clover systems



DYNAMIC BALANCE ANALYZER

OPERATING MANUAL

Version 1.4

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INTRODUCTION

The Clover Systems Dynamic Balance Analyzer is a tool for measuring imbalance of DVD and CD discs. Specification of disc imbalance was added to the Red Book standard in 1994. Conformance to Red / Yellow / Orange Book and DVD standards can be verified with this system. The Clover Systems Balance Analyzer is a compact and easy-to-use desktop system that measures disc imbalance in accordance to Philips / Sony Red Book and Orange Book standards, as well as DVD standards. It will display the results in either g-mm (gram-millimeters), g-m (gram-meters), or Newtons. It will also display PASS or FAIL based on a user-settable limit. It also displays the direction of imbalance in degrees.

The advent of high-speed CD-ROM and DVD-ROM drives makes disc unbalance an important issue. The forces generated increase with the square of the rotational rate, so at high speeds, the forces are extreme. These forces and resultant vibration can adversely affect disc performance and drive life.

High-speed CD-ROM drives will reduce their read speed if they have trouble reading the disc. One of the causes of speed reduction is vibration caused by disc unbalance. Only a properly balanced disc will provide the maximum throughput these drives are capable of.

Imbalance and vibration cause increased jitter in CD-R and DVD-R writers. Therefore, the requirements for balance of CD-R and DVD-R discs are more stringent than pre-recorded discs.

Disc imbalance can be caused by thickness variation of the substrate, lacquer coating, CD-R dye coating, or DVD bonding layer as well as asymmetrical label design.

If a printer is attached to the built-in printer port, results of each test will be printed.

An RS-232 serial connection is provided on the rear panel for connection to a PC. Optional software provides data collection, display, and archiving of test results.

INSTALLATION

When unpacking, be sure to remove the gray foam under the dust cover that protects the disc spindle. Save the box and packing materials in case you need to ship the unit.

Place the unit on a sturdy, flat surface. The Clover Dynamic Balance Analyzer is very resistant to external vibration, but obviously shock or vibration could affect the results.

Check to make sure that the AC line voltage selector on the rear panel is set to match your local AC power. In the 115v position, the unit will accommodate input voltages from 90 VAC to 130 VAC, 50/60 Hz. In the 230v position, it will work with input voltages from 180 VAC to 260 VAC, 50/60 Hz.

If you are using a printer, connect it to the PRINTER port on the rear panel of the Balance Analyzer using an ordinary PC parallel printer cable. You can use any printer, which has a Centronics type parallel interface and accepts ASCII text. Note that some printers (know as “Windows Printers”) will only work with the MS Windows operating system. When selecting a printer, be sure that it will accept ASCII text, or will work with MS-DOS operating system.

You can also connect the serial port to a computer using the cable supplied (see SERIAL INTERFACE - Pg. 7). You can capture the test results using Hyperterminal which comes with MS Windows. These results can then be copied to a spreadsheet or other document.

OPERATION

TESTING A DISC

NOTE -- Allow the unit to "warm up" for 10 minutes before making any measurements.

Open the dust cover by lifting up on the front handle. Place the disc on the spindle by holding the disc by the edge and placing it over the spindle hub. Let it drop down on the hub, then gently press the disc straight down flat against the turntable with both hands. Be sure that you are pressing straight down, and not an angle. It makes no difference how the disc is oriented or whether it is right side up. Be sure that it is flat against the turntable. To start the test, press TEST. The disc will spin up to 1800 RPM. Once the disc speed is phase locked to the crystal oscillator, the test will begin. The test takes 8 seconds at the FAST speed, and 13.5 seconds at SLOW speed. When the disc has stopped, the results will be displayed. Results include the disc imbalance in g-mm, g-m, or Newtons, the angle of the imbalance in degrees, and either "--- PASS ---" or "*** FAIL ***" depending on whether the measured value exceeds the limit set by the user (see SET LIMITS on page 3).

Once the disc has stopped, remove the disc by lifting the edge of the disc with fingers of both hands. Be sure to lift straight up, so that the spindle hub is not damaged. It may be helpful to press down on the spindle hub with your thumbs while lifting with your fingers.

It is OK to press down on the top of the spindle hub, but you should avoid touching the sides of the inner spindle hub. Grabbing the inner spindle hub (the part with the metal fingers) could deform it and affect the measurements.

It is not necessary to close the dust cover during testing. The main purpose of the dust cover is to protect the spindle from damage when not in use. It is also useful for excluding strong air currents from HVAC systems, which may affect the results. If air currents are not a problem, you can leave the cover open when using it. Close the cover when the unit is not in use, so that the spindle will not be accidentally damaged.

The direction of imbalance is displayed as part of the test result. To locate this direction on the disc, use the protractor printed on the top of the unit: With the disc stopped, turn the disc by hand until the green LED just above the 0° mark on the scale lights. When the LED first lights while turning the disc clockwise, the protractor scale will read correctly.

Please note that if the disc is perfectly balanced, the measured angle of imbalance will be meaningless and random. Similarly, the measured angle of well-balanced discs will have more variation than that of poorly balanced discs.

SET LIMITS

You can set an upper limit for the disc imbalance. If the current measurement exceeds this limit, the display will show "*** FAIL ***" at the end of the test. Otherwise, it will display "---PASS ---". This provides a means of setting up a GO / NO GO test. PASS or FAIL is also printed on the printer for each test.

Press the SET button to get to the Set Pass Limit screen. The current limit setting will be displayed. You can change it in 0.1 g.mm increments by pressing the up arrow ↑ or down arrow ↓ buttons. Once it is set to the desired limit, press SET again. This will bring you to the angle calibration mode (see CALIBRATION on page 5). Pressing SET again will step to the Disc Weight entry mode, and pressing SET again will return you to the normal mode.

Here are the standards for disc unbalance as set by the Philips Red Book, Yellow Book, and Orange Book and DVD specifications:

STANDARD	MAX. Ud (g.mm)	MAX Fu (N)
Red Book	Ud ≤ 10 g.mm	Fu ≤ 0.0395 N
Yellow Book	Ud ≤ 7 g.mm *	Fu ≤ 0.0276 N
Orange Book CD-R (12cm)	Ud < 2.5 g.mm	Fu < 0.01 N
All 8cm Discs (incl. CD business card)	Ud < 1 g.mm	Fu < 0.004 N
Orange Book CD-RW	Ud < 2.5 g.mm	Fu < 0.01 N
DVD	Ud ≤ 10 g.mm**	Fu ≤ 0.0395 N

Notes: g.mm = Gram Millimeters
N = Newtons.
Ud = Disc Unbalance
Fu = Unbalance Force at 10 Hz rotation rate.

* Ud ≤ 5 g.mm is recommended.
** DVD standards use gram-meters; 10 g.mm = 0.01 g-m.
The reported imbalance force (Fu) is normalized to an equivalent force at a rotation speed of 10 Hz to match the standards.

SET DISC WEIGHT

The measurement sensitivity of the DBA is dependent on the weight of the disc. Therefore, it the weight of your discs is significantly different than the calibration discs, you must enter the weight of your disc for most accurate results.

The weight of the calibration discs are 15.5 grams, and this is the default disc weight. You can change the disc weight using the SET button. The set button cycles through three modes: Set Limit, Set Weight, and Set Phase (angle). Press the SET button until you come to the Set Weight screen. The current setting is displayed, and you can change it by using the up arrow ↑ or down arrow ↓ buttons. The range of setting is 10 grams to 35 grams. The disc weight setting is saved in non-volatile memory, and will retain it's setting even with the power off.

Note: When performing spindle or disc calibration, you MUST have the disc weight set to the weight of the calibration discs (normally 15.5 grams)!

MODE

The MODE button allows you to select the display units, the test speed, and calibration mode. Repeatedly pressing MODE sequences through these settings.

Display Mode

The results of the test can be displayed in units of either gram-millimeters, gram-meters, or Newtons. The mode button allows you to change the display units. First press MODE. The current display units in use are now shown. If you wish to change it, press up arrow ↑ or down arrow ↓ to toggle between gram-millimeters, gram-meters, and Newtons. Press MODE again to exit. The display mode is saved in non-volatile memory, so it is retained even with the power off.

Test Speed

There are two test speeds that can be selected: FAST or SLOW. SLOW is the default mode, and should be used whenever possible. The FAST mode allows for a shorter test time, but sacrifices some accuracy.

To change the test speed, press MODE. Current display units are now shown. Press MODE again to show the current speed setting. Use the up arrow ↑ or down arrow ↓ to toggle between speeds. Press MODE again to exit. The test speed is saved in non-volatile memory, so it is retained even with the power off.

CALIBRATION

NOTE -- Allow the unit to "warm up" for 10 minutes before making any measurements or attempting calibration.

When performing calibration, be sure that the disc weight [1] is set to the weight of the calibration discs (typically 15.5 grams). There are two calibration modes, which are selected by the MODE button.

Spindle Calibration

Spindle Calibration measures the imbalance of the spindle and motor. This value is then subtracted from the measured disc value. This allows accurate results even if the spindle or motor are not perfectly balanced. Spindle Calibration should be performed before Disc Calibration.

The spindle balance value is stored in non-volatile memory, so it is retained even with the power off. This procedure has been done at the factory, so theoretically there is no need to perform this function unless the spindle has been removed.

To perform the spindle calibration, press CAL. Then press MODE to select spindle calibration. Remove any disc present on the spindle, and press CAL again. At the end of the procedure, the results are displayed for a couple seconds and the unit returns to its normal mode.

Disc Calibration

Disc Calibration allows you to change the sensitivity of the unit to match known calibration standards. Two calibration discs are provided, but you can use any disc with known imbalance.

Before attempting disc calibration, you should first use the system for a while to get a feel for the natural variation in results. Results will naturally vary ± 0.2 g-mm due to the centering accuracy of the disc.

Ordinarily, calibration is not required on a regular basis. Calibration is only required if something in the system has changed. If you are getting unexpected results from a test, you should first check to see if the disc is mounted on the spindle crooked before changing calibration. A large variation in ambient temperature can also affect the results. For best results, DBA should be used in a temperature controlled environment.

To calibrate the unit, place a disc on the spindle and press CAL. Now press CAL again to select Disc Calibration. The disc will spin up and continuously measure until you stop it by pressing CAL again. Let it run for 30 or 60 seconds to get a stable reading. To change the sensitivity, press up arrow ↑ or down arrow ↓ to increase or decrease the sensitivity. Since each measurement takes several seconds, the value will

[1] See “Set Disc Weight” on page 4

change only every five or ten seconds (depending on the SPEED). The sensitivity is increased / decreased in very small steps (about 0.05 g.mm) when ↑ or ↓ are pressed, and as long as the buttons are held down. With a little practice you can get a feel for how long to hold down the button. For small adjustments, just press the button two or three times, then wait for the measurement value to be updated.

In order to indicate when the value is updated, a "*" is displayed in the first column of the bottom row on the display. When the "*" appears or disappears, you know the value has been updated.

The measurement sensitivity is saved in non-volatile memory, so it is retained even with the power off. When checking spindle or disc calibration, remember that the TEST result is the important one; CAL results may be slightly different.

Angle Calibration

You can adjust the angle measurement ± 30 degrees using the SET mode. Press SET until you get to the Calibrate Angle screen. The current setting of "phase shift" is displayed. This is an offset added to the angle measurement for calibration purposes. This is set at the factory, and ordinarily should not need to be changed unless some component is changed. To calibrate the angle, use a disc with known angle of imbalance, such as the provided calibration disc. If the measured angle does not correspond to the indicator on the top of the unit (when the green LED is lit), then you can increase or decrease the measured angle by pressing the up arrow ↑ or down arrow ↓ keys. The current offset is displayed, and saved in non-volatile memory.

USING THE PRINTER

The Dynamic Balance Analyzer will work with any printer with parallel (Centronics) interface that prints ASCII text. Please note that some printers will work only with Microsoft Windows and cannot be used. When selecting a printer, make sure that it is "MS-DOS Compatible".

Connect the printer to the Dynamic Balance Analyzer 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. Enable printing by selecting "ON-LINE" on your printer. If the printer is not ON-LINE, or turned off, the Dynamic Balance Analyzer will simply ignore it. When a printer is connected to the DBA, the DBA should be turned on BEFORE turning the printer on.

With the printer connected, turned on, and selected, the printer will print a header when the first disc is tested after turning on power to the Dynamic Balance Analyzer, or on command.

The printer will print the results of each test as it is completed. This includes the amount of imbalance in g-mm, g-m, or Newtons, the angle of the imbalance in degrees, and "--- PASS ---" or "*** FAIL ***" depending on whether the measured value is greater than the limit set by the user.

You can make the DBA start a new page at any time by pressing both up arrow ↑ and down arrow ↓ at the same time while in Normal mode. The printer will form-feed to the next page, and print a header.

USING THE SERIAL INTERFACE

The serial interface is an RS-232 connection on a DB-9 connector. It connects to a PC using an ordinary 9-pin serial cable. The cable should be "straight through" and not a "null modem" cable, as the Balance Analyzer is wired as DCE (Data Communications Equipment).

The Dynamic Balance Analyzer sends ASCII text with comma delimiters and a carriage-return at the end of the record. The easiest way to use the Balance Analyzer with a Windows PC is to run HyperTerminal, which comes with Windows. Set up HyperTerminal to communicate directly to the COM port you wish to use. Set the communications parameters as shown below. You can control the DBA by typing the commands shown below, and the results will be displayed on the screen, and can be saved. It is also possible to direct the DBA results into a spreadsheet.

Communications Parameters

9600 baud, 8 data bits, one stop bit, no parity, no flow control.

Message Format

The message consists of four items separated by commas, with a carriage-return + linefeed at the end:

"PASS" (or "FAIL"),

Measurement result (g.mm, g.m, or Newtons, depending on mode setting),

Current Limit Setting (g.mm, g.m, or Newtons, depending on mode setting),

Speed ("FAST" or "SLOW", depending on mode setting)

Carriage Return + Linefeed

Here are actual results from Windows HyperTerminal:

```
PASS,9.7 g.mm,10.0 g.mm,SLOW
PASS,9.6 g.mm,10.0 g.mm,SLOW
PASS,9.6 g.mm,10.0 g.mm,SLOW
PASS,2.9 g.mm,10.0 g.mm,SLOW
PASS,2.8 g.mm,10.0 g.mm,CAL
PASS,2.9 g.mm,10.0 g.mm,SLOW
FAIL,10.0 g.mm,10.0 g.mm,SLOW
FAIL,10.1 g.mm,10.0 g.mm,SLOW
FAIL,10.2 g.mm,10.0 g.mm,SLOW
PASS,9.5 g.mm,10.0 g.mm,SLOW
PASS,9.6 g.mm,10.0 g.mm,SLOW
```

Command Codes

The Dynamic Balance Analyzer can also be controlled using the serial interface. All front panel commands can be duplicated by commands sent to the serial port.

COMMAND	ASCII CODE	ASCII CHARACTER	PC KEYBOARD CODE
↑	81h (129d)	ü	ALT + 0129
CAL	82h (130d)	é	ALT + 0130
SET	84h (132d)	ä	ALT + 0132
↓	98h (152d)	ÿ	ALT + 0152
MODE	94h (148d)	ö	ALT + 0148
TEST	A4h (164d)	ñ	ALT + 0164

CALCULATING THE MOMENT OF INERTIA OF A DISC

The DVD Standards specify the maximum allowable Moment of Inertia . The Moment of Inertia can be calculated from your Balance Analyzer measurements.

The Moment of Inertia for a flat disc with a hole in the center is:

$$I = (M/2) \bullet (R1^2 + R2^2)$$

Where

I = Moment of Inertia
M = Mass (weight) of the disc
R1 = Radius of inner hole
R2 = Radius of the disc
/ = divide
• = multiply

So, a typical disc with R1 = 7.5 mm (radius of inner hole) and R2 = 60 mm (radius of entire disc), and a weight of 15 grams will have a moment of inertia of 27422 g-mm^2 .

The DVD spec uses units of gram - meters^2 , so divide by 1,000,000 to get g - m^2 (there are 1,000,000 square millimeters in a square meter). So this disc would have a moment of inertia of 0.027 g-m^2.

If the disc is not perfectly uniform (balanced), then the moment of inertia is increased by $M \bullet h^2$. M is the weight of the disc, and h is the distance between the geometric center of the disc and the center of mass (which is exactly what the Balance Analyzer measures). The disc unbalance (Ud) as measured by the DBA is Mh, where M is in grams and h is in millimeters. You can find h by dividing Ud by M.

$$Ud = Mh \quad \text{so } h = Ud/M$$

So if the unbalance is 10 g-mm, then h = 10 g.mm divided by 15 g = 0.67 mm. So now $Mh^2 = 6.7\ g.mm^2 = 0.0000067\ g.m^2$. As you can see, an acceptable amount of imbalance adds very little to the Moment of Inertia. Using the maximum allowed weight (20g) and maximum allowed unbalance (10 g-mm), gives a moment of inertia of 0.037 $g\text{-}m^2$, which is less than the allowed 0.040 gm^2 for moment of inertia.

CALIBRATION DISCS

Supplied with your unit are two discs with known imbalance. They are calibrated using Philips Standards. Both discs are provided with measured results from your tester before it left the factory. To confirm that your system is operating properly, test both discs and compare the results with the results we have provided. If the results are significantly different, you may need to calibrate the system. Calibration discs are also available directly from Philips at www.licensing.philips.com.

MAINTENANCE AND SERVICE

Ordinarily, there are no adjustments or maintenance required. If you need to replace the fuse for any reason, use a ½Amp fuse.

If you need repairs, first call us for help in diagnosing the problem, and to get a return authorization and shipping instructions:

Tel: +1 949.582.8010
Fax: +1 949.582.1016
Email: Service@CloverSystems.com
Internet: 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 Balance Analyzer in at least 3" of bubble-pak before shipping. Secure the disc spindle with the original foam, or packing tape.

Removing the Dust Cover

In case you wish to remove or replace the dust cover, just open the dust cover and remove the four screws fixing the hinges to the top cover using a Phillips screwdriver.

The nuts on the inside are attached to the top cover, so there is no need to remove the top cover.

Removing the Top Cover

WARNING -- Do not exert any force on the motor spindle or shaft, as this may damage the spindle or motor mount.

In order to change the firmware EPROM, you will need to remove the top cover.

1. Unplug the AC power cord from the player.
2. Open the dust cover and remove the spindle: Use the special tool provided to pull the spindle off the motor shaft. DO NOT grasp the inner hub. Deforming the inner hub will affect the performance.
3. Cover the hole in the spindle hub with tape to keep dirt from falling into the hole. Do not place tape over the black index mark, as this may stick to the tape and come off.

WARNING -- Do not allow anything (dirt, dust, etc.) to enter the hole in the spindle, as this will affect the performance.

4. Remove the four Phillips head screws in the top cover near the spindle.
5. Remove the four screws holding the top cover, which are on the sides of the chassis.
6. Slide the top cover towards the rear of the chassis about 3/8" to disengage the lip on the top cover that engages with the front panel.
7. Now lift the top cover up until you can reach inside.
8. Remove the wire to the green LED. It simply pulls off. When re-installing, the red wire goes toward the front of the chassis.
9. Remove the ribbon cables going to the display and keyboard. When re-installing, the keyboard cable is keyed, and can only go one way. The display is marked where pins 1 & 2 are. Pin one is the red wire.
10. The top cover can now be fully removed.

Changing the EPROM

The firmware EPROM is an integrated circuit located on the main circuit board labeled 16-022. This IC is in a socket labeled U4. It should have a label on it with the Clover Systems logo. Remove the chip from the socket using an IC removal tool or small screwdriver. Gently pry the chip from the socket, being sure that you are prying up the chip only, and not the socket.

Installation is simply a matter of pressing the new IC into the socket. One end of the EPROM IC has a notch in it. Align the chip so that the end with the notch is facing the rear of the unit. Make sure all pins go into the holes in the socket, and press the IC into the socket. To re-assemble, follow steps 1-10 in reverse order.

SPECIFICATIONS

- Resolution = 0.1 g-mm (4 x 10^{-5} Newton)
- Repeatability / Accuracy = ± 0.5 g.mm
- Range = 0.0 - 17.0 g-mm (0 - 0.07 N)
- Rotational speed = 1800 RPM
- Angular accuracy = ± 3 degrees
- AC voltage = 115 / 230 VAC, 50 / 60 Hz, ½A
- Power consumption = 30 W
- Dimensions = 17" x 13" x 4.75"
- Weight = 20 lbs.