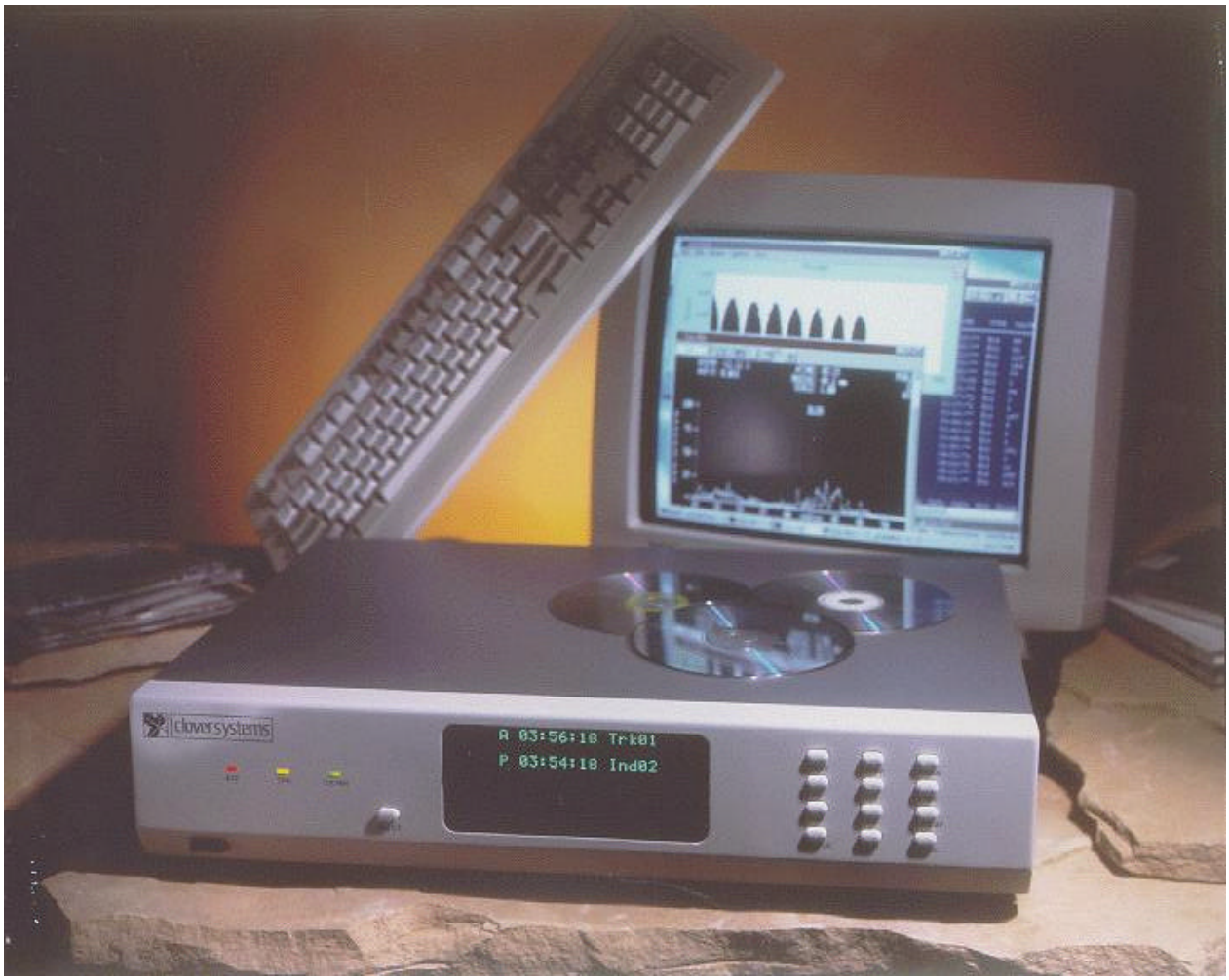
clover systems



QA-101
COMPACT DISC ANALYZER

OPERATING MANUAL

Version 4.0

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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, menu commands, dialog boxes, buttons, and named windows.

INTRODUCTION

The Clover Systems QA-101 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, CD-RW, Enhanced CD, and Photo-CD discs at 2X or 1X speed.

The QA-101 measures disc quality by examining the quantity and severity of CIRC errors generated during playback. It also provides the capability to measure signal parameters related to pit geometry, such as I_{11}, I_3, asymmetry, beta, radial contrast, crosstalk, and reflectivity. It can also be used to measure jitter, with the Jitter Option. Together, this information provides a thorough analysis of disc quality. Also see the section titled "INTERPRETING THE RESULTS."

The QA-101 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 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 / RS-485 serial connection is provided on the rear panel for connection to a PC. Optional software provides data collection, display, and archiving for up to eight QA-101 units.

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

An AES/EBU connector on the rear panel allows connection to an external DAC. Analog audio outputs are also provided.

INSTALLATION

The QA-101 is set up and used just like an ordinary CD player. The unit will accommodate input voltages from 90 VAC to 260 VAC, 50/60 Hz, so it can be connected to any line voltage in this range.

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 digital audio output on the rear panel into any commercial audio D/A converter that accepts AES/EBU input. Generally, the best audio quality will be obtained using the AES/EBU output.

If you are using a printer, connect it to the PRINTER port on the rear panel of the QA-101 using an ordinary PC parallel printer cable. You can use any printer that has a Centronics type parallel interface and accepts ASCII text. For details see USING THE PRINTER (Pg. 8).

OPERATION

CONTROLLING THE PLAYER

The QA-101 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 a single track

To play just a single track, first select which track you want using the ">" and "<" buttons (see Pg. 4), then press PLAY while holding down the PAUSE button. When the end of the track is reached, the player will stop.

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. The <<, >>, and PAUSE controls will not do anything while playing lead-in.

Playing at 1X speed

The QA-101 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.

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 lead-in at 1X speed, and will play all the way through until the start of the second lead-out. Since there is no ATIME in the lead-in, you will not see any TIME display for the first minute or two. TIME will be displayed as soon as the first track is reached. In this mode, you cannot use any of the normal player controls such as PAUSE, NEXT, PREVIOUS, SCAN FORWARD, or SCAN BACKWARD. It will only start at lead-in, and only play at 1X speed.

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 a minute 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-101 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-101'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, BEGL, 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 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 also 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. 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. 3).

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-101. To change the date and time settings, see CHANGING THE DATE AND TIME on pg. 22. 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-101 v4.0" appears on the display. You will now be able to change the date and time as described in the instruction manual. To return to "protected" mode, just turn the power off and back on.

MEASURING ERROR RATES

Measuring error rates on the QA-101 is very easy: Just put in a disc and press play. The errors will then be displayed, printed, and sent to QA-Net if installed.

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-101'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" on Pg. **Error! Bookmark not defined.**).

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 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.

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.

Likewise, the yellow TRK LED will light if the player skips tracks and serves as a warning that there are tracking problems with the disc.

Disc Grading System

Display Mode 1 displays 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 20 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 (track skipping).

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. Some 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. Likewise, if the disc skips tracks (TLoss) it becomes Grade F because the Red Book forbids track skipping. Grade F discs do not meet Red Book specs, and therefore should be rejected.

Depending on your own requirements, you will have to decide where to draw the line as far as what you are willing to consider necessary and sufficient performance. Also please see the section INTERPRETING THE RESULTS (Pg. 18).

USING THE PRINTER

QA-101 will work with any printer that accepts ASCII text and has a parallel (Centronics) interface. However, many inexpensive printers will only work with MS Windows and have only USB interface. There are literally hundreds of models of printers available, and they change often, so it is impossible to evaluate them all. When choosing a printer for QA-101, be sure that it states that it will accept plain ASCII text. Unfortunately, this is not always clear when you buy a printer.

Hewlett-Packard has the best selection of printers that will work with QA-101. Of the current models, the lowest cost HP printer that will work with QA-101 is the **Deskjet 3820**, which sells for around $99. Most older HP printers will also work. Here is HP's advice:

"All Hewlett-Packard printers that have PostScript printer language will accept plain ASCII (American Standard Code for Information Interchange) text. Hewlett-Packard manufactures many printers that have PostScript and a parallel interface. Since other factors may also affect your purchase decision, I strongly recommend that you contact our representatives at 1-800-752-0900, so we can recommend the best Hewlett-Packard solution to meet your needs. You can reach our presales consultants Monday-Friday from 6am-5pm Pacific Time, Saturday 7am-4pm Pacific Time."

HP's web site has detailed information on their current printers, and specify if they accept plain ASCII text.

Connect the printer to the QA-101 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-101. 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 date and time of the test, the disc type, the test speed, and 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, seconds, and frames 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 1 – Sample Printout

```
*****************************************************
Clover Systems QA-101 v4.0                      Node 0
*****************************************************
Oct 12 2001 11:15:03          Test Speed: 2X
Disc Type: MULTI SESSION            Trks: 13

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
 Ave El1 =  13.2          Pk  El1 =   38
 Ave E21 =  1.0           Pk  E21 =   13
 Ave E31 =  0.0           Pk  E31 =   19
 Ave El2 =  8.4           Pk  El2 =  306
```

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 E22 =  0.0           Pk  E22 =    1
 Ave Berl=  0.8           Pk  Berl=    5
 Tot E22 =  1
 Tot E32 =  0
 Tot Begl=  0
 Tot Drop=  0
 Tot  TL =  0
     Grade  C
 Tot Test 51:36
*****************************************************
 End of Test
```

SPLIT TEST

QA-101 can perform a "Split Test" using two QA-101's to cut the total test time in half. Identical replicas are placed in the two QA-101s. One QA-101 tests the first half of the disc and the other tests the last half. The node select selects the split test mode (see CHANGING THE NODE NUMBER Pg. 22). With the node number set to 0 - 29 (0 hex - 1D hex) the QA-101 operates in the normal fashion, and tests the whole disc. With the node number set to FIRST, the QA-101 is in split test mode, and tests the first half of the disc. With the node number set to LAST, the QA-101 is in split test mode and tests the last half of the disc.

The two QA-101'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-101 of the pair is set to node number FIRST, and one is set to LAST (see CHANGING THE NODE NUMBER Pg. 22). 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 the disc. 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. The pits and lands must be the correct size and shape in order to generate the proper signals used by the player's focus and track following servos. Deviations from the ideal size and shape of the pits are what causes playback problems. The only requirement for players is that they play a Red Book disc. Therefore, some players will have more tolerance for out-of-spec discs than others. As a result, a marginal disc may play on one player, but not another. In order to have high confidence that a disc will play reliably on all players, you must look at the pit geometry. Pit geometry can be measured by looking at the HF signal coming from the pickup (also see INTERPRETING THE RESULTS Pg. 18). This is accomplished by connecting an oscilloscope to the QA-101.

Using the Oscilloscope

Choosing an Oscilloscope

Virtually any oscilloscope will work with the QA-101. 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. 2 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-101. You can also connect to the TRK output on the QA-101 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 are generally expressed as a fraction of I_{top}. Doing this makes your measurements independent of laser power or reflectivity.

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 on page **Error! Bookmark not defined.** 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 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.

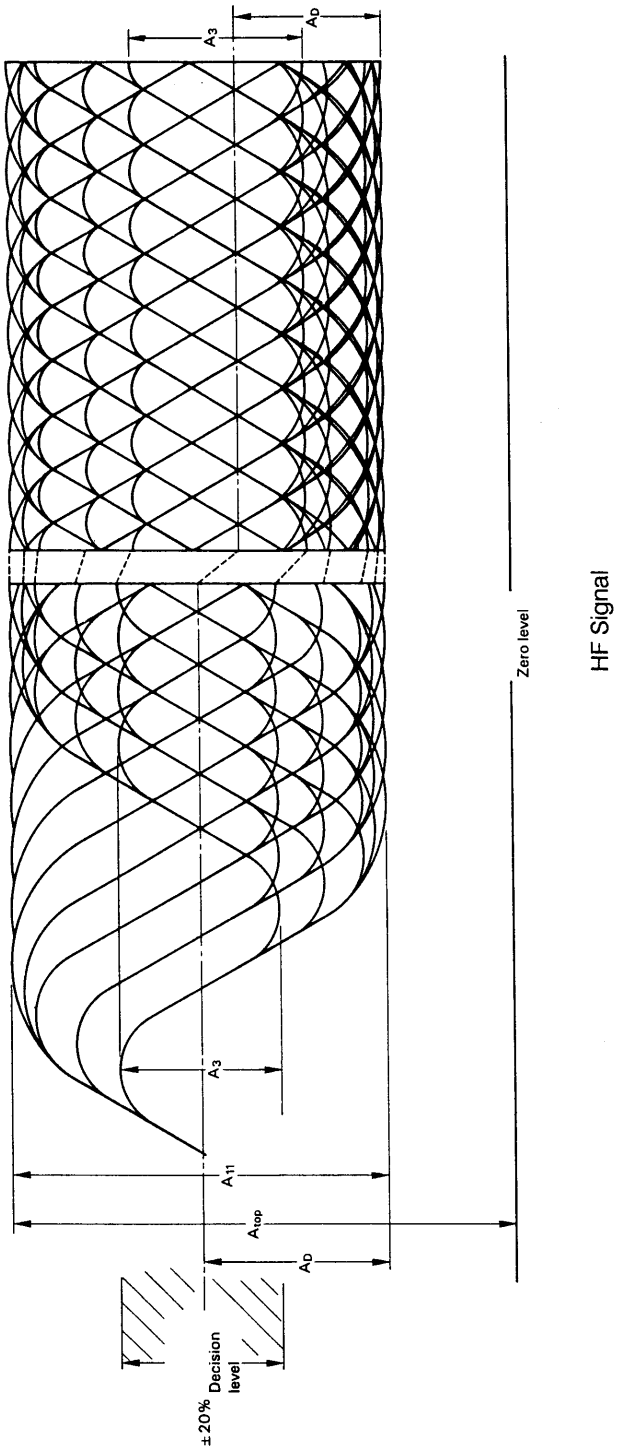


Figure 2 - Eye Pattern on Oscilloscope

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 total amount of pit to be the same as the total amount of land. However, mastering and molding considerations can cause them to become unequal. For instance, overexposure of the pits during mastering causes them to be longer than normal, causing some negative asymmetry. Generally, some overexposure is desirable because it increases the signal-to-noise ratio and pit wall steepness.

The formula for measuring the asymmetry according to Figure 1 is

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

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 Jitter

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

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 that 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-101. Make sure the 'scope is set to DC coupling. Put the QA-101 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 its smallest value), then divide by the peak-to-peak voltage over the track (at its largest value). Maximum allowable Crosstalk is 0.5.

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

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 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.

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.

One E31 error can be distributed into up to 28 blocks by the de-interleaving process. Therefore, it is possible for E12 error rates to reach as much as 28 times the E31 error rate. This is why E12 error rates are often higher than the other error rates.

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 the number of successive C1 uncorrectable frames must be less than seven. 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 10% 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 atomic force 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 necessarily 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-101 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 QA-Net with a PC, each QA-101 connected to the PC must have a unique "Node Number". For QA-Net v3, the node number can be 0 - 7. 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-101 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-101 to us. Call us for help in diagnosing the problem, and to get a return authorization.

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-101 in at least 3" of bubble-pak before shipping.

QA-Net SOFTWARE

QA-Net is a Windows program that will run under either Windows 95 / 98 / ME / NT / 2000. If running Windows NT, v3.51 or later is required. QA-Net gathers data from up to eight QA-101's, and displays the data in the form of charts. It also displays statistics for the whole disc, and prints a summary of the results. Data can be saved to disk for future reference.

HARDWARE SETUP

The QA-Net Network requires one communications port. This port can be COM1, COM2, COM3, or COM4. The QA-Net serial port on the QA-101 can be configured for either RS-232 or RS-485 operation. RS-232 operation is used if you have only one QA-101 attached to QA-Net. RS-485 operation is used if you want to connect more than one QA-101 to the computer. QA-101'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-Net 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-101

Multi-Unit Configuration

If you wish to connect more than one QA-101 to your PC, the serial port must be configured for RS-485. In the QA-101D, this is accomplished by changing an IC inside. The QA-101E (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-101 node number using the "<" and ">" buttons. When multiple QA-101's are connected, each QA-101 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-101s. Use the supplied ribbon cable to connect the adapter to the QA-101s. Up to 8 QA-101s may be connected to one COM port at once.

SOFTWARE SETUP

Insert the floppy disk and select Run from the Start Menu. Type a:setup and press OK, then just follow the directions on the screen.

In Windows, a shortcut will automatically be created. You can also copy this shortcut to your desktop or Start menu. When you start QA-Net, it automatically uses COM1. If you are consistently going to use a different port, COM2 for instance, you should change your command line in the shortcut to "QA-NET.EXE" COM2. Right click on the shortcut, then select Properties. If you are not sure, or you will be changing ports a lot, you can change ports in QA-Net's Communications menu.

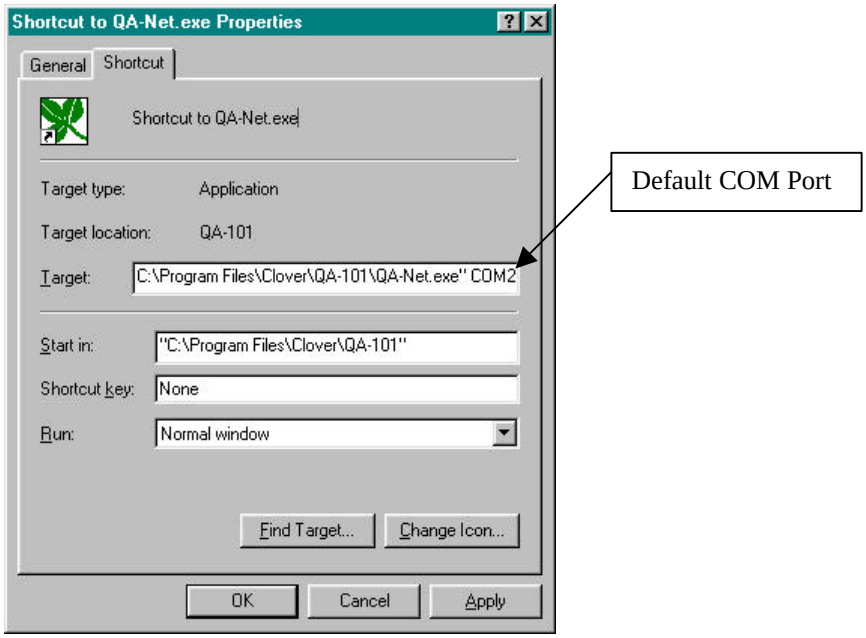


Figure 3 - Shortcut Properties

Now you are ready to run QA-Net. Double click the QA-Net icon. QA-Net will first check to see which players are connected to the network. If QA-Net fails to find any players connected, make sure the QA-101 is turned on and connected to QA-Net. 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 QA-Net menu. 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 is helpful for diagnosing communications problems. The QA-Net light comes on whenever the QA-101 is receiving commands or sending data. The LED should light when you click Find Nodes or launch QA-Net. When QA-Net 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-101 is playing at 1X or 2X speed. QA-101 will default to 2X speed. To test at 1X speed, start the player playing at 1X speed by pressing ALT + PLAY (see PLAY command). QA-Net will automatically detect the player's speed.

USING QA-Net

Each QA-101 connected to the network is a "Network Node." Every QA-101 is programmed with a "Node Number" which can be displayed by pressing ALT + MODE. Each QA-101 on a network *must* have a unique node number. For version 3, it must be 0 through 7.

The Node Number can be changed if necessary. To do this, see the section "Changing the Node Number" under "Maintenance" in the QA-101 manual.

The players should be connected and turned on. Upon start-up, QA-Net checks to see what nodes are connected. You will get a message that shows how many players QA-Net found. If this differs from the actual number of players connected, check your cable connections and try again. Also make sure that the players are turned on. Every time you connect or disconnect a player, you need to use the Find Nodes command in the QA-Net menu so that QA-Net knows exactly what is connected.

MAIN WINDOW

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 TL and DROP errors. If any of these parameters goes over a user selectable limit, the indicator will turn red. The node whose data is displayed is selected using the radio buttons in the main window. Each error type can also be graphed by using the CHART menu.

There are three types of charts: Single Node Chart, Multi-Node Chart, and All Chart. The Single Node Chart displays any combination of error types for one player. The Multi-Node Chart displays one error type for any combination of players. The All 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 QA-Net are 10-second averages. All data displayed on the front panel of the QA-101 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 in QA-Net are 10-second averages. All data displayed on the front panel of the QA-101 are one-second averages.

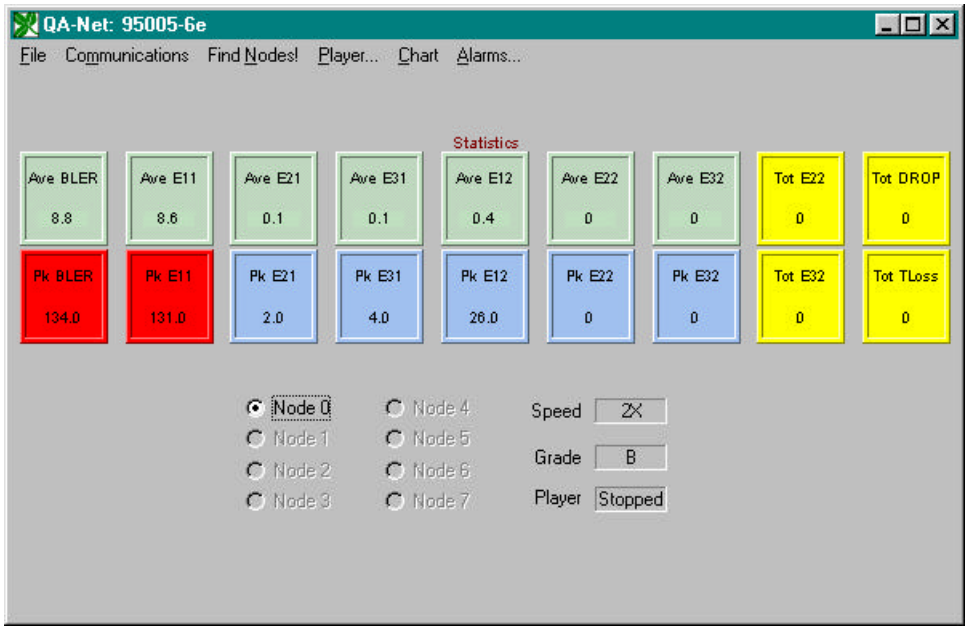


Figure 4 - QA-Net Main Window

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 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.

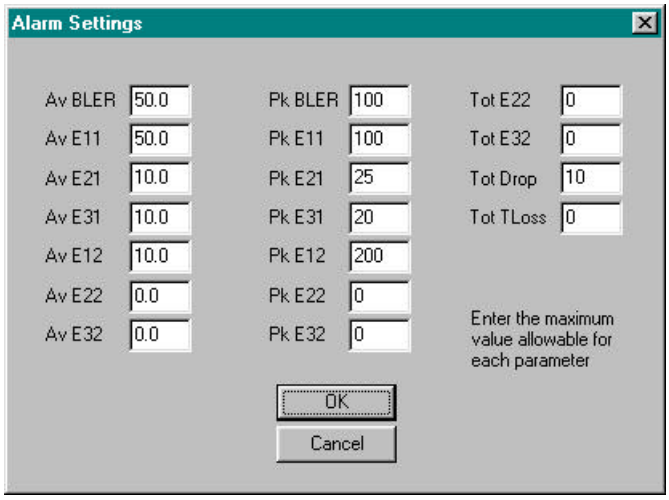


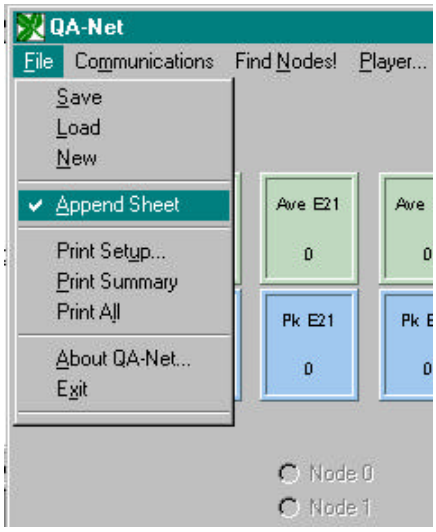
Figure 5 - Alarm Settings Dialog

SAVING THE DATA

Select File | Save in the menu. A dialog box prompts for a filename. Data for the currently selected node will be saved. You can save the data at any time, even while the test is running. The default file extension for data files is .dat but you can use another file extension if you wish.

Saving Results to a Spreadsheet

Figure 6 - Enable 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 and installed in the DATA subdirectory. You can format the spreadsheet any way you want, but it must be named CLOVER.WK1 and must be located in the same directory where you store your test data.

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-101's attached, you can start and stop each player at will.

MAKING CHARTS

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

The title bar of the chart window tells whether it is a Single 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.

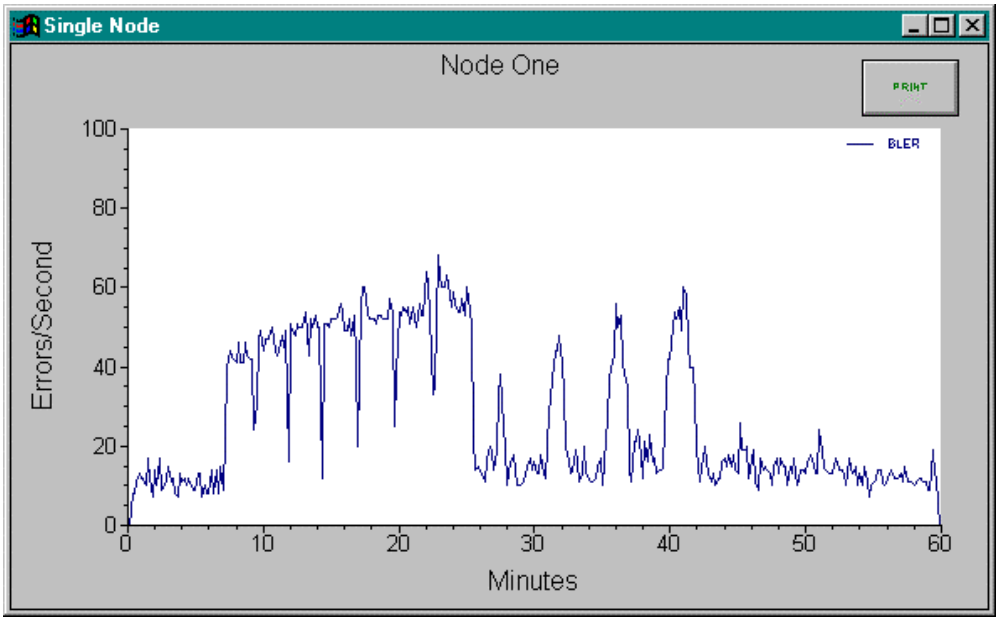


Figure 7 - Sample Single Node Chart

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.

All Chart

This menu selection creates a page of eight individual charts of each parameter for one player. The node that is selected by the radio buttons in the main window is the one that 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. The vertical scale can be individually set for each chart in this window. This can be done manually or automatically (see following section).

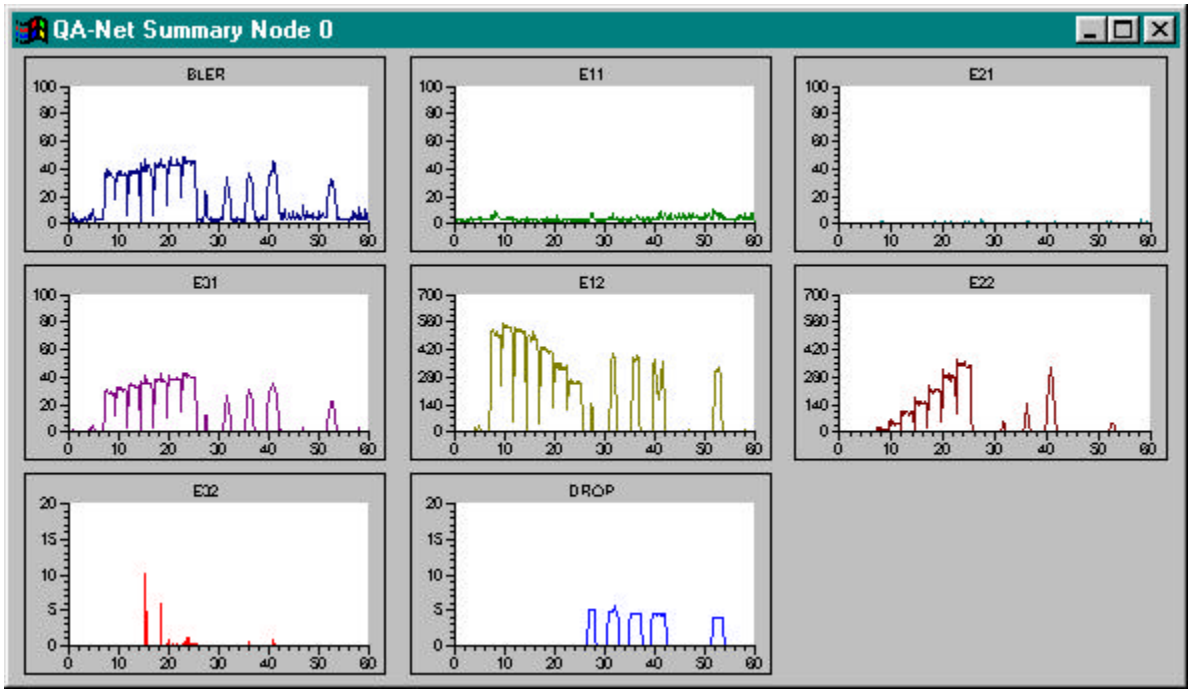


Figure 8 - Sample All Chart

Modifying the Charts

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

Changing the Axes

Double-click on the axis you want to modify. A dialog will appear that allows you to set both the minimum and maximum values for the range of that axis. You can also set the number of major and minor tick marks. If you make the range of the axis really large, be sure to adjust the space between tick marks accordingly. Otherwise you may generate an axis labeled with hundreds of tick marks! You can also apply grid lines to the chart with this dialog. The axis settings are saved for all charts, so that the next time you run 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. This data can also be copied to the clipboard, then pasted into another applications such as a spreadsheet.

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 in the upper corner. Clicking this button will print the chart. A dialog box allows you to set the size and location on the paper of the chart. Please note that if you select Actual Size for the chart, the size of the printed chart will be dependent on the size of the window on your desktop. In this case, the chart will be printed at the size and shape it appears on the monitor. To print the All Chart, select File | Print All in the main menu. The All Chart will be printed in landscape mode and fill the page.

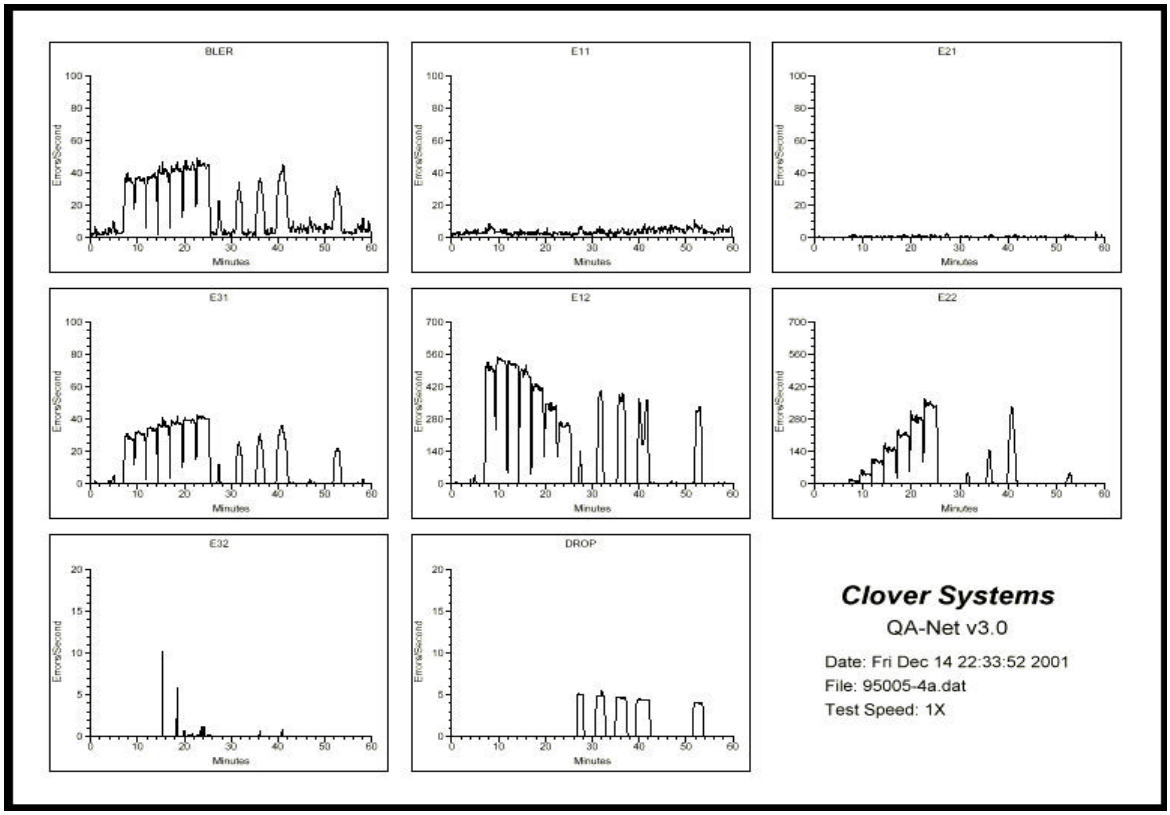


Figure 9 - Sample Print All Chart

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. A dialog lets you select which node you want to load the data as. In this way, you can load up to eight data files at once. 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.

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) 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 that exceeded the Alarm Limits will be marked by "**".

```
                    Clover Systems QA-Net v3.0

                        Summary of Results

Date:Fri Oct 14 22:50:42 2001          C:\QA-Netv3\Data\95005-6e.dat

Test Speed: 2X

            Node number: 0

            Av BLER = 8.8                 Pk BLER = 134.0**
            Av E11  = 8.6                 Pk E11  = 131.0**
            Av E21  = 0.1                 Pk E21  = 2.0
            Av E31  = 0.1                 Pk E31  = 4.0
            Av E12  = 0.4                 Pk E12  = 26.0
            Av E22  = 0.0                 Pk E22  = 0.0
            Av E32  = 0.0                 Pk E32  = 0.0
            Tot E22 = 0                   Tot E32 = 0
              Grade = B                   Tot DROP = 0
```

Figure 10 - Sample Summary Printout

CONTROLLING THE PLAYER

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-101's. If you have multiple players, the player that is currently selected by the radio buttons in the main window is the one that will receive the commands.

COMMUNICATIONS PROBLEMS

Your COM port will be set to the correct protocol automatically by the QA-Net 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-101 is receiving commands or sending data. The LED should light when you click Find Nodes or launch QA-Net. When QA-Net is running, the light should blink every 10 seconds (or every five seconds at 2X). If the computer receives corrupt data from the QA-101, 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.

QA-101 QUALIFICATION DISCS

Supplied with your unit are two discs; a "good" disc, and a disc with known defects. Both discs are provided with measured results from your player before it left the factory. To confirm that your system is operating properly, test both discs at 2X and compare the results with the results we have provided. If the results are significantly different, there may be a problem with the system. Obviously, dirt, dust, and scratches will affect your results, so you should be careful to avoid damaging these discs.

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

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

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

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

Test results for disc SBC 444A are provided in the form of graphs for the whole disc. 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.

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 different at different speeds. 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.