



DVXTM



DVD / CD ANALYZER

OPERATING MANUAL

Version 3.1

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INTRODUCTION

The Clover Systems DVX is an affordable high-speed tool to quantitatively measure the quality of DVD and CD discs. It will analyze DVD discs at up to 16X, and CDs at up to 48X. The exclusive QuickScan feature further reduces test time by up to 10 times.

DVX measures disc quality by examining the quantity and severity of errors generated during playback. It can also automatically measure Beta and Jitter. It provides the capability to measure additional signal parameters related to pit geometry, such as modulation (I_{14} / I_{14H}), resolution (I_3 / I_{14}), I_{11} / I_{top} , I_3 / I_{top} , asymmetry, and reflectivity using the optional Analog Measurement Module AMM-1. Together, this information provides a thorough analysis of disc quality. Also see the section titled [INTERPRETING THE RESULTS](#) on pg. 41.

DVX can perform various format-checking tests on data discs, and do bit-for-bit data comparison on all types of DVDs and CDs.

On CDs, DVX automatically measures and displays BLER (Block Error Rate), E11, E21, E31, E12, E22, and E32 (uncorrectable errors)¹. 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.

On DVDs, DVX measures and displays PI bytes, PO bytes, PIE, POE, PIF, POF, and UNCR (uncorrectable blocks). In addition to peak and average values, the total number of each type of error is also displayed.

DVX also can measure Beta, plus Focus Error and Tracking Error on both DVDs and CDs, as well as Jitter on DVDs.

The built in grading system assigns a quality grade (A-F) based on the results of the test.

The DVX software is a Windows program that will run under Windows 2000/XP/Vista. It gathers data from the DVX, and displays the data in the form of charts and statistics for the whole disc, and prints a summary of the results.

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.

¹ See [HUncorrectableH](#) on Pg. 42



INSTALLATION

The DVX is set up and used just like an ordinary DVD-ROM drive. The I/O panel installs in an unused expansion slot.

HARDWARE INSTALLATION

IDE / ATAPI Version

Drive Configuration

First set the jumpers on the rear of the drive. DVX should be set for Master, and connected to a separate dedicated IDE channel.

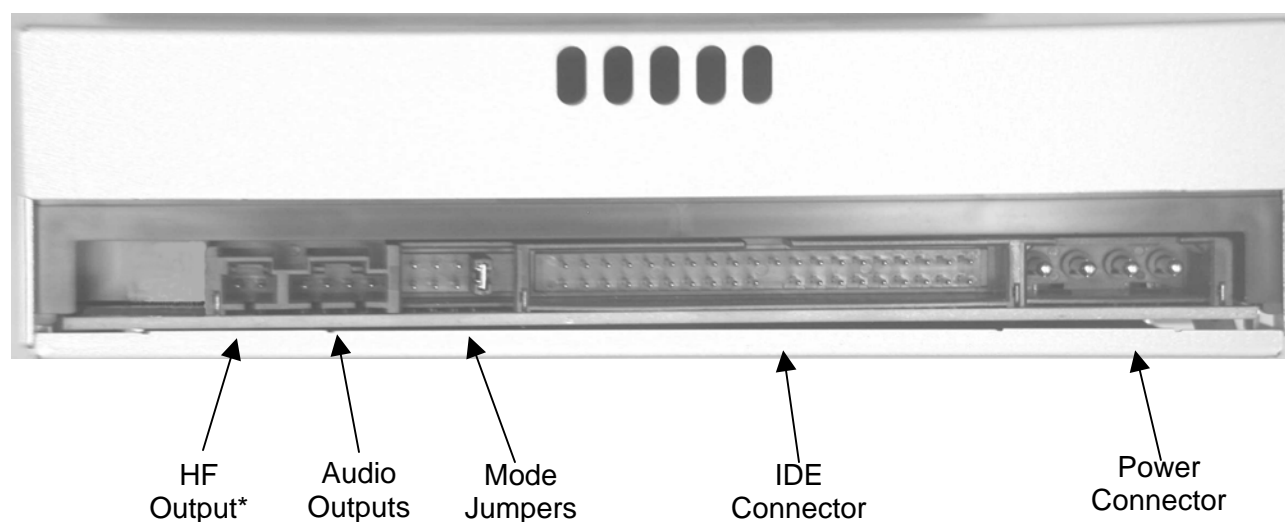


Fig. 1 - Rear Panel Connections

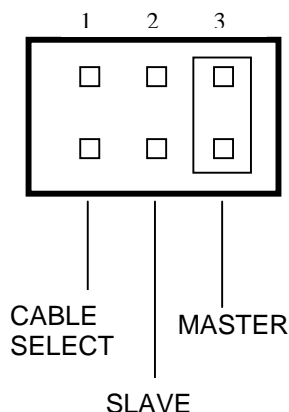


Fig. 2 - Jumper Settings

Jumper Settings

DVX is factory set to Master mode. This is the preferred configuration, and will work in most situations. In this case, DVX must be either the only drive on the cable, or if two drives are connected to the cable, DVX must be at the end of the cable, and the other drive must be configured as Slave.

Connecting the Cable

Be sure to use the supplied 80-conductor cable. A 40-conductor cable may work, but performance will be compromised. Connect the blue plug of the cable to the motherboard IDE socket. Connect the other end of the cable to the DVX drive in the same way. If DVX is the only device, be sure that it is connected to the end of the cable, not the middle connector.

Serial ATA Version

The SATA drive has no jumpers to configure. Just connect the included SATA cable from the drive to the motherboard. Also included is a SATA power adapter in case your PC does not already have the correct power connectors.

USB Version

Connect the provided USB cable to the DVX rear panel and any USB port on the PC.

DVX SOFTWARE INSTALLATION

Once you have the DVX drive installed and running, load the DVX Installation and Qualification CD into the drive. If the installation does not start automatically, select *Start / Run* from the Start Menu, and enter “D:SETUP”, where “D” is the drive letter of your DVD/CD-ROM drive. Alternatively, you can double-click on SETUP.EXE in Windows Explorer. Then just follow the instructions on the screen. The DVX software requires about 8 MB of free disk space to install, and 25 MB of free RAM to run.

A CLOVER SYSTEMS folder will be added to the Start | Programs menu and a shortcut is added to your desktop. A DVX DATA folder will be added to the MY DOCUMENTS folder, where DVX results data will be saved.

ASPI Manager

ASPI Manager (Advanced SCSI Programming Interface) is required for DVX to run. This program will be automatically installed by the setup program. If you have another version of ASPI installed, the installation will overwrite it.

Spreadsheet Files

Spreadsheet files are also installed in your MY DOCUMENTS | DVX DATA folder. These files are appended when the Append to Spreadsheet feature is used. The files installed contain only the column headings.

If you re-install the software, these files will not be overwritten, in order to preserve your data. If you are updating from an earlier version that has different headings, rename your two spreadsheet files so that the newest version will be installed.

Two sets of spreadsheet files are included: One set for Excel format, and one set for Lotus 1-2-3 format. Excel format is the default, but you can make it use Lotus format by using a command line switch “/L”. See [Saving Results to Spreadsheet](#) on Pg. 19 for details.

Running DVX with Foreign Language Windows

When running DVX with a foreign language version of Microsoft Windows, you may need to use the command line switch “/W”. This will compensate for the different width of some non-roman characters, and make the main window the correct size. If you do not use this switch, the main window will be initialized to the wrong size.

To start DVX with the “/W” command line switch, do this: After installing the DVX software, delete the shortcut that is created on the desktop. Go to the Clover Systems folder, and create a new shortcut to DVX.EXE on the desktop. Now right-click on the shortcut and select Properties.

In the *Target* edit box, add “/W” (without the quotes) to the end of the target specification. The Target specification should now look like this: “C:\Program Files\Clover Systems\DVX.exe” /W

Note that the “/W” is outside the quotation marks and there is a space between the quote and /W.



Now, when you run DVX from the desktop shortcut, it will size the main window correctly.

ANALOG MEASUREMENT MODULE INSTALLATION

The Analog Measurement Module (AMM-1) is an optional tool to expand the testing capabilities of your DVX. The AMM-1 helps evaluate disc quality by automatically measuring parameters such as reflectivity, Beta, I_3/I_{top} , I_{11}/I_{top} , Modulation (I_{14}/I_{14H}), and Resolution (I_3/I_{14}), Tracking Error, Focus Error, and displaying the data in the DVX software. Together with analyzing playback errors, this information provides a thorough analysis of disc quality.

I/O Panel Installation

When ordered with the AMM-1, DVX includes an output panel that provides a connector for the HF output, which can be connected to the AMM-1 Analog Measurement Module, or other measurement equipment. Install the DVX I/O panel in an open slot. Connect the panel coaxial cable to the 2-pin connector on the rear of the DVX. When making HF measurements, the I/O panel must be grounded to the PC chassis.

The AMM-1 connects to the HF output of the DVX I/O panel with a coaxial BNC cable, and uses a USB port to communicate with the PC. The DVX software automatically gathers data from the AMM-1 and displays the data as statistics and easy to read charts. Summary of the data, along with the charts can be printed and/or easily saved to disk for future use.

There are two connectors on the AMM-1, one is a BNC connector, the other a USB connector. Connect the USB connector to any available USB port on the back of the PC with the cable provided, and connect the BNC connector to the I/O panel of DVX labeled “HF OUT” with the provided coaxial cable. The AMM-1 is powered by the USB port.

The DVX software (and AMM-1 driver) should be installed before attaching AMM-1 to a USB port, otherwise the AMM-1 driver will not be found. After connection to the USB port, you should receive a “New Hardware Found” message from the operating system, and the AMM-1 driver should install automatically.

Before using the AMM-1, you will need to set the calibration values as described in the [Calibration](#) section of this manual on page 7.

DUAL DVX INSTALLATION

Two DVX drives can be installed in one PC and operate simultaneously. Each DVX should be configured as Master, on it's own IDE channel, using two separate 80-conductor cables. Operating two DVX's as Master and Slave on one cable will work, but may compromise performance, depending on the speed of your PC.

Installing the Software

If you bought a dual DVX system, select the Dual DVX radio button in the installation dialog.

To run two DVX's simultaneously, two instances of the program are run at the same time. The first instance is the normal DVX software, and the other instance is a program named DVX2. If you choose the dual installation, an additional shortcut will be added to the desktop that will launch both DVX and DVX2. DVX.EXE will attach to the first DVX (lowest drive letter), and DVX2 will attach to the other. If you have monitor resolution higher than 800 x 600, you can arrange the two windows on the screen so that you can easily switch back and forth. If your screen resolution is 800 x 600, each instance will fill the screen, but you can easily switch back & forth by clicking the icons in the task bar at the bottom of the screen.

You must setup each instance separately using the *Preferences...* selection in the main menu.

DRIVE SETTINGS

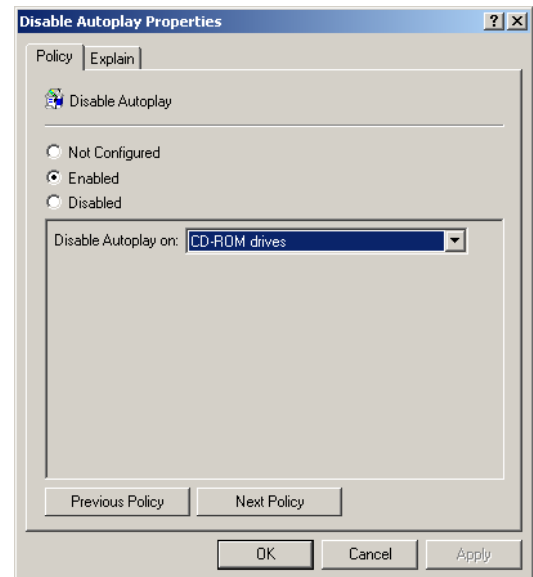
Note: Failure to set these properly may prevent DVX from working!

Autoplay (Auto Insert Notification) must be disabled in order to prevent other programs from running and conflicting with DVX!

Disabling AutoPlay in Windows 2000

In Windows 2000, the automatic running of programs is called AutoPlay. The DVX installation will automatically disable AutoPlay. If you need to disable AutoPlay manually, select *Run* from the Start Menu. Type GPEDIT.MSC and click OK. Navigate to Computer Configuration \ Administrative Templates \ System. Double-click “Disable Autoplay” in the list box. Select the Enabled radio button, and select CD-ROM Drives in the list. Press OK.

This will prevent programs on a data disc from running. However, you also need to disable the CD Player program, to prevent it from playing an audio disc when inserted. To disable CD Player, Open My Computer, then select the *Tools / Folder Options* menu. Select the File Types tab in the dialog, and select CD Audio Track from the list of Registered File Types. Press the Advanced button, then select the Actions tab. Click in the list box, but not on “play”. Then press the Set Default button. This will set the default action to “nothing.” If play is set to the default action, it will appear in bold.



Disabling AutoPlay in Windows XP / Vista / 7

The DVX installation will automatically disable Autoplay in Windows XP / Vista. If you need to do this manually, run the Registry Editor (regedt32) from the Start | Run menu. Navigate to HKEY_CURRENT_USER \ Software \ Microsoft \ Windows \ CurrentVersion \ Policies \ Explorer, and change the value “NoDriveTypeAutoRun” to B1 hex.

DMA Settings

DVX drives with ATAPI (IDE) interface can suffer from a Windows problem that disables the drive’s DMA transfer mode. For maximum performance, the IDE channel connected to the DVX drive should be set for DMA mode. This allows the drive to operate at full speed without using any processor resources. It is reported that several circumstances can cause Windows to disable DMA mode, and revert to PIO (Programmed I/O) mode. These apparently include things like excessive DMA errors causing timeouts. This can happen when testing discs that are severely damaged, or otherwise unreadable.

Fig. 3 - Disable Autoplay

Depending on the speed of your processor, you may experience a drastic reduction in test speed. With a fast processor, you may not experience any reduction in test speed, but you will slow the processor down enough that other tasks become sluggish. You can see if DVX is using processor resources by running Windows Task Manager. You can also view the ATAPI controller properties in Device Manager / IDE ATA/ATAPI controllers. Transfer mode should be set to “DMA if available”, and Current Transfer Mode should be “Ultra DMA n” DVX is capable of running in Ultra DMA modes 0-4. The actual mode (n) will depend on the capabilities of your motherboard, and is unimportant.

One would expect that Windows would restore the DMA mode after a re-boot or after changing the settings in Device Manager, but it does not. To restore DMA mode, you will have to do one of the following:

- Run the Visual Basic Script RESETDMA.VBS which is installed in the Clover Systems program files folder, then re-boot.
- You can edit the Registry manually:

Run REGEDIT. Go to the following key:

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Class\{4D36E96A-E325-11CE-BFC1-08002BE10318}

It has subkeys like 0000, 0001, 0002, etc. Normally 0001 is the primary IDE channel, 0002 the secondary, but other numbers can occur under certain circumstances. You have to go through these subkeys and check the DriverDesc value until you find the proper IDE channel.

Delete MasterIdDataChecksum or SlaveIdDataChecksum, depending on whether the device in question is attached as master or slave, but it can’t actually hurt to delete both. Reboot. The drive DMA capabilities will be redetected.



Open Device Manager again and check whether the device is now actually using DMA mode. If not, you may have to change the IDE channel setting from PIO back to the highest available DMA mode and reboot again.

Drive Speed Settings in DVX Software

Select *Preferences...* in the main menu. A property sheet will appear that allows you to specify the speed of the drive for both DVD and CD discs.

Test Speed

For CD discs, you can select 4, 8, 24, 32, 40, or 48 from the drop-down list. For DVD discs, you can select 2, 5, 8, 12, or 16 from the drop-down list. You can change the test speed at any time using this property sheet. The two lowest speeds are CLV (Constant Linear Velocity). All other speeds are CAV (Constant Angular Velocity), which means that the disc spins at a constant speed. Since the circumference at the outside is twice as large as at the inside, the transfer rate at 24X CAV is 10X at the inside, and 24X at the outside (average 17X). At the 40X setting, the actual speed is 17X at the inside, and 40X at the outside (average 30X).

QuickScan™

DVX includes a feature that greatly increases the speed of disc testing. When QuickScan is enabled, the speed of the test is increased by about 3½ times for CDs, and 10 times for DVDs. 48X test speed on a CD then becomes effectively 168X, and 16X DVD test speed becomes 160X. QuickScan™ increases the speed of both error tests and Analog tests. See the description of QuickScan below and the [TestTimes](#) table on pg. 57.

There are some speed limitations for both CDs and DVD discs:

1. Only single layer molded DVDs will run at 16X.
2. DVD±R and DVD±RW discs have a maximum speed of 12X CAV.
3. DVD+R DL has a maximum speed of 8X CAV.
4. The Analog and Beta / Jitter tests run only at 4X speed on CDs, and 2X speed on DVDs.
5. In all cases, if the speed is set higher than the maximum possible for a given test, the speed will be set to the maximum allowed during the test. No user intervention is required.

CALIBRATION

Your DVX analog measurements have been calibrated at the factory, using Philips Single Layer DVD Signal Disc, Philips DVD+R Signal Disc, Philips BH-1 CD, and Philips JT-1 CD. If your DVX includes the AMM-1, calibration also includes ABEX Low Reflection CD, and ABEX Low Reflection DVD. If you purchased DVX with a PC or AutoLoader, the calibration constants have already been entered into the software, and you needn't do anything further. If you are installing DVX in your own PC, you will need to enter the calibration constants into the software.

The required calibration constants are written on the DVX Final Test sheet that is included in the back of this manual. Select *Preferences...* from the main menu, and select the *Analog Calibration* tab. Enter the values from the test form in the corresponding edit boxes, then press OK (see figure below).

If you do not have the AMM-1, you will only need to enter calibration constants for Beta and Jitter.

If you have the AMM-1, please refer to the [Analog Measurement Module](#) section on page 36.

The default password for the calibration settings is “Clover”. The password is case sensitive.

CD		DVD	
	Offset		Gain
REF	3.32	REF	1.5
I11	-0.025	I11	0.538
I3	0.073	I3	0.462
Beta	-4.78	Beta	1.374
Jitter	84.6	Jitter	0.332
TE	10.0	TE	1.0
FE	-7.0	FE	0.5

DVD		Automation	
	Offset		Gain
REF	-0.53	REF	2.05
MOD	0.435	MOD	0.261
RES	-0.2	RES	2.40
Beta	-3.1	Beta	1.46
Jitter	19.6	Jitter	0.523
TE	25	TE	1.10
FE	20	FE	0.54

Enter values from test sheet

OK Cancel Apply

Fig. 4 - Entering Calibration Constants

USING DVX

THE MAIN WINDOW

The main window displays information about the disc, a summary of all error rates, charts of each type of CIRC error, and results of all tests. You can print any window by activating it, then clicking the printer icon in the toolbar, or selecting *File / Print* in the menu.

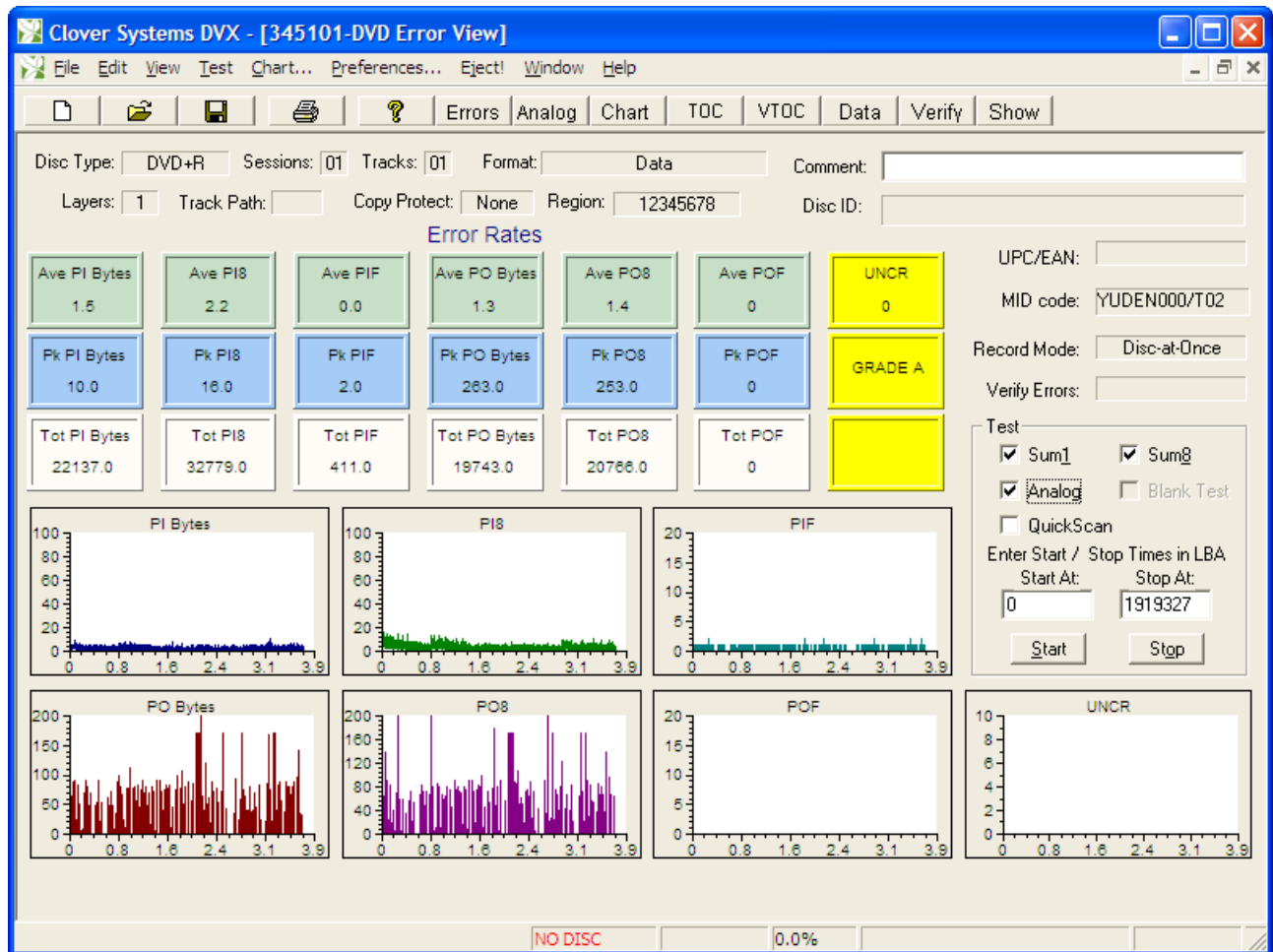


Fig. 5 - DVX Main Window

Disc Information

Disc Type

For CDs, this can be CD-DA, CD-ROM, CD-R, or CD-RW. In the case of CD-R or CD-RW discs, the disc capacity is also shown in minutes, i.e., 63, 74, 80, etc.

For DVDs, this can be DVD-ROM, DVD-R, DVD-RW, DVD+RW, DVD+R, or DVD+R DL.

Number of Sessions

The number of complete sessions on the disc. Each session consists of a lead-in, program area consisting of up to 99 tracks (DVDs have only one track), and lead-out.

Number of Tracks

The total number of tracks on the disc, including all sessions.

Format

The format of the data on the disc. It can be one of the following:

CDs --

- Blank
- Audio
- Enhanced CD
- Mode 1 Data
- Mode 2 Data
- Mixed Mode
- Multi-Session Audio
- Multi-Session Data
- CD-I

DVDs --

- Blank
- Video
- Data

In addition, Mode 1 Data discs and Mode 2 Data discs can be further qualified with the extensions ISO9660, Joliet, HFS, or Rockridge.

Mixed Mode discs have both audio and data tracks. Multi-Session discs are formatted as if they were two separate discs. CD-Enhanced discs have one session with audio tracks, and a second session with data tracks.

Disc ID

The Disc ID edit box in the main window is provided for the user to enter some name, work order, comment, or other means of identifying this disc. If the disc has a volume descriptor, the Volume ID will be entered in the Disc ID field automatically. You can overwrite this if you wish. The Disc ID will be saved with the test results and printed on the various reports.

Block Size

The number of user bytes in each sector of a data disc. This can vary, depending on the format of the disc. Audio discs have no sectors, so in this case it shows the number of bytes in a subcode frame, which is the same size as a sector on a data disc.

UPC/EAN Code

Universal Product Code; usually implemented as bar code on a package, it can also be encoded into the disc Table of Contents.

MID code

This is the manufacturers identification code. It is embedded in recordable media to identify the manufacturer of the media.

Record Mode

The possible modes are: Disc-at-Once, Track-at-Once, Session-at-Once, Fixed Packet, Variable Packet, Not Tested, and Unknown. Disc-at-Once means that the disc was written from start of lead-in to end of lead-out without any write splices. Track-at-Once means that the disc has write splices at the start and end of each track. Packet mode means the disc was written incrementally, with write splices between each packet. The size of the packets can be variable or fixed. This information is useful for evaluating masters that will be used for duplication or replication. Only Disc-at-Once masters can be made into a glass master for replication. Also, Track-at-Once recording may cause clicks or pops



between songs. Incrementally written discs will have write splices between each packet, which can generate many uncorrectable errors. This makes it difficult to evaluate the quality of an incrementally written disc.

This feature will only work for data discs. Audio discs do not use link blocks or track descriptor blocks, and so it is not possible to detect write splices. The write mode will be displayed as “Unknown” for audio discs.

When “Get Write Mode” is turned on in the Options Property Sheet, the write mode of the disc will be displayed in the Disc Info dialog. This feature can be turned off by clearing the checkbox in the Options dialog.

Test Results

The main window shows a summary of all error rates, over-range alarms (Pass / Fail status), and disc Grade.

Error Rates

Error rate data is displayed in two ways: The average and peak values (over the whole disc) are displayed, as well as totals for E22, and total E32 errors on CDs and for all DVD error types. Each error type is also shown in a graph in the main window.

One-Second and Ten-Second Averaging (CDs Only)

When the player is testing, it will send all error parameters to DVX once every second of program time. All CD data displayed in DVX 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. The DVX main window displays both 1-second and 10-second peak values.

Sum1 and Sum8 Reporting (DVDs Only)

By convention, some DVD errors are reported per 1 ECC block, and others are reported for 8 ECC blocks. PI bytes and PO Bytes are always reported per 1 ECC block. PIE and POE errors are counted per 8 ECC blocks. PIF and POF errors are counted per 1 ECC block.

Pass / Fail Indication

If any of these error values goes over a user selectable limit, the indicator will turn red. This provides a simple Pass / Fail indication of test results.

Grade

A letter grade A – D, or F is assigned according to the test results. This provides a simple quantitative result without having to deal with the detailed results. The criteria for the grading systems are explained in the section [DISC GRADING SYSTEM](#) on pg. 21.

Subcode Skew (CD Data Discs Only)

This shows the results of the Subcode Skew test. The Q-channel subcode on a disc contains time code, called Atime, which is used for rapid locating of specific places. This time code should be identical to the sector address contained in the sector header of a data disc. 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 the header address. Negative skew means the Atime is less than the header address. This test applies only to data discs, as audio discs have no sector headers. DVD discs have no subcode, so this does not apply.

Postgap (CD Data Discs Only)

Shows the results of the Postgap test. The last track on a disc must be followed by a Postgap. The Postgap contains all zeros (or digital silence). A minimum of 150 sectors is required.

Verify

Shows the results of the Verify Disc or Verify File test. This is the total number of bytes that did not compare, or PASS or FAIL if the Validate Clover Signature test was performed.

Test Controls

Start At / Stop At

Sets the start and stop points for the CIRC, PIPO, Beta/Jitter, and Verify tests. This allows you to test only portions of a disc. Default values are the begin and end of the information area. For CDs, you can enter new values in Minutes, Seconds, and Frames, or Physical Sectors². For DVD discs, enter Logical Block Address.

Start Button

Starts the error and/or analog tests.

Stop Button

Stops the current test in progress.

MSF Button (CD Only)

Causes the START and STOP points to be displayed and entered in Minutes, Seconds, and Frames.

Sectors Button (CD Only)

Causes the START and STOP points to be displayed and entered in Physical Sectors (see [Logical Blocks and Sectors](#) pg. 12).

Sum1, Sum8 Checkboxes (DVD Only)

These checkboxes select which tests are performed when you press START. All of the tests selected will be performed in sequence. To measure all error rates, select Sum1 and Sum8. If you also want to perform the analog test, check Analog also. If both tests are selected, they will be performed in the order: Sum8, then Sum1.

Analog Checkbox

If checked, will cause the Analog test to be automatically performed after the error tests. If AMM-1 is not installed, only Beta and Jitter will be measured. Test speed is automatically set to 4X (CD) or 2X (DVD).

Analog Only Checkbox (CDs Only)

If checked, only the Analog test will be performed. This checkbox does not appear in the DVD view, because only the analog test will be performed if the Analog box is checked and Sum1 or Sum8 are not checked.

Blank Test Checkbox

Only applicable when a blank disc is in the drive. Performs Focus and Tracking Error tests, which can only be measured on a blank disc.

QuickScan™

When checked, the test time is reduced by about 3½ times for CDs and 10 times for DVDs. 48X test speed on a CD then becomes effectively 168X, and 16X DVD test speed becomes 160X. See the [QuickScan](#) section on page 7.

The Status Bar

The status bar at the bottom of the main window shows the drive status, drive speed, and progress of the current test. The status bar can be viewed or hidden by checking or un-checking *View | Status Bar* in the main menu.

² See [HLogical Blocks and SectorsH](#) on pg. 12

The drive status shows what the DVX drive is doing at all times. When QuickScan is enabled, “QS” is appended to the current drive speed indicator.

DISPLAYING ADDITIONAL DISC INFORMATION

Table of Contents

CD Discs

This shows the starting time (or physical sector number) for each track, the track length, the track type, copy permit status, and ISRC codes for audio tracks. You can display the Start and Length times in MSF (Minutes, Seconds, Frames) or physical sector number format.

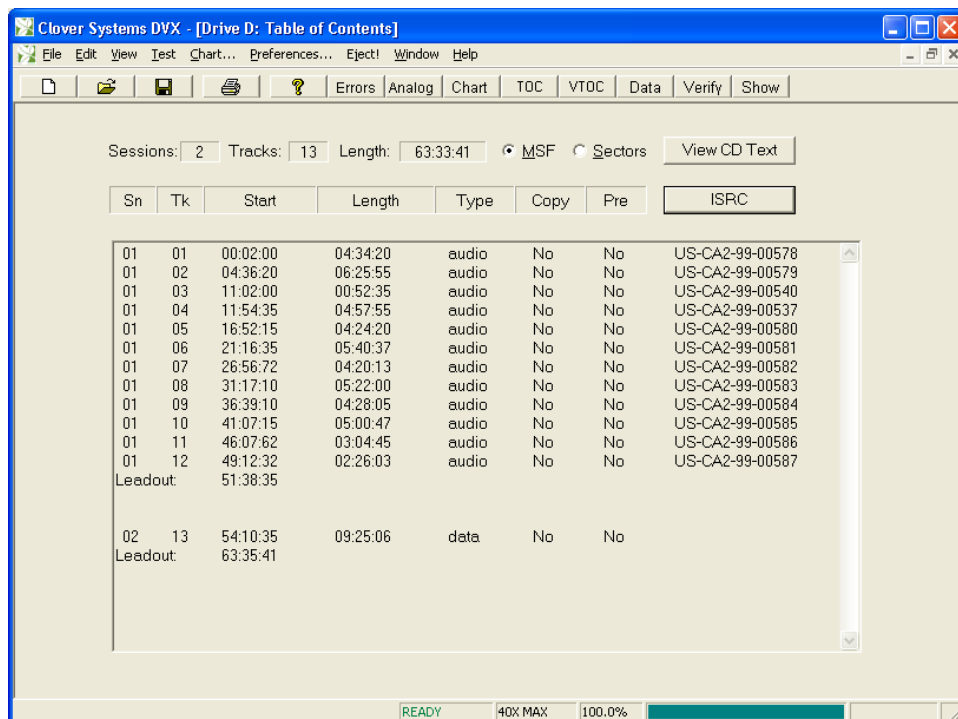


Fig. 6 – CD Table of Contents

DVD Discs

DVD discs have only one track plus leadout, per session. Start times are shown as Logical Block Addresses.

ISRC Codes

Clicking the *ISRC* button in the Table of Contents view will get and display the ISRC codes if present. This applies to audio, video, and CD Enhanced 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 (or video) selection itself, so DVX must scan each music track or video file to read the codes.

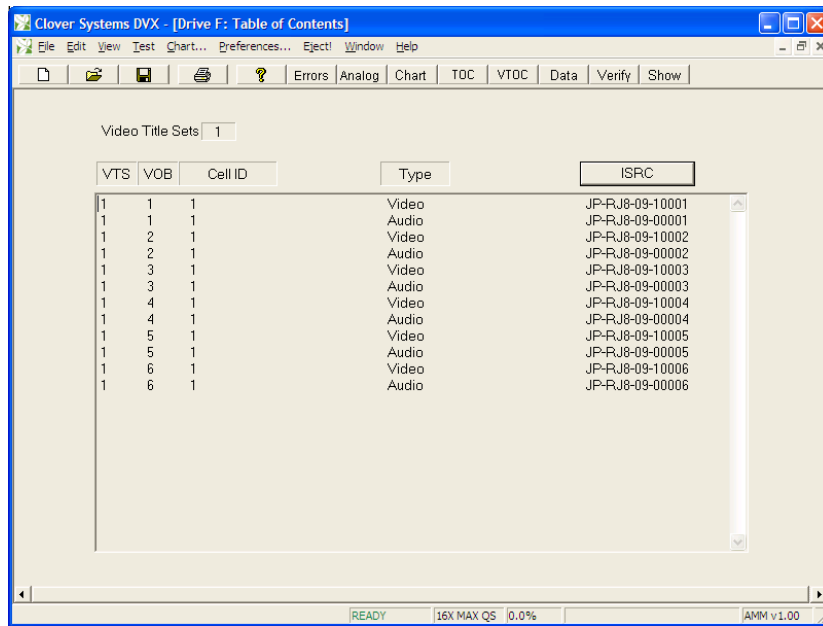


Fig. 7 – ISRC on DVD

CD Text

Pressing the View CD Text button in the Table of Contents view will display the CD Text that is recorded on the disc. This information can be printed using the print button in the toolbar, or *File / Print* in the main menu. Results can be printed to a PDF or text file using the appropriate PDF or text print driver.

In addition, the data can be exported to an Excel spreadsheet by selecting the Export button. CD Text will be appended to the Excel spreadsheet file CDText.xls in your *My Documents / DVX Data* folder.

- CD Text can then be formatted or exported to other applications.
- Current data will be added to the end of the spreadsheet. Therefore, if you want the data to start at row 2, you must delete any previous data. Use the delete command, rather than clear. Clearing the data does not remove the existing cells, it just empties them.
- You can delete any previous data in the file, but **do not delete the first row**, which contains the column headers. This header row must be present for the export to work.
- The file “CDText.xls” must exist in your *My Documents / DVX Data* folder for export to work.
- The Excel spreadsheet file “CDText.xls” must be closed at the time of export.

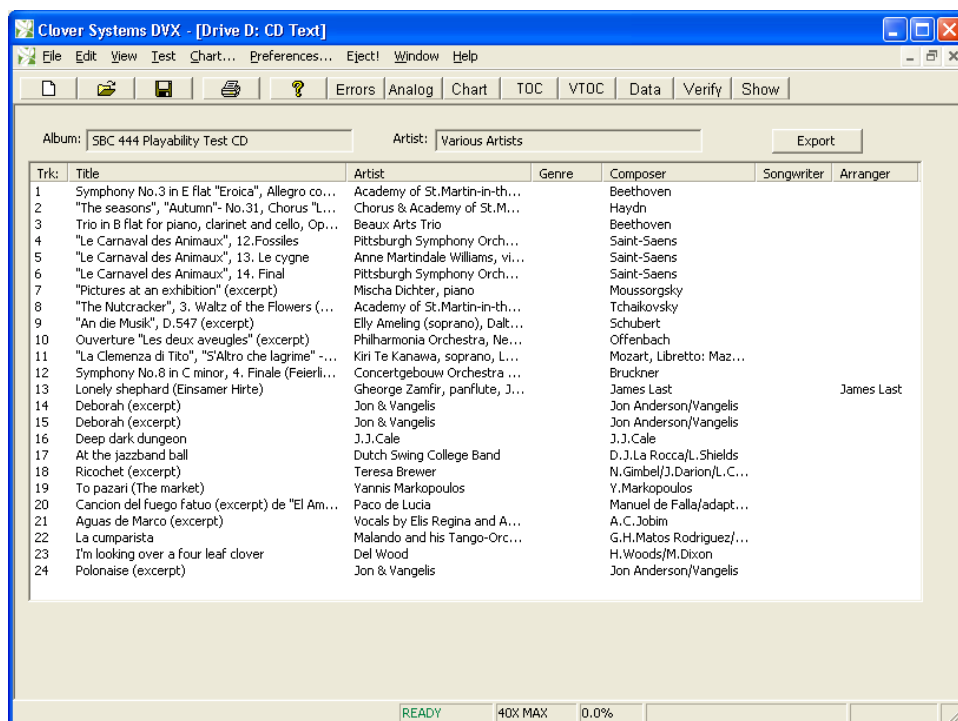


Fig. 8 – CD Text

Volume Descriptors

Selecting *Vol Desc* in the View menu (or VTOC button in the toolbar) will display the disc volume descriptors (all disc types except CD-DA). In addition to the primary volume descriptor, you can display the supplementary volume descriptor if the disc has one.

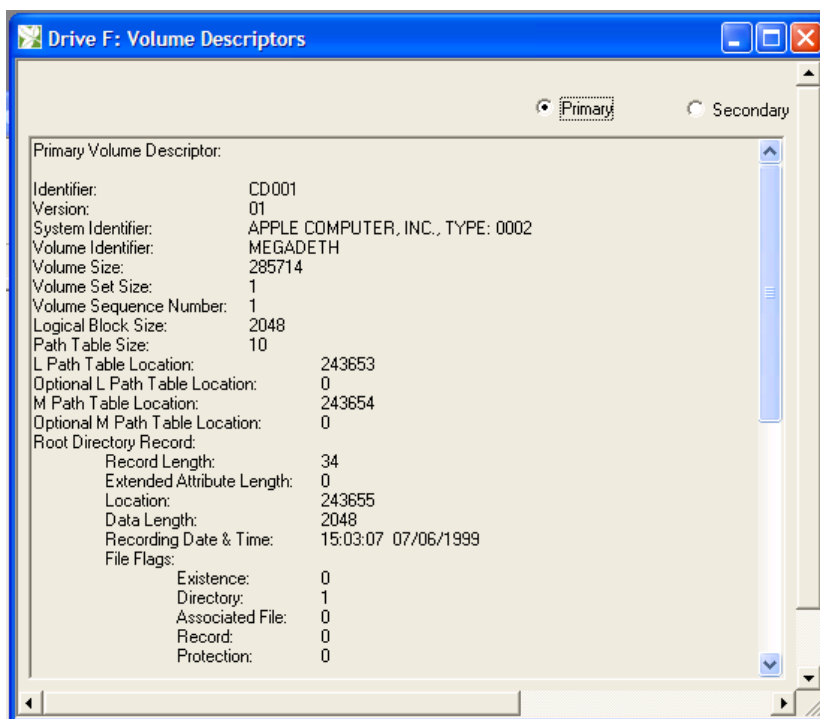


Fig. 9 - Volume Descriptor

Summary of Results

View | Summary opens the Summary view. This shows a complete summary of all test results. The summary can be printed by selecting *File | Print* in the main menu, or clicking the print icon in the toolbar. See [samples](#) on pg. 32.

SETTING OPTIONS

Drive Speed

Select *Preferences...* in the main menu. A property sheet will appear that allows you to specify the speed of the drive for both DVD and CD tests, and other options.

For CD discs, you can select 4, 8, 24, 32, 40, or 48 from the drop-down list. For DVD discs, you can select 2, 5, 8, 12, or 16 from the drop-down list. You can change the test speed at any time using this property sheet. The two lowest speeds are CLV (Constant Linear Velocity). All other speeds are CAV (Constant Angular Velocity), which means that the disc spins at a constant speed. Since the circumference at the outside is twice as large as at the inside, the transfer rate at 24X CAV is 10X at the inside, and 24X at the outside (average 17X). At the 40X setting, the actual speed is 17X at the inside, and 40X at the outside (average 30X).

QuickScan™

DVX includes a feature that greatly increases the speed of disc testing. When QuickScan is enabled, the speed of the test is increased by about 3½ times for CDs, and 10 times for DVDs. 48X test speed on a CD then becomes effectively 168X, and 16X DVD test speed becomes 160X. QuickScan™ increases the speed of both error tests and Analog tests. See the description of QuickScan below and the [TestTimes](#) table on pg. 57.

There are some speed limitations for both CDs and DVD discs:

1. Only single layer molded DVDs will run at 16X.
2. DVD±R and DVD±RW discs have a maximum speed of 12X CAV.
3. DVD+R DL has a maximum speed of 8X CAV.
4. The Analog and Beta / Jitter tests run only at 4X speed on CDs, and 2X speed on DVDs.
5. In all cases, if the speed is set higher than the maximum possible for a given test, the speed will be set to the maximum allowed during the test. No user intervention is required.

Choosing the Best Test Speed

In general, it is best to test at the fastest speed. However, some types of defects are greatly magnified at higher speed, so you may need to use a slower speed. Furthermore, there are no standards for playing at high-speed. All standards apply to 1X speed only. Some CDs and DVDs will not play satisfactorily at higher speeds. DVD-ROM drives are designed to fall back to a slower speed if they cannot read reliably, and will also re-try up to 10 times before failing. As a result, it is not obvious in normal usage that a disc is not functioning at full speed. You may find 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), DVX provides a way to confirm that the disc can play at the required speed.

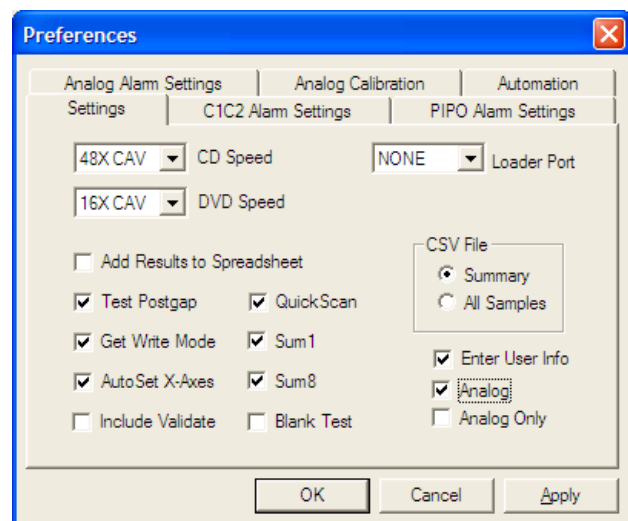


Fig. 10 - Option Settings

Add Results to Spreadsheet

When checked, DVX will add a summary of the test results to the end of the spreadsheet DVDTests.xls (for DVD discs) or CDTTests.xls (for CD tests). For details, see [Saving Results to a Spreadsheet or Database](#) on pg. 19.

Test Postgap

When this is enabled, the tests will include the Postgap area of the disc. This applies to CDs only.

Get Write Mode

When checked, DVX will determine the recording method of a disc when it is loaded (except audio discs).

When checked, DVX will automatically set the horizontal axes of all graphs according to the size of the disc. When not checked, the default value for the X axes is 80 minutes for CDs and 5 GB for DVDs. You can change the axis values for all charts, and the settings will be remembered.

Include Validate

When checked, DVX will verify the data on the disc while performing the error test. The program will prompt you for a Clover Signature at the start of the test. It will then attempt to validate this signature during the error test. The results will be displayed in the "Verify Errors" box in the main view, and also in the Summary view. Before beginning the test, you must create the signature from your master disc that you want to compare against. (See: [CREATING OR VALIDATING A DISC SIGNATURE](#) on pg. 28) In automation mode, you will only be prompted once for the Clover Signature at the beginning of the test. Each subsequent disc will then be validated against this signature.

Enter User Info

When checked, the user will be prompted for information related to the disc under test, when the disc is loaded. For details, see [Entering User Information](#) on pg 17.

Automation

In Automation mode, the test is started automatically when a disc is loaded, and the results can be saved automatically without user intervention. This mode is also used with the Autoloader. For details, see [Using the Autoloader](#) on pg. 34

Enable Automation

Automation mode is enabled in the *Automation* property page of the *Preferences* menu.

Prompt for Filename

When enabled, you will be prompted at the end of the test for a filename for the saved results. When disabled, the file will be saved without user input, with a made-up unique name. If Enter User Info is checked in the Options page, the text in the user information box #1 will be used for the saved filename.

AutoPrint

When enabled, results will automatically be printed at the end of the test. You can select which views you wish to print automatically, including any or all of: All Charts; Summary; Error View; or Analog View. When the Summary view is selected, you can choose to

print either one or two pages of the summary. All views can be printed at any time by selecting *File / Print* in the main menu, or pressing the print icon in the toolbar.

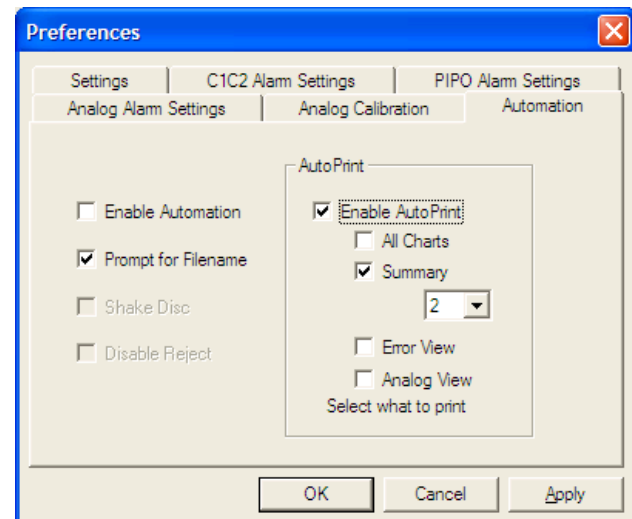


Fig. 11 - Automation Settings

Shake Disc

When the Autoloader is attached, you can enable this option, which will cause it to shake the disc when picking from the input stack. Enable this if you have trouble with discs sticking together.

Disable Reject

When enabled, this will prevent the Autoloader from outputting a failed disc to the reject bin. Instead, all discs will be output to the “good” output bin.

Table 1 - AutoSave Rules

Enter User Info Off:	
Prompt for Filename Off	Uses made-up filename
Prompt for Filename On	Prompts for filename with default made-up name
Enter User Info On:	
Prompt for Filename Off	Uses User Info Box #1
Prompt for Filename On	Prompts for filename with default User Info name

With Automation on and the AutoLoader attached, it never prompts for User Info or Filename, and always uses a made-up name.

LOADING THE DISC

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

Entering User Information

You can enter up to 10 fields of user information. This can be things like work order, disc identification, publisher, or anything else you wish. Labels describing each field are user customized. This information will be printed in the Summary View, and also added to the spreadsheet.

User Info can be enabled or disabled in the Settings tab of the Preferences dialog. To enable User Info, check the “Enter User Info” checkbox.

When enabled, the User Info dialog will appear whenever a new disc is loaded. To set up the User Info dialog, press the “Edit Labels” button. This will allow you to edit the labels for each field. You will be prompted for a password, to avoid unauthorized modification of the labels. The password is the same one used for entering Alarm Limits. The default password is “Clover” (without the quotes), and is case sensitive. You can change the password by checking the “Change” box in the password dialog. Each label can be up to 64 characters. Use the tab key to advance to the next label. The labels will be permanently saved in the Registry.

To enable the fields you want to use, check the checkbox next to the edit box.



The image shows a 'Disc Information' dialog box with a title bar and a close button. The main area is titled 'Enter Disc Info' with a subtitle 'Check the Box to Enable a Field'. It contains several text input fields and checkboxes arranged in two columns. The first column has 'Work Order' (WO 123456789), 'Disc ID' (Phillips SBC 444), 'Operator' (GBR), 'Label 4', and 'Label 5'. The second column has 'Label 6', 'Label 7', 'Label 8', 'Label 9', and 'Label 10'. Each field has a corresponding checkbox to its right. At the bottom are 'OK', 'Cancel', and 'Edit Labels' buttons.

Field	Value	Enabled
Work Order	WO 123456789	<input checked="" type="checkbox"/>
Disc ID	Phillips SBC 444	<input checked="" type="checkbox"/>
Operator	GBR	<input checked="" type="checkbox"/>
Label 4		<input type="checkbox"/>
Label 5		<input type="checkbox"/>
Label 6		<input type="checkbox"/>
Label 7		<input type="checkbox"/>
Label 8		<input type="checkbox"/>
Label 9		<input type="checkbox"/>
Label 10		<input type="checkbox"/>

Fig. 12 - Disc Info Entry Dialog

For each disc, you can enter the appropriate information into each edit box. There is no limit to how many characters you can enter. If the entry goes beyond the end of the box, the text will scroll to the left. You can start a new line by pressing ENTER.

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 (CDs only). Data discs default to display in Sectors, and audio discs default to display in MSF. For DVDs, start and stop points are always entered in Logical Blocks Addresses.

Selecting Which Tests to Run

In the case of DVD discs, all possible measurements cannot be made at once. In the TEST group of the main DVD view, there are four checkboxes that select which tests you want to run: Sum1, Sum8, Analog, and Blank Test. Whichever combination of tests are selected will be run sequentially when you press Start.

Starting the Test

Click the Start button in the main window, or select *Test / Main Test* in the main menu. The current speed setting for the DVX drive is displayed in the status bar. You can change it using the Settings property sheet described above. The test will stop automatically after the specified number of sectors are tested. Progress is displayed in the status bar at the bottom of the window.

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. A 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 “.DVX” for DVD tests, and “CDX” for CD tests, but you can use another file extension if you wish. You can also enter a comment or identification string in the Disc ID edit box in the main window. This is a text string that is printed on the Summary Printout, and can be used to identify the disc.

Saving Results to a Spreadsheet or Database

The summary of test results can be saved to a spreadsheet. This feature is enabled by setting the Append to Spreadsheet checkbox in the Options tab of the Preferences dialog. When enabled (checked), the summary results of the main test will be appended to the end of a spreadsheet named CDTests. xls (for CDs), or DVDTests. xls (for DVDs).

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

Table 2 - Spreadsheet Format

Column	CD Tests	DVD Tests
1	Disc ID	Disc ID
2	File Name	File Name
3	Date and Time of Test	Date and Time of Test
4	User Info 1	User Info 1
5	User Info 2	User Info 2
6	User Info 3	User Info 3
7	User Info 4	User Info 4
8	User Info 5	User Info 5
9	User Info 6	User Info 6
10	User Info 7	User Info 7
11	User Info 8	User Info 8
12	User Info 9	User Info 9
13	User Info 10	User Info 10
14	MID Code	MID Code
15	Grade	Grade
16	Pass / Fail	Pass / Fail
17	AVE BLER	AVE PI Bytes
18	PK BLER	AVE PIE
19	10PK BLER	AVE PIF
20	AVE E11	AVE PO Bytes
21	PK E11	AVE POE
22	10PK E11	AVE POF
23	AVE E21	PK PI Bytes
24	PK E21	PK PIE



25	10PK E21	PK PIF
26	AVE E31	PK PO Bytes
27	PK E31	PK POE
28	10PK E31	PK POF
29	AVE E12	TOT PI Bytes
30	PK E12	TOT PIE
31	10PK E12	TOT PIF
32	AVE E22	TOT PO Bytes
33	PK E22	TOT POE
34	10PK E22	TOT POF
35	TOT E22	--- NOT USED ---
36	AVE E32	MIN TE
37	PK E32	AVE TE
38	10PK E32	MAX TE
39	TOT E32	MIN FE
40	MIN TE	AVE FE
41	AVE TE	MAX FE
42	MAX TE	MIN BETA
43	MIN FE	AVE BETA
44	AVE FE	MAX BETA
45	MAX FE	MIN JITTER
46	MIN BETA	AVE JITTER
47	AVE BETA	MAX JITTER
48	MAX BETA	*MIN REF
49	MIN JITTER	*AVE REF
50	AVE JITTER	*MAX REF
51	MAX JITTER	*MIN Modulation
52	*MIN REF	*AVE Modulation
53	*AVE REF	*MAX Modulation
54	*MAX REF	*MIN Resolution
55	*MIN I_{11}/I_{top}	*AVE Resolution
56	*AVE I_{11}/I_{top}	*MAX Resolution
57	*MAX I_{11}/I_{top}	

58	*MIN I_3 / I_{top}	
59	*AVE I_3 / I_{top}	
60	*MAX I_3 / I_{top}	

* Only available if Analog Measurement Module installed

The "Disc ID" string described above will be saved in column one of the spreadsheet. Sample CDTetsts.xls and DVDTets.xls sheets are included on the distribution disk. You can format the spreadsheet any way you want, but it must be named CDTetsts.xls or DVDTets.xls. They must be located in the same directory where you store your test results.

Note: You may edit and format the spreadsheet any way you wish, but do not modify the first row, or delete any of the first four rows.

Pass/Fail is based on the Alarm settings set by the user. If any parameter goes over the Alarm setting, the result becomes "***Fail***".

In addition, the same summary of results or the complete test data can be saved to a comma-delimited text file named CDTets.CSV or DVDTets.CSV. In the Settings property sheet of the Preferences dialog, you can select either Summary or All Samples in the CSV File group. If you select Summary, a summary of the test results is appended to the CSV file. The format of the data in the text files is the same as in the spreadsheet files.

If you select All Samples, every sample of every parameter will be written to the CSV file. In this case, any previous file contents will be deleted.

These text files can then be imported into most database or spreadsheet programs. If the text file does not exist, it will be created in the directory where the binary data is saved.

You can also export the raw data by using the *Chart...* command in the main menu. See [SingleChart](#) on page 25.

Starting a New Test

To start the test, select the tests you want to perform, then press "Start".

Disc Grading System

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

CD Discs

- GRADE A =
 - AVE BLER over the whole disc not greater than 5.0
 - PK BLER not greater than 100
 - PK E12 not greater 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
 - * REF less than 60%
 - * I_{11} / I_{top} less than 0.6
 - * I_3 / I_{top} less than 0.3
 - * I_3 / I_{top} greater than 0.7



	MAX BETA greater than 15%
	MIN BETA less than -10%
GRADE D =	AVE BLER in all ten second periods is less than 220 E32 greater than 0 on Audio disc
GRADE F =	AVE BLER in any ten second period is greater than 220 TOT E32 greater than 1000 on Audio disc TOT E32 greater than 0 on data disc * REF less than 48% * I_{11}/I_{top} less than 0.48 * I_3/I_{top} less than 0.24 * I_3/I_{top} greater than 0.84 MAX BETA greater than 20% MIN BETA less than -15%

* Only available if Analog Measurement Module installed

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 demanding 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 usable, and the data fully recoverable.

Uncorrectable errors (E32) may not be a problem on audio discs, since the player's interpolation circuitry will hide these errors. Some 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](#) on pg.41.

DVD Discs

GRADE A =	Ave. PI Bytes over the whole disc not greater than 50 Pk. PI Bytes not greater than 250 Ave. POE not greater than 5 Pk. PIE not greater than 140 Pk. PIF not greater than 9 NO POF NO UNCR
GRADE B =	Pk. PIE not greater than 140 Ave. POE not greater than 20 Pk. PIF not greater than 14 NO POF NO UNCR

Setting Pass / Fail Criteria

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 printed in red and will be rejected by the autoloader when installed. This feature allows you to create your own "Pass/Fail" criteria.

To set these limits, select *Preferences* in the main menu. Now select the *C1C2 Alarm Settings*, *PIPO Alarm Settings*, or *Analog Alarm Settings* tab. After making changes, press Apply or OK. The Alarm Settings are password protected to avoid inadvertent changes. Enter your password and click "OK".

C1C2 Alarm Settings		PIPO Alarm Settings			
Av PIB	50	Pk PIB	100	Tot PDF	0
Av PIE	50	Pk PIE	100	Tot UNCR	0
Av PIF	25	Pk PIF	50	GRADE	D
Av POB	25	Pk POB	400		
Av POE	25	Pk POE	800		
Av PDF	0	Pk PDF	0		
Av UNCR	0	Pk UNCR	0		

Fig. 13 - Alarm Settings Property Sheet

The default password is "Clover". The password is case sensitive.

This property sheet will allow you to enter values for each parameter. Average value limits can be entered with one decimal digit. Peak values of error rates, 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.

How Good is Good Enough?

Each user must decide what criteria to use for pass/fail. The higher the cost of failure, the more critical you want to be. Start with the factory defaults, then as you get more experience, you may wish to fine-tune the settings.

Changing the Alarm Settings Password

To change the password, first enter the current password, and then set the *Change* checkbox, and press "OK". You will now be prompted to enter a new password. After pressing OK again, you will be prompted to confirm the new password. If the two entries match, the password will be changed to the new entry.

Note: The default password is "Clover". The password is case sensitive, so you must type it exactly as shown (without the quotes). If you change the password, then forget what it is, you must call the factory for instructions to recover it.

MAKING CHARTS

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

Main Window Charts

The charts in the main window always display all error data. You can change the axes by double-clicking on the axis. This will open a dialog that allows you to change the axis. When Auto Set X-Axes is enabled in Preferences... then the X-axis will be set automatically according to the length of the disc. Each chart can be customized; see [Modifying the Charts](#) on pg. 26.

Single Charts

To graph one or more errors or analog values in a single chart, select *Chart* in the main menu or toolbar. A dialog box will appear which allows you to select which parameters you wish to display. Check the boxes of the errors you want to display then click OK. To select a different chart, just press *Chart* again to bring up the selection dialog. To print the chart, select *File | Print* in the main menu or click the printer icon in the toolbar.

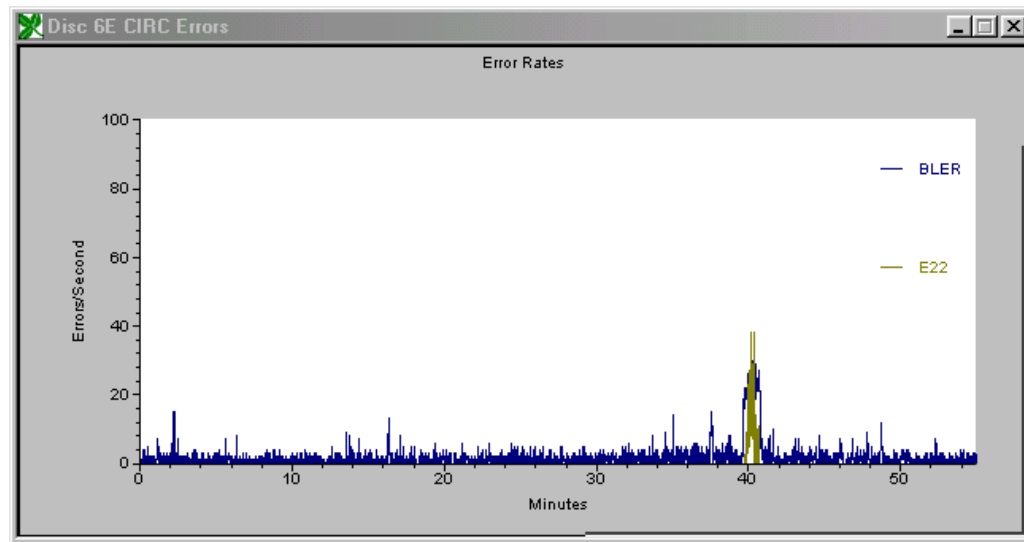


Fig. 14 - Sample Single Chart

The Single Chart graphs have some useful features: You can modify both the horizontal and vertical axes to zoom in on detail. You can superimpose two or more error types to see how they are correlated. These charts can be sized, and printed at any size. All objects in the chart can be customized by double-clicking on the object.

Double-clicking the line plot will open a dialog that allows you to change various line attributes, and also display the data in tabular form. The resulting data table can be copied and pasted to another application, such as a spreadsheet or database program.

The X-Axis units are minutes (for CD), or Gbytes (for DVD).

Print All Charts

This menu selection prints a page of eight individual charts of each parameter, similar to that displayed in the main window. This group of charts allows you to print graphs of all results on one page of paper, plus it provides a means of printing all parameters at once with different vertical scales. The vertical and horizontal scale can be individually set for each chart by setting the charts in the main window. The printed charts will use the same settings as for the main window charts.

If the Analog test has been performed, both the Error View and the Analog View will be printed.

PIB		
Copy Format		
#	X	Y
0	0	8
1	5e-004	9
2	1e-003	9
3	1.5e-03	8
4	2e-003	8
5	2.5e-03	6
6	3e-003	6
7	3.5e-03	7
8	4e-003	7
9	4.5e-03	10
10	5e-003	8
11	5.5e-03	9
12	6e-003	8
13	6.5e-03	9
14	7e-003	11
15	7.5e-03	8
16	8e-003	7
17	8.5e-03	7
18	9e-003	7
19	9.5e-03	8
20	1e-002	8
21	1.05e-02	9
22	1.1e-02	10

Fig. 15 - Sample Data Table

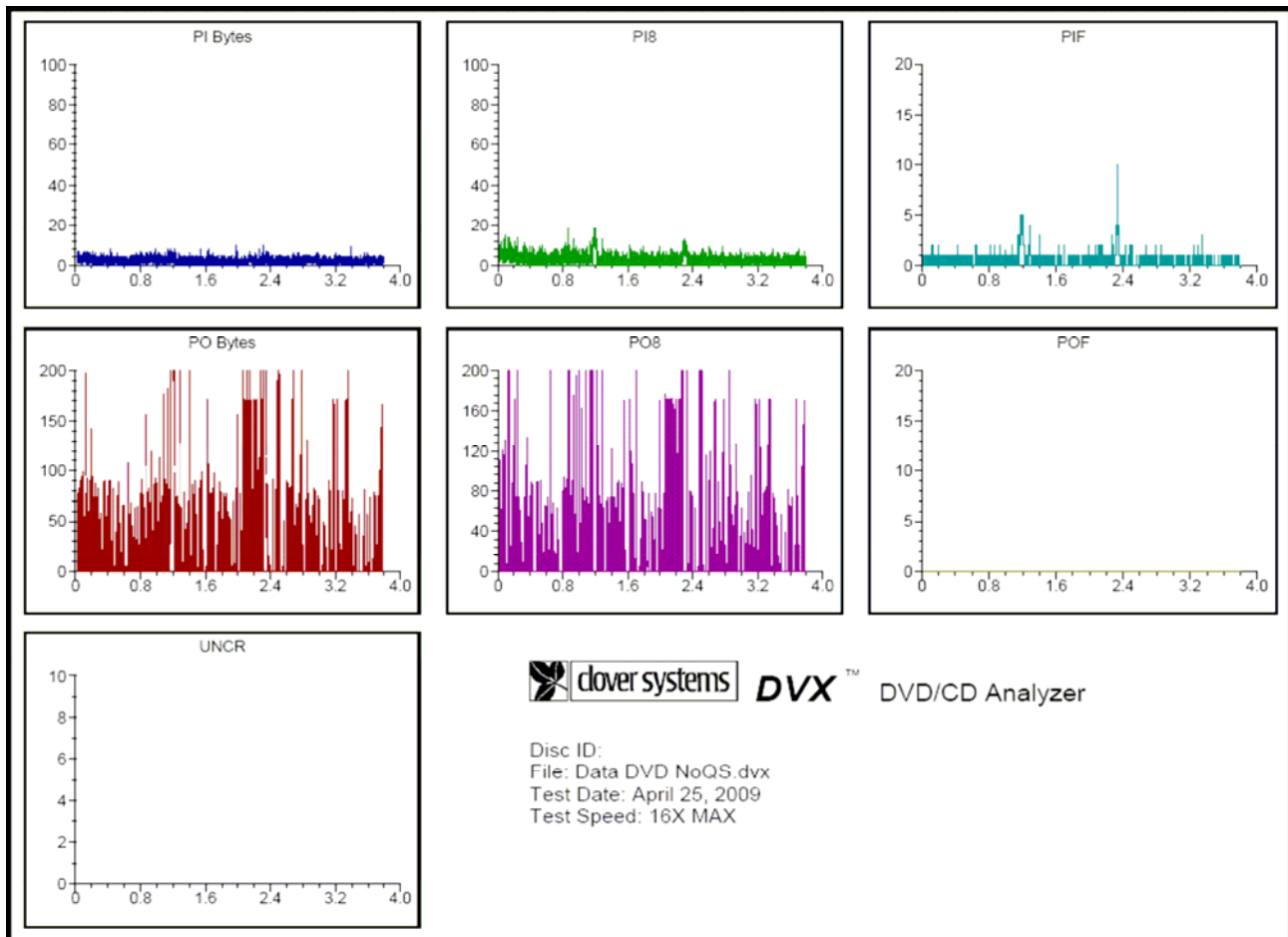


Fig. 16 - Sample All Chart

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, labels, and titles.

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 DVX, it will start up with the axes set the way you left them.

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.

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.

LOADING IN SAVED DATA

Test data that has been previously saved can be loaded back in to display and print. Select *File / Open* from the main menu. Enter the name of the file you want to load, or select from the list. 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.

Test data created with Clover Systems CDX v2 & v3 can also be loaded.

You can double-click on a DVX data file (with extension “.dvx” or “.cdx”) to open it. If the DVX program is not already running, it will automatically start. When the DVX program is first run, it will set the file types “.dvx” and “.cdx” to automatically open in the DVX program. However, if some other application has already set the “.dvx” or “.cdx” file type to use a different application, the setting will NOT be changed. Therefore, if this feature does not work, you can use the *View / Folder Options...* menu and *File Types* tab in Windows Explorer to change the default application for file type “.dvx” and “.cdx”.

The four “Most Recently Used” files will appear in the *File* menu. Selecting one of these will open the file.

VERIFYING DATA

Disc to Disc

Data Verification allows you to compare the data on one disc to another disc or a disc image on your hard drive. This is useful to make sure that you have recorded the correct thing, or to verify that the recording system is working correctly.

To compare two discs, you must of course, have two DVD/CD-ROM drives installed. To compare two audio discs, both drives must be capable of audio extraction. Some DVD/CD-ROM drives will not read audio discs reliably (“reading” is not the same as “playing”). If you do not have two DVD/CD-ROM drives installed, you can compare a disc to a disc image on your hard drive.

In the *Test / Verify Data...* dialog, select the drives you want to use. The Copy must be a DVX drive. Master can be any DVD/CD-ROM drive or an image file. All installed DVD/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.

All sectors that fail to verify are listed in the window on the right. Double click on any sector in the list to view that sector’s data.

The verify test will begin and end at the START and STOP points entered in the main window. These default to the begin and end of the program area when you insert the disc, but you can change them to any values you wish, in either MSF format or physical sectors (for CD) or Logical Blocks (for DVD).

Disc to Image

If you choose Image as the Master, the program prompts you for a file to compare to. The default file extension is “.iso.” 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.

Verify with Offset

Ordinarily, the verify test requires that the two discs are identical. However, there are some cases where there is an offset between the two discs. To accommodate this, you can enter a value in the “Copy Offset” edit box in the Verify dialog. The offset affects only the DVX drive (copy). The offset can be positive or negative. A positive offset means that the copy drive starts at a later sector, whereas a negative offset means that the copy drive starts at an earlier sector. The offset can be entered in MSF format or physical sectors, depending on the setting of the “MSF” and “Sectors” radio buttons in the main view.

Disc copying programs do not always make an exact copy of a disc. They may change the mode, the starting point, or other factors that do not necessarily affect the data. In these cases, the master and copy will not be identical, and therefore will not verify. To pass this test, the copy must be identical to the master. If you wish to compare only the data files on such discs, you can use a file compare utility. There are many available for free on the internet, or use the



DOS command “FC”. At the DOS prompt, type fc /? for instructions. Of course File Compare cannot work on Audio discs, as there are no files.

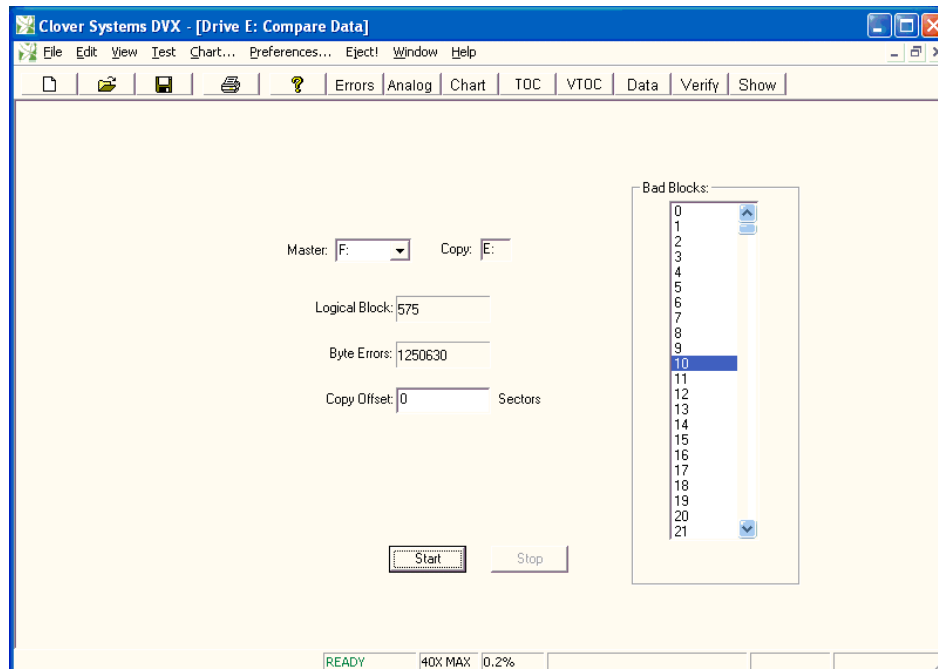


Fig. 17 - Verify View

CREATING OR VALIDATING A DISC SIGNATURE

Bit-for-bit verification between two discs confirms that the two discs are identical. DVX includes a way to validate a copy of a disc when you don't have the original. This is accomplished by generating a “Clover Signature” based on the original disc data. This number is a 160-bit “Secure Hash Algorithm” that is guaranteed to be unique, based on the contents of the disc. Additionally, it is impossible to deduce the contents of the disc based on the number, and it is impossible for any other data to generate the same signature.

This scheme has many uses: You can verify that a disc is an exact duplicate of the original, without having the original. You can validate a disc or copy as authentic, and confirm that the contents have not been tampered with. A Clover Signature can be generated from the original disc, then e-mailed or otherwise transferred to anyone who needs to validate the disc or a copy. Verifying the Clover Signature is also faster than comparing two discs, and can be performed simultaneous with the error test.

To generate a Clover Signature, select *Test / Clover Signature / Create* in the main menu. Press Start in the dialog box to start the process. You can abort the process by pressing Stop. After the data on the disc has been processed, the Clover Number will appear in the edit box. It is a 160-bit binary number, represented by 20 hex digits. The number will be saved with the test data if you select *File / Save* in the menu, or toolbar. You can also select the number using the mouse, and press Ctrl-C to copy it to the clipboard. You can then paste it into another document to mail or save.

To validate a disc, select *Test / Clover Signature / Validate* in the main menu. Type the Clover Signature into the edit box, or paste it from another document. If you have a .DVX or .CDX test data file with the number saved, it will appear in the edit box after the data has been loaded. Now press Start to validate the disc.

The Signature Verify function can also be performed during the error test. When the Include Validate box in the Setup property page is checked, DVX will verify the data on the disc while performing the error test. The program will prompt you for a Clover Signature at the start of the test. It will then attempt to validate this signature during the error test. The results will be displayed (as PASS or FAIL) in the “Verify Errors” box in the main view, and also in the Summary view. In automation mode, you will only be prompted once for the Clover Signature at the beginning of the first test. Each subsequent disc will then be validated against this signature. If the validation fails, the disc will be rejected. Verify during error test cannot be performed with QuickScan enabled. Therefore, Include Validate and QuickScan are mutually exclusive.

Validating Audio Discs

Audio discs do not have any sectors; they are a continuous stream of audio data. Since there are no sector headers with addresses, the only way for the drive can locate to a particular spot is by using the subcode. As there are no standards for locating on an audio discs, different models of drives will interpret the start of a track in different ways. Therefore, a signature made on one model drive may not match one made on a different model drive. To use this feature on audio discs, it is best to use the same model drive for creation and validation. In the case where the two drives are not identical, DVX will attempt to synchronize the two drives. If successful, the offset in bytes, between the two drives will appear in the Copy Offset edit box and the test will proceed. If DVX is unable to synchronize the two drives and error message will appear, and the test will not be performed

Clover Signature vs. MD5

Another data validation scheme known as MD5 is commonly used to verify files. The Clover Signature uses an algorithm devised by the National Institute of Standards and Technology, called SHA-1. SHA-1 is more secure and can accommodate larger files (up to 2^{64} bits) compared to MD5. MD5 produces a 128 bit result; SHA-1 produces a 160 bit result. Additionally, MD5 is not secure; with MD5, it is possible to change the data and still generate the same result.

FORMAT TESTS

ISO9660

Test / Check Format / ISO9660 will check the logical formatting of a DVD or CD data disc. It checks the System Identifiers, Volume Identifiers, Directory Identifiers, and Path Tables for correct formatting and illegal characters. Level 1 is strict ISO9660 format, which only allows 8 + 3 file names, and limited characters. Level 2 tests to Joliet Extension format, which allows long file names and Unicode characters.

Subcode Skew (CD Only)

Test / Check Format / Subcode starts the Subcode Skew test. The Q-channel subcode on a disc contains time code, called Atime (short for Absolute Time), which is used for rapid locating of specific places. This time code should be identical to the sector address contained in the sector header of a data disc. 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 the header address. Negative skew means the Atime is less than the header address.

DVD discs do not have subcode, so this test is not available.

Post Gap (CD Only)

Test / Check Format / Postgap starts the Postgap test. The last track on a disc must be followed by a Postgap. The Postgap contains all zeros (or digital silence). A minimum of 150 sectors is required.

DISPLAYING DISC DATA

View / Data / Disc displays sector data on a disc. The current LBA (Logical Block Address) is displayed. You can type a new LBA into the edit box, or use the PREV and NEXT buttons to select a different sector. Press ENTER after typing a new LBA. Use the scroll bar to scroll through the data. All 2352 bytes in a CD sector, or 2048 bytes in a DVD sector, are displayed in hexadecimal on the left side, and as ASCII text on the right side of the window. You can print the sector data by pressing *File / Print* in the main menu, or using the print icon in the toolbar.

Audio discs do not have sectors, so this window displays the section of the data stream corresponding to an Atime frame. In this case, the logical block number you enter is the frame number from the beginning of the first track.

CD Data disc sector data is displayed 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 encoded in MSF format: Minutes, Seconds, and Frames. Note that these bytes are encoded as Binary Coded Decimal, not binary. In this example, the header address is 0 minutes, 2 seconds, 16 frames, which is logical block 16.

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.

DVD discs do not display sector headers; only the user data.

Please note that on CDs, the sector number you enter in the View Data window is a **Logical Block Address (LBA)**³, whereas the sector numbers displayed in the Table of Contents (Disc Info) and Start and Stop in the main window, are **Physical Sector Addresses**. The numbering of physical sector addresses starts at the beginning of the program area, whereas the Logical Block Address starts at the beginning of the user data area. The difference is due to the length of the Pre Gap. To convert a physical address to a logical address, subtract the value shown in the Start box in the main window (should be 150 or more). So, the first sector of user data is typically physical sector 150, which would be logical block address 0.

DVD sectors are always displayed as Logical Block Addresses.

On CD data discs and DVDs, the first 16 sectors (0-15) are reserved for system use, so the volume descriptor is at Logical Block Address 16, which would be physical sector 166.

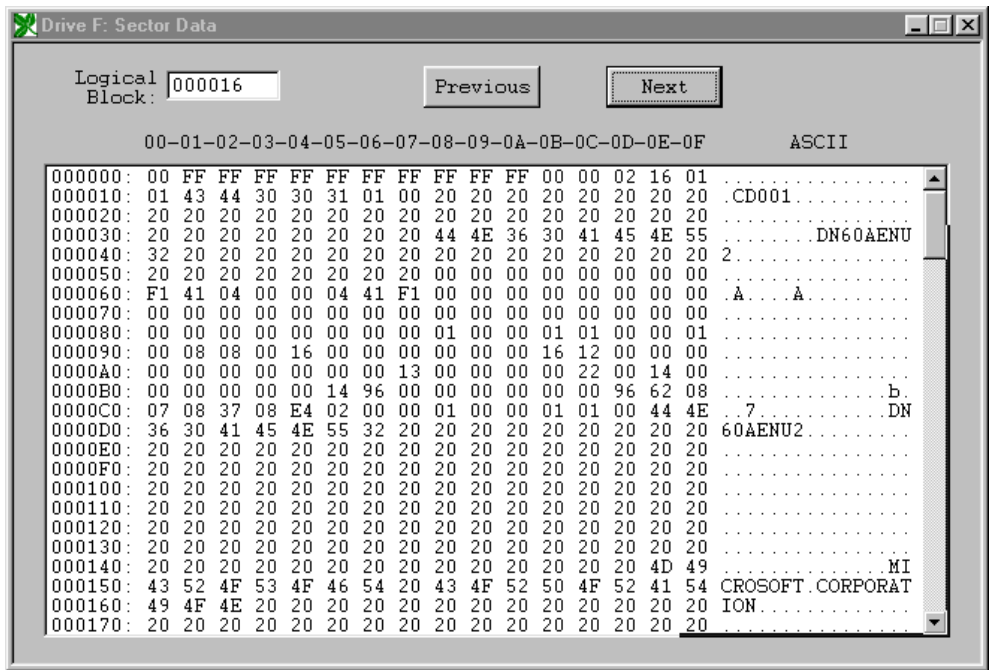


Fig. 18 - Sector Data on Disc

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.

CREATING A DISC IMAGE

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

³ See "[HLogical Blocks and SectorsH](#)" on pg. 12

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 *Preferences | Drive Settings* 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.

PRINTING

All DVX windows can be printed. Select the view you want to print, and then *File | Print* or *File | Print Preview*. Or click on the printer icon in the toolbar. Whichever window is currently active is the one that will be printed. For example:

Printing a Summary

You can print a summary of the test results on the printer by selecting *View | Summary*, then *File | Print*. The printed summary consists of the results of all tests that were performed. The same information displayed in the main window 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 printed in red.

You can also print the main window on the printer, which provides a graphic summary. Just select the main view, and then select *File | Print* in the main menu.

Printing the Charts

Display the chart you wish to print, then select *File | Print* in the main menu.

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.

You can also print all the charts on one page of paper using the *Chart | Print All Charts* item in the main menu. This command will print all the charts on one page, with date, Disc ID, Filename, and test speed. It will print in landscape mode and fill the page. The chart axes used will be the same as set in the main window.

The summary and charts can also be printed automatically at the end of the test. See [AutoPrint](#) on Pg. 16 for details.

Fig. 19 - Sample CD Summary Printout



DVX v3.0
Summary of Results

Page No. 1

Date: March 27, 2009

Test Date: March 22, 2009 11:44

File: \\Loader\Documents\DVX Data\55342-5B.cdx

Disc ID:

User Entered Information:

Work Order: 123456789

Disc ID: Philips 5B.3

Operator: EB

Disc Type: CD-DA

UPC/EAN: 0042281412523

Test Speed: 48X MAX (Analog Measurements are made at 4X)

QuickScan OFF

MID code:

Sessions: 1

Format: Audio

Tracks: 24

Sector Size: 2352

Total Disc Length: 59:40:18

Record Mode: Unknown

CIRC Test Results:

Av BLER = 2.6

Pk BLER = 12

10Pk BLER = 4

Av E11 = 2.5

Pk E11 = 12

10Pk E11 = 4

Av E21 = 0.0

Pk E21 = 1

10Pk E21 = 0

Av E31 = 0.0

Pk E31 = 4

10Pk E31 = 0

Av E12 = 0.1

Pk E12 = 10

10Pk E12 = 1

Av E22 = 0.0

Pk E22 = 0

10Pk E22 = 0

Av E32 = 0.0

Pk E32 = 0

10Pk E32 = 0

Tot E22 = 0

Tot E32 = 0

Grade = A

Analog Test Results:

Min. Ref = 74.8%

Ave. Ref = 75.1%

Max. Ref = 75.4%

Min. I11 = 0.66

Ave. I11 = 0.66

Max. I11 = 0.66

Min. I3 = 0.42%

Ave. I3 = 0.46%

Max. I3 = 0.50%

Min. Beta = -2.6%

Ave. Beta = -1.3%

Max. Beta = -1.0

Focus/Tracking Results: Not Performed

CIRC Test *** PASSED ***

Analog Test *** PASSED ***

Data Verification Results: Not Performed

ISO9660 Format Results: Not Performed

Postgap Test Results: Not Performed

Subcode Skew Test Results: Not Performed

Clover Signature:



Fig. 20 - Sample DVD Summary Printout



DVX v3.0 Summary of Results

Page No. 1

Date: March 27, 2009

Test Date: March 27, 2009 10:13

File: \\Loader\Documents\DVX Data\Test1.dvx

Disc ID: DVD Test Disc

User Entered Information:

Work Order: 123456789

Disc ID: Philips SL

Operator: EB

Disc Type: DVD-ROM

UPC/EAN:

Layers: 1

Track Path:

Copy Protect: None

Region: 12345678

Test Speed: 16X MAX (Analog Measurements are made at 2X)

QuickScan OFF

MID code:

Sessions: 1

Format: Mode 1 Data – Joliet

Tracks: 1

Sector Size: 2048

Disc Size: 515392 Sectors; 1006.6 MB

Record Mode: Disc-at-Once

PIPO Test Results:

Av PI Bytes = 8.4

Pk PI Bytes = 18

Tot PI Bytes = 33954

Av PIE = 46.2

Pk PIE = 89

Tot PIE = 185556

Av PIF = 1.4

Pk PIF = 3

Tot PIF = 5679

Av PO Bytes = 16.0

Pk PO Bytes = 93

Tot PO Bytes = 64524

Av POE = 119.8

Pk POE = 578

Tot POE = 481349

Av POF = 0.0

Pk POF = 0

Tot POF = 0

Grade = C

Tot UNCR = 0

Analog Test Results:

Min. Ref = 57.5%

Ave. Ref = 59.2%

Max. Ref = 60.8%

Min. I14 = 0.89

Ave. I14 = 0.89

Max. I14 = 0.89

Min. I3 = 0.24%

Ave. I3 = 0.24%

Max. I3 = 0.25%

Min. Beta = 5.5%

Ave. Beta = 6.7%

Max. Beta = 8.4%

Min. Jitter = 5.1

Ave. Jitter = 5.7

Max. Jitter = 6.4

Focus/Tracking Results: Not Performed

PIPO Test * FAILED *****

Pk PIE Over Limit

Av POE Over Limit

Analog Test *** PASSED ***

Data Verification Results: Not Performed

ISO9660 Format Results: Not Performed

Postgap Test Results: Not Performed

Subcode Skew Test Results: Not Performed



CONTROLLING THE DRIVE

The DVX works just like an ordinary DVD-R/RW writer. 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. DVX is supplied with Roxio CD and DVD Creator, which can be installed from the included CD.

To make your DVX last as long as possible, please do not use it for recording.

USING THE AUTOLOADER

Provisions have been made to enable automation of disc testing. An optional disc loader can be interfaced to the DVX, and controlled by the software. One or two DVX's can be installed in the Autoloader, and operate simultaneously.

In Automation mode, no user intervention is required. This feature can be enabled or disabled using the *Automation* property page in the *Preferences* menu. To enable Automation, check the Automation box and select OK. When the test is completed, the data is automatically saved to a binary file using an automatically generated file name of the form xxxxx.dvx (for DVD) or xxxxx.cdx (for CD), where xxxxx are unique letters and numbers generated by the operating system.

A summary of results is always appended to the spreadsheet DVDTests.xls or CDTests.xls and DVDTests.txt or CDTests.txt when in Automation mode. Discs that do not pass the PASS/FAIL criteria are unloaded to a separate bin from the good discs.

The Error View, Analog View, Summary View and/or Charts can be automatically printed at the end of the test. To enable this feature, check *Enable AutoPrint* in the *Automation* property sheet of the *Preferences* dialog. You can select what combination of views you want to print in the dialog. This feature works even if there is no AutoLoader.

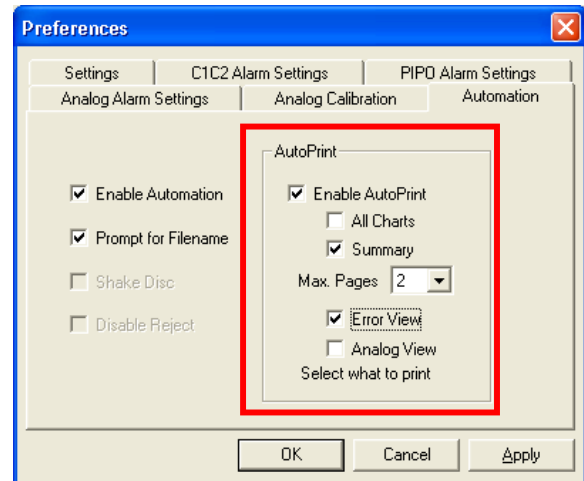


Fig. 21 - AutoPrint Feature

Installation

Connect a monitor, keyboard, mouse, and printer to the system. Monitor and printer are not included with the system, and must be user-supplied. You can also connect the system to a network, using the built-in Ethernet connection. All software is already factory installed, and the system has been calibrated.

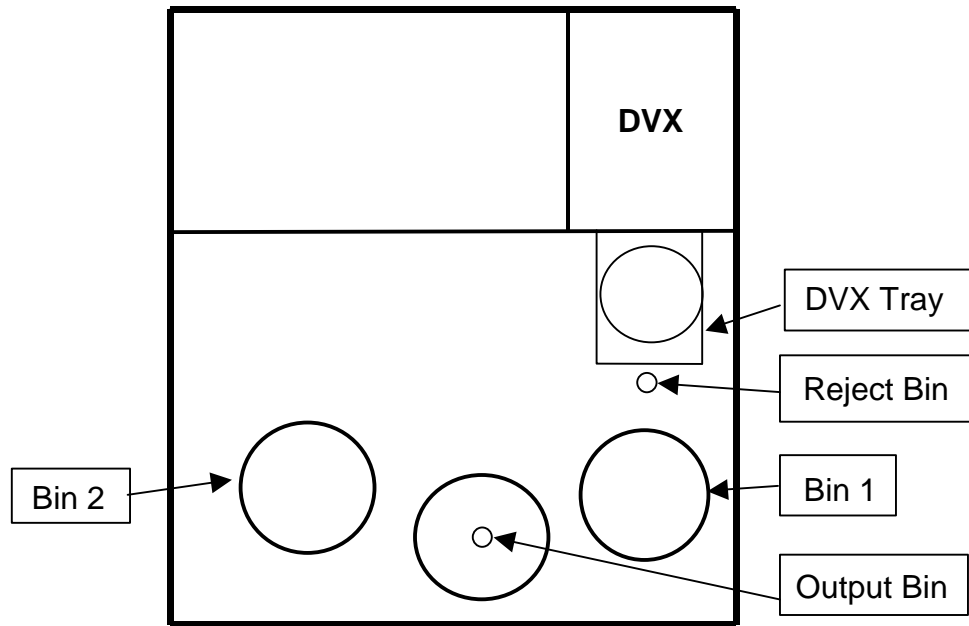


Fig. 22 - AutoLoader Layout

Loading the discs

Load the discs to be tested into bins 1 and 2. Initially, discs will be loaded into the DVX from bin 1, and output to the output bin. When bin 1 runs out, discs will be loaded from bin 2, and output to bin 1. In this way, you can test up to 250 discs unattended.

Starting the test

To run DVX in fully automatic mode, select *Preferences...* from the main menu. In the *Automation* property sheet, check the Automation checkbox.

To start the testing, click the START button, or place a disc in the DVX tray, and close the tray.

MEASURING PIT GEOMETRY – THE KEY TO INTERCHANGABILITY

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 primary goal of disc quality is to make sure that a disc will work in every drive, every time. The key to making this happen is proper pit geometry.

In order to play the disc, the player must follow the track and stay in focus as the disc turns and wobbles up and down. This is accomplished using servo signals that are derived from the way the laser beam bounces back from the disc. Generation of the proper servo signals is wholly dependent on the size and shape of the pits.

There are specifications for pit length, depth, and width, but you would need an electron or atomic force microscope to measure them! Pit geometry can be measured indirectly by looking at signals like I_{11} , I_3 , 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.

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.

Pit geometry can be measured by looking at the HF signal coming from the pickup (also see [INTERPRETING THE RESULTS](#) Pg. 41).

Analog Measurement Module

The Analog Measurement Module is an optional tool to make signal measurements related to pit geometry. The AMM helps evaluate disc quality by automatically measuring parameters such as reflectivity, I_3/I_{top} , I_{11}/I_{top} , I_{14}/I_{14H} (modulation), I_3/I_{14} (resolution) and asymmetry / beta and displaying the data in the DVX software. Together with analyzing playback errors, this information provides a thorough analysis of disc quality.

The AMM connects to the HF output of the DVX I/O panel with a coaxial BNC cable, and uses a USB port to communicate with the PC. The DVX software automatically gathers data from the AMM and displays the data as statistics and easy to read charts. Summary of the data, along with the charts can be printed and/or saved to disk for future use.

Setting Analog Alarms

Under the Analog Alarms tab of the *Preferences* menu you will be able to set the individual alarms for each analog parameter. Notice that some parameters have different entries for CD or DVD, or DVD5 (single layer) vs. DVD9 (dual layer).

Analog Calibration

Your DVX analog measurements have been calibrated at the factory, using a Philips Single Layer DVD Signal Disc, Philips BH-1, Philips JT-1, and A-BEX TCD-W082L test discs. If you purchased DVX with a PC or AutoLoader, the calibration constants have already been entered into the software, and you needn't do anything further. If you are installing DVX in your own PC, you will need to enter the calibration constants into the software.

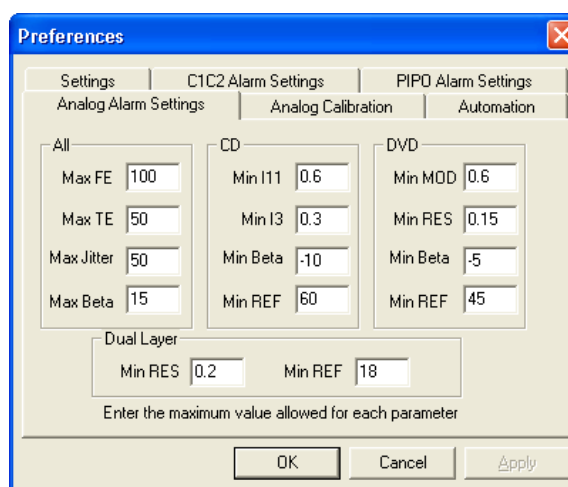


Fig. 23 - Analog Alarms Setting

The required numbers are written on the DVX Final Test sheet that is included in the back of this manual. Select *Preferences...* from the main menu, and select the *Analog Calibration* tab. Enter the values from the test form in the corresponding edit boxes, then press OK (see figure below).

The default password is "Clover". The password is case sensitive.

IMPORTANT

Because the results can be affected by the PC (power supply voltage, temperature, etc.), it may be necessary to re-calibrate your DVX. This can be accomplished using the test discs provided. The correct values for all parameters are printed in the back of this manual, so you can calibrate the system by testing these discs and adjusting the offset values in the Analog Calibration property sheet. It is not necessary to change the gain setting, as only the offsets are affected.

Some parameters are also affected by temperature. Therefore, DVX should be used in a temperature controlled environment. In addition, the temperature of the laser increases as it is used, so it is best to "warm up" the DVX before making analog measurements. The best way to do this is to play a disc for about ½ hour. Since CDs and DVDs use different lasers, you will need to warm them up separately.

You can also calibrate the system using test discs available from Philips or others. Philips test discs are available directly from Philips at <http://www.licensing.philips.com/>. If you have discs calibrated to some other standard such as Datarius, AudioDev, etc. you can use these discs as well.

It is best to use test discs with more than one measurement value, so that you know that the results are accurate over a wide range.

If you have discs with multiple known values, you can set the gain of each parameter by comparing the difference of the measured values to the difference of the known values. For instance, if you have two discs with known values for Beta, such as +10 and -3, and your measured results show +8 and -2, you can then change the Beta gain by a factor $(10 + 3) / (8 + 2) = 1.3$. In this example, you would multiply the current Beta gain by 1.3 to obtain the new gain setting.

After setting the gain, you can adjust the offset. If the new gain setting produces results of +13 and 0, then you must subtract 3 from the current offset setting.

NOTE – Please note that analog measurements are very sensitive, and differences of only a fraction of a percent are noticeable.

CD		DVD	
Parameter	Value	Parameter	Value
REF Offset	3.32	REF Offset	-0.53
I11 Offset	-0.025	MOD Offset	0.435
I3 Offset	0.073	RES Offset	-0.2
Beta Offset	-4.78	Beta Offset	-3.1
Jitter Offset	84.6	Jitter Offset	19.6
TE Offset	10	TE Offset	25
FE Offset	-7	FE Offset	20
REF Gain	1.5	REF Gain	2.05
I11 Gain	0.538	MOD Gain	0.261
I3 Gain	0.462	RES Gain	2.4
Beta Gain	1.374	Beta Gain	1.46
Jitter Gain	0.332	Jitter Gain	0.523
TE Gain	1	TE Gain	1.1
FE Gain	0.5	FE Gain	0.54

Enter values from test sheet

OK Cancel Apply

Fig. 24 - Analog Calibration

Making Analog Measurements with the AMM

NOTE - Measuring analog parameters must be done at constant linear velocity. The fastest speed that the drive will play CLV is 4x for CD and 2x for DVD. Therefore, the analog tests are limited to those speeds. Enabling QuickScan will greatly reduce the test time.

The test speed will automatically be set to the appropriate CLV speed when the test starts, and returned to the default speed when finished, so there is no need to set the speed.

You can view the analog test results by selecting the Analog button in the toolbar.

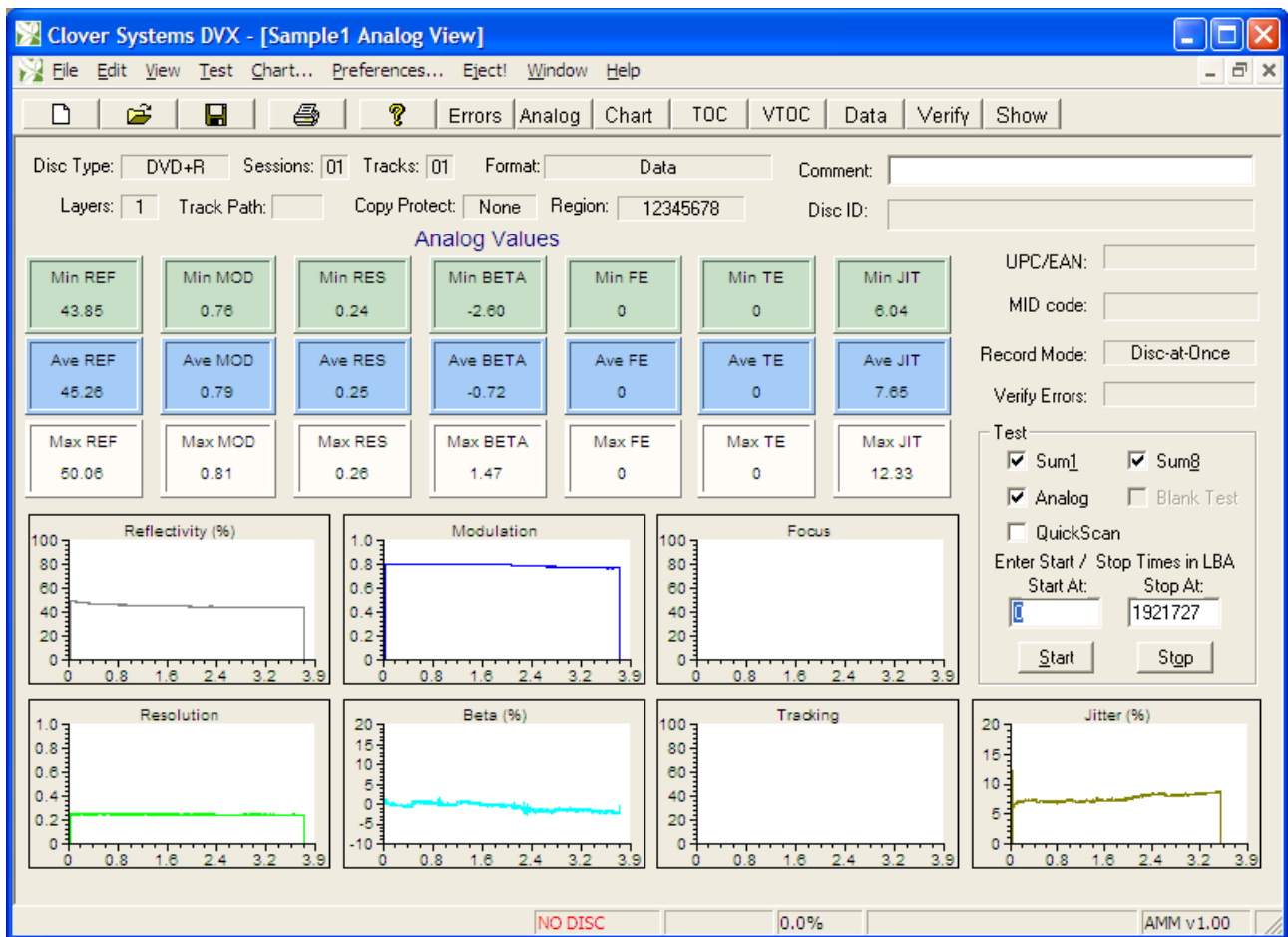


Fig. 25 - Analog View with AMM

Making Analog Measurements without the AMM

Without the Analog Measurement Module installed, you can still measure Beta and Jitter on recorded discs, and Focus Error, and Tracking Error on blank media.

Beta / Jitter

Selecting the Analog checkbox will cause the Beta / Jitter test to be performed after the error test. Or, you can select Analog Only (for CDs) checkbox if you want to skip the error test. On DVD discs, you can perform the Analog Only test by checking the Analog box, and un-checking Sum1 and Sum8.

Focus Error / Tracking Error

The Focus and Tracking error test can be performed ONLY on a blank recordable disc. When a blank disc is loaded, the Blank Test checkbox will be enabled, otherwise it is disabled. No other tests can be performed on a blank disc.

Currently there is no way to calibrate the TE and FE signals because there are no calibration discs of this type available. Therefore, the absolute value of the result is pretty much meaningless. However, you can make a qualitative judgment about the results by looking at the graphs.

There are two things you can look for: One, which is probably the most useful, is to look for spikes in the results. Any spikes in the graph indicate a physical defect in the pre-groove that will disturb the recording. If you get a spike in the same place on several discs from the same batch, it indicates a defect on the stamper that was used to make the media. Any defect on the stamper will be reproduced on every disc. Ideally, the graph should be pretty uniform across the whole disc. A rising or falling graph indicates some non-uniformity of the pre-groove across the disc. After you get some experience with different discs, you can save the best results you get (lowest average error with no spikes), then

use this as a reference to compare other disc with. With practice, you will be able to recognize good from bad by looking at the graphs.

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.

CD HF Signal

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 I_3 , I_4 , I_5 , I_6 , I_7 , I_8 , I_9 , I_{10} , and I_{11} respectively. I_3 represents the shortest pit / land, and I_{11} represents the longest pit or land. Generally, we only need to look at the longest and shortest pits to get a good picture of pit geometry.

DVD HF Signal

The eight-to-sixteen (EFM+) modulation scheme used, produces eleven different possible lengths of pits and lands. Therefore, the resulting HF consists of square waves of eleven 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 eleven different lengths. Each of the eleven pit/land lengths are exact multiples of one fundamental length, called 1T. The eleven possible lengths of pits and lands are 3T, 4T, 5T, 6T, 7T, 8T, 9T, 10T, 12T, 13T and 14T. The waveforms generated by these pits & lands are called I_3 , I_4 , I_5 , I_6 , I_7 , I_8 , I_9 , I_{10} , I_{12} , I_{13} , and I_{14} respectively. I_3 represents the shortest pit / land, and I_{14} represents the longest pit or land. Generally, we only need to look at the longest and shortest pits to get a good picture of pit geometry.

Terminology

The CD and DVD standards use different terminology to refer to the same concepts. For instance, the maximum light level returned from the disc is called I_{top} in CD terminology, but is called I_{14H} in DVD terminology.

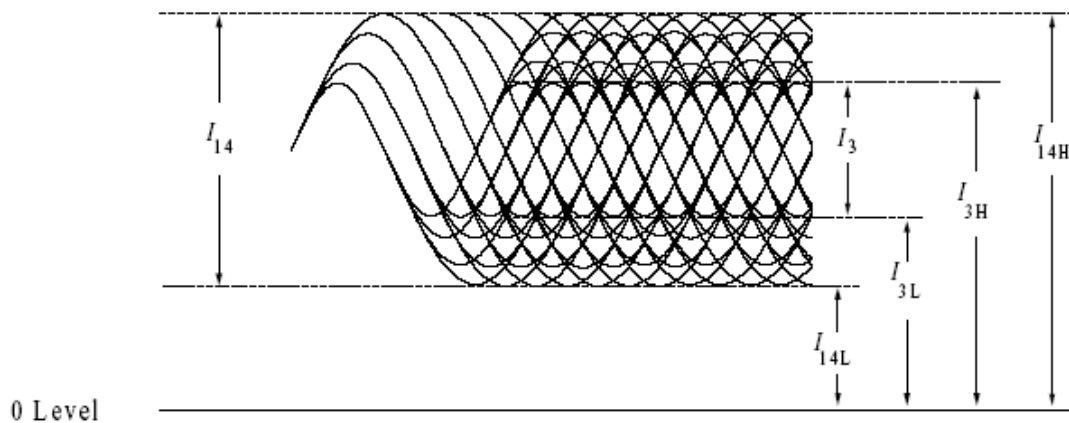


Fig. 26 - DVD HF Eye Pattern

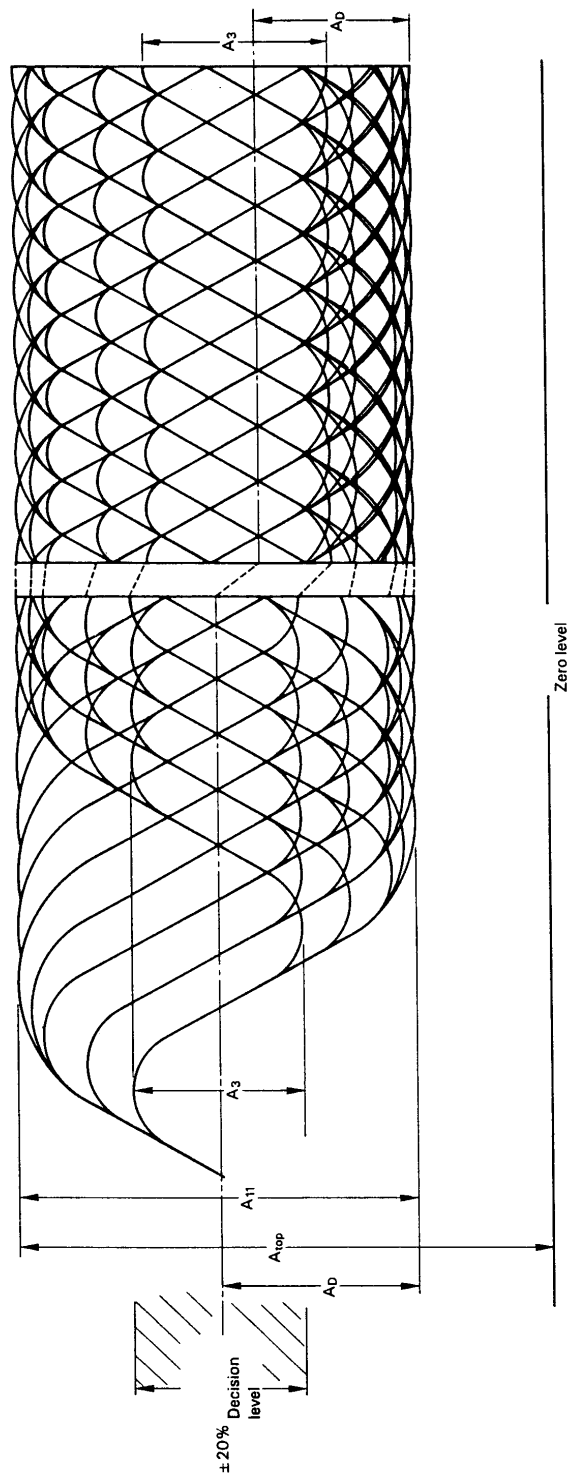


Fig. 27 - CD HF Eye Pattern

INTERPRETING THE RESULTS

INTERPRETING 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 aging 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 time code 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.

CDs and DVDs could not work without a highly effective error detection and correction scheme. Because the pits 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 this technology feasible. The error detection and correction code used on CDs and DVDs is known as Cross Interleave Reed-Solomon Code (CIRC) or Reed-Solomon Product Code.

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 information 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 not just a repeat of the data, but is cleverly used to record information about the original data, which provides 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

The error type E11 means one bad symbol (byte) 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 is 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.

How DVD Error Correction Works

DVD error correction also uses a Reed-Solomon product code for error correction. The primary difference from CD is the size of the correction block, and the lack of interleaving.

CD error correction uses an error correction block of only 24 user bytes. CDs were designed for audio, and you don't want an uncorrectable block to be too noticeable. DVDs, on the other hand, use an error correction block of 32 kB. It turns out that the error correction capability of Reed-Solomon product codes increases with the size of the block, so this gives a much greater error correction capability, which is required due to the small size of the pits.

DVD error correction also works in two stages, but instead of C1 and C2 as on a CD, DVD error correction arranges each block of data into 208 rows and 182 columns. Each row and column has its own parity bytes. Correction of the rows is known as "Inner Parity" or PI. Correction of the columns is known as "Outer Parity" or PO. The rows are corrected first, so uncorrected bytes in a row may still be corrected by the outer parity correction.

Therefore, PI Fails (PIF) are not fatal. But PO fails cannot be corrected, and should not be allowed.

Summary of Error Names

For CDs, each count of:

E11 means there was one bad byte in a data frame at the C1 stage, which was corrected.

E21 means there were two bad bytes in a data frame at the C1 stage, which were corrected.

E31 means there was three or more bad bytes in a data frame at the C1 stage, which were not corrected.

E12 means there was one bad byte in a data frame at the C2 stage, which was corrected.

E22 means there were two bad bytes in a data frame at the C2 stage, which were corrected.

E32 means there were three or more bad bytes in a data frame at the C2 stage, which were not corrected.

BLER is the total number of errors encountered at the C1 stage ($=E11 + E21 + E31$)

AVE values displayed are the averages over the whole of the disc that has been tested.

PK values displayed are the largest one-second samples encountered over the whole of the disc that has been tested.

10PK values are the largest 10-second samples encountered over the whole of the disc that has been tested.

CD Errors are reported for each one second of program time. Since there are 7350 data frames per second, the maximum number of errors per second is 7350.



For DVDs:

1 ECC block = 16 sectors = 32768 user bytes.

PI Bytes is the number of bad bytes encountered in all rows of 1 ECC block.

PIE is the number of rows in 8 ECC blocks that had errors detected by inner parity.

PIF is the number of rows that were uncorrectable by inner parity in 1 ECC block.

PO Bytes is the number of bad bytes encountered in all columns of 1 ECC block.

POE is the number of columns in 8 ECC blocks that had errors detected by outer parity.

POF is the number of columns that were uncorrectable by outer parity in 1 ECC block.

UNCR is the total number of uncorrectable ECC blocks for the whole disc.

AVE values displayed are the averages over the whole of the disc that has been tested.

PK values are the largest values encountered over the whole of the disc that has been tested.

TOT is the total number of errors encountered over the whole of the disc that has been tested.

The Reed-Solomon Product Code can correct 5 bytes per row, and 8 bytes per column. Therefore...

PI Bytes - maximum correctable = 208 rows * 5 bytes = 1040 bytes; default limit = 9.6%

PIE - maximum correctable = 208 rows * 8 blocks = 1664 rows; default limit = 6%

PIF - maximum correctable⁴ = 208 rows; default limit = 24%

PO Bytes - maximum correctable = 182 columns * 8 bytes = 1456 bytes; default limit = 21%

POE - maximum correctable = 182 columns * 8 blocks = 1456 columns; default limit = 55%

POF - maximum correctable = 0; default limit = 0

UNCR - maximum correctable = 0; default limit = 0

As you can see, the default limits are generally set quite low. The only standards for DVD errors are that PIE must be no greater than 280, and there should be no POF errors. You can set the limits as sensitive as required by your application. It all depends on how picky you want to be. Also note that the actual correction capability depends on the pattern of the errors. Maximum error correction capability is not always achievable.

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 may give different results.

How to Interpret the Error Charts

The chart below shows an example of a disc that has low overall error rates, but with a localized defect. This is a good example of why BLER by itself is not a good indicator of disc quality. The average BLER on this disc is fairly low, but there was a burst of E22 errors at around 41 minutes, indicating a local defect at that location.

⁴ Depends on the data



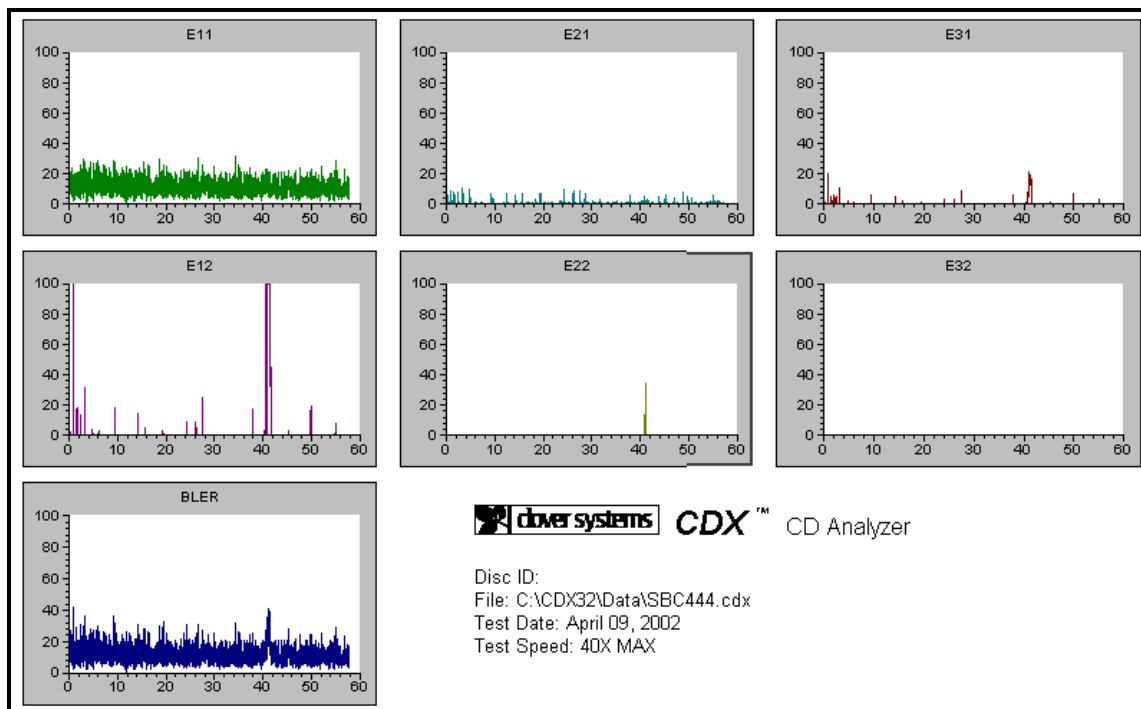


Fig. 28 - Local Defect

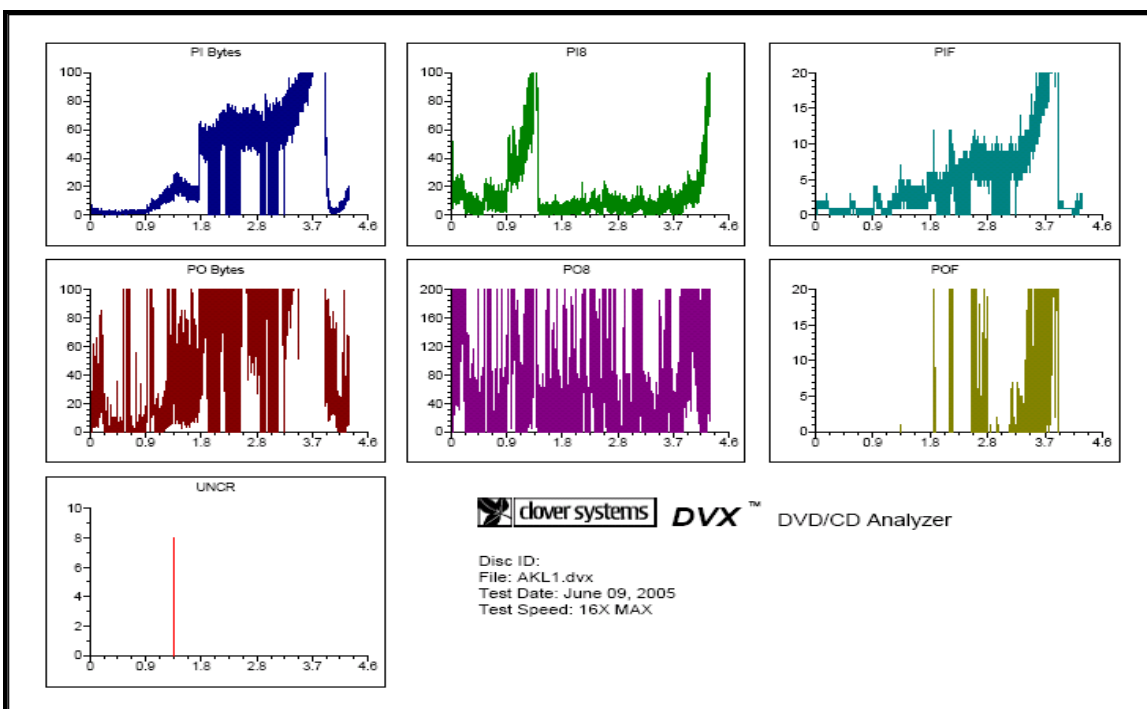


Fig. 29 - Global Defect

Here's an example of a disc with global problems over a large area of the disc.

CD Errors

E11 errors are the smallest errors, and are essentially random. High E11 error rates can be caused by excessive jitter, or low signal-to noise ratio. E21 errors represent slightly larger defects like dust or small scratches. E31 are again larger defects that cannot be corrected at the first stage of error correction (C1), and are de-interleaved and passed to the second stage (C2). De-interleaving of the data turns one E31 error burst into as many smaller errors. Each E31 error can produce as many as 28 E12 errors. It is not possible to predict how many E12 errors will be generated for each E31 error unless you know the exact location of the bad bits. This de-interleaving explains why E12 peaks can reach many times higher than the other errors.

E22 and E32 errors are caused by fairly large defects, or mis-tracking. A common cause of occasional E22 errors on CD-R's is a spec of dust on the disc while recording. This will block the recording beam and create a void where there are no pits. Recordable media should be absolutely clean when recording.

DVD Errors

DVD error correction is much more powerful due to the larger block size, but this also makes it difficult to determine the size of defects, and very small defects will not show up as clearly as on a CD. The "Sum1" test detects the number of bad bytes in rows and columns, plus the number of uncorrectable rows and columns in one ECC block. This is the highest resolution view, so small defects should show up best here. On a good disc, PI Bytes will represent random errors, and so should be fairly low and uniform across the disc. This is comparable to BLER on a CD, so it gives a general view of disc quality, but as with BLER, does not show the severity of defects. On a good disc, PIF error will not exceed four per block, and of course there should be no POF errors.

Similar to C2 errors on a CD, the PO errors can be much larger than PI errors. For example, one PIF error means that one row was uncorrectable, so in principle, there could be as many as 208 bad bytes in that column, so PO Bytes could be as much as 208 times PIF.

The "Sum8" test detects the number of bad rows and columns in 8 ECC blocks. A small defect that only affects one block will be averaged out over the 8 blocks, and therefore not appear as prominent. As with the Sum1 test, POE errors can be, in principle, as much as 208 times as big as one PI error. If all 8 blocks contain PIF errors, then POE could be as large as 1664. The upshot of this is that POE error rates are typically much higher than the others.

On a good disc, you should see PI Bytes and PIF fairly low and uniform across the disc. PO Bytes and POE will be larger and more random, but still should be fairly uniform over the disc. Good discs should have no POF errors (see Fig. 25 below).

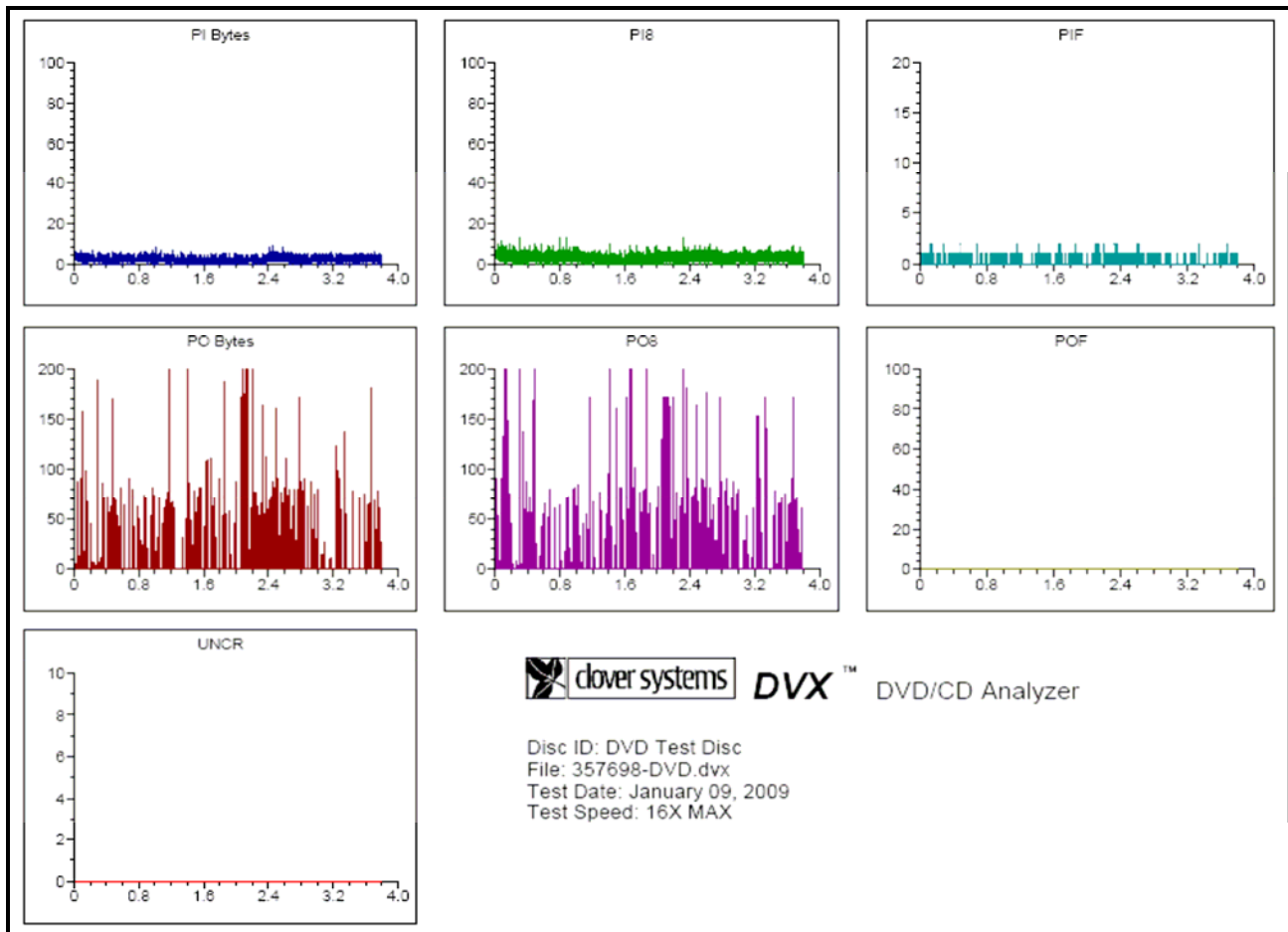


Fig. 30 - “Good” DVD

INTERPRETING HF SIGNALS ON CD

I_{11}

This is a measure of overall signal strength. Too small of a signal makes it difficult to decode. I_{11} is primarily affected by pit depth and width. As a rule, bigger I_{11} is better, and will generally produce lower error rates. Optimum I_{11} is about 0.67 on molded discs but can be significantly higher on recordable discs.

I_3

Represents the shortest pits and lands, and is the highest frequency part of the signal. I_3 is always smaller than I_{11} because the smallest pits are at the limit of resolution of the optics. Pits that are too small can cause Low I_3 . Lower writing speed (higher capacity discs) will make the pits shorter, and I_3 lower. Again, larger I_3 is better, up to a point. Minimum allowed is 0.30, and maximum is 0.60.

Asym & Beta

Asymmetry and Beta are two different ways of measuring the same thing. They are a measure of the relative amount of pit and land. Zero asymmetry (or beta) means that the amount of land is the same as the amount of pit. When they are not the same, this causes distortion of the signal that makes it hard to decode.

Although they measure the same thing, Asymmetry and Beta have opposite signs. So negative asymmetry is the same as positive beta. DVX with AMM-1 measures Beta, so we use that convention.

This measurement is useful because it is a function of the writing power of the laser during glass mastering (or writing a recordable disc). Higher laser power produces more positive beta. Some positive beta is desirable, with optimum of +5% to +10%. The maximum allowed is -5% to +15% for molded discs, and -10% to +15% for CD-R. Beta must not vary by more than 2% over the disc. CD-Recordable discs with low I_3 and negative beta are often found to give unreliable results.

Reflectivity

Reflectivity is a function of the metal reflective layer, and on recordable discs, the absorption of the dye layer that is the active recording medium. The reflectivity of aluminum is about 80%, so this is usually the maximum possible. Some light is absorbed by the plastic substrate, so typical values for good molded discs are around 75%. Reflectivity of CD-R discs is usually lower, and the minimum allowed is 65%. Low reflectivity is a common problem with CD-R, which causes lower signal strength, making the signal harder to decode.

INTERPRETING HF SIGNALS ON DVD

HF signals on DVD discs are substantially the same as for CD, except that there are now 11 possible pit sizes ($I_3 - I_{14}$) instead of 9. Also, the frequency of these signals is higher due to the higher bit rate of DVD discs.

I_{14}/I_{14H} (Modulation)

This is a measure of overall signal strength. Too small of a signal makes it difficult to decode. I_{14} is primarily affected by pit depth and width. As a rule, bigger I_{14} is better, and will generally produce lower error rates. Optimum I_{14}/I_{14H} is about 0.67 on molded discs.

I_3/I_{14} (Resolution)

I_3 represents the shortest pits and lands, and is the highest frequency part of the signal. I_3 is always smaller than I_{14} because the smallest pits are at the limit of resolution of the optics. Pits that are too small can cause low I_3 . Again, larger I_3 is better. Minimum allowed I_3/I_{14} is 0.15 for single layer discs, and 0.20 for dual layer discs.

Asym & Beta

This is a function of the writing power of the laser during glass mastering (or writing a DVD-R). **Asymmetry for DVD is defined with the opposite sign as for CD.** Therefore, positive asymmetry on a DVD corresponds to negative asymmetry on a CD, and positive Beta. Higher laser power produces more positive asymmetry (positive beta). Some positive asymmetry is often desirable, with optimum of 0 - 5%. The maximum allowed is -5% to +15%.

Beta measures substantially the same thing as asymmetry, and is always defined in the same way for DVD and CD.

Reflectivity

Reflectivity is a function of the metal reflective layer, and on recordable discs, the absorption of the dye layer that is the active recording medium. The reflectivity of aluminum is typically about 80%. Some light is absorbed by the plastic substrate, so typical values for good molded discs are around 75%. Reflectivity of recordable discs is usually lower, and the minimum allowed is 45%. Low reflectivity makes the signal harder to decode. Dual layer discs must have lower reflectivity, because the beam must "see" through the first layer to the second layer. Therefore, the minimum reflectivity for dual layer discs is 18%, and the maximum is 30%.

True reflectivity is difficult to measure. What we are doing here is measuring the intensity of the laser beam reflected from the disc. This is affected not only by the disc's reflectivity, but also the pit geometry, due to diffraction of the beam by the pits. As a result, discs with strange pit geometry can produce erroneous reflectivity measurements.

DVX QUALIFICATION DISCS

IMPORTANT: Do not lose these discs! They allow you to determine if your DVX is working properly.

Supplied with your unit are two Qualification discs with measured results from your DVX before it left the factory. To confirm that your system is operating properly, test these discs 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. The factory results are made at 40X for the Setup & Qualification Discs 6F (the installation disc), and the DVD test disc is tested at 12X. All analog measurements (Beta, Jitter, etc.) are made at 4X for CDs and 2X for DVDs.

The Setup & Qualification Disc is an ordinary CD-R disc that is known to have low error rates. Playing this disc will confirm that the unit is capable of generating low error rates. Likewise, the DVD Qualification Disc is a DVD-R disc with known error rates. Many subtle problems with the player can be detected using these discs.

Test results for all discs are provided in the form of graphs for the whole disc, plus summary report. You can compare your results with the charts. 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 some error rates may be higher at faster speeds, and others will be higher at lower speeds. In general, error rates on good discs will be about the same at higher speeds as at the slowest speed. 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.

QUALITY CONTROL BASICS

WHAT IS DISC QUALITY?

We define disc quality as having every disc work in every drive, every time, with a lifetime appropriate to the application. You must decide what level of confidence you need for your application. The higher the cost of failure, the more careful you want to be.

It's Worse Than You Think...

One problem in evaluating disc quality is that discs that appear "good" may not be. All CDs and DVDs have very powerful error correction built in that hides a multitude of sins. In principle, it is possible to drill a 2mm hole through the disc and still recover every single bit! However, you wouldn't want to rely too heavily on having that disc work reliably. Many people think that just because a disc seems to be readable, it is good. But it actually may be on the verge of failing.

WHY TEST DISCS?

DVD / CD Duplicators

You can improve profitability and reduce costly problems in your DVD-R / CD-R duplication business. As a disc duplicator, you are responsible for the quality of your product. Data comparison does not measure disc quality. Just because you can read it doesn't mean it's good. Poor disc quality can cause unreliable operation and short lifetime.

Evaluate and Qualify Recordable Media - All DVD and CD recordable media are not the same. Compatibility between writer and media is crucial. Find out which type of media works best with your writers. In addition, anyone can make a bad batch of media. Localized defects and dye coating problems are not uncommon. Identify bad batches of media before burning a bunch of bad discs.

Furthermore, you can discover the lowest cost media that meets your quality requirements, providing significant cost savings.



Detect Media and Recorder Compatibility Problems - Compatibility between media, writer, and software is necessary to produce good discs. Certain combinations of write strategy, recording speed, and media type can produce poor results. Determining the best media to use with a given recorder (or vice versa) is greatly facilitated by testing disc quality. Identify burners that are failing or about to fail. Discover if the problem is the media or the writer.

Manufacturers

Disc manufacturers must test discs to ensure conformance to standards & license agreements. But of course the main goal is customer satisfaction. Many replicators have found our products useful for screening discs on the production line to spot problems before many bad discs are made.

Distributors

Distributors can use disc testing as a way to manage quality variations from vendors, and make sure they get what they paid for. Although most replicators produce good quality products, bad discs often slip through. Discs that are made thinner than usual and physical defects such as pit distortion from short manufacturing cycles indicate poor manufacturing techniques and can result in unusable discs. If you are paying for premium discs, you want to be sure the quality measures up. In addition, you can avoid returns and unhappy customers.

Studios & publishers

Avoid problems with mastering - In the majority of glass mastering systems, uncorrectable errors (referred to as E32; see discussion below) automatically abort the mastering session, causing costly delays for both the mastering house and the customer. Most replicators prefer that you be able to demonstrate that your CD-R does not reach this level of error.

Provide confidence in product quality - When problems occur, they can be resolved more quickly and easily if publishers know the quality of their discs and have a way to check them. Also, once a product is in the field, fixing a problem becomes more difficult and expensive. Publishers can avoid returns and maintain a good reputation by tracking the quality of their discs.

End Users

Critical Applications – If your application has a high cost of failure, you can increase your confidence level by testing the discs.

Archiving – The initial quality of a disc profoundly affects its potential lifetime. A good disc has greater tolerance for the effects of aging than a poor one. If you are archiving either DVD/CD-Recordables or replicas, you will want to select the highest quality discs to archive. This is possible only if you have a way of measuring disc quality.

Avoid long access times – As discs degrade, access times increase dramatically.

HOW TO MEASURE DISC QUALITY

Traditionally, many disc producers evaluate the quality of disc copies by comparing the copy with the original. In some cases, this can be useful, but data comparison does not measure disc quality. For instance, a bad disc can still verify. The DVD/CDs error correction can make a bad disc work, but it may be about to fail, or may not work on all readers.

The easiest way to measure disc quality, however, is to measure error rates. This technique is effective because any serious problems on the disc will affect error rates. A meaningful quantitative measure of disc quality can be obtained by measuring the quantity and severity of errors generated on playback. Important information can be gleaned by looking at the size of the errors as well as just the number. BLER (BBlock Error Rate) only counts how many errors occurred; it does not tell you anything about how severe those errors were. It is quite possible to have a low BLER, but have serious uncorrectable errors. DVX measures six different sizes of errors, and graphs them by increasing radius, providing a detailed picture of disc quality and defects.

Errors are not necessarily physical features on the disc, but are a measure of how well the total system (disc plus player) works. In fact, all discs generate errors on playback - even the best discs produce thousands of errors. The errors are partly due to the fact that playing a DVD or CD is a difficult and complicated process. The width of the pits on a disc is smaller than the wavelength of the light used to detect them, so players are operating at the limit of physical laws.



Playing a disc is not wholly deterministic, but is rather a statistical process. Therefore, the results will not necessarily be the same each time.

Moreover, the objective (the lens that picks up the laser beam that reads the disc) must stay focused within a range of less than 4 microns while the disc is moving both horizontally and vertically. The pickup must follow the spiral track of pits as it moves to an accuracy of much less than one micron (one millionth of a meter). Several highly tuned and sophisticated servo (control) systems are used to maintain focus, follow the track, control the spindle speed, and handle timing issues related to reading the data. These servos are very sensitive and work only within a certain range. Thus, some of the errors occur as a result of the narrow tolerances within which the equipment must function.

Two primary features of the disc itself that can cause errors are poor pit geometry and physical defects. Pit geometry refers to the depth, width, length, and wall slope of the physical pits created in the disc. Although recordable discs do not have pits, the recording process produces areas on the disc that function like pits and are subject to imperfections that cause errors. Physical defects include pinholes in the reflecting layer, black spots, bubbles, and scratches. Poor pit geometry and physical defects can make it difficult or impossible for the servomechanisms to read the data properly.

A determination can often be made as to whether problems are caused by pit geometry or local defects. A burst of large errors confined to a small part of the disc is most likely caused by some kind of local defect. If many large errors are found over the whole disc (or a large part of it), then the problem is most likely poor pit geometry.

It is extremely difficult to measure pit geometry directly. An easier approach is to play a disc and look at the signals produced by the pickup. The way the light beam reflects back is influenced by the size and shape of the pits. By observing the pattern (referred to as an “eye pattern”) created by the playback signal, it is possible to measure features such as pit depth and length. DVX provides a simple way to make pit geometry measurements using the optional Analog Measurement Module, or oscilloscope.

MAJOR CAUSES OF DISC FAILURE

The most common cause of disc failure is **scratches and dirt** due to handling.

With molded discs that have not been handled, the most common cause of defects is a **defective master or stamper**. This is true because any defect on the stamper will be faithfully reproduced on every disc.

With DVD/CD-Recordables, the most common problem is **incompatibility between the writer and the media**. Often the case is that the recording speed is too high for the type of media being used. Generally, higher recording speeds produce poorer results. This problem usually manifests itself as high error rates across the whole disc. Another common cause of problems is a speck of dust or dirt on the disc (readout) surface when recording. This blocks the recording beam, producing a void, where there are no “pits”. Likewise, bubbles or black spots in the disc substrate can cause the same problem. These type of errors show up as local defects, for example like in fig. 9 on page 26.

Quality Clues

Most problems are traceable to the disc. Often people will encounter a situation where a disc works in one drive, but not another. The tendency is to blame the drive, concluding that “the disc must be good because it plays in this other drive”. However, almost certainly it is the disc that is at fault. Since there are no standards for players (other than that they must play a disc that meets the standards), a disc that is outside the Red Book or DVD specs may play on some drives, but not others.

The solution is that all discs must conform to the standards. Discs that are made well within Red Book or DVD standards should play on any player.

A disc that behaves erratically is invariably bad. A disc that is outside the specs (or marginal) will behave in a way that is not predictable. If a disc produces different results each time you test it, that tells you that the disc does not meet Red Book (or DVD) specs.

DISC DUPLICATION TIPS

How to Test Blank Media

DVX will measure Focus Error and Tracking Error on a blank disc (CD or DVD). To do this, load the disc, and wait for it to initialize. Then select the "Blank Test" checkbox in the main screen, then press "Start".

Although some things can be measured on a blank disc, none of these things will predict how the disc will work. The recording action is in the dye layer, and the only way to test the dye is to record on it.

We recommend that you record the full disc (74 or 80 minutes) at the speed you wish to use in production. This is important because defects are more common at the outside of the disc. Then do the Error Test to measure the results. Analog pit geometry measurements are especially useful for qualifying new media.

Since the media is generally quite consistent within a batch, it is only necessary to test one or two samples from each batch of new media.

You will also find that the results vary according to the recording speed. Generally, results are worse at the highest speeds. Ideally, you should make full test recordings at several different speeds to discover what is the highest speed that will give satisfactory results.

Hints for Producing Good Discs

- The number one issue is compatibility between the writer and the media. There isn't necessarily a "best" writer or "best" media; some combinations work better than others. The writer's laser power and write strategy must match the type of media used. Both media and writers have evolved over the years, so there are many opportunities for mis-match.
- Use DVX to determine the best type of media for your application. Most major brands will produce good results with modern writers. But anybody can make a bad batch. The media is pretty consistent within a batch, so if there is a manufacturing defect, every disc will be bad. We have gotten bad batches from most major manufacturers. Defects range from stamper defects to bubbles in the plastic, to dirty discs and dye layer coating problems. We have had to change brands several times over the years when a particular brand's process changed. One major advantage of having something like DVX is that you can discover what type of media works best with your writers. You can also discover which is the lowest cost media that gives satisfactory results. The best approach is to try several different types of media in your burners and see which works best.
- Recording speed also makes a big difference. Again, your results will depend on the combination of writer and media, but try each type of media at different speeds to see what works best.

Discs must be perfectly clean when recording. One of the most common problems is a speck of dust on the disc while recording. The speck will block the recording beam and create a "void", where there are no "pits". This will show up in the test results typically as E22 errors. Since data discs should not generate E22 errors, this can be a fatal flaw.

APPENDIX

LOGICAL BLOCKS AND SECTORS

CD Discs

Data CDs are arranged in sectors, so that the data can be randomly accessed. These sectors are always of a fixed size, but the amount of user data may vary. Also, each sector may contain additional parity bytes for error correction, depending on the mode.

Audio discs have no sectors; the data is a continuous stream of music. However, they do have time code that can be correlated to sectors. The size of a subcode frame is the same as the size of a sector on a data disc. Therefore, it is possible to convert between Atime and Sector number.

Physical sector numbers start at the beginning of the disc, and continue to the end. However, the first 150 sectors of a data disc are used for pre-gap, and contain no information. Therefore, the data area begins at physical sector 150, and is called Logical Block 1. Logical Blocks (abbreviated LBA for Logical Block Address) are the same thing as physical sectors; the only difference is that they are numbered beginning at physical sector 150. Whenever we refer to a data disc sector, we mean physical sector unless we say logical block or LBA.

DVX software uses both physical sectors and logical block addresses. When entering START and STOP points, use physical sectors. When viewing disc data, use logical block addresses.

DVD Discs

All DVD discs are addressed using **Logical Block Addresses**. DVD locations are never entered in physical sector numbers or Minutes:Seconds:Frames.

How QuickScan™ works

QuickScan™ is an exclusive feature of DVX that speeds up testing by 3½ times for CDs and 8 to 10 times for DVDs. This allows you to test an 80 minute CD in as little as 48 seconds, or a DVD5 in 38 seconds. The [table](#) on page 57 shows test times for various types of discs with and without QuickScan™.

QuickScan works by testing only samples of the disc. If the samples are very close together physically on the disc, no significant information is lost. Serious errors are caused by physical defects that prevent the drive from reading the data on the disc. Due to the powerful error correction on CD and DVD discs, a physical defect has to be about 100µm in diameter to cause serious errors. Therefore, if we sample the disc every 50µm, there is no chance of missing a significant defect. Samples are designed so that they always cover at least one complete revolution of the disc (and usually much more). Then the pickup jumps ahead 50µm to the next sample. Any defect in the skipped section would have to be no more than 50µm in size, and therefore would not generate any serious error. In practice, defects are usually much larger than this, and may even include the entire disc.

QuickScan works at all test speeds. So 2X becomes 7X, 4X becomes 14X, etc. When QuickScan is enabled, the status bar shows the current speed as “48X MAX QS” for instance instead of “48X MAX” so you can know when QuickScan is enabled. The Summary Report also shows whether QuickScan was used for the test.

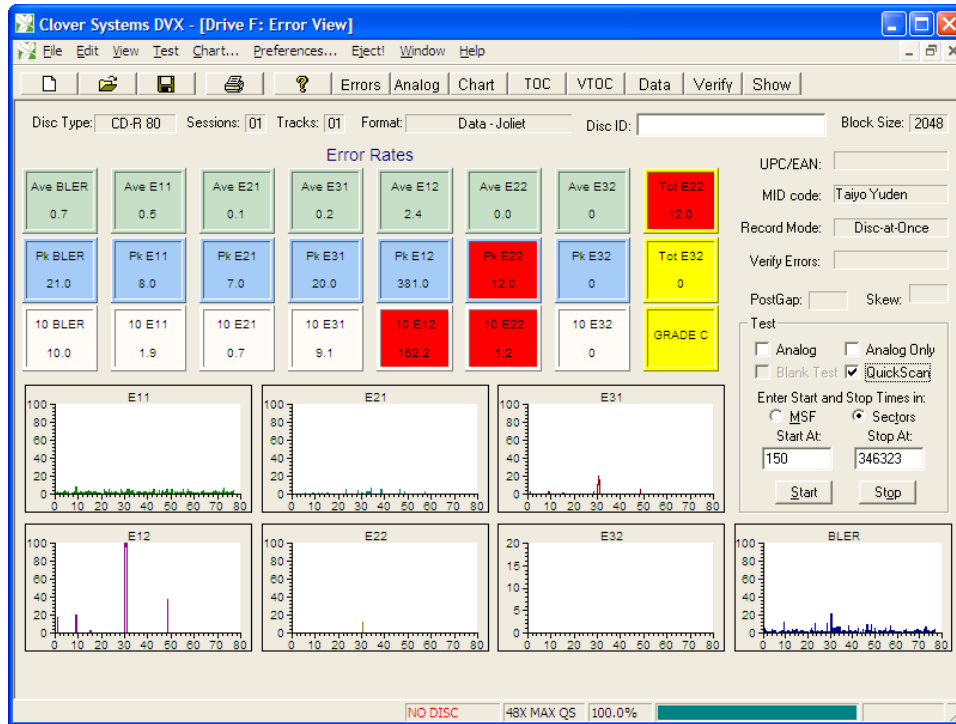


Fig. 31 - CD Error Test with QuickScan

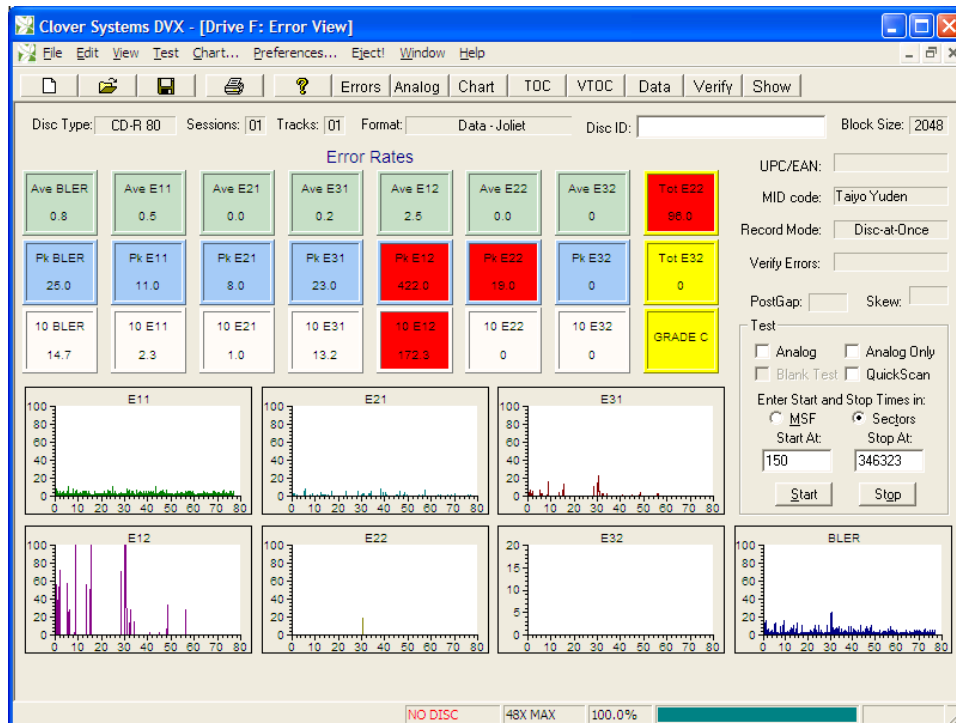


Fig. 32 - CD Error Test without QuickScan

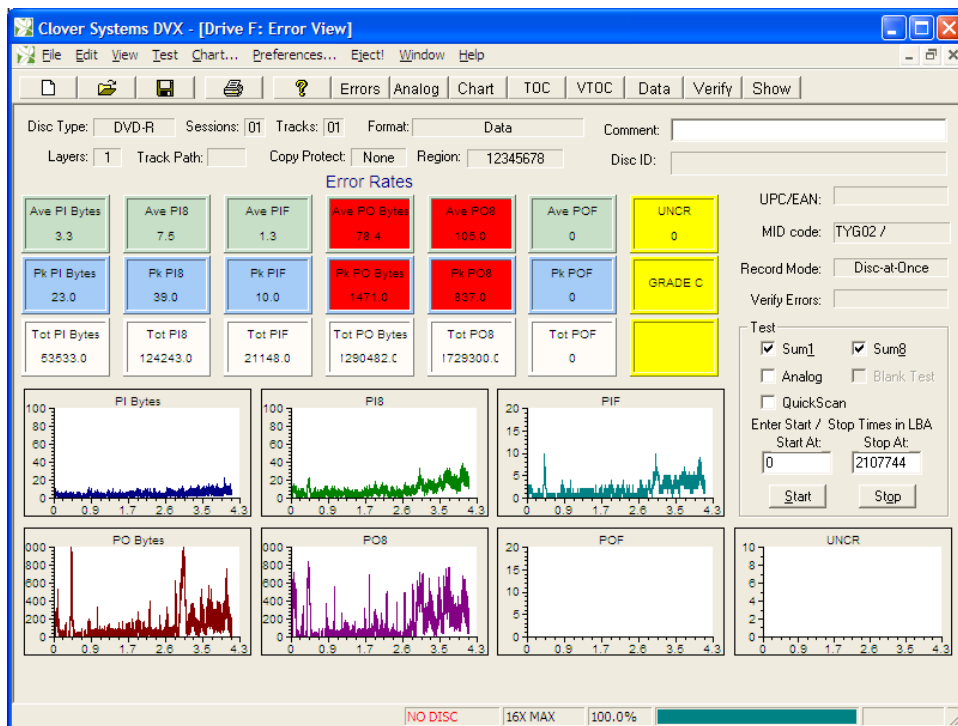


Fig. 33 - DVD Error Test without QuickScan

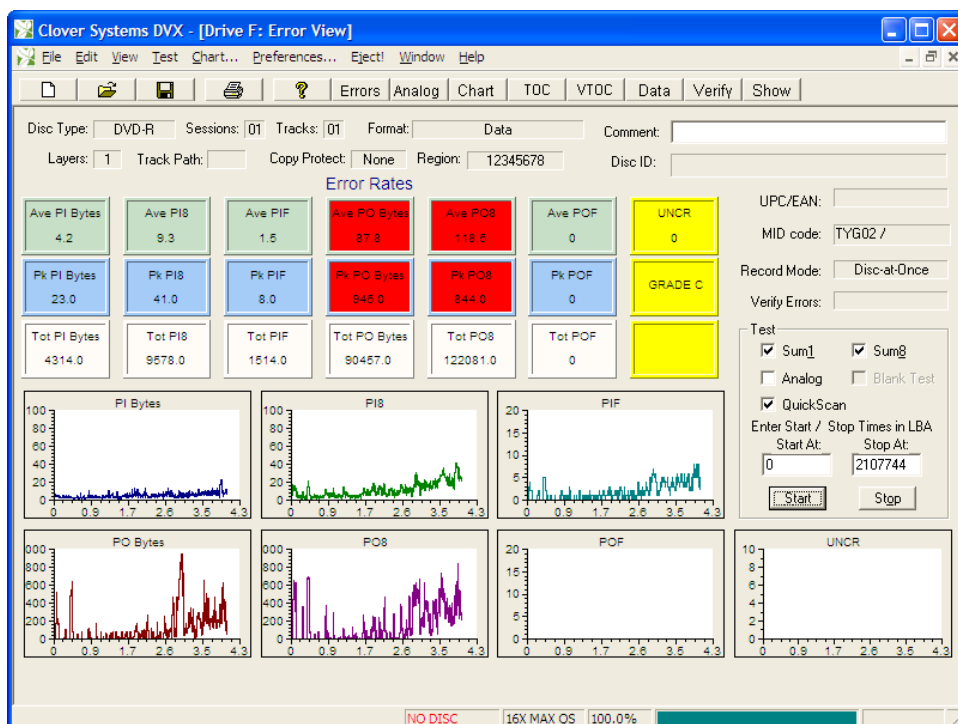


Fig. 34 - DVD Error Test with QuickScan

MAINTENANCE AND SERVICE

Ordinarily, there are no adjustments or maintenance required. If you need repairs, send the DVX 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 DVX in at least 3" of bubble-pak or foam rubber before shipping.

Service Contacts:

Tel: +1 949.598.0700
Email: service@cloversystems.com
Web: <http://www.cloversystems.com>

IMPORTANT

The primary thing that can go wrong with the DVX drive is that eventually the lasers will wear out. The lifetime of the lasers varies considerably from drive to drive, so it is difficult to predict the lifetime. However, since recording discs uses 10 times the laser power of playing back, using the DVX to record discs will shorten the laser's life.

To make your DVX last as long as possible, please do not use it for recording.

Trouble Shooting

DVX Does Not Run at Full Speed

Parallel ATA drives

DVX drives with ATAPI (IDE) interface can suffer from a Windows problem that disables the drive's DMA transfer mode. For maximum performance, the IDE channel connected to the DVX drive should be set for DMA mode. This allows the drive to operate at full speed without using any processor resources. It is reported that several circumstances can cause Windows to disable DMA mode, and revert to PIO (Programmed I/O) mode. These apparently include things like excessive DMA errors causing timeouts. This can happen when testing discs that are severely damaged, or otherwise unreadable.

Depending on the speed of your processor, you may experience a drastic reduction in test speed. With a fast processor, you may not experience any reduction in test speed, but you will slow the processor down enough that other tasks become sluggish. You can see if DVX is using processor resources by running Windows Task Manager. You can also view the ATAPI controller properties in Device Manager / IDE ATA/ATAPI controllers. Transfer mode should be set to "DMA if available", and Current Transfer Mode should be "Ultra DMA n" DVX is capable of running in Ultra DMA modes 0-4. The actual mode will depend on the capabilities of your motherboard.

Solution

One would expect that Windows would restore the DMA mode after a re-boot or after changing the settings in Device Manager, but it does not. To restore DMA mode, you will have to do one of the following:

- a) Run the Visual Basic Script RESETDMA.VBS which is installed in the Clover Systems program files folder, then re-boot.
- b) You can edit the Registry manually:

Run REGEDIT. Go to the following key:

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Class\{4D36E96A-E325-11CE-BFC1-08002BE10318}



It has subkeys like 0000, 0001, 0002, etc. Normally 0001 is the primary IDE channel, 0002 the secondary, but other numbers can occur under certain circumstances. You have to go through these subkeys and check the DriverDesc value until you find the proper IDE channel.

Delete MasterIdDataChecksum or SlaveIdDataChecksum, depending on whether the device in question is attached as master or slave, but it can't actually hurt to delete both. Reboot. The drive DMA capabilities will be redetected.

Open Device Manager again and check whether the device is now actually using DMA mode. If not, you may have to change the IDE channel setting from PIO back to the highest available DMA mode and reboot again.

Serial ATA drives

A similar problem can occur with SATA drives. In this case, the drive becomes unresponsive, and so Windows thinks that the drive is disconnected and disables it. This can be remedied by re-booting the system.

Registry Settings

The DVX installation sets registry entries for proper operation. If for some reason you need to set these manually, the settings are:

WinNT/2000/XP/Vista

```
[HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\ASPI32]
"ErrorControl" = dword:00000001
"Start" = dword:00000001
"Type" = dword:00000001
[HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\ASPI32\Parameters]
"Exclude Miniports" = ""
[HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies\Explorer]
"NoDriveTypeAutoRun" = REG_DWORD: 0xB1
```

DVX Test Times

Test Type	80 Min CD		DVD 5		DVD 9		DVD±R		DVD+R DL	
	Normal	Quick	Normal	Quick	Normal	Quick	Normal	Quick	Normal	Quick
CIRC Test	02:17	00:48								
Sum8 Test			05:16	00:38	09:34	01:09	06:35	00:45	19:36	01:58
Sum1 Test			05:16	00:38	09:34	01:09	06:35	00:45	19:36	01:58
Both Tests			10:32	01:16	19:08	02:18	13:10	02:18	39:02	03:56
Analog Test	20:00	04:52	27:33	02:41	50:03	04:52	27:33	02:41	50:03	04:52
All Tests	22:17	05:00	38:05	03:57	69:11	07:10	40:43	04:59	89:05	08:48

All times are in minutes and seconds (MM:SS).

All times are for a full disc; if disc is not full, time will be proportionally less.

DRIVE SPECIFICATIONS

Power Supply

DC +12V ±10% - 2.0A Max.

DC +5V ±5% - 1.7A Max.

Ave. power consumption: 22 W

Cable: IDE bus 80-pin flat ribbon cable. Maximum length = 18 in.

Dimensions: 5.75" x 1.63" x 7.48"

Weight: 1.0 kg

Host Interface

Type: ATA/ATAPI-5 compliant

PIO Transfer: Modes 0-4

DMA Transfer: Modes 0-2

Ultra DMA Transfer: Modes 0-4 (Ultra DMA66)

Inquiry String: CLOVER DVX DVD ANALYZER

Environmental

Mounting: Horizontal ±15 degrees

Operating Temperature: 5 – 40 degrees Celsius

Operating Humidity: 20 – 80% non-condensing

MTBF: 60,000 hours



Read Speed DVD

Minimum: 2X CLV

Maximum, molded single layer disc: 6-16X CAV

Maximum, molded dual layer disc: 5-12X CAV

Maximum, DVD±R/RW: 5-12X CAV

Maximum, DVD+R DL: 3-8X CAV

Read Speed CD (all types)

Minimum: 4X CLV

Maximum: 20-48X CAV for Mode 1 Data Discs

17-40X CAV for all others

Safety and EMC Standards

USA	UL	UL60950
	FDA	21 CFR 1040.10. 1.40.11
	FCC	Part 15B-Class B
Canada	C-UL	CSA 22.2 No. 60950
	IC	ICES-003 Class B
Europe	CE	EN60950
		EN60825-1
		EN55024
		EN50022 Class B
Taiwan	BSMI	CNS13438 Class B
Korea	MIC	
Australia	C-Tick	EN55022 Class B

DRIVE ERROR CODES

If the DVX drive is unable to complete a command, it may display an error code and message. The error code has three parts: The digit is the Sense Code. The next two digits are the Additional Sense Code (ASC), and the last two digits are the Additional Sense Code Qualifier (ASCQ).

EXAMPLE: Error 30000

Sense Code = 3 (Medium Error)

Additional Sense Code = 00

Additional Sense Code Qualifier = 00

The Sense Code is described in the error message. The ASC and ASCQ provide additional details to pinpoint the cause of the problem. If ASC = 00 and ASCQ = 00, it means that the cause of the problem cannot be determined. The example error code means that the disc is unreadable for unknown reasons.

TIP: Error 30000 (Medium Error) is the most common error. It means that the disc was unreadable for unknown reasons. In this case, the drive will stop and may not report any CIRC / PIPO errors because it was unable to read the disc due to servo problems, and therefore there was no data to decode. This is typically caused by a physical defect that disturbs the drive's tracking and focus servos.

The following table lists the additional sense codes and additional sense code qualifiers.

Sense Code (ASC) and Additional Sense Code Qualifier (ASCQ) Descriptions

For Sense Key RECOVERED ERROR (1):

ASC	ASCQ	Description

18	03	RECOVERED DATA WITH CIRC
18	04	RECOVERED DATA WITH L-EC

For Sense Key NOT READY (2):

ASC	ASCQ	Description

04	00	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
3A	00	MEDIUM NOT PRESENT
3A	01	MEDIUM NOT PRESENT TRAY CLOSE
3A	02	MEDIUM NOT PRESENT TRAY OPEN
57	00	UNABLE TO RECOVER TABLE-OF-CONTENTS
53	00	MEDIA LOAD/EJECT FAILED
04	01	LOGICAL UNIT IS IN PROGRESS OF BECOMING READY (TABLE-OF-CONTENTS READ IN PROGRESS)

For Sense Key MEDIUM ERROR (3):

ASC	ASCQ	Description

00	14	AUDIO PLAY OPERATION STOPPED DUE TO ERROR
02	00	NO SEEK COMPLETE
02	80	SERVO SEEK ERROR
02	81	SYNC ERROR
02	82	HEADER ERROR
02	83	TARGET NOT MET
06	00	NO REFERENCE POSITION FOUND
11	05	L-EC UNCORRECTABLE ERROR
11	06	CIRC UNRECOVERED ERROR

For Sense Key HARDWARE ERROR (4):

ASC	ASCQ	Description

08	00	LOGICAL UNIT COMMUNICATION FAILURE
09	00	TRACKING FOLLOW FAILURE
09	01	TRACKING SERVO FAILURE
09	02	FOCUS SERVO FAILURE
09	03	SPINDLE SERVO FAILURE
1B	00	TRANSFER ERROR
40	00	DIAGNOSTIC FAILURE ON COMPONENT O (INTERNAL BUS FAILURE)
44	00	INTERNAL TARGET FAILURE
B6	00	MEDIA LOAD MECHANISM FAILED

For Sense Key ILLEGAL REQUEST (5):

ASC	ASCQ	Description

20	00	INVALID COMMAND OPERATION CODE
21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
24	00	INVALID FIELD IN CDB
25	00	LOGICAL UNIT NOT SUPPORTED
26	00	INVALID FIELD IN PARAMETER LIST
53	02	MEDIUM REMOVAL PREVENT
81	00	LOGICAL UNIT IS RESERVED
63	00	END OF USER AREA ENCOUNTERED ON THIS TRACK
64	00	ILLEGAL MODE FOR THIS TRACK
85	00	AUDIO ADDRESS NOT VALID



For Sense Key UNIT ATTENTION (6):

ASC	ASCQ	Description

28	00	NOT READY TO READY TRANSITION
29	00	POWER ON, RESET OR BUS DEVICE RESET OCCURRED
2A	01	MODE PARAMETER CHANGED

For Sense Key ABORTED COMMAND (B):

ASC	ASCQ	Description

43	00	MESSAGE ERROR
45	00	SELECT/RESELECT FAILURE
48	00	INITIATOR DETECTED ERROR MESSAGE RECEIVED
49	00	INVALID MESSAGE ERROR
4E	00	OVERLAPPED COMMAND ATTEMPTED
B9	00	AUDIO PLAY OPERATION ABORTED



GLOSSARY

ATime	(<i>Absolute Time</i>) Timecode encoded in the subchannel of a CD in the form of playing time at 1X in minutes, seconds, and frames from beginning of the program area.
ATIP	(<i>Absolute Time In Pregroove</i>) Same as ATime but encoded in the pregroove and used by a writer to locate position on an unrecorded disc.
BLER	(Block Error Rate) The total number of errors encountered at the C1 stage (=E11 + E21 + E31)
CAV	(<i>Constant Angular Velocity</i>) The disc rotates at a fixed RPM. This results in a variable data rate, as the discs are recorded with CLV. Data rate is higher at the outside of the disc.
CD-DA	(<i>CD-Digital Audio</i>) Audio disc using 16 bit linear streaming data to represent each digital sample of two audio channels. CD-DA discs do not have sectors.
CD-R	(<i>CD-Recordable</i>) Write once-read many disc specified by the Orange Book Part II. It uses a molded in pre-groove to guide the laser during recording. The laser makes marks in the dye polymer layer by heating.
CD-ROM	(<i>CD-Read Only Memory</i>) Data discs made according to the Philips/Sony Yellow Book. This term is often used to signify a molded disc as opposed to a CD-R disc.
CD-ROM XA	(<i>CD-ROM eXtended Architecture</i>) A data disc that includes a subheader to support various modes of interleaving audio, graphics, video and computer data using CD-ROM XA Mode 2/Form 1 and CD-ROM XA Mode 2/Form 2 sectors. Error correction capability depends on the mode and form of the data.
CD-RW	(<i>CD-ReWritable</i>) Re-Writable disc made according to Orange Book Part III that can be recorded, erased, or overwritten. Uses a pre-groove like CD-R, but recording mechanism is phase change. Heat from the laser changes the medium from crystalline to amorphous structure, which has lower reflectivity. CD-RW reflectivity is much lower than CD-R, so not all drives can read these discs.
CIRC	(<i>Cross Interleave Reed-Solomon Code</i>) A method of error detection and correction employing parity bytes together with interleaving. Interleaving distributes the data over a relatively large area of the disc, so that one large defect becomes many small defects after de-interleaving. C1 is the first stage of error correction, followed by de-interleave and C2 the correction stage.
CLV	(<i>Constant Linear Velocity</i>) The scanning speed of the laser over the pits is constant. All CDs and DVDs are formatted this way. This requires higher rotational speed at the inside of the disc, and lower speed at the outer tracks. This produces a constant data rate.
DAO	(Disc At Once) Recording method where the entire disc contents are recorded in one continuous operation. Molded discs are always recorded using this method.
E11	One bad byte in a data frame at the C1 stage, which was corrected (CD Only).
E21	Two bad bytes in a data frame at the C1 stage, which were corrected (CD Only).
E31	Three or more bad bytes in a data frame at the C1 stage, which were not corrected (CD Only).
E12	One bad byte in a data frame at the C2 stage, which was corrected (CD Only).
E22	Two bad bytes in a data frame at the C2 stage, which were corrected (CD Only).
E32	Three or more bad bytes in a data frame at the C2 stage, which were not corrected (CD Only).
EDC / ECC	(<i>Error Detection Code / Error Correction Code</i>) Additional error correction data that is added to data CDs, providing an additional layer of error correction in addition to CIRC.
ECC Block	On a DVD disc, this refers to one Reed-Solomon Product code error correction block. 1 ECC block = 16 sectors = 32768 user bytes.



EFM	(<i>Eight-to-Fourteen Modulation</i>) Modulation scheme used by CDs; converts eight data bits to fourteen channel bits prior to recording.
EYE PATTERN	The HF signal from the pickup as displayed on an oscilloscope.
GB	(Gigabyte) 1 GB equals 1024 megabytes. Often, 1 GB is defined as 1000 megabytes. Usage varies.
GRADE	Letter A, B, C, D, F indicating disc quality, assigned based on the test results. There are no standards for assigning letter grades.
HF	(<i>High Frequency</i>) This refers to the signal from the pickup's light detector that corresponds to the pits and lands on the disc.
ISO9660	Data format specification for data discs.
ISRC	(I nternational S tandard R ecording C ode)
Jitter	Variation in the detected lengths of the pits and lands upon playback.
kB	(Kilobyte), 1 kB equals 1024 bytes.
Land	The area of the disc that is not pits.
LBA	(<i>Logical Block Address</i>) Address of a sector on a data disc. Sectors are numbered consecutively starting with 0 at the beginning of the data area.
Lead-In	Area at the beginning (inside) of a disc containing the Table of Contents (TOC).
Lead-Out	Buffer area following the Program Area used in case the player reads past the end of the track.
Multisession	Each session is like a complete disc, with lead-in, program area, and lead-out, so a multi-session disc is like two or more discs spliced together.
PI Bytes	Number of bad bytes encountered in all rows of 1 ECC block (DVD only).
PIE	Number of rows in 8 ECC blocks that had errors detected by inner parity (DVD only). Sometimes called PIE or PIE8
PIF	Number of rows that were uncorrectable by inner parity in 1 ECC block (DVD only).
PO Bytes	Number of bad bytes encountered in all columns of 1 ECC block (DVD only).
POE	Number of columns in 8 ECC blocks that had errors detected by outer parity (DVD only).
POF	Number of columns that were uncorrectable by outer parity in 1 ECC block (DVD only).
Pit	Information is recorded as a series of pits and lands. Pits appear darker than land on playback. Viewed from the readout side, pits are actually bumps. A transition between pit and land (or land and pit) is a one, and everything else is a zero.
Post-Gap	Two second area at the end of a CD program area or Mode change, encoded as null data or audio silence.
Pre-Gap	Two second first part of a CD program area or track, normally encoded as null data or audio silence.
Red Book	Proprietary Philips/Sony specification (red cover) for CD-Audio, subsequently published as IEC 908.
Reed-Solomon Code	Byte-structured parity format used for error detection and correction on optical and magnetic media.
Reflectivity	The percentage of light that is reflected from the disc surface.
SAO	(<i>Session At Once</i>) Recording method where one complete session of a multi-session disc is recorded in one continuous operation.
Sector	Fixed size unit of data on a data disc. Starts with a sector header containing the sector address.
SHA-1	(<i>Secure Hash Algorithm –1</i>) Derives a 160 bit word based on a block of data, which can be up to 2 ⁶⁴ bits. This word is unique to this data set; changing any bit (or combination of bits) will change the result.



Skew	(Subcode Skew) The difference between a sector address contained in a sector header, and the Atime contained in the subcode.
Subcode	Ninety-eight-bit codes used in the CD format. P and Q codes contain flag and control information. Timecode (Atime) is encoded in the Q channel. Codes R,S,T,U,V,W may be used for CD+G or other specialized applications.
Table of Contents (TOC)	Lists number of CD tracks, their starting locations, total length of data on the disc, and identification of type of disc. The TOC is placed in Q-subcode in the lead-in area of a CD disc.
TAO	(<i>Track At Once</i>) Recording method where one track is recorded. Lead-in and lead-out are added later.
UPC/EAN	(<i>Universal Product Code / European Article Numbering</i>) A code identifying a consumer product. Usually appears as a bar code on the package, and can be encoded into a CD.
UNCR	Total number of uncorrectable ECC blocks for the whole disc (DVD only).
Volume Descriptor	Up to four sectors containing information describing the disc information.
Write Mode	Method used to record a recordable disc: Can be TAO (track-at-once), SAO (session-at-once), or DAO (disc-at-once).

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