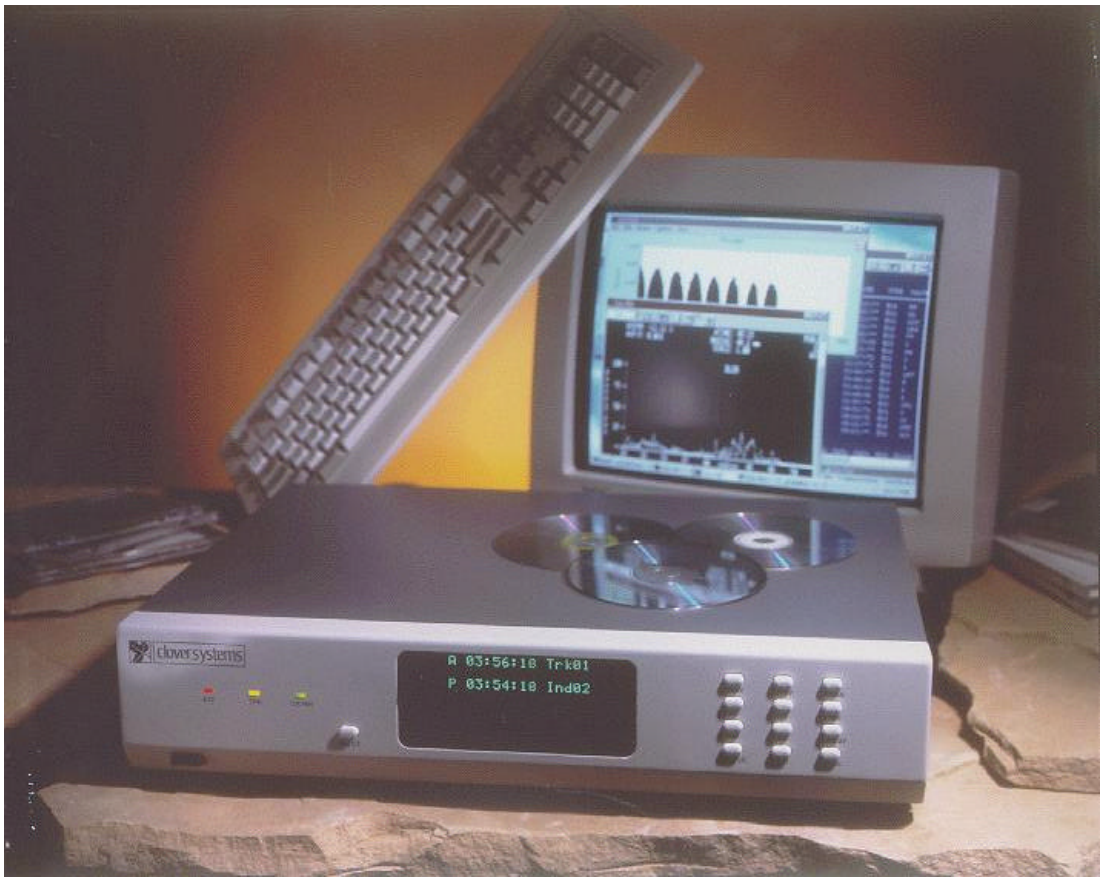
clover systems



QA-201
COMPACT DISC JITTER ANALYZER

OPERATING MANUAL

Version 3.0

COPYRIGHT 2001 © CLOVER SYSTEMS
ALL RIGHTS RESERVED

TABLE OF CONTENTS

INTRODUCTION **1**

INSTALLATION **2**

HARDWARE 2
AC Power Connection 2
Audio Connections 2
Printer Connection 2
QA-Net Connection 2
Single Unit Configuration *3*
Multi-Unit Configuration *3*
Installing the TIA Board 3
I/O Base Address *3*
Changing the Board Address *4*
Installing the Board in your PC *5*
Device Conflicts *5*
Connecting the Cable *5*
SOFTWARE 6
Windows NT / 2000 Installation 6
System Setup 7

OPERATION **7**

CONTROLLING THE PLAYER 7
PLAY 8
Playing from the lead-in *8*
Playing at 1X speed *8*
Quick-Scan *8*
Playing Multi-Session discs *8*
Playing CD-I discs *9*
STOP 9
PAUSE 9
> (NEXT TRACK) 9
< (PREVIOUS TRACK) 9
>> (SEARCH FORWARD) 9
<< (SEARCH BACKWARD) 9
Display Modes 9
Display Mode 1 ..... *10*
TIME Formats *10*

Display Mode 2 ..... *11*
Display Mode 3 ..... *11*
Display Mode 4 ..... *11*
Display Mode 5 ..... *11*
Controlling the Player from the PC 11
MEASURING ERROR RATES 12
Starting the Test 12
Controlling the Error Display 12
Indicator Lights 12
Disc Grading System 13
Displaying Errors on the PC 14
Setting Alarm Limits 15
USING THE PRINTER 16
SPLIT TEST 18
Setup 18
Operation 19
MEASURING PIT GEOMETRY 19
Using the Oscilloscope 19
Choosing an Oscilloscope *19*
Connecting the Oscilloscope *20*
Oscilloscope Settings *20*
Components of the HF Signal 20
Measuring I_{top} 20
Measuring I_{11} 21
Measuring I_3 21
Measuring Asymmetry 23
Measuring Beta 23
Measuring Reflectivity 23
Measuring Radial Contrast 24
Measuring Crosstalk 24
MEASURING JITTER & EFFECT LENGTH DEVIATION 24
Setup 24
Setting the I/O Base Address *24*
Number of Samples *25*
Making Effect Length Measurements 25
Test Results Summary 25
SAVING THE DATA 25
Saving Results to a Spreadsheet 26
STARTING A NEW TEST 26
LOADING IN SAVED DATA 27
MAKING CHARTS 27
Single Node Chart 27
Multi-Node Chart 28
Multi Chart 28

Effect Length Charts 29
Histogram *29*
Jitter *30*
Mean *31*
Deviation *31*
Pits or Lands *31*
Jitter Summary Chart *31*
MODIFYING THE CHARTS 32
Changing the Axes 32
Changing the Line Style & Color 33
Other Chart Customization 33
PRINTING THE CHARTS 33
PRINTING A SUMMARY 33

INTERPRETING THE RESULTS 34

CIRC Error Correction 34
TYPES OF ERRORS 35
WHY E32 IS CONSIDERED UNCORRECTABLE 35
BURST ERRORS 35
BERL 36
BEGL 36
DROPOUT 36
TRACK LOSS 36
INTERPRETING HF SIGNALS 37
HF SIGNALS AND DISC DEFECTS 37

MAINTENANCE AND SERVICE 38

CHANGING THE DATE AND TIME 38
CHANGING THE NODE NUMBER 38
EMERGENCY EJECT 38
SERVICE 38

COMMUNICATIONS PROBLEMS 39

CALIBRATION 39

SYSTEM REQUIREMENTS 40

QA-201 QUALIFICATION DISCS 40

TABLE OF FIGURES

Figure 1 - Main Window 14
Figure 2 - Alarm Settings Dialog 16
Figure 3 – Sample Printout 17
Figure 4 – Eye Pattern on Oscilloscope 22
Figure 5 - Sample Single Node Chart 28
Figure 6 - Sample Multi Chart 29
Figure 7 - Sample Histogram 30
Figure 8 - Sample Jitter Chart 30
Figure 9 - Sample Jitter Summary Chart 32

INTRODUCTION

The Clover Systems QA-201 Compact Disc Analyzer is the first affordable tool to quantitatively measure the quality of a CD. It will analyze CD-DA, CD-ROM, CD-ROM XA, CD-I, CD-R, and CD-RW discs at 2X or 1X speed.

The QA-201 measures disc quality by examining the quantity and severity of CIRC errors generated during playback. It also provides the capability to measure signal parameters related to pit geometry, such as I11, I3, asymmetry, and Itop. It can also be used to measure reflectivity, eccentricity, and crosstalk. The Clover Systems QA-201 also measures Effect Length and Jitter in accordance with the Red Book and Yellow Book standards, with resolution of 1 nanosecond. “Effect Length” means the length of each size of pits and lands. It is easier to say “effect” than “pits and/or lands.” Together, this information provides a thorough analysis of disc quality. Also see the section titled "INTERPRETING THE RESULTS."

The QA-201 automatically measures and displays all error rates and detects and counts dropouts and tracking errors. The QA-101 measures and displays BLER (Block Error Rate), E11, E21, E31, E12, E22, E32 (uncorrectable errors), BERL, BEGL, TrackLoss, and DROPOUTS. Three different types of measurements are made for each of these parameters (except E32, BEGL, and DROPOUT); they are CURRENT value, AVERAGE value, and PEAK value. For E32, BEGL and DROPOUT, there are two types of measurements: CURRENT value, and TOTAL number. For E22, TOTAL is displayed in addition to CURRENT, AVERAGE, and PEAK. There is also a front panel indicator for Track Loss, which indicates potential tracking problems, and a built in Grading System that assigns a quality Grade based on the results of the test.

The type of error displayed, and its measurement modes are selected by buttons on the front panel. In addition, there is an LED on the front panel that lights and stays lit if an uncorrectable error is encountered.

If a printer is attached to the built-in printer port, certain errors will be printed with the current ATIME (Absolute Time) as they occur. When the test is completed, a summary of the results is printed.

An RS-232 serial connection is provided on the rear panel for connection to a PC. Windows software provides data collection, display, and archiving for up to eight QA-201 units.

BNC connectors on the rear panel provide buffered HF and TRK outputs for connection to an oscilloscope, spectrum analyzer, or other measurement equipment.

An AES/EBU digital audio output on the rear panel allows connection to an external DAC. Analog audio outputs are also provided. For highest audio quality, use the digital audio output with an external DAC.

The QA-201 player has an additional data slicer which is fed from the unequalized HF signal. It's output goes to a BNC jack on the rear panel labeled "EFM." This TTL EFM signal is then connected to the TIA board installed in the PC.

QA-201 v3.0 software is a Windows program that gathers both CIRC error data from the player, and effect length data from the TIA board. It calculates and displays the average effect (each size of pit or land) length, the deviation of the average lengths from the ideal values, and the standard deviation (jitter) of each effect length.

All data can be graphed on the screen, and can be printed. A summary of error results is displayed in the main window, and can be printed using the File / Print Summary command. Jitter / Effect Length summary data is displayed in it's own window and is printed with the summary.

INSTALLATION

HARDWARE

AC Power Connection

The QA-201 is set up and used just like an ordinary CD player. The QA-201 will accommodate input voltages from 90 VAC to 260 VAC, 50/60 Hz without any switch required.

IMPORTANT!

In an emergency, you can remove power from the QA-201 player by unplugging the AC power cord from the rear of the unit.

Audio Connections

If you need to audition audio discs, you can connect the RCA audio jacks to your audio equipment using ordinary audio interconnects. Alternatively, you can connect the AES/EBU digital output on the rear panel into any commercial audio D/A converter that accepts AES/EBU input.

Printer Connection

If you are using a printer, connect it to the PRINTER port on the rear panel of the QA-201 using an ordinary PC parallel printer cable. You can use any printer, which has a Centronics type parallel interface and accepts ASCII text. Many printers will only work with Microsoft Windows. When selecting a printer, be sure to get one that will work with MS-DOS, or specifies that it will accept ASCII text.

QA-Net Connection

The QA-201 software communicates with the player using the QA-Net connection. This requires one serial communications port. This port can be COM1, COM2, COM3, or

COM4. The QA-Net serial port on the QA-201 can be configured for either RS-232 or RS-485 operation. RS-232 operation is used if you have only one QA-201 attached to QA-Net. RS-485 operation is used if you want to connect more than one QA-201 to the computer. QA-201's are shipped configured for RS-232 unless a multi-player configuration is requested. Communications are bi-directional half-duplex at 9600 baud. Your COM port will be set to the correct protocol automatically by the QA-201 program. It is not necessary to change the serial port settings in the Windows Control Panel.

Single Unit Configuration

Just plug one end of the QA-Net cable directly into your serial COM port, and the other end into the QA-Net connector on the rear panel of the QA-201. If the PC has a 25 pin connector, you will need to use a 9-pin to 25-pin serial adapter.

Multi-Unit Configuration

If you wish to connect more than one QA-201 to your PC, the serial port must be configured for RS-485. In the QA-201D, this is accomplished by changing an IC inside. The QA-201E (v4.0 and later) serial port can be set to RS-232 or RS-485 operation via the front panel. To use this feature, you must have firmware v4.05 or later. The firmware version is displayed on the front panel when you turn the power on. If you do not have the proper firmware version, please contact the factory.

To change between RS-232 and RS-485 operation, press ALT + MODE on the front panel. This allows you to set the QA-201 node number using the "<" and ">" buttons. When multiple QA-201's are connected, each QA-201 must have a unique node number. Press MODE again, and you can now toggle between RS-232 and RS-485 modes using the "<" and ">" buttons. Set the mode you want, then press MODE again to exit back to normal operation.

Connect the RS-485 adapter that comes with QA-Net to your available COM port. Make sure that the end labeled "Computer" is connected to your computer, and the end labeled "Network" is connected to the QA-201s. Use the supplied ribbon cable to connect the adapter to the QA-201s. Up to 8 QA-201s may be connected to one COM port at once.

Installing the TIA Board

Before handling the TIA board, touch a grounded metal object such as the metal chassis of your computer to remove any static electricity which could damage the board.

I/O Base Address

Before installing the TIA board in your computer, be sure that the I/O address select DIP switch is set to an appropriate I/O address. The default setting as shipped from the factory is 300 hex (768 decimal).

The TIA board uses four I/O addresses: Factory setting is 300h through 303h. Ordinarily, this should not conflict with any other devices, but if you already have some device that uses this address, then set the address to some unused address.

Make sure that there are no other devices in your system which use I/O addresses 300 - 303h. In Windows, you can see what I/O addresses are used by going to the Device Manager.

Changing the Board Address

The DIP switch address bits A2 through A9 are marked on the board. Sliding the switch "up" (On) set the bit to zero, "down" (Off) sets it to 1. The DIP switch should be set as follows for address 300h:

"Down" = "Off" = 1 "Up" = "On" = 0

Address Line	A9	A8	A7	A6	A5	A4	A3	A2		
Switch	Off	Off	On	On	On	On	On	On		
Binary	1	1	0	0	0	0	0	0	0	0
Hex	3		0				0			

Here are some examples of other address settings:

Address Line	A9	A8	A7	A6	A5	A4	A3	A2		
Switch	Off	On	Off	On	On	Off	On	On		
Binary	1	0	1	0	0	1	0	0	0	0
Hex	2		9				0			

Address Line	A9	A8	A7	A6	A5	A4	A3	A2		
Switch	Off	Off	On	On	Off	On	On	Off		
Binary	1	1	0	0	1	0	0	1	0	0
Hex	3		2				4			

Installing the Board in your PC

WARNING!

For protection against electrical shock and to prevent the possibility of damage to your computer, never remove the cover without first ensuring that you computer is turned off and unplugged from the wall socket.

Turn off the power to your computer, and unplug the power cord from the wall.

Remove the computer cover. Typically, it is attached with five screws in the back of the chassis.

The TIA board must be installed so that the BNC connectors project through the rear panel of the computer. If you try to slide the board straight down into the ISA slot, the BNC connectors will hit the rear of the computer chassis. Therefore, you must angle the board so that the BNC connectors slip into the cutout on the rear of the computer chassis. Once the connectors are through the opening, you can then rotate the board to get it into the slot. Notice that the rear of the board is cut away at an angle to allow this maneuver.

Press the board firmly into the edge connector socket. Make sure that the BNC connectors are properly centered in the rear panel cutout.

Install the screw that secures the board to the computer frame. This screw is required for proper grounding of the board. Make sure that tightening this screw does not pull the board out of it's socket.

Replace the computer chassis cover.

Plug the computer back into the AC power, and turn it on.

Device Conflicts

If your computer doesn't boot up or operate properly after installing the TIA board, there may be a device conflict. This can happen if there is some other device in the system which uses I/O addresses 300 - 303h. If this is the case, you will need to change the TIA board base address. The TIA board is not "plug and play". It will not be recognized by Windows, or appear in the Device Manager. You can avoid device conflicts by reserving the I/O addresses used by the TIA board in Device Manager. This will then prevent these addresses being used by another device.

Connecting the Cable

The TTL EFM output of the QA-201 (labeled "EFM") must be connected to the top BNC input on the TIA board using the coaxial cable provided. The "top" BNC is the one nearest to the RJ telephone type jack. For best results, use the RG58 / BNC cable provided. Do not use a cable longer than 6 feet.

SOFTWARE

Insert the floppy disk in your drive, and click on the Start menu at the bottom left of the screen. Select Run from the pop-up menu. Enter "A:Setup" in the edit box and press OK. Now just follow the instructions on the screen.

When you start QA-201, it automatically uses COM1. If you are consistently going to use a different port, COM2 for instance, you should change your command line to QA-201.EXE COM2. If you are not sure, or you will be changing ports a lot, you can change ports in QA-201's Communications menu. To change the default COM port, you can edit the QA-201 shortcut. A shortcut to QA-201 is created by the installation program in the Windows / Start Menu / Programs / Clover folder. You can also make another shortcut on your desktop. Right-click the shortcut and select Properties. Select the Shortcut tab. In the "Target:" edit box, change "C:\Program Files\Clover\QA-201\QA-201.exe" to "C:\Program Files\Clover\ QA-201\ QA-201.exe COM2" to change the default COM port to COM2.

Each QA-201 connected to the QA-Net network is a "Network Node." Every QA-201 is programmed with a "Node Number" which is displayed on the front panel display when you press ALT + MODE. Each QA-201 on a network *must* have a unique node number. For version 3, it must be 0 through 7.

NOTE - Each player displays its NODE NUMBER on its display when you press ALT + MODE.

The Node Number can be changed if necessary. To change the Node Number, see the section "Changing the Node Number" under "Maintenance" in the QA-201 manual (pg. 38).

Windows NT / 2000 Installation

Two installation disks are provided: One for Windows 95/98/ME, and one for Windows NT / 2000 / XP. To install QA-201 software under Windows NT, XP, or Windows 2000, use the installation disk labeled “Windows NT.”

With Windows NT and 2000, it is necessary to configure the driver with the address of the TIA hardware. This is done by running the program DEVCONF.EXE, which is in your QA-201 installation folder (typically \Program Files\Clover\). The default factory setting of the address of the board is 300h. Ordinarily, there is not reason to change it.

When you run the program, you will see a list of installed devices. The list will be empty if you haven't already done this. If you see Device #0 = GT200, I/O Address = 300, then the TIA board is already installed. If you see no devices in the list, then press the NEW button. Now enter "0" for the Device #, then select GT200 from the drop-down list of devices, and enter 300 for the device address. If the board address has been changed from the factory setting, enter the address as set on the switches on the board (see *Changing the Board Address* on page 4 for details). Now click the ADD button, which will add this device to the list. Now click OK to exit.

You must now reboot the PC for the settings to become effective. If you wish, you can run DEVCONF.EXE again to confirm that this device now appears in the list.

System Setup

This software requires a VGA display adapter set to 256 or more colors. Use Windows Control Panel to set up your display. Setting the display to 16 colors will result in a "hatched" background on some of the windows.

OPERATION

Now you are ready to run QA-201. Double click the QA-201 icon. QA-201 will first check to see which players are connected to the network. You will get a message that shows how many players were found. If QA-201 fails to find any players connected, make sure the player is turned on and connected to the PC serial port. Make sure you are specifying the correct COM port on the command line. If you are using a COM port different from the one specified on the command line, you can press "CANCEL" or "YES" in the message box, then use the Communications menu to change the COM port. Then select Find Nodes in the main menu. Any time you add or remove a player from the systems, you need to use the Find Nodes command in the main menu so that the software knows exactly what is connected.

If you still get an error, your PC hardware may not be installed correctly. Consult your hardware manuals and the section at the end of this manual titled "COMMUNICATIONS PROBLEMS".

The green LED on the front panel of the player is helpful for diagnosing communications problems. The QA-Net light comes on whenever the QA-201 is receiving commands or sending data. The LED should light when you click Find Nodes or launch QA-201. When QA-201 is running, the light should blink every 10 seconds when testing at 1X speed, and every five seconds at 2X speed.

The software will automatically determine if the QA-201 is playing at 1X or 2X speed. The default speed is 2X. To test at 1X speed with QA-201, start the player playing at 1X speed by pressing ALT + PLAY (see PLAY command). You can start and stop the player at will and the software will automatically detect any player speed changes. The speed is detected only when the player is polled (every 5 or 10 seconds) so it may take up to 10 seconds for the software to detect a speed change.

CONTROLLING THE PLAYER

The QA-201 player works just like an ordinary CD player, with one exception: You can start playing from the start of lead-in as well as any point in the program area. After inserting a disc and closing the drawer, the player reads the table of contents and displays the total program time along with the number of tracks on the disc. Place the disc in the

loading tray label side up. Use the EJECT button on the left side of the front panel to open and close the tray.

PLAY

Press the PLAY button to start playing at track 1. If you want to start playing at some other track, press the < (previous track) or > (next track) buttons to select the track number you want. Pressing PLAY will now cause it to start playing at the selected track.

Playing from the lead-in

If you want to test the lead-in area of the disc, press PLAY while holding the << (search reverse) button. This will start the player playing from the beginning of lead-in. While playing lead-in, the display will show TRK=0 in display mode 1. The TIME display will always show 00:00 while in lead-in, since there is no timecode in lead-in. In this mode, you cannot use any of the normal player controls such as PAUSE, NEXT, PREVIOUS, SCAN FORWARD, or SCAN BACKWARD, and it will only play at 1X speed.

Playing at 1X speed

The QA-201 normally plays at 2X speed. If you want to play or test at 1X speed, press PLAY while holding the ALT button. To play from the lead-in at 1X speed, press PLAY while holding the ALT and << buttons down. Jitter / Effect Length measurements can be made at either speed, but 1X may be more accurate. The time required to gather a certain number of jitter samples does not depend on the playing speed.

Quick-Scan

On a disc with multiple tracks, you can sample the first 10 seconds of each track automatically. Press PLAY to start the disc playing. Then press ALT + NEXT TRACK(>). This will start the Quick-Scan mode. In display mode 1, the display will read SCAN.

Playing Multi-Session discs

When a Multi-Session disc (CD Enhanced) is loaded, an “M” will appear at the right side of the front panel display. This is to alert the operator that this is a multi-session disc. When testing a multi-session disc in the normal way as described above, only the first session will be tested. If you wish to test the entire disc, press PLAY while holding STOP. This will start the disc playing at the beginning of track 1 at 1X speed, and will play all the way through until the start of the second lead-out. In this mode, you cannot use any of the normal player controls such as PAUSE, NEXT, PREVIOUS, SCAN FORWARD, or SCAN BACKWARD, and it will only play at 1X speed. Multi-session discs can also be played beginning at the lead-in by using the << + PLAY command described above. Also please note that the start point is not perfectly repeatable. It may start a few seconds before or after the beginning of track one.

Playing CD-I discs

When testing CD-I discs, the test will start in the lead-in instead of the beginning of track one. Since there is no timecode in lead-in, the display will read 00:00 for about 30 seconds before it reaches track one. Also, timecode will not be displayed when you use the search (<< and >>) buttons.

STOP

The STOP button will stop the player if it is playing. Pressing ALT + STOP with the player stopped will put the player into Open-Loop Tracking mode which is used to measure Radial Contrast, Reflectivity, and Eccentricity. Pressing STOP when the player is in Open-Loop Tracking mode will return the player to normal operation.

PAUSE

Pressing the PAUSE button while playing will suspend play mode. Pressing it again will resume playing at the same location. The player will not PAUSE when playing the lead-in.

> (NEXT TRACK)

This causes the player to move ahead to the next track. If you are already at the last track, it will wrap around to the first track.

< (PREVIOUS TRACK)

This causes the player to move back to the beginning of the previous track. If you are at the first track, it will wrap around to the last track.

>> (SEARCH FORWARD)

The QA-201 plays fast forward until you release the button. There are two search speeds; after you've held the button a few seconds, the speed will increase.

<< (SEARCH BACKWARD)

Plays backward until you release the button. After you've held the button a few seconds, the search speed will increase.

Display Modes

The QA-201's Vacuum Florescent Display shows both player information and error rates. There are five display modes showing different combinations of player information and error information. Pressing the DISPLAY button steps through the five display modes.

Display Mode 1

The default display mode shows disc time and track number on the top line, and error data on the bottom line. After inserting a disc and closing the drawer, the player reads the table of contents and displays the total playing time of the disc, plus the total number of tracks on the disc. While playing, the current time and track number are displayed. This mode also shows the status of the loading tray (OPEN, CLOSE), and displays READ while it is reading the Table of Contents. It displays PAUSE when in playing is paused, and STOP when the player is stopped.

TIME Formats

There are two types of timecode recorded on the disc: Absolute Time and Program Time. Absolute Time starts at 00:00:00 (minutes, seconds, and frames) and runs continuously for the total time of the disc. Program Time starts at 00:00:00 at the start of each track, and shows how long that track has been playing. Note that there are 75 frames per second on a CD, as opposed to 30 frames per second for video.

In all display modes, each of these can be displayed as either elapsed time or remaining time. Therefore, there are four ways of displaying the time. These different formats are selected using the TIME button on the front panel.

ATIM - Shows the current Absolute Time. Absolute Time starts at 00:00:00 and runs continuously for the total Time of the disc. Since there is a two-second pause before each track, track 1 starts at ATIME 00:02:00.

AREM - Shows the Remaining Absolute Time. This is the time remaining until the end of the program area of the disc. This is useful if you want to know how long it will be before the test finishes.

PROG - Shows the current Program Time. Program Time starts at 00:00:00 at the start of each track, and shows how long that track has been playing. Note that even for track 1, ATIM and PROG are not the same. ATIM starts at the beginning of the 2-second pause before track 1, whereas PROG starts at the beginning of track 1. Therefore, ATIM will always be larger than PROG by at least two seconds.

PREM - Shows the remaining Program Time. This is the time remaining until the end of the current track.

The bottom line of the display shows one type of error, which is selectable using the ERROR and MODE buttons. To select a particular type of error on the display, press the ERROR button repeatedly until the desired error is displayed. This button sequences through the eleven error types plus GRADE.

To select CURRENT, AVERAGE, PEAK or TOTAL measurement, press the MODE button. It sequences through the various measurement modes, so press it repeatedly until you arrive at the desired mode. The selected MODE will be remembered for each ERROR type, so that when you change ERROR types, it will display the MODE that was last set for that ERROR type.

Display Mode 2

Pressing the DISPLAY button steps through the four display modes. This mode shows all of the statistics for one type of error. Current, Average, and Peak are all displayed simultaneously for most errors. E22, E32, DROPOUT and TLOSS errors show Current and Total. As with Mode 1, you can select the type of error with the ERROR button. The current TIME as described above is also displayed.

Display Mode 3

Display Mode 3 shows the Disc ID number or UPC/EAN codes. If UPC/EAN (bar code) is encoded on the disc, it will be displayed in display mode 3. If UPC/EAN code is present, it will be printed on the printer. The current TIME as described above is also displayed.

Display Mode 4

Display Mode 4 displays the ISRC code for each music track if encoded on the disc. If present, ISRC codes will be printed on the printer as well. If no ISRC code is present, Mode 4 will display "ISRC TRKn: 0000000000000". ISRC codes are used only for music tracks, and identify the copyright holder. Since this code is present only on the music tracks, you must play each track to read the codes. It generally takes a few seconds for it to read the code. Since the ISRC code is encoded in the Q-subchannel, which has no CIRC error correction, it will take longer to read the code on discs with high error rates. You can get a quick listing of the ISRC codes on the printer by using the SCAN mode (see Pg. 8).

Display Mode 5

Display Mode 5 shows the current time of day and date. This is printed on the test printout when a printer is connected to the QA-201. You can change the date & time using the front panel buttons: Use the “<” and “>” buttons to move the cursor from one field to the next. Then use the “<<” and “>>” buttons to increment or decrement the current setting. The clock runs on an internal battery with a lifetime of 10 years.

In order to prevent accidental changing of the date and time, in normal operation the date and time cannot be changed. To set the date and time, hold the "<<" and ">>" buttons on the front panel while turning on the power. Keep them depressed until "QA-201 Node XX" appears on the display. You will now be able to change the date and time as described above. To return to "protected" mode, just turn the power off and back on.

Controlling the Player from the PC

The Player selection in the main window opens a window with player controls: Play, Stop, Pause, Previous Track, Next Track, and Eject. These controls simply duplicate the front panel controls of the QA-201’s. All player commands go to the currently selected player. The PLAY control will play at the default speed only. If you want to play at 1X, you must use the front panel buttons.

MEASURING ERROR RATES

Measuring error rates on the QA-201 is very easy: Just put in a disc and press play. The errors will then be displayed, printed, and sent to the PC when connected. It is not necessary for the QA-201 player to be connected to the PC to measure error rates.

Starting the Test

To start the test, load a disc in the player and press play. The error display will be updated once every second of playing time. You can start the test at any point on the disc by the usual method of selecting a track or searching to a particular location. In addition, you can skip ahead by selecting a new track or searching while the test is running. If searching during a test, it is best to press PAUSE first, then search to the desired location and press PAUSE again.

To start a new test, open the tray, load a new disc, and press PLAY.

NOTE - Closing the disc loading tray erases all data and prepares the unit for the next test.

Controlling the Error Display

The QA-201's Vacuum Florescent Display shows both player information and error rates. There are several display modes that combine different combinations of player information and error information. The display mode is changed by pressing the DISPLAY button (SEE SECTION "DISPLAY MODES").

To select a particular type of error on the display, press the ERROR button on the front panel repeatedly until the desired error is displayed. This button sequences through the eight error types plus GRADE.

To select CURRENT, AVERAGE, PEAK or TOTAL measurement, press the MODE button. It sequences through the various measurement modes, so press it repeatedly until you arrive at the desired mode. The selected MODE will be remembered for each ERROR type, so that when you change ERROR types, it will display the MODE that was last set for that ERROR type.

The AVERAGE, PEAK and TOTAL data are retained UNTIL YOU OPEN AND CLOSE THE DRAWER. You can stop and start the player and it will continue to accumulate the AVERAGE, PEAK, and TOTAL values.

Indicator Lights

If an uncorrectable (E32) error is encountered, the red LED on the front panel will light and stay lit. This allows you to see at a glance if a disc has uncorrectable errors.

The yellow TRK LED will light and stay lit if the player skips tracks. This serves as a warning that there are tracking problems with the disc. Discs that skip tracks should be considered unusable.

Disc Grading System

Display Modes 1 and 2 display a GRADE letter that is based on the results of the test. There are five different grades covering a wide range of performance: A, B, C, D, and F. This feature provides a means of instantly evaluating a disc without looking at the individual data. Here are the criteria used to determine the GRADE. These criteria are somewhat arbitrary, but reflect generally accepted practice in the industry.

GRADE A = AVE BLER over the whole disc less than 6
NO E22 ERRORS
NO E32 ERRORS
NO BEGL ERRORS

GRADE B = AVE BLER over the whole disc less than 51
NO E22 ERRORS
NO E32 ERRORS
NO BEGL ERRORS

GRADE C = AVE BLER over the whole disc less than 101
NO E32 ERRORS
LESS THAN 1000 DROPOUTS

GRADE D = AVE BLER in all ten second periods is less than 220

GRADE F = AVE BLER in any ten second period is greater than 220 or Track Loss occurred.

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

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

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

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 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. 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.

The Yellow Book (CD-ROM) specifies that there shall be no E22 or E32 errors on a newly made disc.

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.

Displaying Errors on the PC

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



Figure 1 - Main Window

There are three types of charts: Single Node Chart, Multi-Node Chart, and Multi Chart. The Single Node Chart displays any or all error types for one player. The Multi-Node

Chart displays one error type for any or all players. The Multi Chart displays individual charts of each parameter for one player.

When the player is playing, it will send all nine error parameters to QA-Net once every ten seconds (or every five seconds at 2X). The parameters are averaged over ten seconds of program time.

All data displayed in the software are 10-second averages. All data displayed on the front panel of the QA-201 are *one-second* averages. Therefore, you will notice that the instantaneous and peak values will be different. 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 Philips Red Book specification calls for averaging error rates over 10 seconds. Many CD analyzers use one second samples, so you must be careful in comparing data from other systems. With this system, you have both methods of averaging.

NOTE - All data displayed on the PC are 10-second averages. All data displayed on the front panel of the QA-201 are one-second averages.

Setting Alarm Limits

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

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

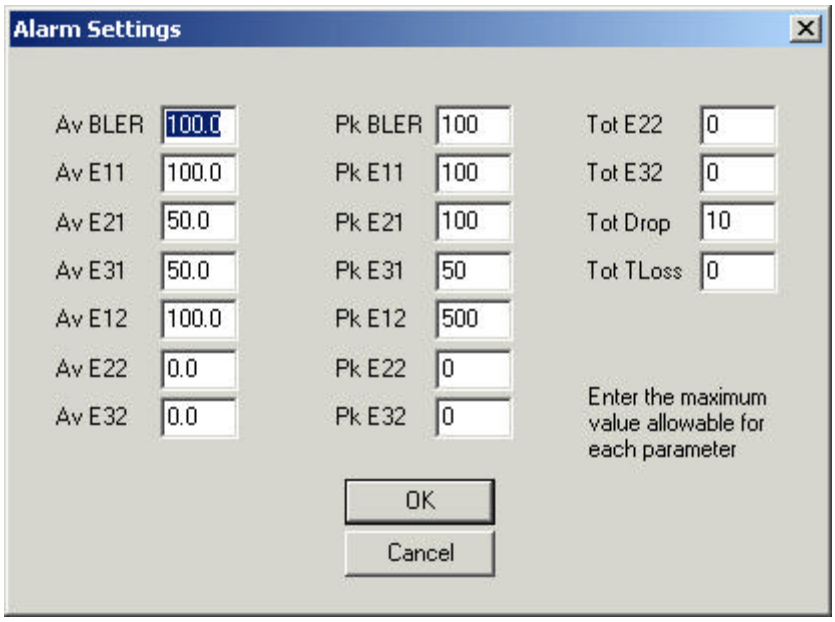


Figure 2 - Alarm Settings Dialog

USING THE PRINTER

Connect the printer to the QA-201 with a PC parallel printer cable (DB-25P to Centronics). Be sure that the printer is turned off or set to "off-line" before connecting or disconnecting it. The printer should be off-line (or turned off) when you power up the QA-201. Enable printing by selecting "ON-LINE" on your printer. If the printer is not ON-LINE, or turned off, the QA-101 will simply ignore it.

With the printer connected, turned on, and selected, starting the test will initiate printing. The printer will print a header at the beginning of the test. The header includes the disc Table of Contents. For each track on the disc, the start time, track type (audio or data), copy permit flag, and pre-emphasis flag are printed. The start time is in minutes and seconds from the start of the program area of the disc. The copy permit flag is intended to be used by recorders to signify whether copying of that track is to be allowed. Pre-emphasis is only meaningful on audio tracks. When pre-emphasis is ON, a low-pass filter is switched into the playback circuitry. This flag is set when the audio is recorded with a high-frequency boost. The purpose of this is to reduce high-frequency noise in the audio signal.

The printer will print all instances of certain errors in real time: All E22, E32, BEGL, and Track Loss errors are printed as they occur with the current ATIME. If the error occurs in lead-in, the ATIME will be 00:00. ISRC codes (if present) will also be printed in real time as they are encountered.

At the end of the test (when you open the drawer), the summary of results for the disc are printed, including average and peak values for each error type, plus a GRADE for the overall disc, plus UPC/EAN code (if present).

Figure 3 – Sample Printout

```
******************************************************
Clover Systems QA-201 v4.01                    Node 1
******************************************************
Apr 12 2001 11:15:03
Disc Type: MULTI SESSION         Trks: 13
Test Speed = 2X

Table of Contents:

     Trk#      Start          Type      Copy      Pre
      1        00:02:00       Audio     No        No
      2        04:36:20       Audio     No        No
      3        11:02:00       Audio     No        No
      4        11:54:35       Audio     No        No
      5        16:52:15       Audio     No        No
      6        21:16:35       Audio     No        No
      7        26:56:72       Audio     No        No
      8        31:17:10       Audio     No        No
      9        36:39:10       Audio     No        No
      10       41:07:15       Audio     No        No
      11       46:07:62       Audio     No        No
      12       49:12:32       Audio     No        No
Lead-out       51:38:35
Session 2      54:08:35
Lead-out       63:35:41

TRK = 01       ISRC:USCA29900578
TRK = 02       ISRC:USCA29900579
TRK = 03       ISRC:USCA29900540
TRK = 04       ISRC:USCA29900537
TRK = 05       ISRC:USCA29900580
TRK = 06       ISRC:USCA29900581
26:58 E22 =    1
TRK = 07       ISRC:USCA29900582
TRK = 08       ISRC:USCA29900583
TRK = 09       ISRC:USCA29900584
TRK = 10       ISRC:USCA29900585
TRK = 11       ISRC:USCA29900586
TRK = 12       ISRC:USCA29900587

 UPC/EAN: 0724349913400
******************************************************
 Error Summary

 Ave Bler=  16.0
 Pk  Bler=   43
```

If ISRC codes exist, they are printed.

All instances of the four most serious types of errors are printed here with the timecode.

If UPC code exists, it is printed.

```
 Ave El1 =   13
 Pk  El1 =   38
 Ave E21 =    1
 Pk  E21 =   13
 Ave E31 =    0
 Pk  E31 =   19
 Ave El2 =    8
 Pk  El2 =  306
 Ave E22 =    0
 Pk  E22 =    1
 Tot E22 =    1
 Tot E32 =    0
 Ave Berl=    8
 Pk  Berl=    5
 Pk  Begl=    0
 Tot Begl=    0
 Tot Drop=    0
 Tot  TL =    0
     Grade    C
 Tot Test 51:36
*****************************************************
 End of Test
```

SPLIT TEST

QA-201 firmware v3.1 and later adds "Split Test" capability using two QA-201's. Identical replicas are placed in the two QA-201s. One QA-201 tests the first half of the disc and the other tests the last half. The node select DIP switch inside the QA-201 selects the split test mode. With the node number is set to 0 - 29 (0 hex - 1D hex) the QA-201 operates in the normal fashion, and tests the whole disc. With the node number set to "FIRST" , the QA-201 is in split test mode, and tests the first half of the disc. With the node number set to "LAST", the QA-201 is in split test mode and tests the last half of the disc.

The two QA-201's are connected together via the QA-Net serial interface using a null modem cable. During the test, results are transferred from LAST to FIRST and combined. The LAST player displays and prints only it's own results of the last half of the disc. The FIRST player displays and prints the COMBINED results. The exception is the current values (the one-second averages) of all errors displayed on the front panel, which are the current values for FIRST only. AVERAGE and PEAK values displayed are for the COMBINED results. Also, all results printed by FIRST are COMBINED results.

Setup

First make sure that one QA-201 of the pair is set to node number FIRST, and one is set to LAST. The node number is displayed on the front panel display when you press ALT

+ MODE. Connect the two QA-Net serial interface connectors using a null modem cable. Connect the printer to the FIRST player.

Operation

Open both loading trays and insert two identical discs. Press PLAY on the FIRST player. Both players will automatically start together. FIRST will start at the beginning of track 1. LAST will start at the halfway point calculated from the total program time. FIRST will stop when it reaches the halfway point, and LAST will play to the lead-out. LAST must always finish before FIRST, because FIRST is polling LAST for data only while it is playing. The timing is worked out so that LAST will finish just before FIRST.

The header and any instances of the four most serious types of errors (from both players) will be printed on the printer with the ATIME just like usual. When the test completes and FIRST stops, both trays will open to indicate that the test is completed, and the summary of results is printed on the printer. Place the next two discs in the trays and press PLAY on the FIRST player to start the next test.

When started automatically, LAST will only play at 2X speed. To test at 1X speed, start both players manually using ALT + PLAY. Start the LAST player first.

MEASURING PIT GEOMETRY

Unfortunately, error rates do not tell the whole story. Measuring error rates is useful because any serious problems will be reflected in higher error rates. But when it becomes necessary to establish the cause of high error rates, or compatibility with different players, you must look at the geometry of the pits. If the pits are the right size and shape, everything should work fine. Deviations from the ideal size and shape of the pits is what causes playback problems. Pit geometry can be measured by looking at the HF signal coming from the pickup (also see INTERPRETING THE RESULTS).

Using the Oscilloscope

Choosing an Oscilloscope

Virtually any oscilloscope will work with the QA-201. The requirements are not stringent. Only one channel is required, and bandwidth should be 5MHz or greater. Most oscilloscopes have multiple channels and 20MHz or greater bandwidth.

Analog vs. Digital - Generally, HF measurements are easier to make on an analog oscilloscope. This is because an analog ‘scope shows a multitude of sweeps superimposed, whereas a digital ‘scope shows only a “snapshot” of one brief sample. The “Eye Pattern” shown in Fig. 4 is what you see on an analog scope. You cannot see this eye pattern on a digital scope. Instead, you see just a sampling of a few pits and lands. A digital ‘scope is good for close inspection of individual pits, but what we are interested in is the average values over many pits.

Connecting the Oscilloscope

Use a BNC to BNC cable to connect the 'scope to the HF output on the rear of the QA-201. You can also connect to the TRK output on the QA-201 to view tracking errors and "push-pull tracking".

Oscilloscope Settings

All HF measurements should be made at 1X speed. Set the horizontal sweep to 0.5µS per division. Set the vertical sensitivity to 0.5 volts per division. Make sure the Trigger Source is set to the channel you are using. Adjust the Trigger Level to get the clearest image.

Components of the HF Signal

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

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

Measuring I_{top}

I_{11} and I_3 measurements can be made two ways: By comparison with a calibrated test disc, or by expression as a fraction of I_{top}.

I_{11} and I_3 measurements expressed as a percentage of I_{top} will require you to measure I_{top} first. A_{top} in the picture is the same as what we are calling I_{top}. I_{top} is also proportional to reflectivity and the intensity of the laser beam. By expressing I_{11} and I_3 as a percentage of I_{top}, you get a consistent result whatever the reflectivity of the disc or the brightness of the laser.

Measure the voltage of the top of the HF eye pattern relative to zero volts. Make sure you are measuring relative to zero volts, rather than whatever voltage you get when the player is not playing - which may not be exactly zero.

Measuring I_{11}

I_{11} is the largest component in the HF eye pattern. Measure the peak-to-peak value of the pattern (A_{11} in the picture), and divide by I_{top}. Example: I_{top} = 3 v, A_{11} = 2 v p-p, I_{11} = A_{11}/I_{top} = 0.66. The minimum allowed I_{11} value is 0.60.

Measuring I_3

I_3 is the smallest component in the HF eye pattern. If there is high asymmetry on the disc, it may be a little difficult to pick out. Measure the peak-to-peak voltage of this component (A_3 in the picture) and divide by I_{top}. Example: I_{top} = 3 v, A_3 = 1 v p-p, I_3 = A_3/I_{top} = 0.33. The smallest allowed value for I_3 is 0.30.

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

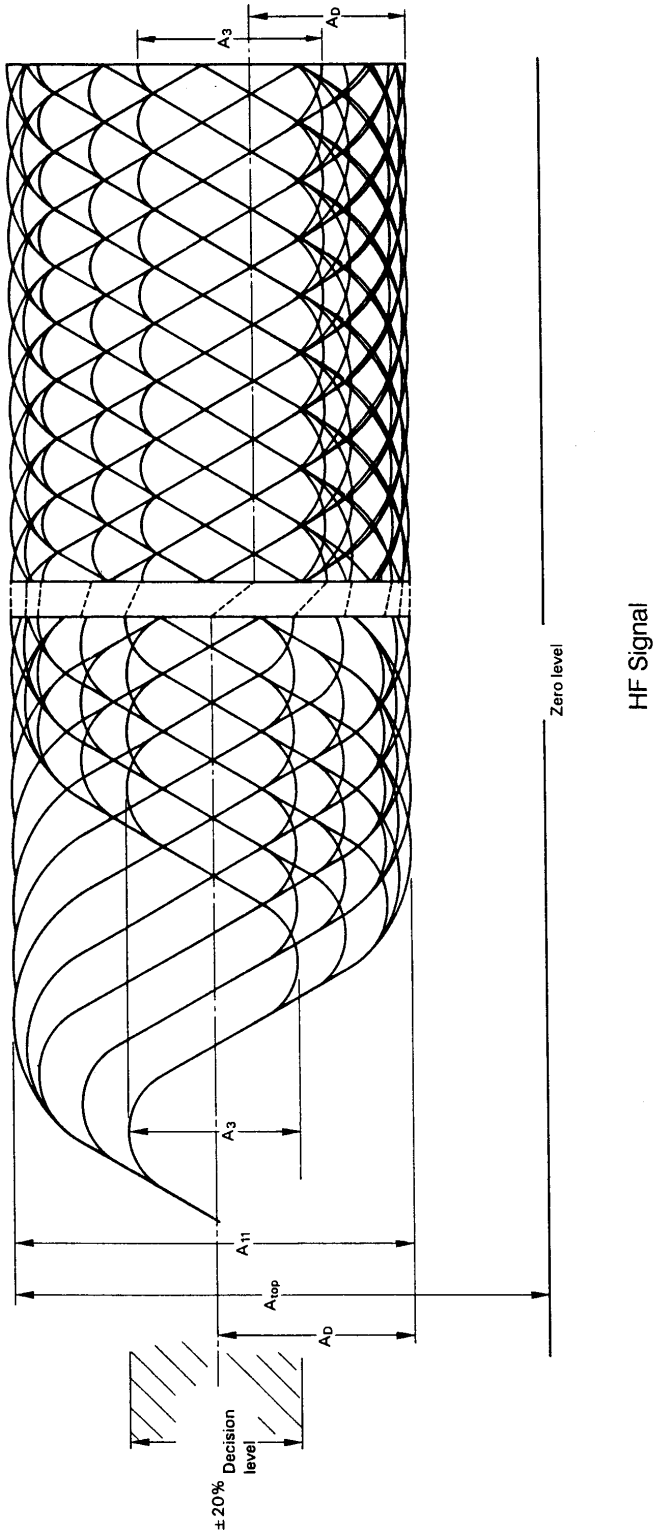


Figure 4 – Eye Pattern on Oscilloscope

Measuring Asymmetry

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

The formula for measuring the asymmetry according to Figure 1 is

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

A_D is measured from the bottom of the HF eye pattern to the "center" of the eye pattern. This point is where the rising and falling edges cross, approximately in the center of the I_3 waveform. The maximum allowed asymmetry is -15% to +5%. -5% to -10% is considered optimum.

Measuring Beta

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

Connect the oscilloscope to the HF output on the rear panel. Unlike the other measurements, the 'scope must be set to AC coupling. Now when observing the HF eye pattern, it will center itself around 0 volts. If we call A_1 the distance that the waveform reaches *above* 0 volts, and A_2 the distance that the waveform extends *below* 0 volts, then

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

Where A_{11} is the peak-to-peak value of the waveform as shown in Fig. 1. Note that since A_2 is a negative number, the result can be positive or negative. The range of allowable β is 0 to +8% (0 - 0.08) with an optimum value of +4%. Since CD writers try to set the laser power to produce +4% beta, the results of this test can reveal an inability of the writer to optimize the laser power, due to malfunction or incompatible media.

Measuring Reflectivity

Since I_{top} is proportional to the disc's reflectivity, you can measure the reflectivity of a disc by comparing I_{top} with that of a reference disc of known reflectivity. On CD-Recordable discs, I_{top} should be measured in Open-Loop Tracking mode, since the pre-groove will diffract the light and reduce the true intensity. That is, the reflectivity along

the track on a CD-R is lower than between the tracks. The minimum allowable reflectivity is 65%.

Measuring Radial Contrast

Radial Contrast is a measure of the strength of the track following signal. Radial Contrast which is too low or too high can prevent the player from properly following the track, and thus generate many errors. Connect an oscilloscope to the HF output jack on the rear panel of the QA-201. Make sure the 'scope is set to DC coupling. Put the QA-201 into Open-Loop Tracking mode by pressing ALT + STOP. You will see that the HF modulation gets bigger and smaller as the beam crosses the tracks. HF is at it's maximum when the beam is directly over the track. It is at a minimum when exactly between to tracks. Also notice that I_{top} also is higher between tracks. Measure the average voltage of HF (relative to zero volts) between the tracks. We will call this I_l. Then measure the average HF voltage when over the track. We will call this I_g. Radial Contrast is defined as:

$$RC = 2\frac{\left(I_l - I_g\right)}{\left(I_l + I_g\right)}$$

Radial Contrast must be between 0.3 and 0.6.

Measuring Crosstalk

Crosstalk is the ratio of HF signal while between tracks to HF signal directly over the track. This is measured in Open-Loop Tracking mode as described above. Measure the peak-to-peak voltage of HF between tracks (at it's smallest value), then divide by the peak-to-peak voltage over the track (at it's largest value). Maximum allowable Crosstalk is 0.5.

MEASURING JITTER & EFFECT LENGTH DEVIATION

Setup

Jitter and Effect Length Deviation are measured using the TIA board and the QA-201 software. Before using the QA-201 software, you must set two parameters using the SETUP menu. A dialog box appears that allows you to set the NUMBER OF SAMPLES, and I/O BASE ADDRESS. These settings are stored in the file QA-201.INI in the windows directory.

Setting the I/O Base Address

The QA-201 is factory set for I/O address 300 hex. If this conflicts with other devices, you will need to change the setting on the TIA board (see above). In order for the software to know where to find the board, the I/O Address must be set in the software. Use the Setup menu selection to do this. A dialog box will appear which allows you to set the I/O address *in hexadecimal*.

Number of Samples

You can set the number of samples desired, and the program will automatically stop taking samples when this number is reached. For most purposes, 500,000 samples gives accurate results in minimum time. Good results can be attained with 400,000 to 1,000,000 samples. Beyond 500,000 samples, there is little change in results. Calibration is performed using 1,000,000 samples. QA-201 will make about 1800 measurements per second. This means that to acquire 1 million samples takes about 10 minutes. Discs with program time shorter than 10 minutes can be repeated as necessary for best accuracy.

Making Effect Length Measurements

Effect length measurements should be made at 1X speed. The system will measure jitter and effect length at 2X speed, but accuracy is reduced. Jitter at 2X will be considerably higher (approximately double) than at 1X. Therefore, when accurate results are required, you must test at 1X speed.

To start the test, start the player and click Start! in the TIA menu. Sampling will stop when the desired sample size is reached, or if you click TIA / Stop! The EFM signal comes out of the player only while it is playing. Therefore, you can pause, stop, and change tracks while the test is running. It is, however possible to pick up spurious noise when the player is stopped, so it is best to not leave the test running with the player stopped for long periods.

For best results, measure an area of the disc that contains random data (not digital silence). Dirt, scratches, and other defects will affect the results, so try to measure a clean area of the disc. This system has been calibrated to Philips test sample 5B.3. You can check the calibration by playing 5B track 6 (or another calibration disc) until 1,000,000 samples are accumulated. For further details, see "QA-201 Software" section.

Test Results Summary

A summary of all test results are displayed in the TIA Summary window (TIA / View). This includes average length of all pit and land effects, jitter of all pit and land effects, and average length error for all pit and land effects. Also included is the number of TIA samples taken. You can scroll through the data using the scroll bar on the right side of the window. Results are updated once every 10 seconds.

SAVING THE DATA

To save your test data, select File / Save from the main menu. You can save your data at any time, even while the test is running. A dialog box will prompt you to select which QA-201's data you want to save. Non-existent nodes will be inactive. After clicking OK, a new dialog box prompts for a filename. This dialog box allows you to select a destination drive, directory path, and filename. Although you can use any file extension you want, the default file extension is .dat. It is recommended that you use the default file extension so that test data are easily identified. Each data file is about 41kb, so one floppy disk will hold about 30 data files.

Saving Results to a Spreadsheet

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

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

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

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

Column 1	Disc ID
Column 2	Grade
Column 3	AVE BLER
Column 4	AVE E11
Column 5	AVE E21
Column 6	AVE E31
Column 7	AVE E12
Column 8	AVE E22
Column 9	AVE E32
Column 10	TOT E22
Column 11	PK BLER
Column 12	PK E11
Column 13	PK E21
Column 14	PK E31
Column 15	PK E12
Column 16	PK E22
Column 17	PK E32
Column 18	TOT E32

STARTING A NEW TEST

After saving the data, select File/New from the menu. This will clear the old data in preparation for a new test. To start the test, you only need to press PLAY on the player. If you have multiple QA-201's attached, you can start and stop each player at will.

LOADING IN SAVED DATA

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

MAKING CHARTS

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

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

Single Node Chart

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

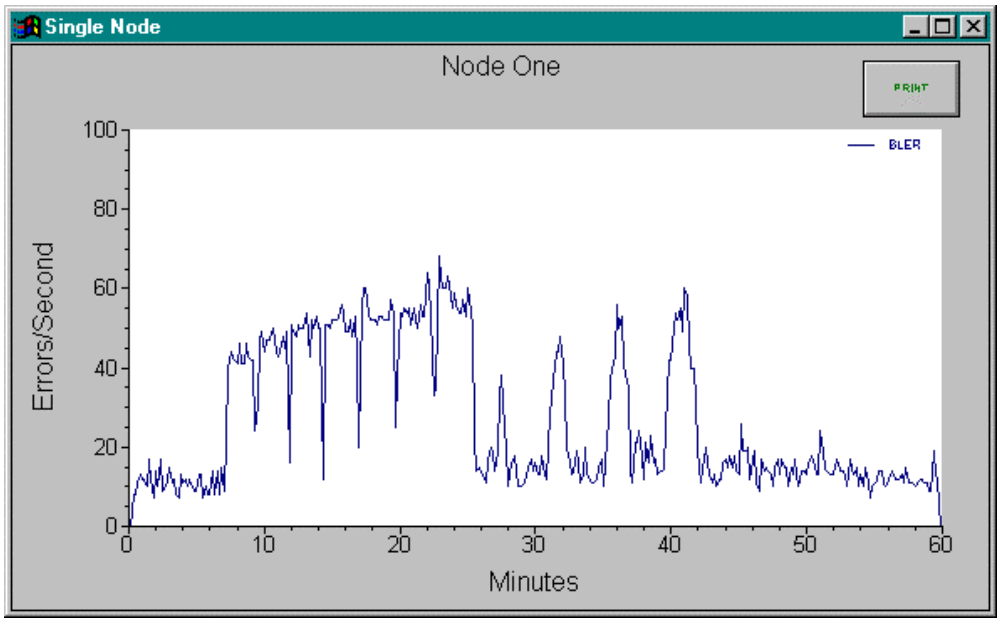


Figure 5 - Sample Single Node Chart

Multi-Node Chart

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

Multi Chart

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

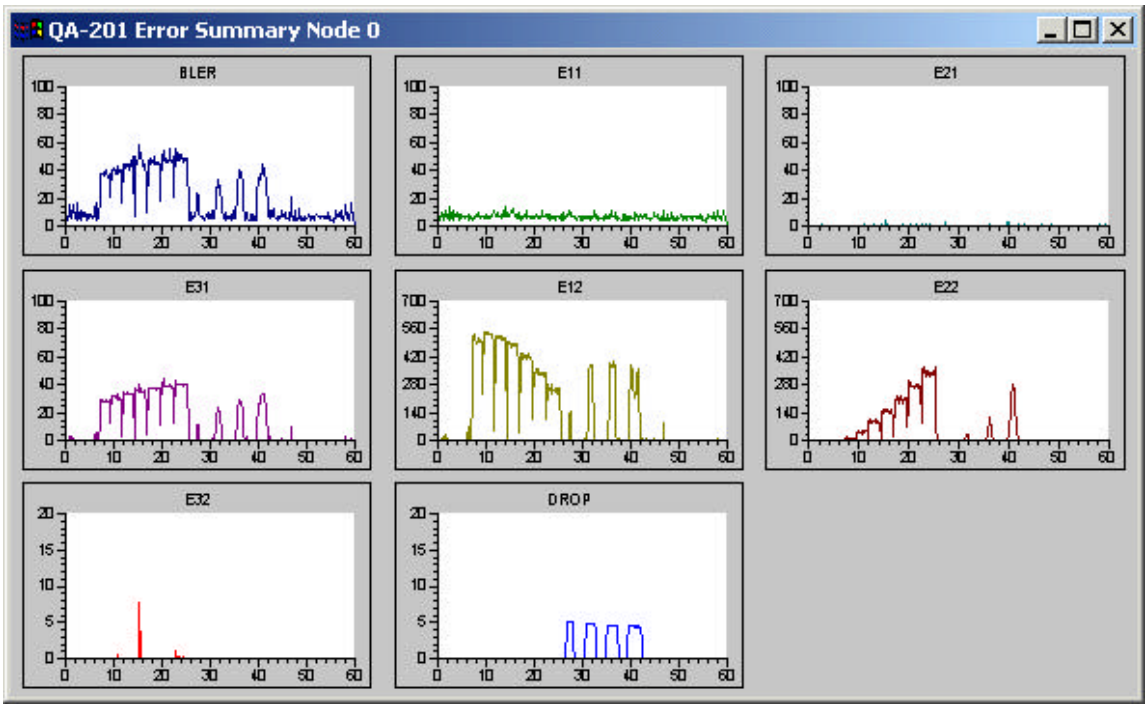


Figure 6 - Sample Multi Chart

Effect Length Charts

There are eight types of effect length charts. All chart windows are movable and sizable. Each chart is created the size of the client area of the main window, but can be maximized, minimized, or stretched to any size.

There are eight different charts for showing effect length data; four for pits, and four for lands. These charts are updated in real time as the test proceeds. As you will see, the jitter measurements get better as more samples are taken. This is because you have to average over a lot of samples to get a statistically valid result, and eliminate the influence of dirt, scratches, etc.

Histogram

This chart displays a histogram of all measured effect lengths. The horizontal axis is effect length in nanometers. The vertical axis is the number of samples which have a particular length. You can think of it as a multitude of bar graphs. For instance, if the height of the line corresponding to 900 nanoseconds (ns) reaches to 1000 (103), this means there were 1000 samples that had a length of 900 ns.

This graph is useful because it shows the lengths of every pit and land, and how they are distributed. This is the point of effect length measurements.

Since the EFM signal consists of nine discrete effect lengths, the histogram shows nine lines. If the signal had no jitter or variation at all, then the chart would show just nine

vertical lines. Variation in the length of the effects (jitter) causes a bell-shaped distribution of lengths. More jitter causes a fatter distribution.

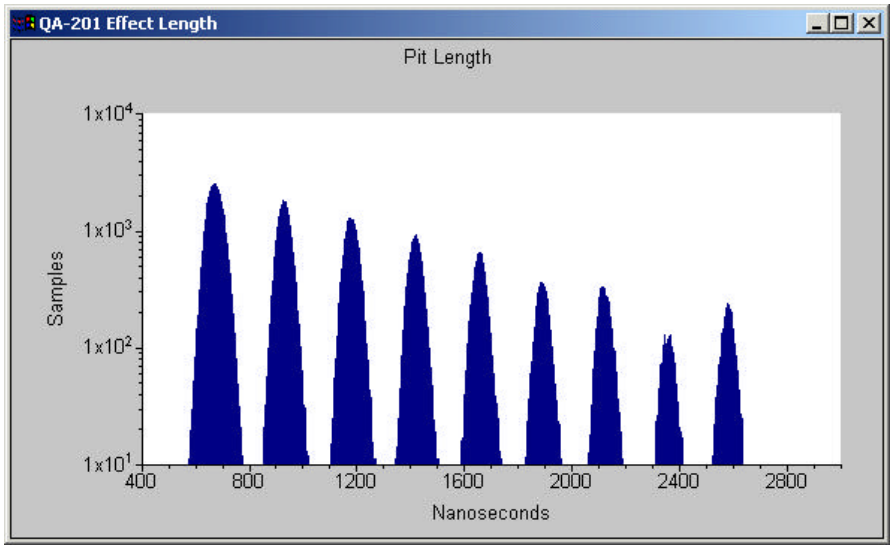


Figure 7 - Sample Histogram

Jitter

Technically, "Jitter" is defined as one standard deviation from the mean. This can be measured from the Histogram data, and is also displayed as a bar graph. Each bar corresponds to one of nine effect lengths. The shortest (T3) is on the left. The actual values of the bars are displayed below the bars.

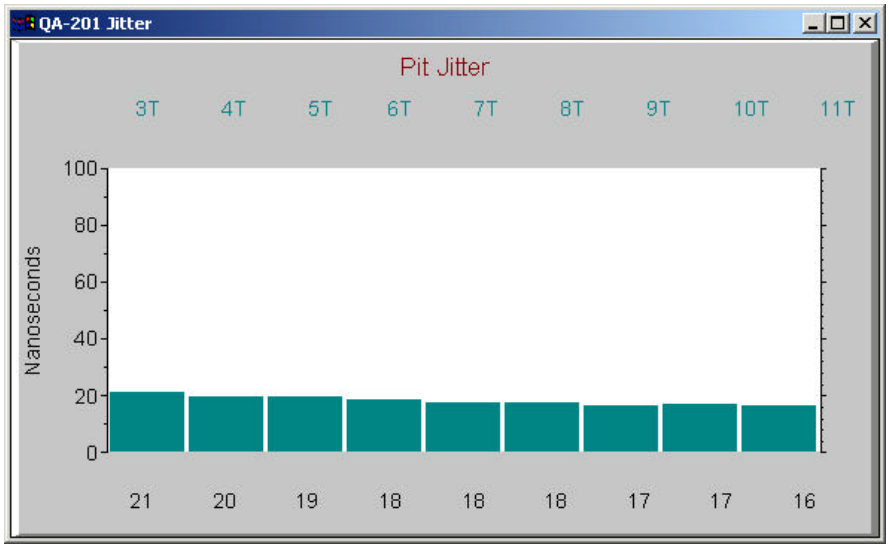


Figure 8 - Sample Jitter Chart

Mean

The average (or Mean) value for each effect length can also be calculated from the Histogram data. This is displayed here as a bar chart, with each bar corresponding to one effect length.

Deviation

This bar graph shows the difference between the average effect length, and the ideal effect length.

NOTE - This average length error is deviation *of* the mean, whereas jitter is deviation *from* the mean.

Pits or Lands

All of the Effect Length Charts can display values for either pit or land. You can select one or the other by clicking Pit or Land in the Chart menu. The current selection is shown by a checkmark next to the menu item. The selection affect only charts that are created after the selection is made; charts already created are not affected.

Jitter Summary Chart

As a convenience in printing the results, you can create a chart that includes all Jitter / Effect Length charts for both pits and lands. This chart can then be printed on one sheet of paper. To create this chart, select Charts / Effect Length / All.

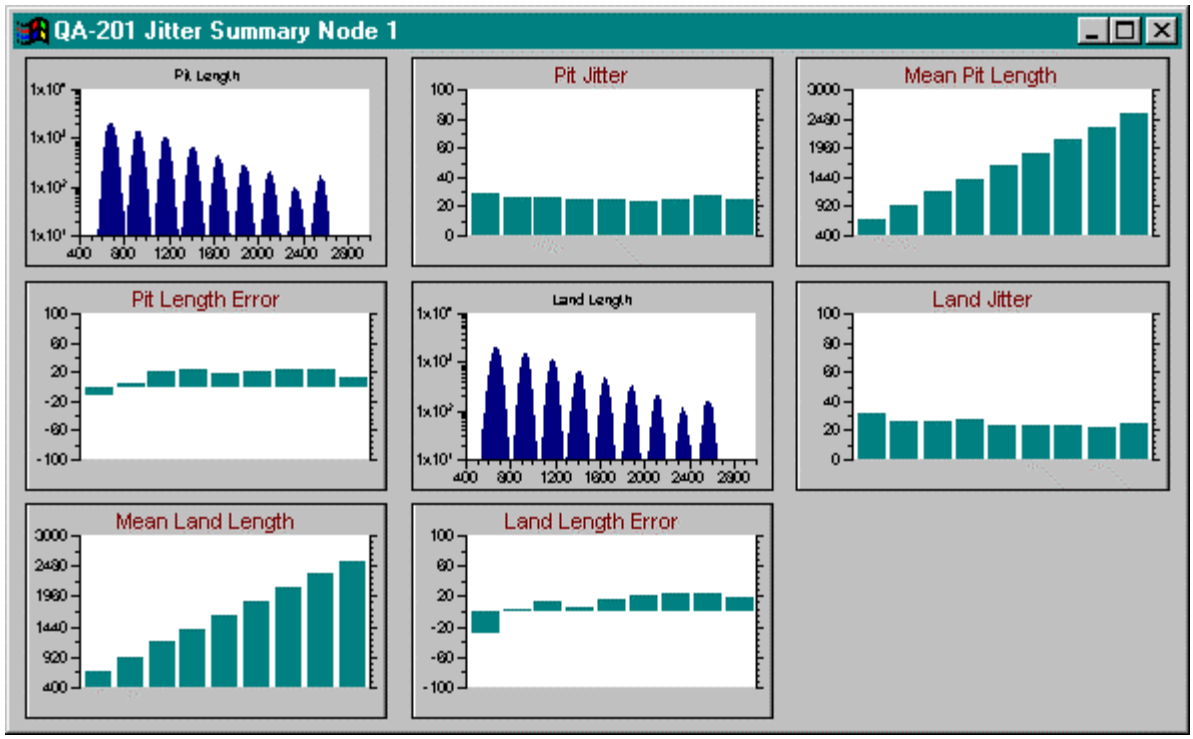


Figure 9 - Sample Jitter Summary Chart

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. Virtually all chart characteristics can be user modified. Double-clicking on the chart object will open a dialog box allowing you to modify it's characteristics. You can change background colors, trace colors, line style, and both vertical and horizontal axes. You can also change the way the charts are labeled, and the size of the text.

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 QA-Net, it will start up with the axes set the way you left them.

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

Changing the Line Style & Color

Double-click on a data plot to open the “Plot Parameters” dialog. Selecting “Line Attributes” will allow you to adjust the color, style, and width of each data plot. Marking the “Fill Area” checkbox will fill in the area under the plot. Checking the “Spline” box will cause the data to be smoothed. Clicking on the “Data” button will open the Data Set window, which displays and allows you to edit the actual data of the 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.

PRINTING THE CHARTS

Each Single Node and Multi Node chart has a PRINT button. Just click the button to print the chart. A dialog box will appear that allows you to customize how the charts are printed. To adjust the size of the printed chart, use the “Actual Size” option in the print dialog. This then enables you to position the chart on the paper, and size the chart. It will print the same size as displayed on the screen, so you can adjust the size of the window on your screen to print the size you want.

To print the Multi Chart, select File / Print / Print All Error Charts in the main menu. Likewise, you can print all the jitter charts on one page. Select File / Print / Print All Jitter Charts.

PRINTING A SUMMARY

You can print a summary of the test results on the printer by selecting File / Print Summary. The printed summary consists of the same information displayed in the main window (peak and average values for each error type, plus total E22, total E32, and total DROP errors) plus all information displayed in the TIA 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 marked by "**".

INTERPRETING THE RESULTS

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

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

CIRC Error Correction

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

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

The other principle used is interleaving. This means that the data is distributed over a relatively large physical area. If the data were recorded sequentially, a small defect could easily wipe out an entire word. With CIRC, the bits are interleaved before recording, and de-interleaved on playback. What happens is that the bits of individual words are mixed up and distributed over many words. Now, to completely obliterate a single byte, you have to wipe out many bytes. 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.

TYPES OF ERRORS

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 uses the "Superstrategy" algorithm that can correct two bad symbols per block in the first stage and two bad symbols per block in the second stage.

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

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

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.

BURST ERRORS

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 reasonably 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.

BERL

BERL stands for Burst ERror Length. It is defined as the number of consecutive data frames that have 2 or more bad bytes at the C1 decoder. The longer the burst of errors is, the harder it is to correct. There is no standard for what BERL should be, but it is a good measure of the amount of significant defects.

BEGL

BEGL stands for Burst Error Greater than Length. The Red Book specifies that burst errors must not be greater than seven frames. Therefore, the threshold for BEGL is set to 7 frames, and any instance where the Burst Error Length is 7 or more frames, counts as a BEGL error. Good discs should not generate BEGL errors, because error bursts of this length could produce E32 errors.

DROPOUT

A DROPOUT is defined as an instance where the signal coming off the disc drops below 75% of its nominal value. These are typically caused by pinholes, black spots, or large scratches, and can cause burst errors. There is no standard definition of a dropout for CD's. Other test equipment may use a different definition for a dropout.

The dropout detector is useful to help establish the cause of high error rates. For instance, if a large burst error (E22 or E32) occurs at a particular spot on the disc, and there are also dropouts at that same place, then the error is due to a physical defect that has caused loss of signal. On the other hand, if there are many burst errors and no dropouts, the problem may be poor pit geometry.

TRACK LOSS

The TRACK LOSS indicator lights when the tracking mechanism looses lock. This generally indicates track skipping. Since track skipping is not allowed by the Red Book spec, any track loss will automatically change the GRADE to F. All instances of tracking loss are printed on the printer with the ATIME, as well as the total track loss count.

NOTE -The AVERAGE and PEAK and TOTAL values are over the whole disc. CURRENT values are averages over one second.

INTERPRETING HF SIGNALS

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

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

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

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

Our players are designed to play "Red Book" specification discs. 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.

HF SIGNALS AND DISC DEFECTS

Looking at the HF signal can reveal potential problems and their causes. This is helpful in troubleshooting problem discs and finding the source of problems. For instance, with CD-Recordables, certain effects are a due to the media:

Low reflectivity – The highest point on the eye pattern (Itop) is determined by the reflectivity of the disc. If not enough light is reflected, problems can result. Often you can see Itop moving up and down as the disc rotates. This indicates that either the reflective metal layer is not uniform, or the disc is warped.

Local defects – Sometimes you will find a batch of CD-R media that produce burst errors at the same location on every disc. This is typically caused by a defect on the stamper used to make the media. Often, it is necessary to reject a batch of media because of this.

Other effects are a function of the writer:

Asymmetry / Beta – This parameter is a direct function of the laser power in the writer. Optimum asymmetry is –5% (+4% Beta). Positive asymmetry (negative beta) is caused by inadequate laser power for the type of dye used. You may need to try a different type of media, or replace the writer. Low laser power could be a sign of aging of the writer's laser.

Jitter – High values of E11 errors across the disc often indicate excessive jitter in the writer. Again, this can be a sign of aging.

MAINTENANCE AND SERVICE

CHANGING THE DATE AND TIME

In order to set the date and time, you must enter a special mode. This is to prevent accidental changing of the date and time. To do this, first turn off the power. Now turn on the power while pressing the "<<" and ">>" buttons simultaneously. Hold the two buttons until you see "QA-201 v4.0" on the display. Changing of the date and time is now enabled.

Go to display mode 5, and use the "<" and ">" buttons to move the cursor from one field to the next. Then use the "<<" and ">>" buttons to increment or decrement the current setting. To go back to normal mode, turn the power off and then on.

CHANGING THE NODE NUMBER

If you are using multiple QA-201 or QA-101 players with a PC, each unit connected to the PC must have a unique "Node Number". To view the current node number or change it, press the MODE button while holding ALT while the player is stopped. The current node number is now displayed, and can be changed using the "<<" and ">>" buttons. To exit this mode, press any other button.

EMERGENCY EJECT

QA-201 incorporates a tray locking mechanism to prevent the tray from opening during shipment. If for some reason you need to open the disc tray when there is no power applied, or the unit is inoperative, insert a straightened paper clip or other thin rigid object into the small hole in the tray front. Pushing in on the paper clip will push the tray out.

SERVICE

Ordinarily, there are no adjustments or maintenance required. You may wish to check for dirt on the objective lens from time to time, although this rarely seems to be a problem. If you need to replace the fuse for any reason, use a 250V ½Amp Slo-Blow fuse.

If you need repairs, send the QA-201 to us. Call us for help in diagnosing the problem, and to get a return authorization. You can contact us at:

Clover Systems
26945 Cabot Road, Suite 114
Laguna Hills, CA 92653
Tel: 949.582.8010

Fax: 949.582.1016
Email: info@cloversystems.com
URL: http://www.cloversystems.com

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 QA-201 in at least 3" of bubble-pak before shipping.

COMMUNICATIONS PROBLEMS

Your COM port will be set to the correct protocol automatically by the QA-201 program. It is not necessary to change the serial port settings in the Windows Control Panel.

The green LED on the front panel is helpful for diagnosing communications problems. The QA-Net light comes on whenever the QA-201 is receiving commands or sending data. The LED should light when you click Find Nodes or launch QA-201. When QA-201 software is running, the light should blink every 10 seconds (or every five seconds at 2X). If the computer receives incorrect data from the QA-201, it will try again. Therefore, if you see the LED blink twice in rapid succession, it tells you that the communication link is unreliable, and the host must re-try.

CALIBRATION

There is no hardware calibration for error rates (see QA-201 Qualification Discs on page 40). There is however, software calibration for jitter and effect length measurements. Ordinarily, there should be no reason to change the calibration unless some component is changed.

Thirty-six calibration constants for the Effect Length and Jitter measurements are included in the initialization file QA-201.INI. If you need to change the calibration, you can do so by editing this file. In the section [CAL], you will see eight variations of four different parameters. “PD” stands for pit deviation (jitter). “LD” stands for land deviation (jitter). “PM” stands for pit mean (length), and “LM” stands for land mean (length). Subscript [0] represents 3T pits or lands. Subscript [8] represents 11T pits and lands. Therefore, pd[0] is 3T pit jitter, and lm[8] is 11T mean land length. The numbers in the QA-Net.INI file are added to the measured results to obtain the correct measurement as specified by Philips test sample 5B.3.

To calibrate the effect length / jitter measurements, play track six of Philips test sample 5B.3 until 1,000,000 TIA samples have been accumulated. Print the results using File / Print Summary. Compare the results with those provided with the 5B.3 disc. Calculate the difference between the measured result and the Philips result, and add this to the value in QA-201.INI for that effect. Run the test again to confirm the desired result.

SYSTEM REQUIREMENTS

QA-201 v3.0 requires:

- ‘486 or higher PC (Pentium Recommended)
- One available full-length ISA slot for the TIA board
- One available serial port
- VGA monitor and video board capable of 256 colors
- Windows 95 / 98 / ME / 2000 / XP or Windows NT v3.1 or higher.
- 32 megabytes of RAM
- Hard disk with at least 10MB free.
- Your computer must be able to supply this power to the TIA board:
  +5 V at 0.8 A
  -5 V at 0.05 A
  +12 V at 0.2 A
  -12 V at 0.02 A

QA-201 QUALIFICATION DISCS

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

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

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

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

Disc SBC 444A provides two kinds of defects: Missing information, and black spots. The tracks with missing information should provide fairly repeatable results since these errors are encoded into the data. The sections with Black Spots have the information in tact, but obscured by the black spots. In this case, not only is there information lost, but the servomechanisms are stressed. For example, when the readout beam encounters the

black spot, focus, track following, and clock recovery servo signals disappear. After the beam has passed the black spot and the signal is restored, the pickup is out of focus, off track, and the bit clock is at the wrong frequency. This causes many additional errors to be generated in an unpredictable way.

Test results for disc SBC 444A are provided in the form of graphs for the whole disc. If you have the QA-Net software, the test data is included on the QA-Net floppy disk. You can play selected tracks of the disc and compare your results with the charts. Again, one-second peaks will be higher than shown on the charts. You can see the ATIME at which various events occur on the charts, then figure out which track that corresponds to by referring to the included Table of Contents.

An additional disc, Philips SBC 444 is supplied for checking jitter. It is substantially the same as SBC 444A, except without the built-in defects. If has very low jitter, so is good for checking TIA performance. The jitter measurements included are made at the beginning of the disc.

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

Please note that error rates may be higher at 2X speed. In general, error rates on good discs will be about the same at 2X as at 1X. Small errors such as E11 & E21 will not be affected much. Burst errors, on the other hand, will be greatly affected. Most burst errors (E22 & E32) are caused by disturbances to the servo systems, rather than missing data. This effect is greatly magnified at high speed. Also, jitter and HF measurements should always be made a 1X speed for best results.