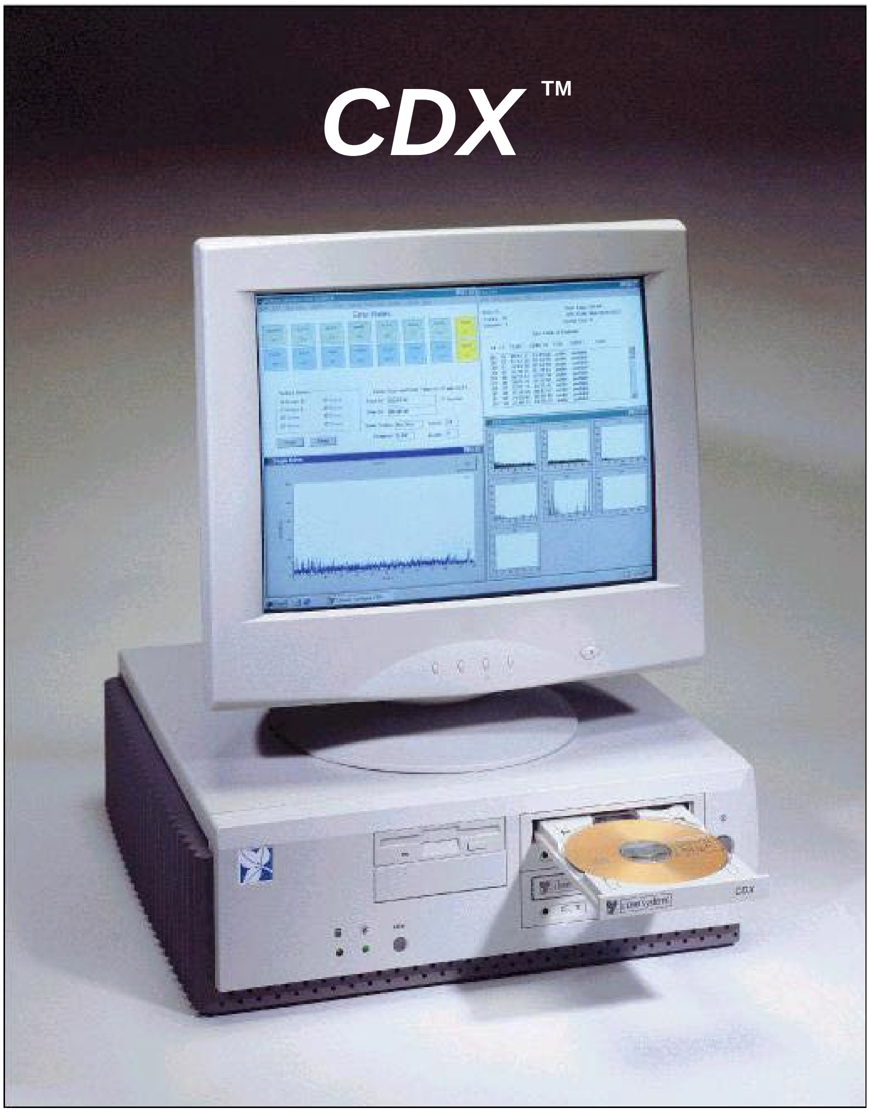

HIGH-SPEED CD ANALYZER

OPERATING MANUAL

Version 1.1

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INTRODUCTION

The Clover Systems CDX Compact Disc Analyzer is an affordable high-speed tool to quantitatively measure the quality of a CD. It will analyze CD-DA, CD-ROM, CD-ROM XA, CD-I, CD-R, Photo-CD, and CD-RW discs at 1X, 2X, 4X, 8X or 24X (CAV) speed.

CDX measures disc quality by examining the quantity and severity of CIRC errors generated during playback. It also provides the capability to measure signal parameters related to pit geometry, such as I_{11}, I_3, asymmetry, and Itop. It can also be used to measure reflectivity. Together, this information provides a thorough analysis of disc quality. Also see the section titled "INTERPRETING THE RESULTS."

CDX automatically measures and displays BLER (Block Error Rate), E11, E21, E31, E12, E22, E32 (uncorrectable errors), and DROPOUTS. Both Average values and Peak values are displayed for each parameter. For E22 and E32, the TOTAL count is displayed in addition to AVERAGE and PEAK. There is also a built in Grading System that assigns a quality Grade based on the results of the test.

A BNC connector on the rear panel provide a buffered HF output for connection to an oscilloscope or other measurement equipment.

The CDX software is a Windows program that will run under Windows 3.1, Windows 95, or Windows 98. It gathers data from up to eight CDX's, and displays the data in the form of charts. It also displays statistics for the whole disc, and prints a summary of the results.

CDX can also perform various format-checking tests on CD-ROM's, and do bit-for-bit data comparison on all types of CD's.

CONVENTIONS

The following document conventions are used throughout this manual:

CAPITAL LETTERS	Represent filenames, directory names, or drive letters.
Initial Capitals	Represent names of programs, menus, dialog boxes, buttons, and named windows.
Italic	Represent menu commands.

INSTALLATION

The CDX is set up and used just like an ordinary CD-ROM drive. The drive mounts in a 5¼" drive bay using the screws provided, and the SCSI Host Adapter installs in a 16-bit ISA slot. The I/O panel installs in an unused expansion slot.

HARDWARE INSTALLATION

Drive Configuration

First set the SCSI Target ID using the jumpers on the rear panel of the drive. Make sure that no other SCSI device connected to the same host controller has the same ID. The factory setting is 3.

If CDX will be the last device on the SCSI bus, set the termination to ON using the jumpers on the rear panel. Only the last device on the bus should have the termination on, and all others should be OFF. By the “last device”, we mean the one closest to the end of the cable.

The PARITY jumper (PRTY) must be ON.

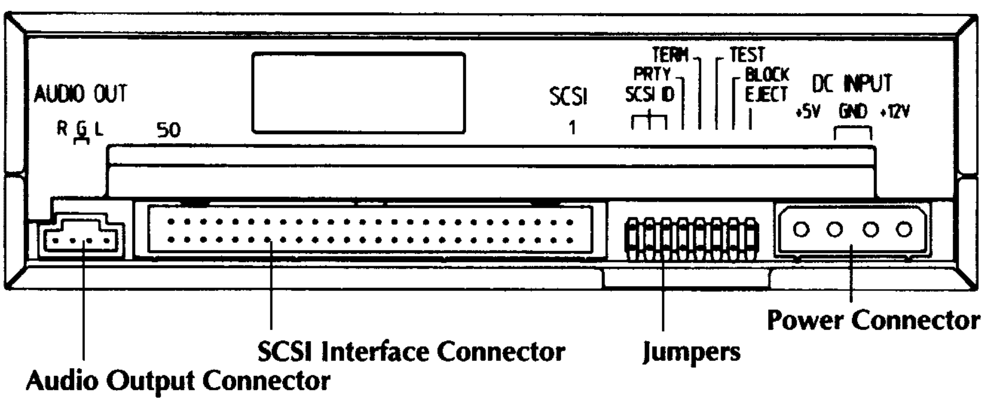

Fig. 1 - Rear Panel Connections

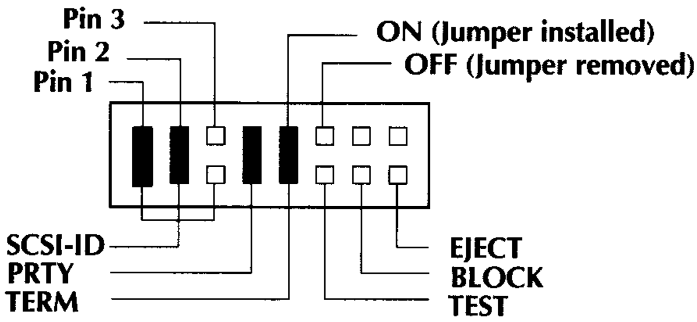

Fig. 2 - Jumper Settings

For additional details, see Plextor "UltraPlex CD-ROM Drive Operation Manual."

SCSI Host Adapter Installation

Ordinarily, we supply a PCI buss plug & play adapter. If you require an ISA buss adapter, we can supply one. The PCI Host Adapter has no jumpers or other settings. It will be configured properly when the driver software is installed.

Inserting the Host Adapter

Find an unused slot of the proper type, and remove the expansion slot cover panel. Align the bus connector on the bottom of the host adapter with the slot, and carefully insert it into the slot. Attach the Host Adapter bracket to the PC chassis with the screw that came from the empty slot cover panel.

Connecting the Cable

Be sure that the SCSI device that will be at the end of the cable has it's termination ON. Insert one end of the cable into the 50-pin connector on the Host Adapter. Be sure that pin 1 on the cable (usually red) is connected to pin 1 on the connector. Connect the other end of the cable to the CDX drive in the same way. You can also connect one other SCSI device to the same cable, providing it's termination is OFF. If you wish to connect more than two SCSI devices, you will need a special cable with more connectors.

Operating System Support

Tekram PCI Host Adapter

If using the Tekram adapter, you will need to install a driver from the floppy disk that comes with the Tekram board. Select Add New Hardware in the Control Panel. Select SCSI Adapter from the list of devices, and Show All Drivers. Click the Have Disk button and insert the Tekram floppy disk. Use the Browse button to locate the directory on the floppy disk that corresponds to your operating system.

Adaptec ISA Host Adapter

Windows 98, 95 and NT have built-in support for the Adaptec AHA-1535A. Select Add New Hardware in the Control Panel. Select SCSI Adapter from the list of devices. The AHA-1535A adapter uses the same drivers as AHA-1540 / 1542, and usually shows up as AHA-154x in the list of drivers.

I/O Panel Installation

The included CDX computer panel provides connectors for both the serial interface and the HF output. The CDX uses one serial communications port. This port can be COM1, COM2, COM3, or COM4. In order to conveniently connect to your computer's COM port, an RS-232 connector is included on the CDX computer panel.

Single Drive Configuration

Install the CDX I/O panel in an open slot. Connect the panel ribbon cable to J4 on the rear of the CDX. Pin 1 (the red wire) goes to the pin marked with a small triangle. It is often most convenient to do this before installing the CDX drive in the chassis. Connect the CDX RS-232 connector to your PC's COM port using the provided cable. If your COM port has a 25-pin connector, you will need a 9-pin to 25-pin adapter.

The serial port on the CDX can be configured for either RS-232 or RS-485 operation. RS-232 operation is used if you have only one CDX attached. RS-485 operation is used if you want to connect more than one CDX to the computer. CDX's are shipped configured for RS-232 unless a multi-drive configuration is requested. Communications are bi-directional half-duplex at 19200 baud. Your COM port will be set to the correct protocol automatically by the CDX program. It is not necessary to change the serial port settings in the Windows Control Panel.

Dual Drive Configuration

The easiest way to connect two CDX drives is using two RS-232 COM ports. Installation is identical to the single drive configuration, and each CDX is connected to a separate COM port.

Multi-Drive Configuration

If you wish to connect multiple CDX drives to your PC, the serial connection on each CDX must be configured for RS-485.

You will also need an RS-485 to RS-232 adapter and special cable that can be provided with multiple CDX systems. Up to 8 CDXs may be connected to one COM port at once. Contact the factory for details.

Installing the CDX Drive

CDX installs in a 5/12" half-height drive bay like an ordinary CD-ROM drive. Be sure that circuitry attached to the rear of the drive does not touch anything after it is installed.

SOFTWARE INSTALLATION

CDX Software

Insert the CDX floppy into your floppy drive. Select *Start / Run* from the Start Menu, and enter “A:SETUP”, where “A” is the drive letter of your floppy disk. Alternatively, you can double-click on SETUP.EXE on the floppy disk in Windows Explorer. Then just follow the instructions on the screen.

A “Clover” folder will be added to the Start / Programs menu. You can create a shortcut on your desktop by going to the C:Program Files / Clover / CDX folder in Windows Explorer. Then drag the CDX icon to your desktop.

USING CDX

MAIN WINDOW

The main window shows a summary of all error rates, over-range alarms, drive status, drive speed, and disc Grade. It also shows progress of the current test, and allows you to select from up to eight different drives.

Error rate data is displayed in two ways: In the main window, the average and peak values (over the whole disc) are displayed, as well as total E22, and total E32 errors. If any of these parameters goes over a user selectable limit, the indicator will turn red. The drive whose data is displayed is selected using the radio buttons in the main window. Each error type can also be graphed by using the Chart menu.

There are three types of charts: Single Drive Chart, Multi-Drive Chart, and All Chart. The Single Drive Chart displays any or all error types for one player. The Multi-Drive Chart displays one error type for any or all players. The All Chart displays individual charts of each parameter for one drive.

When the player is testing, it will send all six error parameters to CDX once every second of program time. All data displayed in CDX are one-second averages. . Many CD analyzers use one second samples, but the Philips Red Book specification calls for averaging error rates over 10 seconds, so you must be careful in comparing data from different systems. The one-second data will have higher peaks and lower valleys. The 10-second data is smoother because it is averaged over more samples. The average values will be identical for one and ten second data.

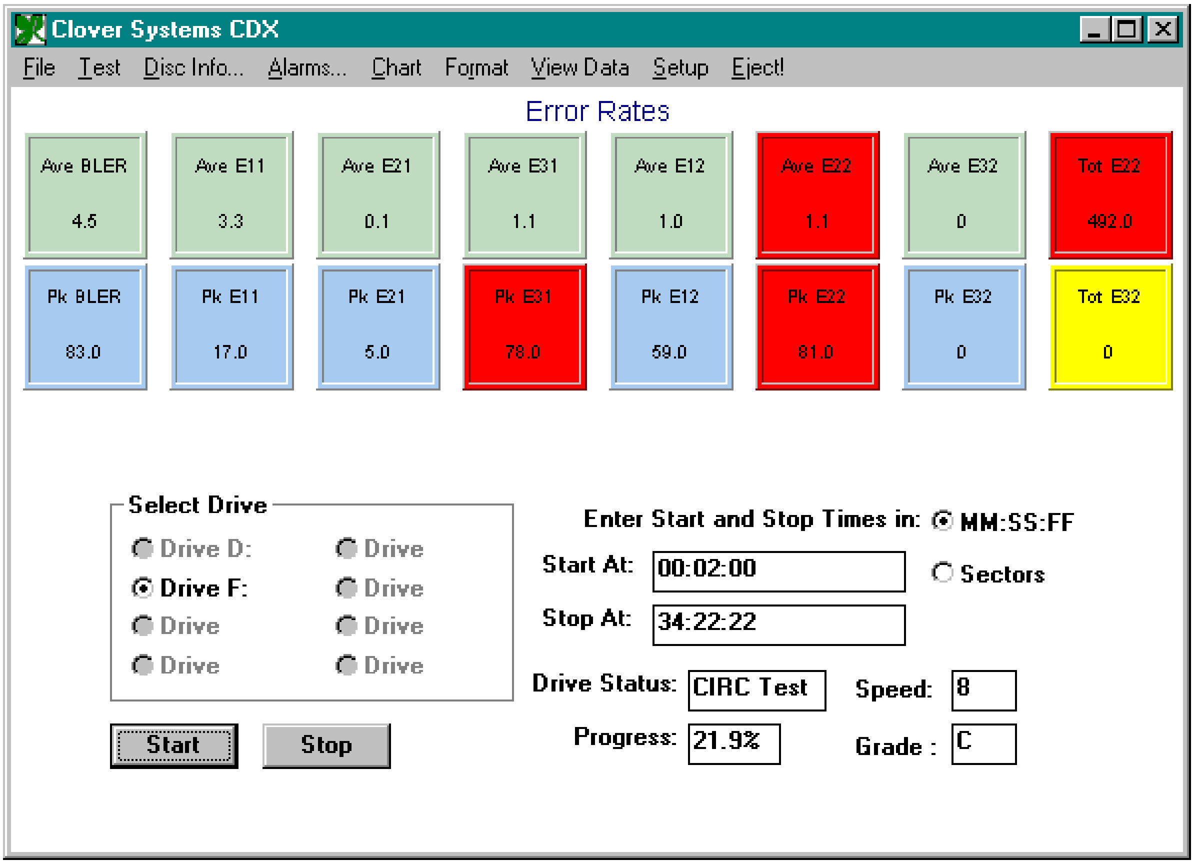

Fig. 4 - CDX Main Window

Configuring the drives

SCSI Host & Target ID's

In order for the software to recognize your CDX, you need to tell it how it is configured. You will need to know the SCSI Host ID and SCSI Target ID of your CDX drive, as well as its drive letter. The Target ID is set by jumpers on the CDX drive as described above. If you have more than one CDX drive, setting them to different Target ID's will make it easier to identify which one is which. The SCSI Host Adapter ID is typically set by Windows starting with 0. To see what Host ID Windows has assigned to your SCSI adapter, run the ScanSCSI.exe utility program included with CDX. It will scan the SCSI buss and provide a list of all installed host adapters and devices connected. The CDX drive will appear as Plextor PX-32. Write down the Host ID and Target ID of these drives. Do not make any assumptions about the Host ID. Even if there are no other SCSI adapters installed, it will not necessarily be Host ID 0. Also, devices such as parallel port ZIP drives are assigned SCSI Host ID's.

You can write your system settings here to avoid confusion:

First Host Adapter ID __________
Second Host Adapter ID __________
First CDX Target ID __________
Second CDX Target ID __________

CDX Drive Letters

If CDX is your only CD-ROM drive, you can see its drive letter in the CDX software Main Window. If you have several CD-ROM drives installed, they will all be listed in the *Select Drive* section of the CDX Main Window. Use Windows Device Manager to find out which drive is which. . Select *Settings / Control Panel* in the Start Menu. Double-click the SYSTEM icon, then select the *Device Manager* tab. Device Manager will list all of the installed CD-ROM drives. CDX will appear as PLEXTOR PX-32TS. Select this drive, then click on *Properties*, and select the *Settings* tab. This screen will show the Current Drive Letter Assignment. Again, if you have multiple CDX drives, you can differentiate them by setting them to unique Target ID's.

First CDX Drive Letter __________
Second CDX Drive Letter __________

Drive Settings in Device Manager

Select the Disconnect and Sync Data Transfer boxes, and de-select Auto Insert Notification in the Device Manager / Settings tab described above. Failure to set these properly will prevent CDX from working!

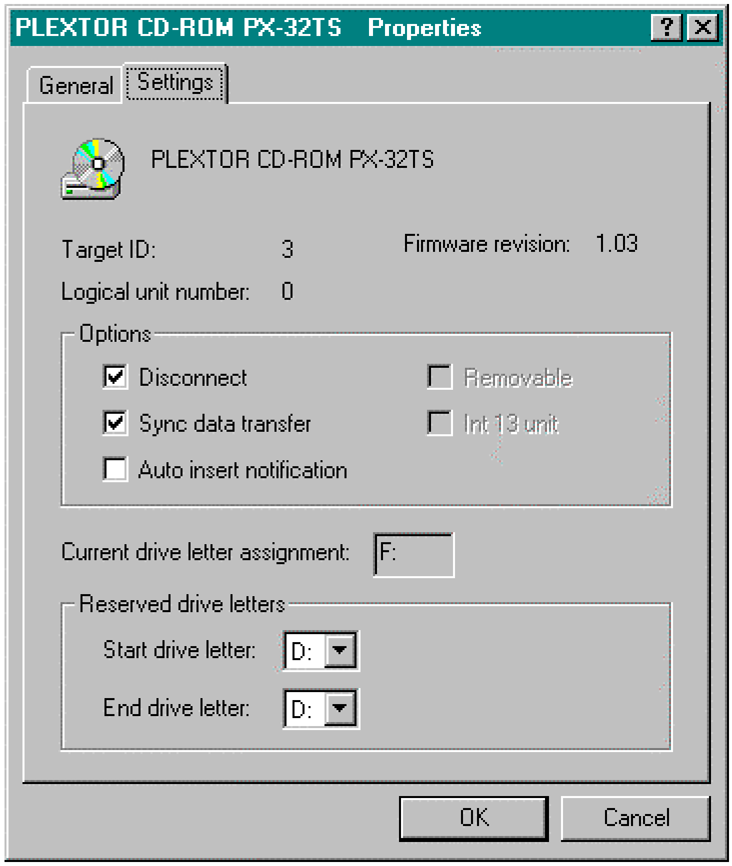

Fig. 5 - Device Manager Drive Settings

CDX Setup Menu

Select *Setup / Drives...* in the main menu. A dialog box will appear that allows you to specify how your CDX is configured. Select the drive letter in the list box that represents your CDX. All installed CD-ROM drives will appear in the drop-down list box

Now set the Host ID to the SCSI Host ID of the SCSI Host Adapter connected to CDX, as determined above.

Next, set the Target ID. This is the SCSI Target ID set by jumpers on the rear of the CDX.

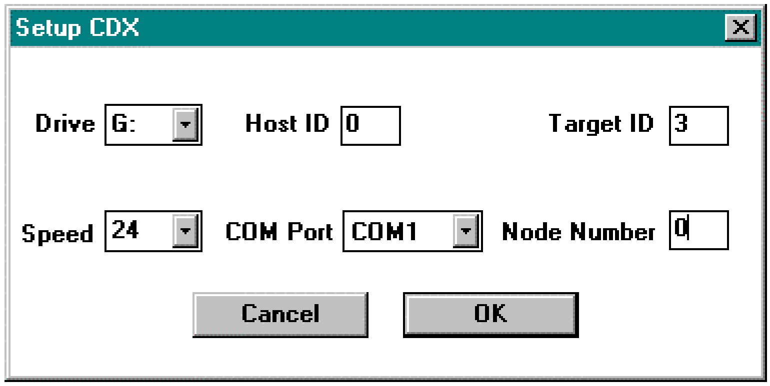

Fig. 6 - CDX Setup Window

You must also set the Node Number of the CDX. This is an identifying number that allows the system to accommodate multiple CDX's. Every CDX is programmed with a "Node Number". If you have just one CDX drive, it is set to Node Number 0, so enter 0 as the Node Number for the CDX drive. **All other (non-CDX) drives should be set to Node Number = -1.** Failure to properly set the node numbers of all CD-ROM drives may prevent the systems from working properly! If you remove a CDX drive without first setting it's Node Number to -1, then the program may crash when it does not find the expected CDX drive.

Now set the COM Port(s) you will be using with CDX.

Finally, you can set the speed you want CDX to run at. Select 1, 2, 4, 8, or 24 from the drop-down list. You can change the test speed at any time using this menu.

If you have changed any Node Number setting to or from -1, you will need to exit the program and re-start it, so that it can recognize the new settings.

Notes on Test Speed: Speeds of 1X, 2X, 4X, and 8X are CLV (Constant Linear Velocity), which is the normal playing mode for all CD's. 24X is CAV (Constant Angular Velocity), which means that the disc spins at a constant speed. Since the data is recorded CLV, the transfer rate at 24X CAV is 14X at the inside, and 32X at the outside.

The general rule is that the higher the speed, the worse the results. This is simply due to the laws of nature. Furthermore, there are no standards for playing at high-speed. All standards apply to 1X speed only. Many CD's will not play satisfactorily at higher speeds. CD-ROM drives are designed to fall back to a slower speed if it cannot read reliably, and will also re-try up to 10 times before failing. As a result, it is not obvious that a disc is not functioning at full speed. CDX does NOT reduce its speed if it cannot read reliably. Therefore, you may find many discs that do not work at high speed. In this case, lower the test speed until you can get reliable results.

If your application requires a certain throughput (like some games), CDX provides a way to confirm that the disc can play at the required speed.

SELECTING THE DRIVE

All installed CD-ROM drives will appear in the “Select Drive” group of radio buttons in the main window. Drives which are not CDX drives will be grayed out, so that only CDX drives can be selected.

Note: The drive selected by the radio buttons is the active drive, and all functions will be directed to that drive.

LOADING THE DISC

Insert a disc in the tray. Press the EJECT button on the front panel, or *Eject!* in the main menu to load the disc. The orange BUSY light will come on for a few seconds as the drive reads the Table of Contents. The Drive Status display will show “Mounting Disc”. Wait ‘till the light goes out and Drive Status reads “Ready”.

MEASURING ERROR RATES

Setting the Start and Stop Points

The “Start At:” and “Stop At:” edit boxes will default to the first sector with data, and the start of lead-out respectively, so that the whole disc is tested. You can change the start and stop points of the test if you wish to test only a portion of the disc. You can also select whether you want to display and enter these points in MSF format (Minutes/Seconds/Frames), or Sector numbers. CD-ROM discs default to display in Sectors, and CD-DA discs default to display in MSF.

Starting the Test

Click the Start button in the main window, or select *Test / CIRC Errors* in the main menu.

The current speed setting for the CDX drive is displayed. You can change it using the Setup menu described above. Click Start to start the test. The test will stop automatically after the specified number of sectors are tested. Progress is displayed in the “Progress” box.

If you wish to abort the test before it reaches the end, press “Stop”. When the test completes, a message box appears with notification that the test has completed.

Saving the Results

The end of test notification prompts the operator to save the results. Selecting YES will save the data; selecting NO will skip the save operation. The data can be saved later on, by selecting *File/Save* in the main menu. In this case, a dialog box will prompt you to select which CDX’s data you want to save. Non-existent Drives will be inactive. After clicking OK, a new dialog box prompts for a filename. You can save the data at any time, even while the test is running. Test data files use the default file extension .dat but you can use another file extension if you wish.

Saving Results to a Spreadsheet

The CIRC error test results summary can be saved to a spreadsheet. The feature is enabled by selecting *File / Append Sheet* in the main menu. This toggles the feature on & off. When enabled (checked), the summary results of the CIRC test will be appended to the end of a spreadsheet named CLOVER.WK1. This sheet is Lotus 1-2-3 format, but can also be loaded into Microsoft Excel and most other spreadsheet programs.

When File/Append Sheet is checked, you will be prompted for a text string used to identify this disc when you save the results (*File/Save*). This string will be saved in column one of the spreadsheet. If you do not wish to enter anything, just click "OK" or press ENTER. If you click CANCEL, or press ESCAPE, nothing will be saved. When the Append Sheet feature is turned off, this dialog box will not appear.

A sample CLOVER.WK1 sheet is included on the distribution disk. You can format the spreadsheet any way you want, but it must be named CLOVER.WK1.

The results of one test are saved as one row of data. The columns are arranged as follows:

Column 1	Disc ID
Column 2	AVE BLER
Column 3	AVE E11
Column 4	AVE E21
Column 5	AVE E31
Column 6	AVE E12
Column 7	AVE E22
Column 8	AVE E32
Column 9	TOT E22
Column 10	PK BLER
Column 11	PK E11
Column 12	PK E21
Column 13	PK E31
Column 14	PK E12
Column 15	PK E22
Column 16	PK E32
Column 17	TOT E32

Starting a New Test

After saving the data, select *File/New* from the menu. This will clear the old data in preparation for a new test. To start the test, you only need to press "Start". If you have multiple CDX's attached, you can start and stop each player at will.

Disc Grading System

There are five different grades covering a wide range of performance: A, B, C, D, and F. This feature provides a means of instantly evaluating a disc without looking at the individual data. Here are the criteria used to determine the GRADE. These criteria are somewhat arbitrary, but reflect generally accepted practice in the industry.

GRADE A =	AVE BLER over the whole disc not greater than 5.0 PK BLER less than 100 PK E12 less than 400 NO E22 ERRORS NO E32 ERRORS
GRADE B =	AVE BLER over the whole disc not greater than 50.0 NO E22 ERRORS NO E32 ERRORS
GRADE C =	AVE BLER over the whole disc not greater than 100.0 NO E32 ERRORS
GRADE D =	AVE BLER in all ten second periods is less than 220 TOT E32 less than 1000
GRADE F =	AVE BLER in any ten second period is greater than 220 TOT E32 greater than 1000

Generally, a GRADE A disc represents the best possible quality of disc. GRADE B is still an excellent disc, but not quite perfect. GRADES A & B are good discs for any use, including the most stringent CD-ROM uses.

Most CD-ROM publishers do not like to see BLER more than 50 or any E22 or E32 errors. Therefore, GRADES C through F would be unacceptable for these users. However, GRADES C through D are still usable discs. The only grade that is unacceptable is F, since this disc does not meet Red Book specifications. Still, this disc may be perfectly usable, and the data fully recoverable.

Uncorrectable errors may not be a problem on audio discs, since the player's interpolation circuitry will hide these errors. Modern players can interpolate over up to eight consecutive bad samples, although the sound quality may be compromised.

Uncorrectable errors do not necessarily make a CD-ROM unusable either. Errors that are uncorrectable in the main CIRC correction stage may still be corrected by the EDC/ECC sector level error correction used on most CD-ROM's. Therefore, the data may still be recoverable, and can still verify if you are comparing to the original. Of course a disc like this has no tolerance for additional degradation, such as scratches and fingerprints, so access time will increase and it will soon fail.

Since there is no Red Book specification for uncorrectable errors (E32), a GRADE D disc is still considered within Red Book specifications. CD-ROM's however, should have no E22 or E32 errors, as made. If the BLER exceeds 220 in any ten-second period, the disc is outside the Red Book specifications. Grade F discs do not meet Red Book specs, and therefore should be rejected.

Depending on your own requirements, you will have to decide where to draw the line as far as what you are willing to consider necessary and sufficient performance. Also please see the section INTERPRETING THE RESULTS (pg.27).

Setting Alarm Limits

It is possible to set limits for each parameter measured. If the value for any parameter exceeds this limit, then the corresponding indicator in the main window will turn red, indicating an over-range condition. In addition, any parameters which went over it's limit will be marked in the printed summary with an "**". This feature allows you to create your own "Pass/Fail" criteria.

To set these limits, select *Alarms...* in the main menu. A dialog box will appear which allows you to enter values for each parameter. Average value limits can be entered with one decimal digit. Peak values, however, must be integers. Note that the value you enter is the maximum allowed, so that the value must be larger than this number to generate an alarm. All alarm settings are permanently saved when you click OK.

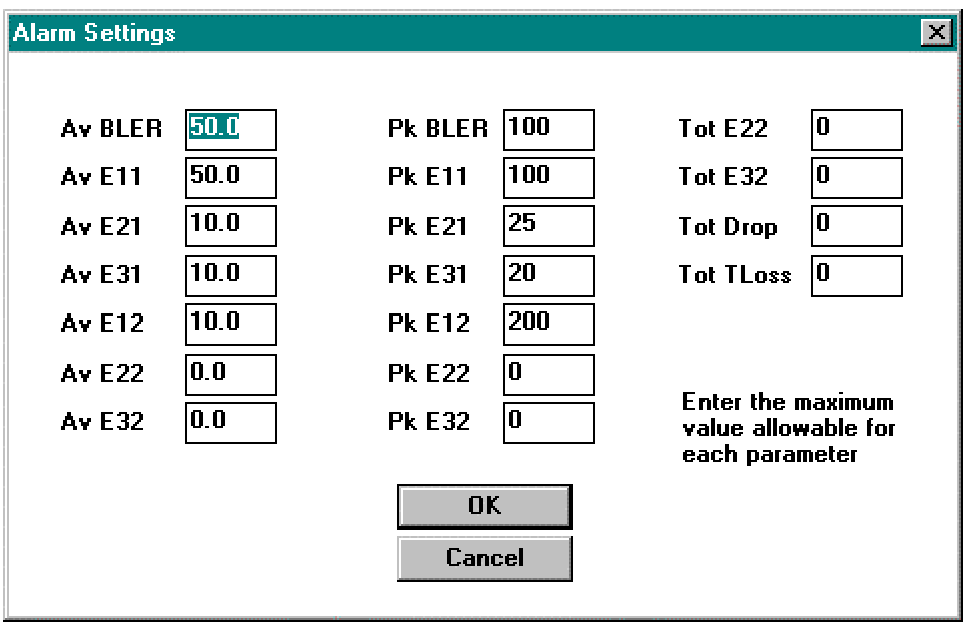

Fig. 7 - Alarm Settings Dialog

MAKING CHARTS

There are three types of charts: Single Drive Chart, Multi Drive Chart, and All Chart. The Single Drive Chart displays any or all error types for one player. The Multi-Drive Chart displays one error type for any or all players. The All Chart displays individual charts of each parameter for one player. On charts with multiple parameters or players, the individual traces will be color-coded. If you have a color printer, they will be printed in color.

The title bar of the chart window tells whether it is a Single Drive or Multi Drive chart. At the top of the window the Drive number (Single Drive) or error type (Multi Drive) is displayed.

Single Drive Chart

To graph the errors of one player, select *Chart / Single Drive*. A dialog box will appear which allows you to select which error types you wish to display. First, select which player you want to display errors for, using the radio buttons. Drives that do not exist will be grayed out. Next click the check boxes of the errors you want to display then click OK.

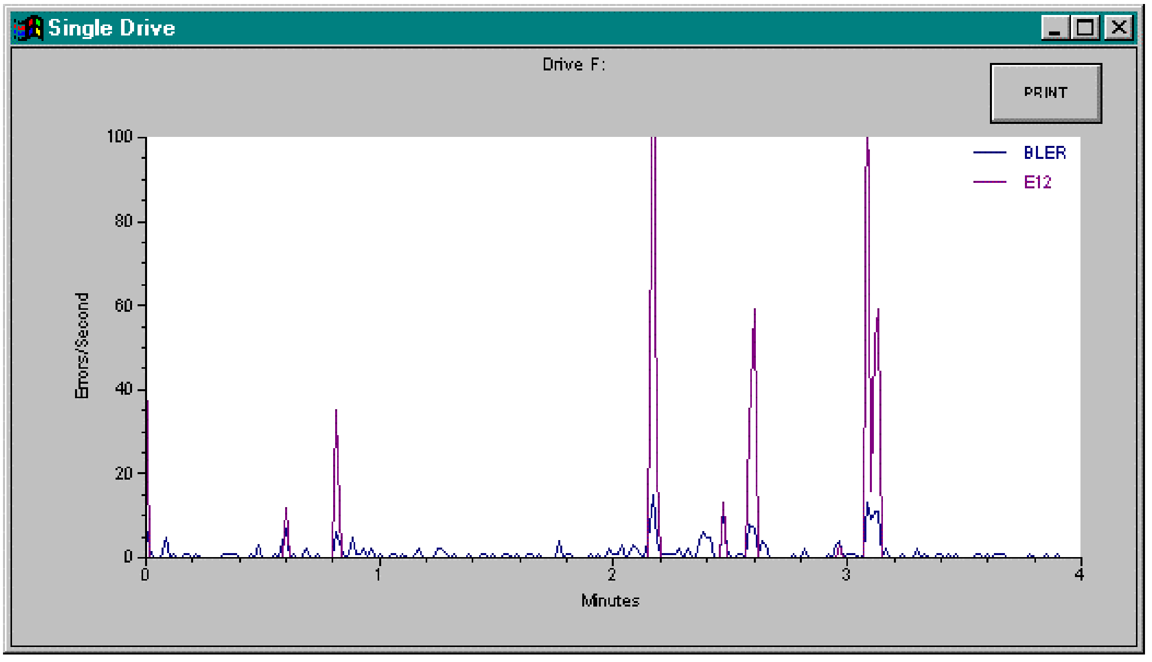

Fig. 8 - Sample Single Drive Chart

Multi-Drive Chart

You can also make a graph of one parameter for all players, using the *Chart / Multi Drive* menu. It works the same way as described above, except the error type is now radio buttons, and the Drive numbers are checkboxes. This chart is only useful if you have more than one player connected.

All Chart

This menu selection creates a page of eight individual charts of each parameter for one player. The Drive which is selected by the radio buttons in the main window is the one which is displayed. This group of charts allows you to print graphs of all results on one page of paper, plus it provides a means of displaying all parameters at once with different vertical scales. This chart also uses black as the default color for convenience in using a black & white printer. The vertical scale can be individually set for each chart in this window. This can be done manually or automatically (see following section).

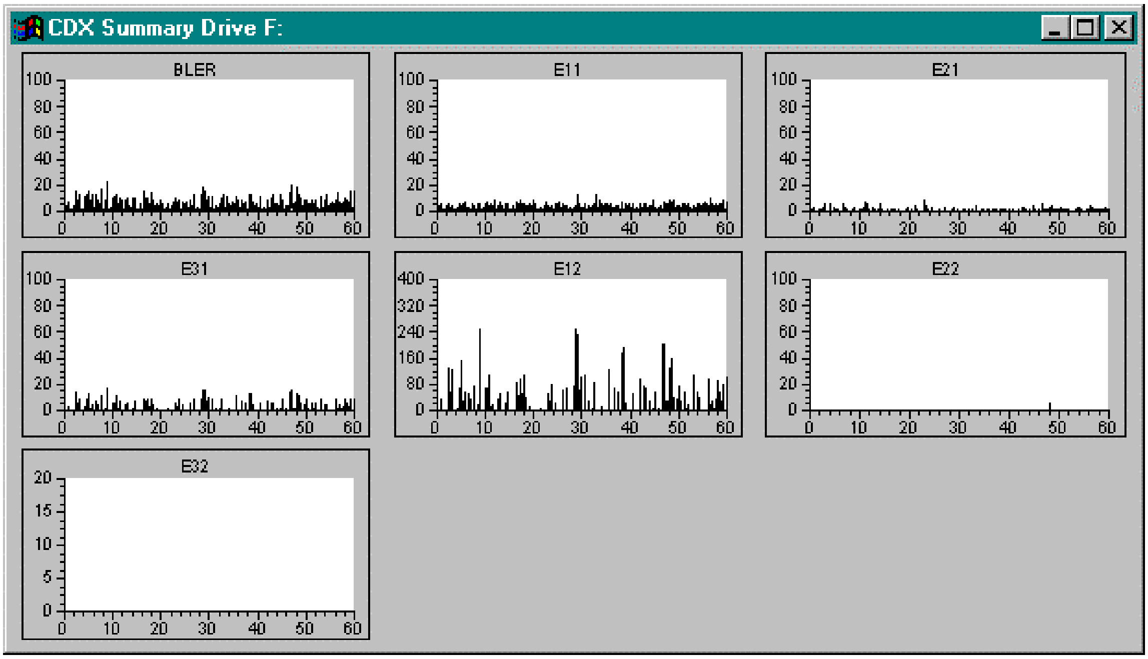

Fig. 9 - Sample All Chart

Modifying the Charts

The graphs can be modified to suit your needs. You can change both the horizontal and vertical axes to fit the data. You can also change the line styles and colors.

Changing the Axes

Double-click on the axis you want to modify. A dialog will appear that allows you to set both the minimum and maximum values for the range of that axis. You can also set the number of major and minor tick marks. If you make the range of the axis really large, be sure to adjust the space between tick marks accordingly. Otherwise you may generate an axis labeled with hundreds of tick marks! You can also apply grid lines to the chart with this dialog. The axis settings are saved for all charts, so that the next time you run CDX, it will start up with the axes set the way you left them.

The Multi Drive chart allows you set and save separate axes ranges for each parameter. These settings are also used in the All Chart window, so you can set the scale for each parameter as you want it, and then the All Chart will use those settings.

Changing the Line Style & Color

Double-click on a data plot to open the “Plot Parameters” dialog. Selecting “Line Attributes” will allow you to adjust the color, style, and width of each data plot. Marking the “Fill Area” checkbox will fill in the area under the plot. Checking the “Spline” box will cause the data to be smoothed, making it easier to see the trends.

Clicking on the “Data” button will open the Data Set window, which displays and allows you to edit the actual data of the plot. The data can also be copied to the clipboard, and pasted into another application, such as a spreadsheet or other analysis software.

Other Chart Customization

All text, legends, background, etc. of the charts can be modified to fully customize your charts. Double-click on the object you wish to edit.

Printing the Charts

Each Single Drive and Multi Drive chart has a PRINT button in the upper corner. Clicking this button will print the chart. A dialog box allows you to set the size and location on the paper of the chart. Please note that if you select “Actual Size” for the chart, the size of the printed chart will be dependent on the size of the window on your desktop. In this case, the chart will be printed at the size and shape it appears on the monitor. To print the All Chart, first create the chart using the *Chart/All* menu selection, then select *File/Print All* in the main menu. Best results are obtained if you first set the printer to “Landscape Orientation” using *File/Print Setup*, then check “Print Graphs to Max Size” and uncheck “Maintain Aspect Ratio” in the print dialog.

DATA VERIFICATION

Data Verification allows you to compare the data on a CD to another CD or a disc image on your hard disk. This is useful to make sure that you have recorded the correct thing, or to verify that the recording system is working correctly. When testing a series of discs produced from one master, it is not necessary to verify the data on every copy. As long as there are no uncorrectable errors (E32) then the data is perfect. It is much faster to test for CIRC errors than to compare data.

You can select from the Test menu, either *Verify CD* or *Verify Image*. Verify CD will compare two CD’s. To use this function, you must of course, have two CD-ROM drives installed. To compare two audio discs, both drives must be CDX drives, or Plextor PX-32s drives. If you do not have two CD-ROM drives installed, you can compare a disc to a disc image on your hard disk.

Verify CD

In the *Test/Verify* CD Dialog, select the drives you want to use. The Master must be a CDX drive. Copy can be any CD-ROM drive. All installed CD-ROM drives will appear in the drop-down list box.

Click START to start the test. You can abort the test at any time by clicking STOP in the Verify Data dialog. The current sector and number of bad bytes detected are displayed as the test progresses. The Verify Data dialog does not have to remain open while the test proceeds. You can close it, and open it later to see the results.

Selecting VIEW will produce a list of sectors that failed the comparison. Up to 1024 sectors can be listed. If there are more, the list will write over itself. Double click on any sector in the list to view that sector's data.

Verify Image

Test / Verify Image prompts you for a file to compare to. The default file extension is ".img." The file you selected becomes the Master, and you can select the Copy drive from a drop-down list of all installed CD-ROM drives. As with Verify CD, you press START to start the comparison, and can abort by pressing STOP. The current sector and number of bad bytes are displayed. Press VIEW to see a list of bad sectors.

Creating a Disc Image

File / Create Image in the main menu prompts for a file name. The default extension is ".img", but you can use other file extensions if you wish.

Click START to start saving the file. You can abort the operation by pressing CANCEL. The disc is read at the speed set in the Setup/Drive menu, so setting the speed to maximum will speed up the operation.

The disc image files preserve all sector header and error correction bytes, not just the user data.

DISC INFO

The Disc Info… menu selection displays information about the disc in the currently selected drive. This includes: Disc Type (CD-DA, CD-ROM, Multi-Session, etc.), the UPC/EAN code (bar code), the number of sessions, and the number of tracks. You can also display the Table of Contents and Volume Descriptor of the disc.

Table of Contents

When you first display the Disc Info dialog, the Table of Contents will be displayed. This shows the starting time (or sector), the track length, the track type, and copy permit status.

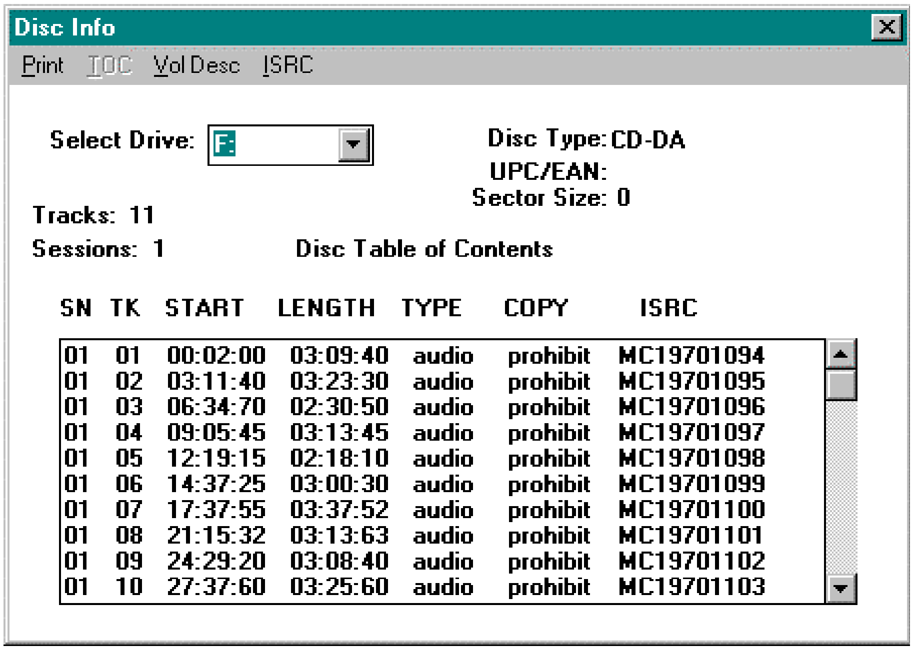

Fig. 10 – Disc Info with Table of Contents

Volume Descriptor

Selecting Vol Desc in the Disc Info menu will display the disc volume descriptor (CD-ROM only).

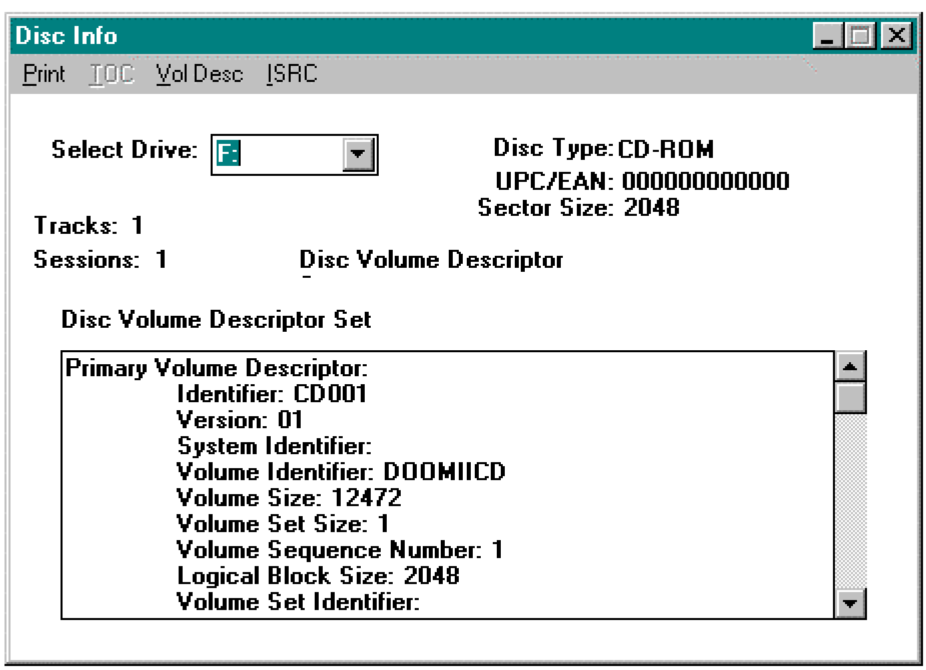

Fig. 11 – Disc Info with Volume Descriptor

ISRC Codes

Selecting ISRC in the Disc Info menu will get and display the ISRC codes if present. This applies to audio discs and multi-session discs only, as ISRC codes are used to identify the copyright owner of music selections. This information is not contained in the Table of Contents, but rather within the music selection itself, so CDX must scan each music track to read the codes.

Print

Selecting Print in the Disc Info menu will print the disc information, including either the TOC or Volume Descriptor.

FORMAT VERIFICATION

ISO9660

Format / ISO9660 will check the logical formatting of a CD-ROM disc. It checks the System Identifiers, Volume Identifiers, Directory Identifiers, and Path Tables for correct formatting and illegal characters.

Postgap

Format / Postgap measures the postgap length. A minimum of 150 sectors are required.

Subcode Skew

Format / Skew measures “Subcode Skew” (CD-ROM only). The Q-channel subcode on a disc contains timecode, called Atime, which is used for rapid locating of specific places. This timecode should be identical to the sector address contained in the sector header. Any discrepancy between these two values is called Subcode Skew. This type of error can be caused by the recording system. Skew up to ± 7 sectors is allowed, but any skew will adversely affect search times. Positive skew means that Atime is higher than header address. Negative skew means the Atime is less than the header address.

VIEW DATA

Disc

View Data / Disc displays sector data on a disc. The current sector number is displayed. You can type a new sector number into the edit box, or use the PREV and NEXT buttons to select a different sector. Press ENTER or NEXT after typing a new sector number. Use the scroll bar to scroll through the data. All 2352 bytes in a sector are displayed in binary on the left side, and as ASCII text on the right side of the window. You can print the sector data by pressing PRINT.

Sector data is display as “raw” data; that is, with the sector header and parity bytes included. The first 12 bytes of every sector are a SYNC pattern that is used to locate the start of the header. It is identical on every sector header, and consists of zero, followed by 10 FF hex bytes, followed by zero. The next four bytes are the sector header. This consists of 3 bytes of address, and one mode byte. The address bytes are encodes in MSF format: Minutes, Seconds, and Frames. Note that these bytes are also encoded as Binary Coded Decimal, not binary. In this example, the header address is 0 minutes, 2 seconds, 16 frames.

The mode byte can be 0, 1, or 2, and determines the size of the user data:

Mode 0: 2048 user data bytes which are all zero, + 288 auxiliary bytes which are all zero.

Mode 1: 2048 bytes user data, plus 288 bytes EDC and ECC error correction code. This is the ordinary CD-ROM mode, which provides error detection and correction beyond the CIRC error correction.

Mode 2: 2336 bytes user data; no EDC or ECC code. Typically used for multi-media; has increased user data, but no additional error correction.

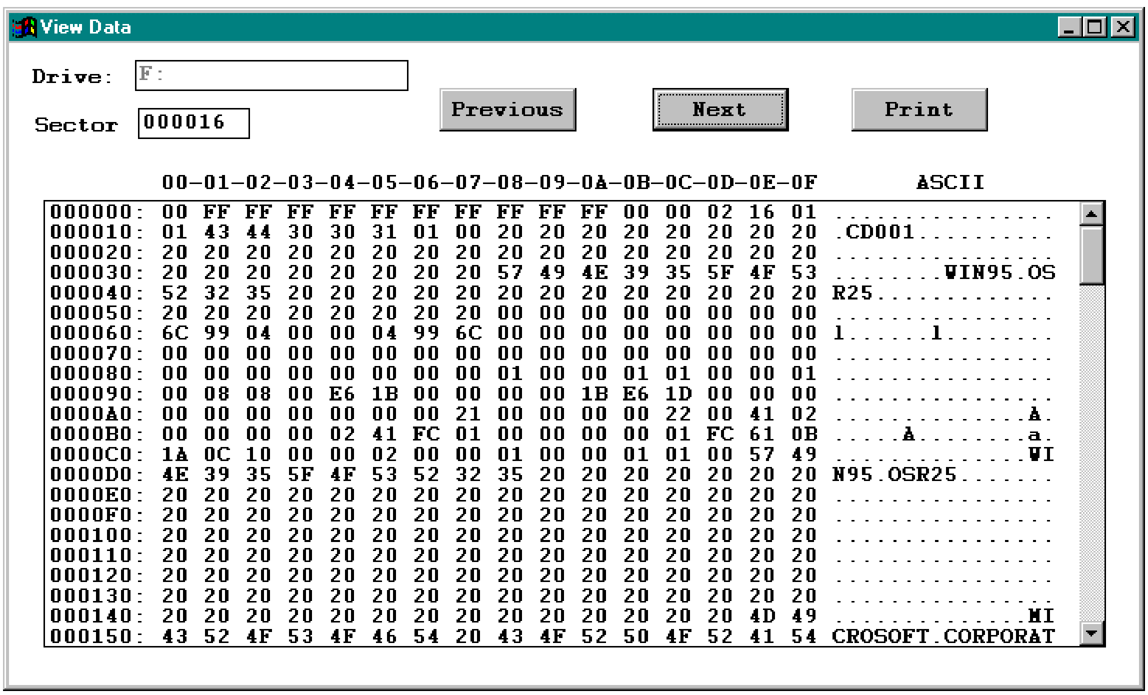

Fig. 12 – Sector Data on Disc

File

View Data / File displays sector data in an image file on your hard disk. It works the same way as described above, except that you select an image file to read from. Image files are saved with all sync, sector header, and parity bytes, so they look the same as on the disc.

LOADING IN SAVED DATA

Test data that has been previously saved can be loaded back in to display and print. Select *File/Load* from the main menu. Enter the name of the file you want to load, or select from the list. Data is loaded in with the Drive number that generated the data, so if the test was made on Drive 2, the loaded data will appear as Drive 2 (even if there is no Drive 2 currently connected). The loaded data will overwrite any current data for that Drive. After loading a data file, you can make charts, print a summary, etc. just as if you had just completed the test.

PRINTING A SUMMARY

You can print a summary of the test results on the printer by selecting *File/Print Summary*. The printed summary consists of the results of all tests that were performed. The same information displayed in the main window (peak and average values for each error type, plus total E22, total E32, and total DROP errors) as well as the current date and time, and the filename. If you want the summary printout to have a filename, which can be used to identify the disc, you must save the data first. If you print the summary before saving the data, there will of course be no filename. Any parameters which exceeded the Alarm Limits will be marked by “**”.

Fig. 13 – Sample Summary Printout

```
                     Clover Systems CDX v1.0

                        Summary of Results

Date:Sat Sep 09 14:35:39 2000                      C:\CDX\DOOM.DAT
Disc Type: CD-ROM                           UPC/EAN: 000000000000
Test Speed: 8X
Sessions: 1
Tracks: 1
Drive F:                 TABLE OF CONTENTS

  Sn. Trk.   Start      Length     Type     Copy           ISRC
  01   01       150      12772    data    prohibit
  Leadout:     12922

CIRC Test Results:
               Av BLER = 4.1                       Pk BLER = 17.0
               Av E11  = 3.8                       Pk E11  = 11.0
               Av E21  = 0.2                       Pk E21  = 7.0
               Av E31  = 0.1                       Pk E31  = 5.0
               Av E12  = 0.4                       Pk E12  = 29.0
               Av E22  = 0.0                       Pk E22  = 0.0
               Av E32  = 0.0                       Pk E32  = 0.0
               Tot E22 = 0                         Tot E32 = 0
               Grade   = A

Data Verification Results:
     Number of Bad Bytes: 0

ISO9660 Format Results:
     System Identifiers OK
     Volume Identifiers OK
     Directory Identifiers OK
     Path Tables OK
     Meets Level1 Specs

Postgap Test Results:
     Postgap = 300 Sectors; PASS

Subcode Skew Test Results:
     Skew = 0
```

CONTROLLING THE DRIVE

The CDX works just like an ordinary CD-ROM drive. Place the disc in the loading tray label side up. Use the EJECT button on the right side of the front panel to open and close the tray. You can also play audio discs using the >/>> button on the front panel, or Microsoft CD Player, which comes with Windows.

MEASURING PIT GEOMETRY

Unfortunately, error rates do not tell the whole story of disc quality. Measuring error rates is useful because any serious problems will be reflected in higher error rates, and it is easy to do. But when it becomes necessary to establish the cause of high error rates, or compatibility with different players, you must look at the pit geometry. The pits and lands must be the correct size and shape in order to generate the proper signals used by the player's focus and track following servos. Deviations from the ideal size and shape of the pits are what causes playback problems. Pit geometry can be measured by looking at the HF signal coming from the pickup (also see INTERPRETING THE RESULTS Pg. 27).

Components of the HF Signal

The HF (High Frequency) signal coming from the pickup represents the light intensity of the beam reflected back from the disc surface. A higher voltage represents greater light intensity, and a lower voltage represents less light. The signal is rapidly changing between light and dark as the beam passes over the pits. When the beam is over a pit, the light intensity is reduced. When the beam is between pits (over "land"), the light intensity is higher. Data is encoded in the transitions between pits and lands.

The eight-to-fourteen (EFM) modulation scheme used produces just nine different possible lengths of pits and lands. Therefore, the resulting HF consists of square waves of nine different durations. The signal appears sinusoidal on the 'scope because of the limited frequency response of the optics. The "eye pattern" displayed on the oscilloscope is a superposition of many sweeps, each consisting of up to nine different lengths. Each of the nine pit/land lengths are exact multiples of one fundamental length, called 1T. The nine possible lengths of pits and lands are 3T, 4T, 5T, 6T, 7T, 8T, 9T, 10T, and 11T. The waveforms generated by these pits & lands are called I3, I4, I5, I6, I7, I8, I9, I10, and I11 respectively. I3 represents the shortest pit / land, and I11 represents the longest pit or land. Generally, we only need to look and the longest and shortest pits to get a good picture of pit geometry.

Measuring I_{top}

Itop (see fig.) is the maximum light intensity reflected from the disc. Therefore, it is related to the laser power and disc reflectivity. In order to make signal measurements that are independent of laser power and reflectivity, I11 and I3 measurements are generally expressed as a fraction of Itop. Atop in the picture on page 25 is the same as what we are calling Itop.

Measure the voltage of the top of the HF eye pattern relative to the level when the disc is not playing. Make sure you are measuring relative to not playing, rather than zero volts. The HF output will be at a positive (constant) voltage when not playing. This procedure is different than that used for our QA-101 CD Analyzer.

Measuring I11

I11 is the largest component in the HF eye pattern. Measure the peak-to-peak value of the pattern (A11 in the picture), and divide by Itop. Example: Itop = 3 v, A11 = 2 v p-p, I11 = A11/Itop = 0.66. The minimum allowed I11 value is 0.60.

Measuring I3

I3 is the smallest component in the HF eye pattern. If there is high asymmetry on the disc, it may be a little difficult to pick out. Measure the peak-to-peak voltage of this component (A3 in the picture) and divide by Itop. Example: Itop = 3 v, A3 = 1 v p-p, I3 = A3/Itop = 0.33. The smallest allowed value for I3 is 0.30.

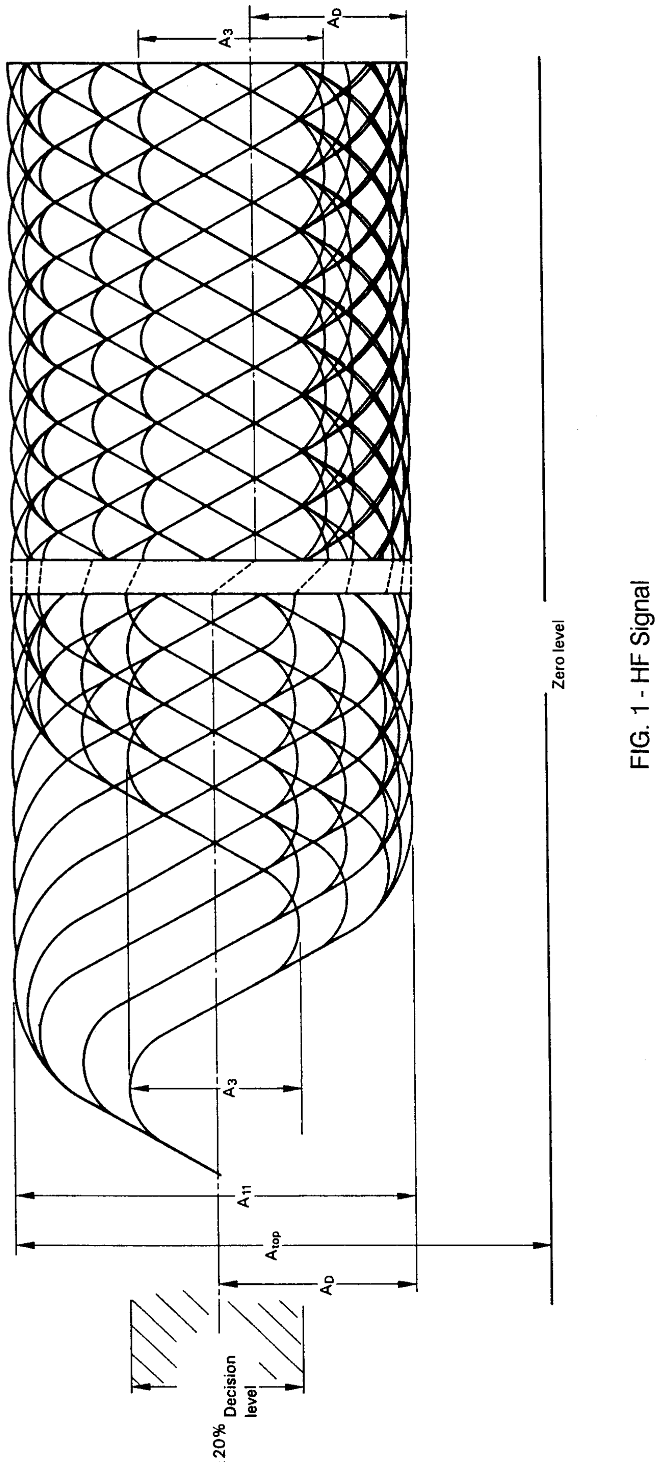

Fig. 14 – HF Eye Pattern

NOTE - All pit geometry measurements MUST be made at 1X speed only.

Measuring Asymmetry

Asymmetry is a measure of the ratio of pit to “land” (the space between the pits) in the track. The EFM modulation scheme causes the total amount of pit to be the same as the total amount of land. However, mastering and molding considerations can cause them to become unequal. For instance, overexposure of the pits during mastering causes them to be longer than normal, causing some negative asymmetry. Generally, some overexposure is desirable because it increases the signal-to-noise ratio and pit wall steepness.

The formula for measuring the asymmetry according to Figure 1 is

$$\left(\frac{A_D}{A_{11}} - \frac{1}{2}\right) \bullet 100 = \text{ percent asymmetry}$$

AD is measured from the bottom of the HF eye pattern to the “center” of the eye pattern. This point is where the rising and falling edges cross, approximately in the center of the I3 waveform. The maximum allowed asymmetry is -15% to +5%. -5% to -10% is considered optimum.

Measuring Beta

Beta is a measurement similar to Asymmetry that is easier to make. Also, since beta is directly related to the writing power in a CD-R writer, this measurement is used by CD writers to optimize their writing power.

Connect the oscilloscope to the HF output on the rear panel. Unlike the other measurements, the ‘scope must be set to AC coupling. Now when observing the HF eye pattern, it will center itself around 0 volts. If we call A1 the distance that the waveform reaches above 0 volts, and A2 the distance that the waveform extends below 0 volts, then

$$b = \frac{A_1 + A_2}{A_{11}}$$

Where A11 is the peak-to-peak value of the waveform as shown in Fig. 10. Note that since A2 is a negative number, the result can be positive or negative. The range of allowable β is 0 to +8% (0 - 0.08) with an optimum value of +4%. Since CD writers try to set the laser power to produce +4% beta, the results of this test can reveal an inability of the writer to optimize the laser power, due to malfunction or incompatible media.

Measuring Jitter

You can get an idea of the amount of jitter on a disc by measuring the width of the transitions in the eye pattern. This is normally expressed in nanoseconds. Jitter of ±115 ns will cause errors. Keep in mind that the oscilloscope measurement will give you (approximately) a peak-to-peak measurement, whereas jitter is normally expressed as one standard deviation. You can also connect the HF output to a jitter analyzer designed to accept an HF input.

Measuring Reflectivity

Since Itop is proportional to the disc's reflectivity, you can measure the reflectivity of a disc by comparing Itop with that of a reference disc of known reflectivity. On CD-Recordable discs, Itop will measure a little lower than it's true value, since the pre-groove will diffract the light and reduce the true intensity. That is, the reflectivity along the track on a CD-R is lower than between the tracks. The minimum allowable reflectivity is 65%.

INTERPRETING THE RESULTS

ERROR RATES

Any serious disc defects will cause an increase in the error rates. Therefore, measuring the number and severity of errors gives a good indication of disc quality. High error rates are generally caused by local physical defects or poor pit geometry.

Although in some sense any disc that plays without uncorrectable errors is "perfect," there are other considerations. For one thing, we may wish to know how close is it to getting uncorrectable errors. Obviously, a disc with very low error rates has more tolerance for dirt, scratches, and the differences of players before it will produce an uncorrectable error. Other discs, although they may not produce uncorrectable errors, may be on the verge of doing so. In addition, older first generation players may produce many uncorrectable errors on such a disc because they use a less effective error correction algorithm than newer players do. Because the timecode used to search to a location does not have CIRC error correction, CD-ROM access times can rise dramatically with error rates, even though the data is fully recoverable.

A CD could not work without a highly effective error detection and correction scheme. Because the pits on the CD are so small, it is impossible to read the disc without errors. Keep in mind that the width of the pits is less than the wavelength of light used to read them! Therefore, it is the error detection and correction codes that really make the CD feasible. The error detection and correction code used on CD's is known as Cross Interleave Reed-Solomon Code (CIRC).

HOW CIRC ERROR CORRECTION WORKS

This scheme uses two principles to achieve a remarkable ability to detect and correct errors. The first is redundancy. This means that extra data is added, which gives you an extra chance to read it. For instance, if all data were recorded twice, you would have twice as good a chance of recovering the correct data. The CIRC has a redundancy of about 25%; that is, it adds about 25% additional data. This extra data is cleverly used to record information about the original data, which allows the ability to deduce what the missing information must have been.

The other principle used is interleaving. This means that the data is distributed over a relatively large physical area. If the data were recorded sequentially, a small defect could easily wipe out an entire word. With CIRC, the bits are interleaved before recording, and de-interleaved on playback. What happens is that the bits of individual words are mixed up and distributed over many words. Now, to completely obliterate a single byte, you have to wipe out a large area. Using this scheme, local defects destroy only small parts of many words, and there is always enough left of each sample to reconstruct it. To completely wipe out a data block would require a hole in the disc of about 2 mm in diameter.

The CIRC error correction used in CD players uses two stages of error correction called C1 and C2, with de-interleaving of the data between the stages. The error correction chip in this unit can correct two bad symbols per block in the first stage and up to four bad symbols per block in the second stage.

TYPES OF ERRORS

Therefore, the error type E11 means one bad symbol was corrected in the C1 stage. E21 means two bad symbols were corrected in the C1 stage. E31 means that there were three or more bad symbols at the C1 stage. This block is uncorrectable at the C1 stage, and is passed to the C2 stage. Because of the de-interleaving of the data between the stages, those three (or more) bad symbols are now in separate blocks, and so can be corrected by the C2 stage. Because of the interleaving, one uncorrectable symbol at the C1 stage can be turned into as much as 28 bad symbols at the C2 stage. This is why E12 is typically much larger than E31.

E12 means one bad symbol was corrected in the C2 stage and E22 means two bad symbols were corrected in the C2 stage. E32 means that there were three or more bad symbols in one block at the C2 stage, and therefore this error in not correctable.

BLER (Block Error Rate) is defined as the number of data blocks per second that contain detectable errors, at the input of the C1 decoder. This is the most general measurement of the quality of a disc. The “Red Book” specification (IEC 908) calls for a maximum BLER of 220 per second averaged over ten seconds. Discs with higher BLER are likely to produce uncorrectable errors. Nowadays, the best discs have average BLER below 10. A low BLER shows that the system as a whole is performing well, and the pit geometry is good.

However, BLER only tells you how many errors were generated per second, it doesn’t tell you anything about the severity of those errors. Therefore, it is important to look at all the different *types* of errors generated. Just because a disc has a low BLER, doesn’t mean the disc is good. For instance, it is quite possible for a disc to have a low BLER, but have many uncorrectable errors due to local defects. The smaller errors that are correctable in the C1 decoder are considered random errors. Larger errors like E22 and

E32 are considered burst errors and are generally caused by local defects. As you might imagine, the sequence E11, E21, E31, E12, E22, E32 represents errors of increasing severity.

WHY E32 IS CONSIDERED UNCORRECTABLE

Although it is possible under some circumstances to correct up to four bad symbols at the second stage, not all players can do this. Until recently, most players could only correct two bad symbols at the C2 stage. For these players, E32 would be uncorrectable. In order to have a high probability of a disc working in any drive, we consider E32 an uncorrectable error, even though some drives may be able to correct it.

This is also the rationale for not allowing E22 or E32 errors on a CD-ROM. The earliest generation of CD players could only correct one bad symbol at the C2 stage. As a result, an E22 error (two bad symbols at the second stage) would be uncorrectable on these drives. In order to have the highest confidence in a data disc, it should have no E22 or E32 errors. Also, keep in mind that this requirement is for new discs, as made. Obviously, the quality will degrade with use and age. Making discs with E22 or E32 errors does not leave adequate margin for future degradation. This is not an onerous requirement, because with modern equipment, there is no reason to make discs with E22 or E32 errors.

In order to work properly, the pits on the disc must have a certain size and shape. There are specifications for pit length, depth, and width, but you would need an electron microscope to measure them! Pit geometry can be measured indirectly by looking at signals like I_{11}, I_3, push-pull, and asymmetry.

Disc performance can only be measured by playing the disc. Unfortunately, when you measure discs by playing them back, you are measuring the performance of the player as well as the disc! As a result, it is quite possible for discs that measure good to have problems playing on certain players. Similarly, discs that measure badly may work fine on other players, and even measure differently on other analyzers. Different players are variously sensitive to different parameters such as asymmetry and tracking.

ERRORS ARE NOT 'THINGS'

Please remember that an error on a disc is not a physical thing. It is a manifestation of how well the total system (disc + player) is working. The disc itself does not have an error rate; *playing* the disc *produces* errors.

Ideally, what you want is a disc that will play back on ALL players with a low error rate. Unfortunately, there are no standards for players, only for the discs. Therefore, each type of player will give different results.

INTERPRETING HF SIGNALS

If a disc is found that won't play or gives poor results, yet plays on another player OK, there is almost certainly something wrong with that disc. Compatibility with all players can best be assured by making sure that the pit geometry is close to optimum. Also see the section DISC GRADING SYSTEM (pg. 12) above.

I11

This is a measure of overall signal strength. Too small of a signal makes it difficult to decode. I11 is primarily affected by pit depth and width. As a rule, bigger I11 is better, and will generally produce lower error rates.

I3

Represents the shortest pits and lands, and is the highest frequency part of the signal. I3 is always smaller than I11 because the smallest pits are at the limit of resolution of the optics. Low I3 can be caused by pits that are too small. Lower writing speed (higher capacity discs) will make the pits shorter, and I3 lower. Again, larger I3 is better, up to a point. Minimum allowed is 0.30, and maximum is 0.60.

Asym & Beta

This is a function of the writing power of the laser during glass mastering (or writing a CD-R). Higher laser power produces more negative asymmetry. Some negative asymmetry is desirable, with optimum of -5% to -10%. The maximum allowed is +5% to -15%. CD-Recordable discs with low I3 and positive asymmetry are often found to give unreliable results.

MAINTENANCE AND SERVICE

Ordinarily, there are no adjustments or maintenance required. If you need repairs, send the CDX to us. Call us for help in diagnosing the problem, and to get a return authorization and shipping instructions.

Please save the original shipping carton and packing materials in case you need to ship it for any reason. If you are unable to save the original shipping materials, you must wrap the CDX in at least 3" of bubble-pak or foam rubber before shipping.

Service Contacts:

Tel: +1 949.582.8010
Fax: +1 949.582.1016
Email: service@cloversystems.com
Web: http://www.cloversystems.com

COMMUNICATIONS PROBLEMS

Your COM port will be set to the correct protocol automatically by the CDX program. It is not necessary to change the serial port settings in the Windows Control Panel.

Some BIOS's do not support COM3 or COM4. You can tell if your BIOS supports COM3 & COM4 by inspecting memory locations E0:0 through E0:07 using the MS-DOS DEBUG program. These bytes should contain the I/O addresses of the COM ports installed in your computer. The first four bytes should contain F8 03 F8 02, which are I/O addresses 03F8 (COM1) and 02F8 (COM2). Note that the high byte of a word is stored at the lower address location. If you have COM3 and COM4 installed, their I/O addresses will appear in the next four bytes. If these bytes are set to zero, then you must change them to the I/O address of your COM port. You can do this by manually editing the data using DEBUG's Edit command, or you can use the DEBUG script file included with CDX.

A software patch is supplied with CDX in case you have this problem. It is a script file that works with the MS-DOS DEBUG program, and is called FIXCOM.SCR. If you encounter this problem, add the following line to your AUTOEXEC.BAT file: DEBUG < C:\CLOVER\FIXCOM.SCR. This will set the BIOS memory locations to the default values for COM3 and COM4. If you need to use addresses different than the default values, you can edit this file.

CDX QUALIFICATION DISCS

Supplied with your unit are two discs; a "good" disc, and a disc with known defects. Both discs are provided with measured results from your CDX before it left the factory. To confirm that your system is operating properly, test both discs at 1X and compare the results with the results we have provided. If the results are significantly different, there may be a problem with the system. Obviously, dirt, dust, and scratches will affect your results, so you should be careful to avoid damaging these discs.

Disc 6E is an ordinary disc that is known to have very low error rates. Playing this disc will confirm that the unit is capable of generating low error rates. Many subtle problems with the player can be detected using this disc.

The other disc supplied is Philips test disc SBC444A. This disc has built-in defects that can be used for checking error rates. In addition to providing known errors, it tests the player under maximum stress.

On disc SBC 444A, certain results may not be perfectly repeatable because the disc stresses the player to its limits. For instance, the number of E32 errors generated by the Black Spots in particular may vary. This is because these errors are "soft errors." That is, they are caused by disturbance to the player's servo systems, rather than loss of data. Each time the disc is played, the disturbance is slightly different, and the results cannot be predicted.

Disc SBC 444A provides two kinds of defects: Missing information, and black spots. The tracks with missing information should provide fairly repeatable results since these errors are encoded into the data. The sections with Black Spots have the information in tact, but obscured by the black spots. In this case, not only is there information lost, but the servomechanisms are stressed. For example, when the readout beam encounters the black spot, focus, track following, and clock recovery servo signals disappear. After the beam has passed the black spot and the signal is restored, the pickup is out of focus, off track, and the bit clock is at the wrong frequency. This causes many additional errors to be generated in an unpredictable way.

Test results for disc SBC 444A are provided in the form of graphs for the whole disc. The test data is included on the CDX floppy disk. You can play selected tracks of the disc and compare your results with the charts. You can see the ATIME at which various events occur on the charts, then figure out which track that corresponds to by referring to the included Table of Contents.

It is not always necessary to test the entire discs. Regular checks of the system can consist of playing the first minute of the "good" disc, and track 17 of SBC 444A. These quick tests confirm that the system is capable of producing low error rates on a good disc, and can also play a disc with large defects.

Please note that error rates may be higher at faster speeds. In general, error rates on good discs will be about the same at higher speeds as at 1X. Small errors such as E11 & E21 will not be affected much. Burst errors, on the other hand, will be greatly affected. Most burst errors (E22 & E32) are caused by disturbances to the servo systems, rather than missing data. This effect is greatly magnified at high speed.