systems with memory addressed as (16-bit) words, the banks may comprise one or two physical rows of chips containing 18 chips if parity is being checked, or 16 chips if parity checking is not provided. The size of each of these banks is double the size of the chips. In other words, a bank containing 64K chips will represent 128K of memory in the system and a bank of 256K chips will represent 512K of system memory. For example, an error at address 090105 in a computer with 64K chips would be in the fifth 128K bank of memory. (The **'9'** tells us that the error is in the tenth 64K segment, which would be the fifth 128K bank). To determine the failing chip the last digit of the number must be examined. If the last digit is even, then the failing chip is in the first physical row or half of the bank, if the last digit is odd, then the failing chip is in the second physical row or half of the bank.

Having determined which half of the bank contained the error, the chip can be determined by counting from the first chip as bit **'0'** and so on until the failing chip is located.

To determine the failing chip in systems with memory addressed as long (32-bit) words, the banks may comprise one, two, or four physical rows of chips containing 34 chips if parity is being checked, or 18 chips if parity checking is not provided. The size of each of these banks is four times the size of the chips. In other words, a bank containing 64K chips will represent 256K of memory in the system, a bank of 256K chips will represent 1024K of system memory, a bank of 1024K chips will represent 4096K of system memory, and a bank of 4096K chips will represent 16384K. For example, an error at address 090105 in a computer with 64K chips would be in the fifth 128K bank of memory. (The **'9'** tells us that the error is in the tenth 64K segment, which would be the fifth 128K bank). To determine the failing chip the last digit of the number must be examined. If the last digit is even, then the failing chip is in the first physical row or half of the bank, if the last digit is odd, then the failing chip is in the second physical row or half of the bank.

Having determined which half of the bank contained the error, the chip can be determined by counting from the first chip as bit **'0'** and so on until the failing chip is located.

One final word on determining the location of a failing chip. Some computers may not use 1-bit chips, they may use 4-bit chips, or some other configuration. In these cases, locating the correct bank will be the same as before, but locating the chip within the bank will depend on size of chip. As an example, if the error is in bit **'5'**, and the computer uses 4-bit chips, then the second chip is the source of the failure.

> **Note:** Consult your memory board hardware manual for further information concerning the arrangement of memory.

- **Memory Map**

See section Memory Map section for a description of the memory map screens. This map is itself a test of memory, since it gives a pictorial representation of the recognized scope of memory. If you believe that your system contains memory that is not listed here, then that memory is not being detected for some reason; perhaps the system configuration is set up incorrectly.

The map can be used to detect configuration conflicts involving adapters with overlapping memory or overlapping BIOSes. Memory between 640K and 1M (0A0000h to 0FFFFFh) is usually dual ported memory. That is, the memory on the adapter board is used to communicate between the CPU and the adapter. Memory above 1M (0FFFFFh to the end of memory) could also be dual ported, but is usually ordinary memory. By turning off the power and removing an adapter, you can see what memory and ROM goes away in the memory map. This of course, is the memory and ROM for that adapter. By keeping track of which memory and ROM is associated with each adapter, you can see if any overlap exists. Overlapping boards should be re-configured (usually a jumper setting) in order to remove the overlap. It is probable that the software and drivers that use the adapter will have to be changed.

- **Quick Test**

The Quick Test performs three checks on each individual bit in the region to be tested. First, the test writes **00H** into every byte in the region, followed by reading the value at each of these bytes to ensure that each bit can be set to zero. Next, the test writes **FFH** into every byte in the region and then reads the value at each of these bytes. An error will occur if each bit could not be set to a logical one. The test then writes random values into every byte in the region and checks the value written. Finally, the test writes the **01H** to generate odd parity. The Quick Test allows you to discover non-functional bits in memory and almost all other memory defects. This test is fast; the time required to perform this test is directly proportional to the number of bytes tested.

- **Walking Bit Test**

The Walking Bit Test is mainly an addressing test, although it does check every bit in the region for incorrect data. It is considered an addressing test, because it will detect the existence of the same data appearing (being shadowed) at another location in the region.

> **Note:** The test will not detect addressing errors between addresses in the testing region and addresses outside of the region.

The Walking Bit Test will reveal memory defects that the Quick Test cannot. In particular, it will reveal defects that cause addressing errors or that cause a change in the contents of one memory location to affect the contents of another. This test is made up of two parts, each complementing the other.

At the beginning of the first part, every bit in the region to be tested is set to a logical zero. Next, the first bit in that region is set to a logical one, and every other bit is tested to determine whether or not it remained zero. Any non-zero bits (except the first) are reported as errors. Then the first bit is reset to zero and the second bit is set to one. Every other bit in the region (including the first) is tested to determine whether or not it remained zero. As before, any non-zero bits (except, in this case, the second) are reported as errors. This same process is repeated, in turn, for every bit in the region. In effect, a bit with a value of one is *walked* from one end of the region to the other. After each step, the rest of the bits in that region are tested to determine whether or not changing the value of any other bit in the region would alter their values.

The second part of this test sets every bit in the region to one. The walking bit is now a logical zero. Otherwise this part is identical to the first part. In this case, any zero-valued bits (other than the walking bit) are reported as errors.

The time required to perform this test is proportional to the square of the number of bytes tested. On an 8 Mhz AT, for instance, the Walking Bit Test will take approximately 11 minutes to test a 16K byte region of memory; a 64K byte region would take about 1 hour and 25 minutes. It will take less time to test several smaller regions in memory than it would to test one large region containing the same total number of bytes. However, to detect the greatest number of possible errors (especially addressing errors), the region tested must be as large as possible.

When the Walking Bit Test reports errors, it could indicate either memory chip failures or errors in the address decoding logic. If the address written and the address modified are in different banks, the failure is most likely in the addressing logic; if the written and modified addresses are in the same bank, a memory chip failure is more likely.

• Burn-In Test

The Burn-In Test is intended to detect undesirable *hysteresis* in the memory. That is, the inability of a memory bit to change from one value to another. This is a problem that is especially likely to occur in dynamic memories. The test subjects the memory to the most intensive conditions; the memory is being accessed with each CPU cycle.

One instruction is loaded into the first two bytes of the memory region to be tested and then executed. This routine is a decrement-and-loop instruction with an initial count register value of zero, which decrements that register by one each time through the loop, and tests it until its value again equals zero, at which point the routine returns control to the test routine. This routine makes no references to memory outside of these two bytes and does not alter the two bytes during execution of the loop. Therefore, executing the commands in such a short a loop this many times (65,536) results in the most intense possible use of the two bytes of memory in which they are stored. The bit values contained in these bytes, which are refreshed every cycle and never altered, are thus thoroughly *burned* into those bytes.

After control is returned to the test routine, the two bytes are complemented, read, and compared with the values originally written to them. This will reveal any bits which could not be complemented. Those bits that are retained from images of their previous values are reported as errors. The Burn-In Test then loads the same short routine into the next two bytes of the region to be tested. This entire process is repeated for each successive two byte segment of memory, in turn, until the whole region has been tested. The time required to perform this test is directly proportional to the number of bytes tested. For a 16K region of memory, the Burn-In Test takes 11 minutes and 15 seconds on an 8 Mhz AT.

• Interpretation of Memory Tests

The failure information can be used to determine the cause of the failure, although this is more of an art than science. Memory is said to fail when it cannot read the same data written, or is reading/writing data from/to the wrong location. The first errors are called data errors and the second are called addressing errors.

All failures are recorded in the log and are printed by location and in a matrix that aids in locating the bad chip. The matrix indicates the failures by bit within each kilobyte. This is useful since many RAM chips are organized by bit. That is, each chip holds one bit within a particular region (1K, 4K, 16K, 256K, 1024K, or 4096K regions are typical). Since chips tend to fail individually, the matrix will locate the particular chip that has failed. Memory chips are often socketed and can be replaced easily. If you do not have spare memory chips and do not have chip locating information, you can still debug the memory by swapping chips until the problem moves.

Keyboard Test

The Keyboard Test is dependent upon your input to evaluate the functionality of the keyboard. The initial screen that is displayed is one of rectangles that represent each key on the keyboard. The test is accomplished by interpreting the scan codes returned by the keyboard and displaying the key that was depressed according to the scan code. The test will detect any key which incorrectly produces another key, in addition to detecting keys which are sticky. That is, ones that either produce multiple key strokes, or ones which do not respond as quickly and easily as they should.

As you press each key on the keyboard, the corresponding position on the display changes to show the interpretation of that key by the system. Pressing shifted characters will cause them to appear above the unshifted characters. As each character is pressed, the scan code for the character is shown. This is the code sent from the keyboard to the system board whenever a key is pressed or released.

If the keyboard test fails, there are several things that can be attempted. First, check to see that the keyboard is plugged into the system. Make sure that it is plugged into the socket marked keyboard. If it is not marked and there are more than one of them, then try them all. Try a different keyboard if you have access to one. Erratic keyboard behavior can be caused by a paper clip or other small object that has fallen under the keytops. Usually the keytops can be removed to aid in fixing the keyboard. Simply pry on one side of the keytop with a soft long tool or a screwdriver while holding the keycaps with one hand. Apply steady pressure until the keytop releases. Do not apply excessive force; some keys might not be removable, and some keyboards do not have removable keys!

If the keyboard exhibits stuck keys, the reason might be that the keytop plastic is rubbing onto an adjacent key. Sometimes the stuck key is the result of a loose or broken spring or wire support (long keytops such as the space keytop usually have a wire support so that both ends travel up and down evenly). Remove the keytop to check these conditions. Removing the keytop may also show that something has been spilled on the keyboard. In this case, it may be possible to fix the keyboard by cleaning it. First, remove the keytops as described earlier. Then use a rag or Q-Tip to clean between the keys. Then, blow air into the crevices in order to remove debris. If this does not fix the problem, then there is a last resort: Unscrew the keyboard case, and remove the keytops, leaving just the printed circuit assembly. Then, pour distilled water over the keyboard in order to attempt to clean it. Place it on its edge and allow it to dry for 24 or more hours. This cleaning may be repeated.

Asynchronous Port Test

The Asynchronous Port Test checks the components of the system from the CPU to the 8250, 16450, or 16550 Universal Asynchronous Receiver Transmitter (UART). This is accomplished by setting the UART's control register to the internal loopback mode. In this mode, all data that is transmitted is immediately made available in the received data register of the UART. The test sends the values 0 (decimal) to 255 (decimal) inclusive at 9600 and 115200 baud, using two different bit combinations. After each character is transmitted, a read of the received character buffer is done to see if it is the same character that was sent. If the incorrect character is detected, it is an indication of a problem somewhere between the UART and the system CPU.

Afterwards, the internal loopback is shut off, and, if the user has specified the external loopback test, it will repeat the character send/receive test using the external loopback plug. Errors occurring in the internal test indicate problems with the UART chip, or a failure somewhere between the CPU and port; if the internal test passes while the external test fails, there is a problem between the UART and the external connector (9 or 25-pin). The test will also report bad protocol lines such as Data Terminal Ready (DTR).

The AT connector is a DB-9 (9-pin), and the PC/XT (and PS/2) use a DB-25 (25-pin) connector.

Table 2 lists the standard pin-outs for PC/XT, AT, and PS/2 computer serial ports:

Table 2. Asynchronous Port Pinouts

9-Pin	25-Pin	Description	Signal Direction and Pairing
3	2	Transmit Data	TD --> RD
2	3	Receive Data	RD <-- TD
7	4	Request to Send	RTS --> CTS
8	5	Clear to Send	CTS <-- RTS
6	6	Data Set Ready	DSR <-- DTR
5	7	Signal Ground	
1	8	Carrier Detect	CD <-- RI
4	20	Data Terminal Ready	DTR --> DSR
9	22	Ring Indicator	RI <--

Parallel Port Test

The Parallel Port Test evaluates the performance of the system from the CPU to the parallel port interface. This is accomplished by putting the parallel port into a loopback mode and repeatedly transmitting a space character followed by a carriage return character. If the character transmitted differs from the character received, an error message is generated. An error is indication of a problem somewhere between the CPU and the parallel interface.

Table 3 shows the proper pin-out for an IBM-compatible parallel port:

Table 3. Parallel Port Pinouts

25-Pin	Description	Signal Direction and Pairing
2	Transmit Data	TD --> RD
3	Receive Data	RD <-- TD
4	Request to Send	RTS --> CTS
5	Clear to Send	CTS <-- RTS
6	Data Set Ready	DSR <-- DTR
7	Signal Ground	
8	Carrier Detect	CD <-- RI
20	Data Terminal Ready	DTR --> DSR
22	Ring Indicator	RI <--

Display and Video Adapter Test

The Display and Video Adapter Test makes use of extensive operator interaction and attention. Various functions will be tested. While the tests are taking place, you must watch your screen closely to note any errors that might occur.

• Display Test

The Display test is divided into four parts. The first screen displays the different types of lines and colors available with the graphics adapter. The first line is a blinking line, followed by a high intensity line, a low intensity line (invisible), a normal intensity line, and a reverse video line. Below these lines a color set display will appear. There will be a rectangle formed by each of the sixteen colors that the monitor can produce and the name of the color to the side of the rectangle.

The second part of the color test is the ASCII Character Display Test. A display of all the available characters in the character set will appear. The correct screen should show well formed complete characters.

The third part of the display test is the 80 and 40 column Barber Pole Test. This test will display every character positioned in every possible screen location, in all possible colors. The test is run first in the 80 column mode and then in the 40 column mode. The Barber Pole Test may be aborted by pressing the <ESC> key while the tests are in progress. The test may be suspended by pressing <Control-S> and restarted by pressing <Control-Q>.

The final part of the display test is the Graphics Display and Color Set Test. This test is performed twice in the 320 x 200 pixel graphics mode and once in the 640 x 200 pixel graphics mode. The first screen should show three clearly formed and solidly filled boxes using color palette zero. The second screen should be the same format, except that it uses color palette one. The last screen is in high resolution mode. It should show three squares, the outer two being white and the middle one being a simulated grey (alternating between white and black dots).

• Circle Test

This test will draw three concentric circles on the screen. Up to 15 circles are drawn if the adapter is EGA or VGA. Each time a circle is completed, it will be painted with the color of its border. The circles should be all the foreground colors of the color set. Each of the circles should appear to be round rather than elliptical, and should be solid in color. If a circle has points which do not match the color that the circle should be, it may be an indication of a problem with one of the graphics adapter components. For example, a consistently incorrect display could indicate that there is a bad memory chip in the adapter. If the circles appear more as ellipses, this more likely indicates that the monitor needs to be adjusted or repaired.

• Grid Test

This test draws a grid on the screen, first at medium resolution, then at high resolution. In each case, the grid should extend to all the edges of the screen. It should consist of continuous lines vertically and horizontally across the screen. If the grid appears warped anywhere, it may be an indication of a problem with the monitor. If the segments that make up the grid are not continuous or are not all the same color, then the problem probably lies in the graphics adapter hardware. If any of the lines are not continuous, it may indicate a problem in the graphics adapter.

If the grid runs off the screen, or is distorted at any point, adjust the vertical and horizontal gain. If the grid is not linear, adjust the linearity potentiometer(s). If the image is curved, ensure that there are no strong magnetic fields nearby (ie. audio speakers). Then, adjust the pincushion compensating magnets that are near the deflection coil. These magnets, as well as some of the adjustment potentiometers are inside the monitor case.

> **Note:** Due to the dangers associated with high-voltage equipment, only qualified individuals should attempt adjustments. This is especially true if the adjustment is attempted with the cover off. When reaching into an energized monitor, always use non-conducting, non-ferrous tools, and keep one hand at your side. Also, wear safety glasses, as cathode ray tubes may explode if hit or scratched. Safety precautions should be observed whether or not power is on to the monitor, since high-voltage capacitors will retain a charge even after power is shut off.

- **Raster and Purity Test**

This test will fill the screen with one foreground color of the two color palettes in medium resolution mode, in addition to one of the background colors. In each case, the screens should appear solid in color. If any of the dots are not filled, or are filled with a different color, then the graphics hardware is probably causing the malfunction.

If the colors are not satisfactory, then try adjusting the R (red) gain, G (green) gain, or B (Blue) gain. If retrace is seen, adjust the brightness.

Floppy and Hard Disk Tests

The Floppy and Hard Disk Tests directly access the controller hardware and access the disk by track (cylinder for hard disks), head, and sector. DOS virtual sector numbering is not used; this allows testing hard disks that are partitioned into sections for different operating systems.

All failures are reported by track or cylinder, head, and sector; they may be classified into read errors (failure to properly read data previously written), write errors (failure to write data onto the disk), or seek errors (reading or writing the wrong location).

- **About Disk Failures**

Random access devices are usually composed of three important functional groups: the controller electronics, one or more mechanical drives associated with the controller, and one or more recording media associated with the drive. Any of these could fail, and sometimes it is hard or impossible to detect which one is at fault. It is easiest to first prove the controller to be reliable, then the drive, and finally the media. If there is one controller for multiple drives, the controller may be found to work with one drive and not with others, thus proving its trustworthiness. The drive may be proven trustworthy if it has removable media (as with floppy diskettes), as more than one media is tried.

Physical sectors on random access devices are usually grouped into tracks, and the tracks into cylinders. All sectors are numbered, usually starting from 0, as this allows each sector to be given a unique mixed radix number (cylinder, track, and sector). Sectors usually correspond to the radially recorded data on one circle of one surface of the medium. The sectors usually start a fixed time after an index is found. On floppy disks, the index is a hole in the media. A track is one circle of sectors on one surface, and a cylinders is composed of all circles of a given radius on the medium.

There is usually one read/write head for each track in a cylinder. Cylinders are usually numbered starting with 0 at the outermost part of the media. If there is only one track per cylinder (one head on the disk), then the track number is zero and is usually not used.

On a typical double-sided 5¼ inch disk, there might be 512 bytes per physical sector, 9 sectors on a track, 2 tracks on a cylinder, and 40 cylinders on a disk. In this example, a track on a given cylinder corresponds to one side of the disk.

Table 4 displays standard floppy disk types:

Table 4. Floppy Disk Types

5¼ Inch	3½ Inch
160K	720K
180K	1.44M
320K	2.88M
360K	
1.2M	

Typical physical disk groupings are:

Sector Range : 1 - 9
Track Range : 0 - 1
Cylinder Range : 0 - 39 (low-density), 0 - 79 (high density)

On a hard disk drive, there can be many different numbers of heads, cylinders, and other parameters. On AT type computers, there is a table in ROM indexed by a CMOS RAM value, that indicates the disk parameters. On an IBM AT, the indexes range between 0 and 23 decimal inclusive. On compatibles with extended CMOS RAM, the indexes go from 0 to a larger number, typically up to 47 decimal.

Table 5 shows specifications for drives manufactured by Seagate Technology. These are not the only drives that can be used with the computer, just representative drives.

Table 5. Sample Hard Drive Specifications

Type	Model	Capacity	Cylinders	Heads	Landing Zone	Precomp
1	ST125	10	306	4	305	128
2	ST138	21	615	4	615	300
3	ST138R	30	615	6		
4	ST157R	65	940	8	940	512
5	ST213	49	940	6	940	512
6	ST225	21	615	4	615	
7	ST238R	18	462	8		
8	ST251	31	733	5	733	
9	ST251R	117	900	15	901	
10	ST277R	40	820	3		0
11	ST4026	37	855	5	855	
12	ST4038	52	855	7	855	
13	ST4051	21	306	8	319	128
14	ST4053	44	733	7	733	
15						
16	ST4096	21	612	4	663	0
17	ST4144R	42	977	5	977	300
18		59	977	7	977	
19		62	1024	7	1023	512
20		31	733	5	732	300
21		44	733	7	732	300
22		31	733	5	733	300
23		10	306	4	336	0

The failure information provided by the disk tests can be used to determine the cause of the failure, although this is more art than science. If all tests indicate that the drive is just not responding, first run the hard disk controller test. If the controller fails, then the drive might be ok, and only the controller has failed. If the controller passes, then first check to see if there is power to the drive. There is a power connector (usually white) in the back of the drive. It should be seated snugly. If there is a light on the drive and it is on, then there is power to the drive. On some drives you can see the drive spindle turning. In addition, you should be able to hear the disk spinning, or feel the entire drive vibrate if there is power.

The platters of some Winchester drives (especially 3½ inch drives) are coated with a lubricant that becomes sticky if the drive is turned off for more than a few minutes; they are not able to startup once this happens. If you are sure that power is being applied to the drive but it is not spinning, then as a desperate measure, try turning the spindle a quarter turn. This should NEVER be done casually, but only as a last desperate measure, as it is sure to shorten (or even terminate) the life of the drive.

> **Note:** You should not leave power applied to a stalled drive for any longer than is necessary.

Other indications to look for when assessing the functionality of a drive include:

- Seeing if the platter spindle rotates during test and boot.
- Listening for clicks or feeling for motion when the read/write heads change or seek to another cylinder.
- Watching for the disk access light to flicker
- Checking what voltage appears at the appropriate color on the power supply connectors.

Some drives have brakes on them to stop the platter from rotating when power is turned off. A hint that your drive is such a drive is a slight grinding noise when your system is powered down. Sometimes this brake mechanism is accessible and can be seen around the spindle of the drive. If it does not release within a few seconds after being powered on, then you might try moving it manually. This, too, should only be used as a last resort.

If the drive is new, or has been moved for some reason, but it is not responding or spinning, check to see if there is a lock on it (designed by the manufacturer for moving the drive). This may either be a switch-like mechanism or a removable mechanism such as a post or peg. Usually if this is a new drive, there will be a bright, fluorescent tag on the locking mechanism.

If the drive is being newly installed, make sure that you are connecting the drive correctly. Check the power to the power connector.

If this is an ST506 drive (the usual PC or AT-type drive), each drive must have two cables connected to it. The cables may have a stripe down one side. Make sure that the cables are connected correctly. The thin cable is the control cable. This smaller cable goes from the hard disk controller to each drive individually. The wider cable is the data cable that is daisy chained from drive to drive. Both cables must be oriented in one way only. That is, pin 1 and 2 on the cable must connect with pin 1 and 2 on the controller and pin 1 and 2 on the drive. The drive will probably have pin 1 or 2 labeled on its connector. The cable will probably have all of its pins labeled (in tiny characters). The cable's connector will also have a triangle on its side next to pin 1. Pin 2 is on the same side of the connector as pin 1. Often a red stripe is on the cable on the pin-1/pin-2 side. Most ST506 disks will have pin 2 on the left of the printed circuit board connectors when viewed after turning the drive upside down.

> **Note:** If the cables are connected or even wiggled with power on, the drive may accidentally go into write mode, destroying data on the disk.

Most AT controllers will control both hard disk and floppy disk drives. The floppy disk drive cable has the same kind of connector as the wider of the hard disk cables. Make sure that the wide cable is plugged into the hard disk connector on the controller and not the floppy connector. Also make sure that the floppy cable is not used on the hard disk. Most floppy cables have connectors for two floppy drives, while most hard drive connectors are not set up for two drives.

Most floppy connectors have a twist in part of the cable, but many hard drive connectors do not. The floppy cable has its twist four wires from one side. If the hard disk has a twist in it, it will be further from the side.

The hard drive (as well as the floppy drives) have jumper options on them. One option is a terminating resistor. The terminating resister (or terminator) must be installed only on the last drive on the daisy-chained cable. The terminator is usually a chip with a number of legs on it coming from only one side of a chip. It is often NOT black. Other options include the drive select. There are two drives selectable from the ST506 controller: drive 0 and drive 1. Often this is a jumper that can be moved to an adjacent header, changing from drive 0 to drive 1. The drives can be setup for drives 0 through 3, but the controller usually only recognizes drive 0 and drive 1.

If there is just one hard drive disk, it should be setup as drive 0. The second drive should be setup as drive 1 unless the daisy-chain cable has a twist in it. In this case, both drives probably should be setup as drive 0. This drive selection setup also applies to floppy drives. The drive manufacturer will be able to help you with the jumper options if you do not have documentation with the drive.

If this is a SCSI-type drive, there should be a single bus cable connected to it. Make sure that there is a terminator on the end of the SCSI bus cable, and that the cable orientation is correct. SCSI drives also have a drive selection option. Drives may be 0 through 7. The drive manufacturer will be able to help you with the jumper options if you do not have documentation for the drive.

If the disk test fails on only one read/write head, then perhaps just that head or disk surface is at fault. If the test only fails a particular cylinder range, then the disk cylinder alignment mechanism may not be positioning the read/write heads over the formatted information, or the record/playback gain may not be correct. The inner cylinders (usually the higher-numbered ones) require more precision with regard to these parameters and are more likely to fail. If a particular sector range is bad, then perhaps the indexing mechanism is bad. If the test only fails over a few sectors (Cylinder X Track Y Sector Z), then the problem may be faulty media (dirt or defects on the disk surface). Intermittent errors can be caught by turning on test logging.

Many drives are manufactured and sold even though they have some defects on their platters. These defects appear as bad sectors or bad tracks. This is done because perfect disks would be prohibitively expensive, and because software is used to map out these bad spots.

There is one place where errors are not acceptable on new drives: cylinder 0, which is the most important cylinder on the drive. This cylinder contains boot code and disk partitioning information. If the very first sector (cylinder 0, track 0, sector 0) is bad, the disk cannot be partitioned or booted. If other sectors on the cylinder are bad, neither Unix nor MS-DOS will be able to start a file system on that cylinder. In other words, a file system partition cannot begin with a corrupt cylinder. However, you may be able to start a partition with the next cylinder.

If a high numbered head (platter) is bad, it may be possible to setup an AT compatible computer to use the disk. This is done by reselecting the disk type to one with fewer heads. The new disk type does not necessarily have to have the same number of cylinders as the actual drive.

> **Note:** Configuration or partitioning of a drive should be done only after backing up all valuable files on the disk.

Sealed hard disks mainly fail in the mechanical drive, or the recording media. For economies of production, hard disks are often not guaranteed to be flawless when purchased. They will probably develop further bad spots over their lifetime in marginal areas. Thus, a few bad sectors on a hard disk is no reason for repair, unless they occur on crucial areas, such as the Boot Sector, DOS File Allocation Table (FAT), or perhaps directory areas, which cannot be mapped out by hardware or software.

Alignment of all disk devices is a problem, especially drives with blind cylinder stepping mechanisms (ie. stepper motors), which cannot determine where the read/write heads are located. This is true of virtually all floppy disk drives. Periodic alignment can, however, be performed by adjusting set screws located at various points on the drive. As with all drives that place the recording heads on the media (such as floppy drives), first suspect dirty read/write heads. They should be cleaned with a head-cleaning kit from Landmark whenever you first suspect a problem.

After a dirty read/write head, alignment problems should be suspected in floppy diskette drives. Surprisingly, magnetic recording media rarely fails by wearing out even in floppy drives. If a particular floppy diskette has been performing flawlessly, it is not likely to ever become a problem unless it becomes dirty or warped. Of course, it is common for a floppy diskette to become unreadable after a period of time. Even with the most meticulous handling, drives tend to become misaligned with respect to the disk, rather than wear on the floppy diskette.

- **Floppy Disk Tests**

The first phase of the Floppy Disk Test is a quick format, without verifying the sectors. After formatting, the sectors are verified. Then, the sectors are labeled and filled with a worst-case test pattern. After writing the disk, the sectors are read and compared with the test pattern. Finally, a seek/read test is done to check head positioner seek accuracy; it randomly seeks to different sectors on the disk and compares the label information with the desired seek location. Errors are reported in all phases of the test and summarized at the end of each phase. If the Service Diagnostics disk is detected in the drive to be tested, the test will not start in manual mode; during a continuous test it will verify the disk. Logging output will be stored in memory during the floppy disk test and written to the log file when the tests are finished.

> **Note:** When logging to a floppy disk, be sure to put the logging floppy back before returning to the Main Menu.

- **Hard Disk Tests**

The Hard Disk Test includes a read test, a write/read test, a seek/read test, a controller check, and a low-level format utility. The user can run the tests over any specified range of the disk, except in the case of the low-level format utility which formats the entire disk. The read test simply reads the existing contents of the disk and reports any errors. The write/read test fills all specified sectors with a test pattern and labeling information, then reads the sectors back, comparing the pattern read from the disk with the pattern written to it. The test checks to make sure that the label matches the current cylinder, head, and sector. The seek/read test seeks to sector 1 for every cylinder and head, seeking to cylinders in the pattern {0, MAX, 1, MAX-1, 2, MAX-2, ...}. As it is a non-destructive test, it relies upon the controller to report seek errors.

The tests report three types of sector I/O errors: Media errors, Soft errors, and Hard errors. Media errors are bad sectors marked as useless at the time the disk was formatted. They are not a cause for alarm; few hard disks are completely error-free. Hard errors are corrupted sectors that are not marked as bad, but are indeed unreadable. They will cause file and program errors unless they are marked as bad. Soft errors are sectors that are readable, but only after one or more tries.

Unless they would cause a severe disk size reduction, they should be marked as bad also. These sectors can be marked as bad by a low-level format program such as Landmark's Service Diagnostics. They can also be removed from service via DOS's "*FORMAT*".

Note that the contents of the disk must be backed up before a format is performed on the disk. A low-level hard disk format should only be performed when the disk is up to its normal operating temperature. The disk should be powered for at least ½ hour before the format is attempted. The low-level format requests an interleave factor and a skew factor be entered. The interleave factor determines the physical order of each track's sectors. Service Diagnostics will default to the usual interleave factor (5 for XT-type machines, and 3 for AT-type machines). An interleave factor of 3, for instance, means that logical sectors are placed on every third physical sector of the track. Therefore, the logical sectors would be ordered, assuming 17 sectors per track, as follows:

{1, 7, 13, 2, 8, 14, 3, 9, 15, 4, 10, 16, 5, 11, 17, 6, 12}

An interleave factor of 1, on the other hand, would simply arrange the logical sectors sequentially on the track. The maximum interleave factor is the number of sectors per track minus one; the optimum interleave factor depends on the computer's CPU speed, bus speed, controller type, and drive type.

Less than optimum settings can result in sluggish hard disk performance. An optimum setting minimizes the number of disk rotations needed to read an entire track. If the interleave is too small, the disk will pass the sector before the next operation is set up and the disk will make a complete rotation in order to read the next sector on the track. Too large an interleave will also cause an unnecessary delay before the next sector is brought under the read/write head; however, a full rotation would not be needed before reaching the next sector. Therefore, an interleave factor that is a little too large will have much less of an impact on performance than one that is even slightly too small.

Skew refers to the placement of sector data. The beginning of the sector is placed next to the outermost track, with the remaining data gradually placed toward the innermost track. This allows the read/write heads to begin reading a sector even though the heads have not quite travelled to the track's center.

A low-level format should be followed by a read/write test to fully test worst case patterns in the various sectors on the disk. A hard disk that fails the read test for any reason, should be low level formatted. A low level format is recommended if your system will sometimes fail to boot from hard disk. It is also recommended whenever you see that new bad sectors are coming into existence (as shown by your operating system, for instance, "Sector not found on drive C:" from DOS).

The hard disk test is performed on disk 0 or disk 1. Note that these disks may or may not be your disk C: or disk D:. Sometimes disks C: and D: are just partitions of disk 0. Use DOS's "*FDISK*" or similar program to determine the partitioning of your disk.

Printer Test

The printer test exercises most of the features of your printer that can be exercised via BIOS. It requires that you closely observe the operation of your printer while it is being put through its paces and note any inadequacies in its performance. If the printer does not function at all, then make sure that there is power to the printer. Make sure that the parallel or serial adapter is operating. Run the parallel or serial test of Service Diagnostics. If the adapter passes, then suspect the cable between the printer and the computer.

If this is a newly connected configuration, there are a large number of things that can be set incorrectly. If the printer uses a serial cable, then it is much more complicated. The cable must be set up correctly at both ends. The computer baud rate must match the baud rate of the printer (usually the printer baud rate can be set). The protocol lines must be set right on both ends. The send/receive lines must be set correctly. This requires study of the printer manual. Suspect the baud rate if the printer prints garbage when printing is attempted. Suspect the protocol lines if the printer works correctly but drops characters.

The following items will be evaluated by the printer test:

- Test each printing ASCII character in each carriage position.
- Test both UPPER and lower case.
- Test head and carriage motions for the most popular daisy-wheel printers Spinwriter, Qume, and Diablo (serial interface only). Including:
  - Forward and reverse printing
  - Interleaved overprinting
  - Forward and reverse overprinting
  - Overprinting with horizontal tabbing
  - Boldface printing
  - Superscript and subscript printing
  - Scale page horizontally and vertically
- Test the following functions for the Epson MX80 and MX100, DEC LA50, and NEC PC8203A printers:
  - Boldface
  - Compressed print
  - Double wide print
  - Horizontal and vertical scaling

- **Printer Test Output Formats**

Standard output depends on the type of printer you have selected. There are essentially three categories: the daisy wheel printers (Diablo, Qume, and Spinwriter), the dot matrix printers (Epson 80, Epson 100, NEC PC-8023A, and DEC LA50), and printers other than those listed. Although each of the printers undergo the barber pole test (described later), the dot matrix and daisy wheel printers undergo different exercises designed particularly for them.

• **Daisy Wheel Printers**

If you have selected one of the daisy wheel printers listed on the menu, then your printer will go through the following tests:

NORMAL PRINT FORWARD AND BACKWARD

This test simply prints the test pattern forward and backward. It is a preliminary test of your printer and its internal buffering logic.

INTERLEAVED OVERPRINTING, FORWARD AND BACKWARD

This test will overprint each character in the test pattern by first printing a character, then backing up, and overprinting it before going on to the next character. It does this in both the forward and backward directions. This is useful to test printer head alignment.

PRINT SAME LINE FORWARD AND BACKWARD

This will print the test pattern once forward and then, without a carriage return or linefeed, backward. This also tests printer head alignment.

OVERPRINT WITH ABSOLUTE HORIZONTAL TABBING

This test will print the pattern once, then overprint this line by the following method: first, overprint the character in position 1; next, the character in position 132; next, the one in position 2; 131, and so on. This will cause the head to fly back and forth quickly. Your printer should be able to perform this overprint just as well as the other examples. This is perhaps the single most rigorous test for a daisy wheel printer. It may be necessary to increase the number of nulls after carriage motion for this test to execute correctly.

PRINT BOLD WITH 1/120" OFFSET

This will print an excellent bold face of the test pattern. It tests the incremental spacing features of your printer.

PRINT NORMAL, SUPER, AND SUBSCRIPT

This will print a line, then backup and print a word in normal, then superscript, then subscript, and so on. This test checks the carriage motions.

SCALE PAGE IN INCHES, HORIZONTALLY

This will print vertical bars on the page, each one inch apart horizontally. This is a measure of the accuracy of the head controller.

SCALE PAGE IN INCHES, VERTICALLY

This prints horizontal lines on the page, one inch apart vertically. This is a measure of the accuracy of the carriage controller.

BARBER POLE TEST

This test will print the ASCII character set in a barber pole fashion. That is, each line will be moved one character over from the preceding, with the first character wrapped around the edge. A portion of the output will look like this:

```
ABCDEFG
BCDEFGA
CDEFGAB
DEFGABC
EFGABCD
FGABCDE
GABCDEF
```

This tests each character in each character position. Press any key to terminate the test.

• **Dot Matrix Printers**

If you are using one of the dot matrix printers listed on the menu, your printer will undergo the following sequence of tests:

BOLD WITH OFFSET

Dot matrix printers achieve boldface by offsetting each character slightly. This test exercises this capability on your printer.

NORMAL, DOUBLE AND COMPRESSED CHARACTERS

This will print the test pattern normally, then print double width characters, and then compressed characters.

SCALE PAGE IN INCHES, HORIZONTALLY

This will print vertical bars on the page, each one inch apart horizontally. This is a measure of the accuracy of the head controller.

SCALE PAGE IN INCHES, VERTICALLY

This prints horizontal lines on the page, one inch apart vertically. This is a measure of the accuracy of the carriage controller.

BARBER POLE TEST

This test will print the ASCII character set in a barber pole fashion. That is, each line will be moved one character over from the preceding, with the first character wrapped around the edge. A portion of the output looks like this:

ABCDEFG
BCDEFGA
CDEFGAB
DEFGABC
EFGABCD
FGABCDE
GABCDEF

This tests each character in each character position. Strike any key to terminate the test.

• **Other Printers**

If you have chosen the menu option for a printer other than those listed, your printer will automatically undergo the barber pole test only (see description above).

• **Test Description and Diagnosis**

This test checks the performance of the printer subsystem of your computer. This includes the printer interface, the cable between the printer interface and printer, and the printer itself. A level of confidence in the printer interface should first be achieved through the use of the parallel or serial interface tests in Service Diagnostics.

If the printer behaves erratically, including the incorrect printing of characters, suspect a faulty cable. If the output is consistently generating a particular pattern, the printer is suspect. An incorrectly wired cable, or a cable that is too long could result in a particular bad pattern of output (such as data overrun causing missed characters). Incorrect output on horizontal and vertical scaling could indicate that the printer is in need of lubrication and adjustment.

Numeric Co-Processor Test Specifications

The Numeric Co-Processor Test evaluates the performance of your system's Numeric Co-Processor. The test operates in a similar fashion to the CPU test. First, a timing test is done for the Numeric Co-Processor by causing it to execute a loop of instructions which should take a predictable amount of time. The CPU is only executing a loop instruction during this test, so that the time received should be directly attributable to the time used by the Numeric Co-Processor. Some Numeric Co-Processors are designed to run at a division of the Processor clock frequency. Often this speed is one third the Processor clock frequency. The time to completion is measured. The calculated clock speed in Mhz is then displayed. The calculated result is the speed of the Numeric Co-Processor, not the speed of the bus interface unit of the Processor. Usually these Processors are connected synchronously to the CPU, which means that the speed of the 80287 will be one third of the CPU's speed and that the speed of the 80387 will be on half of the CPU's speed. If the 80287, 80387 (or similar) is running asynchronously, then the speed will reflect the input frequency of the CLK2 input rather then the CPU CLK input. The 8087 must always run synchronously and at the same rate as the CPU.

If the timing test indicates an apparent Mhz (speed) that is radically different from this time, it may be indicative of a system problem such as an incorrect system crystal. Three of the most suspect components would be of course the Numeric Co-Processor, the CPU, and the system clock.

The second phase of the Numeric Co-Processor Test causes the Numeric Co-Processor to execute nearly all of the instructions available to it. After each instruction is executed, a save state instruction is executed. The resulting image of the state of the Numeric Co-Processor is checked against an expected state table for errors. First each of the word register are checked, starting with the status, control, and tag words; followed by the double word operand and instruction pointer registers. Then, the Numeric data stack registers are checked for errors. Each of the 10 bytes in each stack register is checked to see if it is correct.

Repeated errors by the Numeric Co-Processor are an indication of a faulty Numeric Co-Processor. The test detects problems such as moving the contents of one stack register to another causing a change in yet a third, or an incorrect arithmetic operation, or an arithmetic operation incorrectly altering the control, status or tag words.

Since the co-processor is socketed, replace the co-processor and rerun the test. If the test still fails, then the socket itself should be suspected, along with all connections to the co-processor chip and all support chips. Another option is to replace the CPU.

Floppy Diskette Drive Alignment Tests

The Landmark Diskette Alignment program consists of a battery of nine tests:

Spindle Speed
Centering
Index to Data Timing
Track to Track Seek Time
Head Positioner Hysteresis
Head Positioner Linearity
Radial Alignment
Azimuth Alignment
Analog Alignment

The data obtained from each test is then compared against tables of expected operating ranges to determine the operating condition of your diskette drive. If the tests indicate that the diskette drive is not up to specifications, it is prudent to copy any diskettes written by that diskette drive to another diskette being written by a diskette drive in good condition before having it serviced. If this is not done, the data on the original diskettes may be unreadable by that drive after it is realigned.

These tests work directly on the floppy diskette controller and thus the floppy diskette drive. These tests will not work on non-standard drives (such as drives that require a DOS driver). This driver would either be a "*DEVICE=*" line in your CONFIG.SYS, or a TSR (a .COM file) in your AUTOEXEC.BAT. These tests work with a Digital Diagnostic Diskette.

A diskette drive may fail any of the tests except the speed test due to oxide build up on a diskette drive read/write head. If a failure does occur, then clean the head(s) using a diskette head-cleaning kit from Landmark in conjunction with the Analog Alignment Aid option of Service Diagnostics. Repeat the tests to eliminate dirty heads as a source of the problem.

The accuracy of these tests is also affected by out of specification temperature and humidity. The ideal conditions for performing diskette drive evaluation are at 68 degrees F and 50% relative humidity. If the Diagnostics Diskette or your diskette drive is transported through extremes in temperature, allow them to return to room temperature and humidity before using them.

WARNING!!! Before making any drive adjustments, please verify that the nominal ranges suggested by Service Diagnostics correspond to those recommended by the manufacturer of the drive under test.

- **Spindle Speed Test**

The spindle speed test evaluates the revolutions per minute (RPM's) of the floppy diskette drive. This is accomplished by timing the passage of the index hole of the floppy diskette past the sensor of the diskette drive. The diskette drive is manufactured to run at 300 decimal RPM if it is a 48 TPI diskette drive, and 360 decimal RPM if it is a 96 TPI diskette drive, however, a variation of +/- 5 RPM either side of this amount is acceptable. A diskette drive operating at a rate different than what it is designed to operate, may lead to potential read/write errors. Diskette drives operating in the range of 295 to 305 RPM are in the passing range. Diskette drives running outside of that range, but within the range of 290 to 310 will be considered marginal. Diskette drives outside the 290 to 310 range will fail the test. If the spindle speed of your diskette drive is not in the acceptable range, there is an increased possibility of read/write errors occurring.

The spindle speed of most diskette drives can be adjusted to the correct rate via a potentiometer. Many drives have a strobe pattern on the flywheel that will aid in setting the speed. These patterns can be examined under fluorescent or neon light. There are usually two rings, one for 50Hz AC power and one for 60Hz AC power (the US standard). Adjust the speed potentiometer until the appropriate pattern stands still. Rerun the spindle speed test to verify your adjustments.

- **Centering Test**

This test is sometimes called a clamping test. The centering test evaluates the accuracy of the spindle bearings and the mechanical clamping mechanism of the diskette drive. This mechanism engages each time the door of the diskette drive is closed. This test checks to see if the mechanism is seating and holding the floppy disk properly in the diskette drive.

The test reads sectors on a designated track on each side of the Digital Diagnostic Diskette. This track acts as a triangulation mechanism to determine the rotational center of the diskette. These tracks are written at 7 milli-inches off center for the 48 TPI diskette drives and 3 milli-inches off center for the 96 TPI diskette drives. The second and third centering tracks are written at 8 and 9 milli-inches or 3.5 and 4.0 milli-inches on the respective diskette drive type.

The test begins by reading the first of the three tracks designed to test diskette drive centering. The test repeatedly recalibrates the diskette drive read/write head position and then reads the designated track on each side of the disk. The drive must read all the sectors correctly in order to pass the test. If sectors located opposite of each other on the diskette fail to be read then a clamping error is indicated. Otherwise the centering mechanisms of the drive passes the test.

If the drive fails the test, first try reseating the Digital Diskette by reinserting it, then retry the test. Try cleaning the read/write head(s) of the diskette drive with Landmark's head-cleaning diskette and the Service Diagnostics Analog Alignment Test. Repeated failures indicate the need for repair or replacement. Possible problem areas include the spindle bearings and the diskette clamping mechanism of the diskette drive. This diskette drive should not be used to record anything of value, since other drives may have difficulty reading these disks.

- **Index to Data Timing**

In this test, the time from the photo index signal to the first byte of data available is measured. A nominally adjusted diskette drive should take 200 microseconds to present the first byte of data to the system. An acceptable range of results would be between 100 and 300 microseconds.

- **Track to Track Seek Test**

The Track to Track Seek Test checks the ability of the diskette drive to move from one track on the diskette to another and perform a read of the sectors on the tracks. This is done by requesting a series of seeks and after each seek verifying (via a read) the actual track under the read/write head. Any errors in reading will be reported as failure of the test. Any read failures are reported in a similar fashion to the Track Seek/Read Test.

Diskette drive errors indicate problems in the stepper motor mechanism. One error per head per million seeks is all that is acceptable. So, any seek errors indicates a low degree of reliability and the drive should be serviced.

All rails on which the head moves should be cleaned with evaporating cleaner and a Q-Tip. Check for binding by running the test with the cover off. On some drives a small amount of non-conductive silicon lubricant may be daubed on the rails. Take care to put no lubricant on the drive electronics or head surfaces. Do not touch head surfaces.

- **Read/Write Head Positioner Hysteresis**

The Read/Write Head Positioner Hysteresis Test determines the diskette drive seek hysteresis by seeking to the inner, middle, or outer progressive offset tracks from opposite directions and comparing the read inaccuracy that results. A positive result indicates that the head is too close to the spindle after a seek. A negative result indicates positioning too far away from the spindle.

- **Read/Write Head Positioner Linearity**

The Read/Write Head Positioner Linearity Test checks the alignment of the diskette drive at three tracks on the diskette. The alignment of a diskette drive should be the same across the diskette drive. The results are displayed in milli-inches off of center for each of the three tracks tested. To pass this test, the diskette drive must have the same alignment results for each of the three tracks being tested.

- **Radial Alignment Test**

The radial alignment test checks to see how well your diskette drive can read data at the official center of the track. The test uses tracks that are progressively offset starting at 7 milli- inches from center to 13 milli-inches from the official center (1.0 milli-inches to 7.0 milli-inches by 0.5 milli-inch increments for the 96 TPI diskette drives). The 48 TPI diskette drive should be able to read data that is up to 9 milli-inches from center with a maximum difference of in positive/negative results of 2 milli- inches. The 96 TPI diskette drive should read data at least 3.0 milli-inches off center with a maximum positive/negative difference of 1.0 milli-inches. If the diskette drive could, for example, read only up to 7 milli-inches from center, then the data read path is only 12 milli-inches, the effective data path is narrowed down to 5 milli-inches.

- **Azimuth Alignment Test**

This test checks the skew of the read/write head relative to the data track. The data for this test is recorded on the centerline of the track, but the data is progressively rotated away from normal. The test reads all the tracks with data rotated one direction, then it reads all the tracks with the data rotated the other direction. If the read errors occur symmetrically around the centerline recorded sector, then the read/write head azimuth alignment is rated as correct.