CD Alignments

By Sheldon Fingerman

Maybe you are already repairing CD players, or just contemplating whether to get into it. As with servicing any product, one of your prime concerns is reducing callbacks. One way to minimize callbacks is to follow the manufacturer's alignment procedures. Over the long haul, the money saved by a service center in reduced callbacks could very well cover the cost of any extra equipment needed.

Another reason for checking the alignment of a CD player as part of a service routine is that specs seem to drift over time. You will find that proper alignment will not only solve some annoying problems, but will usually shorten disc access time as well.

It's really amazing how much faster a CD player can jump from track to track after proper alignment. Since deterioration of disc access time occurs over a long period of time, the customer will not only be happy that their player is fixed, but will wonder what you did to "hot-rod" it.

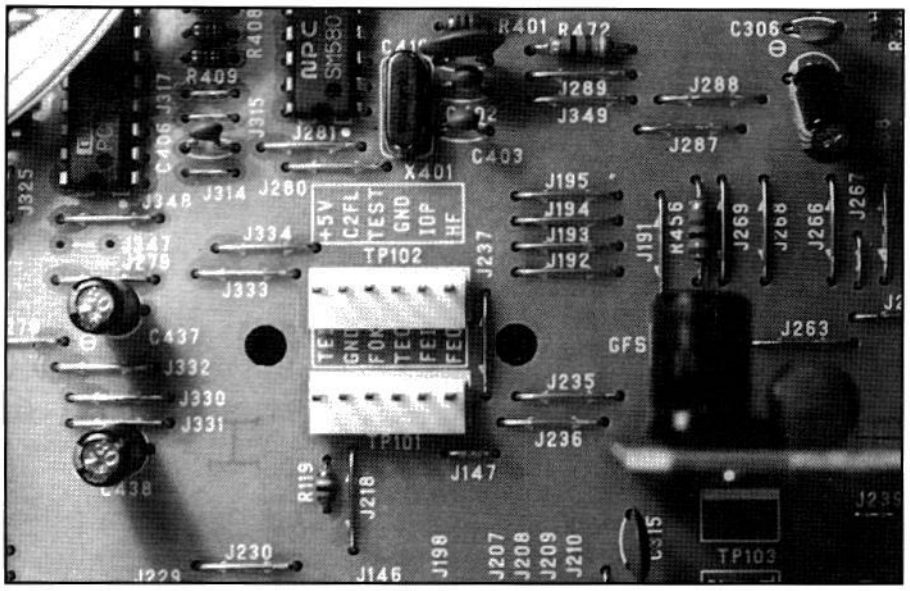

Figure 1. An example of connector type test points on the Denon DCM 777: all grouped together, easy to get to, and well labeled.

CD alignment equipment

The pieces of equipment needed to align most players are a dual-trace scope, an audio generator, a frequency counter, and a specific test disc. Although most manufacturers call for a scope of 100MHz or more, around 50MHz or 60MHz seems to work fine. The frequency counter must read at least 50MHz, and the test disc may have to be purchased from the manufacturer. Some luxury items that are nice to have are a laser power meter and a "torture" disc.

If you're contemplating working on CD players, and you do not have a frequency counter or an audio generator, one of the newer generators with a built-in counter (for use internally or externally) may be just what you are looking for.

Test discs

Some test discs are universally used among several manufacturers, with alignment specs given for the different discs. A test disc from another manufacturer will usually work just fine, but it is strongly recommended that you use a test disc from the manufacturer of the product you're aligning.

Keep in mind, however, that it should never be necessary to turn a pot very much for any adjustment. If you're using another manufacturer's test disc and you find yourself having to turn adjustment pots excessively, the problem may be the wrong test disc, or a symptom of a problem relating to that particular alignment. If you are using the wrong disc you will never know which it is.

It should be noted that in communicating with technical support, my experience has been that many of the support technicians didn't seem overly concerned that I was using another manufacturer's test disc. Most of these discs contain a variety of music (no special test tones that I can discern), and a lot of tracks, and run the information right out to the edge of the disc. You'll have to draw your own conclusions from your own experience.

Service literature

When working on CD players, a service manual is really more of a necessity than a luxury. With the price of some service manuals on the high side, especially for non-authorized service centers, you may be tempted to wing it. If all of the adjustment points and test points are well labeled, it may be worth a try. You should, however, mark all of the adjustment pots before you touch any of them so that you can return them to their original positions—just in case.

Remember, the player should function better, not worse, when you are through.

Many of the newer carousel (turntable) type CD players require removal of the entire loading drawer to gain access to the adjustment points. This usually takes only a few minutes with the proper instructions.

As you are probably aware from servicing other devices, many different models by the same manufacturer are very similar, and a manual from one may be transposed to another. CD players are no different, so you may be able to spread the cost of one manual out over several other models.

Special tools fall into the same category. If you're pretty sure that this is the only CD player of this type, which would be easier to service with a special tool, that you will be servicing, you might be able to get by with the tools you have. But if you know that you can spread the cost of a special tool over several repairs, and it

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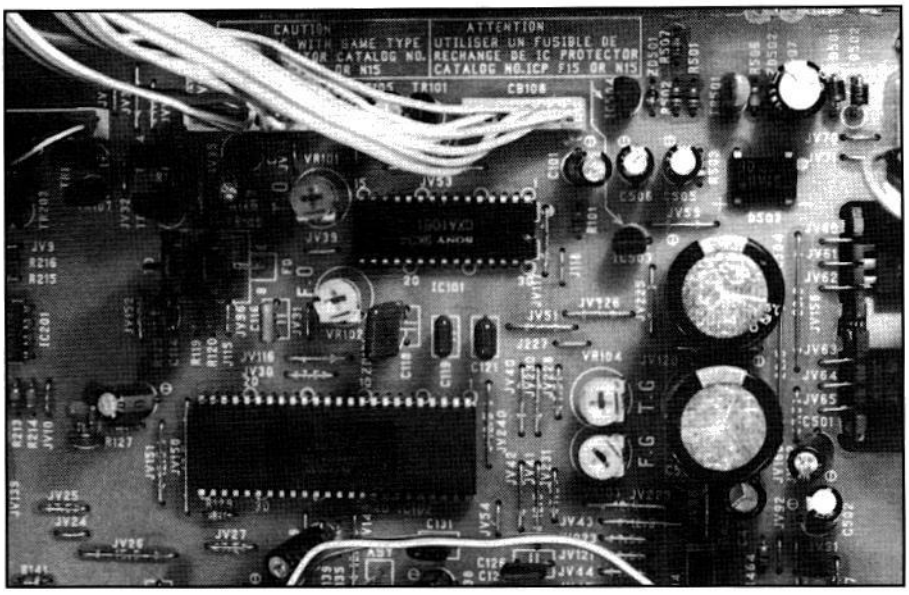

Figure 2. An example of well labeled adjustment pots. Focus offset (FO), tracking offset (TO), focus gain (FG), and tracking gain (TG) can be easily spotted on this circuit board.

will make your servicing more efficient, it may be worth the expenditure.

Some CD player servicing precautions

Before beginning you should take some precautions into account. The service manual will warn you against looking at the laser beam, and tell you not to put the laser diode in your mouth. I can understand why it might be necessary to warn you that you should not put your eyeball up against the laser lens (someone who isn't aware of the danger to eyesight might be tempted to look at it to see if they can tell if it's working), but why anyone would feel compelled to eat the laser diode is beyond me. Other, and more realistic concerns are warnings about proper handling of the laser assembly, and anti-static precautions.

Become familiar with the procedures

Read all of the alignment procedures before you start. This will give you a chance to see if you need any special tools or if you have to make any "filters," and let you explore the circuit board for all of the test and adjustment points (Figure 1). Some of them may be labeled so clearly that you hardly need the manual at all; others may be extremely obscure (Figure

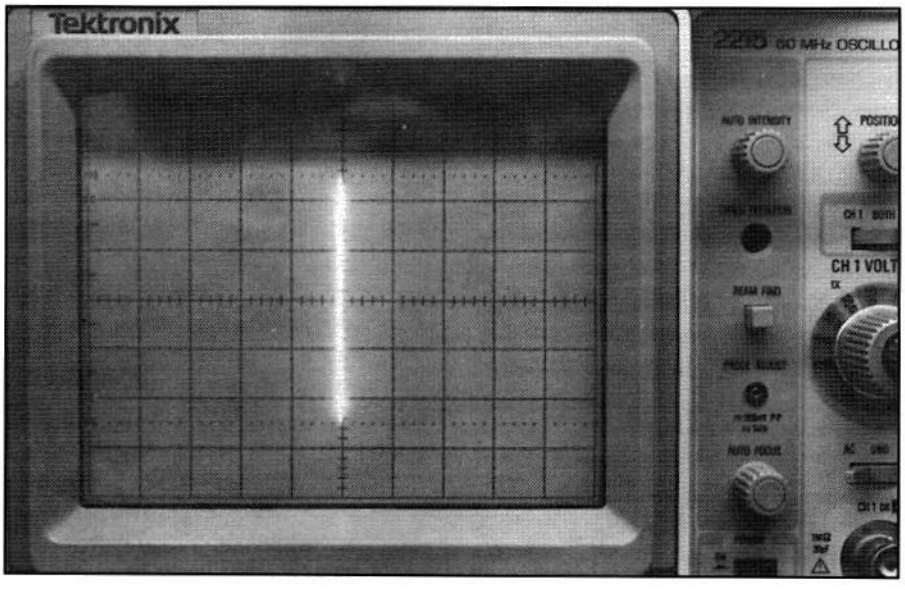

Figure 3. The tracking offset waveform compressed into a single vertical line. Using this method makes it a snap to determine if it's symmetrical about the zero point.

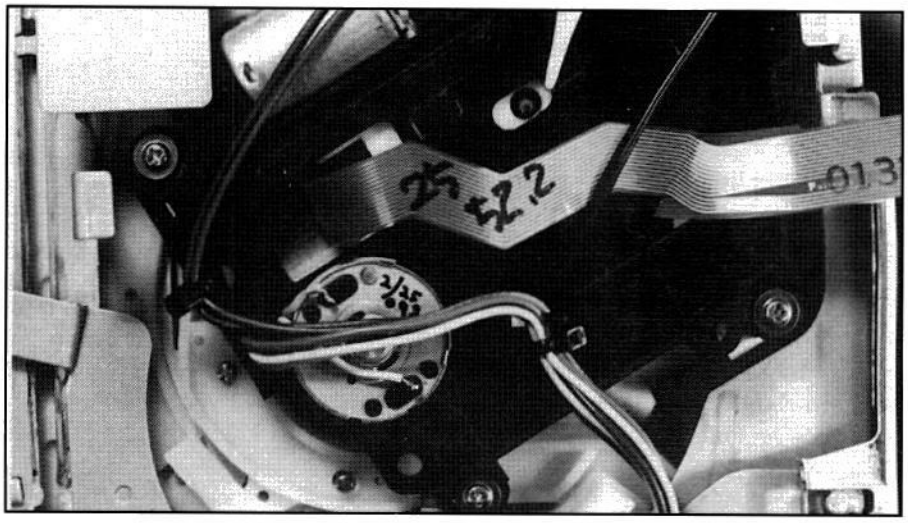

Figure 4. The pointer points to the grating adjustment on the Denon and similar multidisc players. This type of player has the laser assembly aimed downward. The disc is loaded information side up.

2). It's easy to figure that a pot labeled TG is tracking gain, and a test point labeled GND is ground. Labels like VR102 and TP1 aren't going to get you very far without the proper manual.

While we're on the subject of manuals, we have all seen more than one error in service literature. Most manuals are translated into English from another language. From some of the errors I've encountered, I've always felt that the same person who did the translation also proof read it. If you try a procedure that doesn't work, and you've double checked everything, the problem may be that there is an error in the manual.

A couple of methods seem to work for me when this happens. First, read ahead. Maybe you're supposed to be on test point 3, even though the manual says 2. Later, in that same procedure the manual may read, ". . . and be sure to remove the jumper from test point 3..." This would tell you that maybe 3 was the proper test point. In most such cases that I've run into, this cleared up the situation.

Second, if all the test points are lined up, resembling a connector, and numbered like a connector, they are usually labeled as well. It is not uncommon to find that the pin numbers are labeled in an order that's the reverse of the order printed in the manual's instructions.

If the instructions tell you to connect the ground of your scope to pin 5 (GND) of a 5 pin connector, but pin 5 is labeled TEO, check pin 1. If it is labeled GND, either the labels are wrong, or the manual is wrong. Use an ohmmeter to determine which pin is actually ground, and using that as a reference continue on. When in doubt, I've found that the labels on the circuit board are usually more correct than the pin numbers that are called out in the manual.

Labels can also help you when making connections. For adjusting Focus Gain you will have to both read, and inject a signal. You will be adjusting control FG, and attaching your probes to FEI and FEO. When tracing connections remember the I in FEI stand for Input, and the O in FEO stands for output. Obviously, you would not inject a signal into an output.

Using a filter

Most CD players require some kind of "filter" for proper adjustment, and you will have to make one. They are usually composed of a resistor and capacitor, or just a resistor. If another manufacturer calls for values different from those for a filter you have already made, the one you have will probably work fine.

The reason for the filter is to reduce the

amount of "fuzz" in the waveforms. Try viewing some of the waveforms with and without the filter. You will quickly see why it is such a necessity.

Aligning the Denon DCM 777

This article will use a Denon DCM 777 as an example, with references to general alignments and problems found on other players. The Denon DCM 777 is a cartridge type multidisc player, sharing many mechanical components with Pioneer models of the same type. The service manual is easy to understand, and the alignment procedures are well documented.

Before beginning alignments you will have to place the player in the test/service mode. On this Denon you enter the service mode by shorting two pins together when powering up the player. Disc number 1 will appear in the display (0 if no cartridge is present) and you can now remove the short. The player will now stay in service mode until you turn the power off. If you do turn the player off at any time during the alignments, you will have to follow that procedure again if you want to put it back in service mode.

Different players use different procedures for placing them in service mode. Some players require that you leave a jumper in place; others require that you press and hold one or two buttons on the front panel when the unit is turned on. Like models use the same procedures.

Once in service mode you can manually switch different circuits on and off. Numbers will either be displayed, or in some cases not displayed on the front panel, indicating what test mode you are in.

The laser pickup

It is not uncommon to find that some players allow you to switch the laser off and on to see if it's functioning properly, or to adjust the output. If you do not have a laser power meter, checking the laser may be as simple as dimming the lights in the shop and cautiously looking at the lens from a distance of at least a foot, and preferably several feet, and at an angle to the direction of the beam. The beam can be easily seen at an angle quite a distance from the laser assembly.

Although the laser is fairly weak, observe proper precautions that are in the manual, and do not peer into it like a microscope. If you can see no light emitting from the laser (in a darkened room), and you are sure that the player is in the right test mode, there may be a problem with the laser.

Making the adjustments

The first alignment on the Denon DCM 777 is the PLL adjustment. Before you can get the proper frequency, the test points ASY and GND3 will have to be connected with a jumper. The frequency you are looking for is 4.32MHz. If those two points are not connected together via a jumper, you will never even get close to the proper specs. If you are having problems getting 4.32MHz, and the adjustment is at its stop, or close to it, double check your jumper and connections. Also, this measurement is taken through a 10:1 scope probe, not only on the Denon, but on many other brands as well.

The next three adjustments: Tracking DC Offset, RF Offset, and Focus Offset are easily adjusted with a DVM. You can be as much as 50mV off on these adjustments, so as in horseshoes, close counts.

Tracking Offset is adjusted with a scope, using the filter that is called for. Again, this filter is easily constructed and is invaluable in seeing clear waveforms. Although you may have to deviate your scope settings slightly from what is called for, you should see a clear waveform just like the one pictured. Don't forget to switch your scope to dc.

A trick, given to me by Yamaha Technical Support, is to compress the wave into a simple vertical line (Figure 3). Although the normal waveform is clear, it is in constant motion and difficult to get a handle on. One vertical stripe is a snap to adjust.

Adjusting the gains

Focus Gain is adjusted using a pair of filters, a frequency generator, a frequency counter, and a scope. A handful of small hook type connectors can be invaluable here. If you get confused as to where to inject the signal from the generator, once again remember the meaning of the O and the I; FEO (Focus Error OUT) and FEI (Focus Error IN). The generator goes to the input. It is usually best if you make the last connection the positive lead from the signal generator, with the player in the proper mode and the disc spinning.

Tracking Gain is adjusted almost exactly like Focus Gain, using the Lissajous waveform once again. The Denon manual gives scope settings for both Focus Gain and Tracking Gain. You will find that if your scope has V/div settings for

both 10:1 and 1:1 probes, you should use the 1:1 setting with a 10:1 probe.

Virtually all alignment instructions will have you confirm Tracking Offset at some point. Once again, this is an easy alignment, especially if you remember to compress the waveform.

Denon completes their adjustments at this point, having you continue only if you are experiencing problems. Tangential adjustment, or aligning for the optimum Eye Pattern, is fairly simple. The Grating adjustment is not.

The Grating adjustment

The Grating adjustment is probably the most difficult alignment to get right—on any player (Figure 4). And if this adjustment is not correct, the CD player will not play at all. Most new players can be adjusted with a simple screwdriver, but many cannot. Investing in costly alignment tools will greatly reduce your profitability, unless you can be assured they will be used again.

Second, the Grating adjustment is extremely difficult even with the right tools. The main problems are that the adjustment is minute, and that it is difficult to differentiate between the null point of the waveform, and the (exactly as it is translated) "Waveform of not null point."

The Grating adjustment aligns the beams in a "3 beam" laser assembly. A player that won't accept discs may only need a Grating adjustment, assuming the motor and laser circuits are operating properly. Low amplitude of this waveform may indicate a laser problem.

Checking your work

When all alignments have been completed, turn off the power and remove any jumpers and probes still attached. When you power up, the player should return to normal operating mode. If you have one, a "torture disc" can be used to check out your work.

A torture disc is one of those discs with built-in dirt spots, scratches, and fingerprints. Philips manufactures a set of two discs, one with flaws, and one without (for reference). Although pricey, around $100, these discs can be an invaluable diagnostic tool.

If the customer complains of only one or two discs being a problem, make sure they bring the discs in with the repair. If the discs are clean with no major scratches, and you can duplicate the problem with these CDs, playing them after the player has been serviced will help confirm that you have indeed solved the problem, assuming the discs play fine on another player.

A few thoughts

You'd be amazed how many customers don't realize that the "business" side of a CD is the side without writing on it. Yes, all their discs are clean, just on the wrong side. Also, some players, like the Denon DCM 777, accept discs upside down (music side up). Both the Denon and Pioneer cartridge type players share the same transport assembly, and load the same way. Although they are both very good products, neither will play a disc that has been loaded label side up.

Mechanical problems

Remember the good old days of records (LPs)? Remember how you sometimes had to enlarge the hole to get the record to fit on the spindle? Well, some CDs have the same problem. They don't sit properly on the CD "turntable," and have to be gently reamed out. Since everything that goes on inside the player is hidden from view, you can't see that the disc is not sitting flat in the clamper assembly.

Waveforms that pulsate vertically may indicate a bent spindle. Waveforms that pulsate horizontally, like a "Slinky," may be an indication of a motor (speed) problem. And waveforms that will not reach proper amplitude may indicate some sort of laser problem.

You may want to check for service bulletins. The Denon DCM 777 had a problem with intermittent disc access. The problem is solved by replacing R144 (68K ohms) with a 91K resistor. This modifies the feedback circuit driving the spindle motor, allowing the CD to "spin up" faster. If the problem still persists, a new motor may be required.

This information is portable

Alignments on other models are very similar, although the labels and order of adjustments may not be the same. For example, on a particular Yamaha player the PLL adjustment is called VCO Freerun. Yet, you are still looking for a reading of 4.32MHz, and you still are required to use a 10:1 probe.

The more you do these adjustments the easier they get. You will soon begin to see the similarities from one brand to the next, and when you come across one of those really vague service manuals, your previous experience will go a long way.

Experience will also teach you what waveforms to look for when evaluating problems, regardless of the manufacturer or the absence of a manual. It's a great feeling to be able to tell your customers what the problem is, without having to repair the unit first.

Although proper alignment will add time to any repair, I'm reminded of an old saying, "We can never seem to find the time to do it right, but we always have the time to do it over again."

Servicing and adjustment procedures for the Denon DCM 777 compact disc player

The Denon DCM 777 CD player contains a microcomputer that includes all of the programs to perform servicing for each servo adjustment.

To activate the service program, perform the following steps:

1. Turn the power off.
2. Short circuit pins 3 and 4 of TP 102.
3. Turn the power on. The indication "Disc No. 1" will show on the display.
4. Remove the short circuit.

When the unit has been placed in the service mode by following the above steps, the operating controls will not function normally, but will only operate for servicing. When the service program is invoked, the laser pickup will move to the optimum position.

The only controls that are used during normal service procedures are EJECT, STOP, PLAY AND PAUSE. The use of these buttons for service will be described here. All of the other buttons are reserved for factory use, for specific functions such as checking the IC. Operation of these buttons during service could result in incorrect function of the CD player.

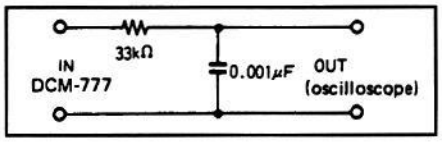

Figure 5. Connect the oscilloscope to the CD player through this filter network for making all adjustments, except where directed otherwise.

If you accidentally push any of these buttons, immediately turn power off and activate the service program again. You should also never use the remote control when the service program is activated.

Note that in a number of the adjustment procedures following, the first step is "Set the unit to test mode." If the unit is already in test mode, you, of course, don't have to go through that procedure again.

Preparations for making the adjustments

Before moving any of the adjustment controls, first adjust, if necessary, the turntable height, the laser pickup system and the spindle motor system. The super linear convertor in this unit ordinarily requires no adjustments.

The equipment required to perform the adjustments are:

- Dual-trace oscilloscope (100MHz or greater bandwidth)
- Adjustment disc (33CA-1094)
- Low frequency oscillator: 10Hz to 10kHz, 0Vpp to 3Vpp
- Frequency counter readable to over 5MHz
- Filter network for measurement (see Figure 5)

Place the unit in service mode as described earlier, then set the adjustment controls (VR102 to VR106) to the positions shown in Figure 6. Make the adjustments in the following order:

1. PLL
2. Tracking dc offset
3. RF offset
4. Tracking offset
5. Focus gain
6. Focus offset
7. Tracking gain
8. Tracking dc offset
9. Tracking offset

PLL (phase lock loop) adjustment

- Set the unit to test mode.
- Confirm that the display shows "Disc No. 1."

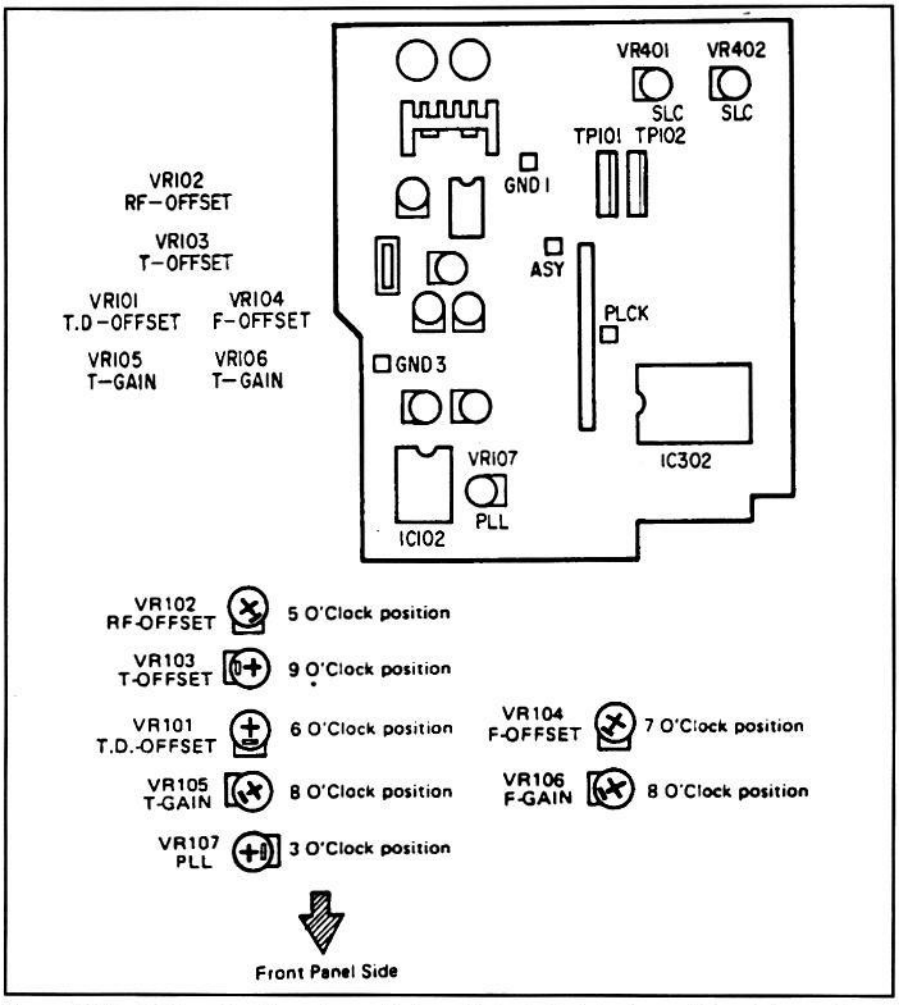

Figure 6. The PC board outline, along with the callouts to the left, give an idea of the position of the adjustment pots. The illustrations below the PC board show the correct initial positions of these pots.

- Connect the ASY to "GND 3" for grounding.
- Connect the positive side of the frequency counter to test point "PLCK" (phase lock) using a 10:1 oscilloscope probe, and the negative side to "GND 1."
- Rotate the PLL VR (variable resistor) to obtain an indication of 4.32MHz ± 10kHz on the counter.
- Disconnect the ASY from the ground.
- Disconnect the frequency counter grounding jumper.

Tracking dc offset adjustment

- Set the unit to test mode.
- Confirm that the display shows "Disc No. 1."
- Set the VR103 (Tracking offset, or T.O. ADJ) to a position 45 degrees clockwise from its mechanical center position.
- Adjust the VR101 (Tracking dc offset, or T.D. ADJ) until the voltage at pin 3 of TP101 (TEO) measures 0V ± 50mV.

RF offset adjustment

- Press the Stop button.
- Confirm that the display on the CD player shows "Disc No. 1."
- Adjust the VR102 (RF offset adjustment) until the voltage at pin 1 of TP 102 is 100mV ± 50mV.

Tracking offset adjustment

After you have completed this adjustment, readjust the Tracking dc offset.

- Set the unit to test mode.
- Insert the adjustment disc into the magazine and insert the magazine into the CD player.
- Press the Stop button and confirm that the display shows "Disc No. 1."
- Set Channel 1 of the oscilloscope for 50mV/div, and ground the input. Adjust the vertical position, if necessary, to make sure that the trace is at the 0 position.
- Set Channel 2 of the oscilloscope to 5ms/div.
- Press the Play button. The disc will be pulled out of the tray and begin to revolve.
- Check to see that the display now shows "Disc No. 2."

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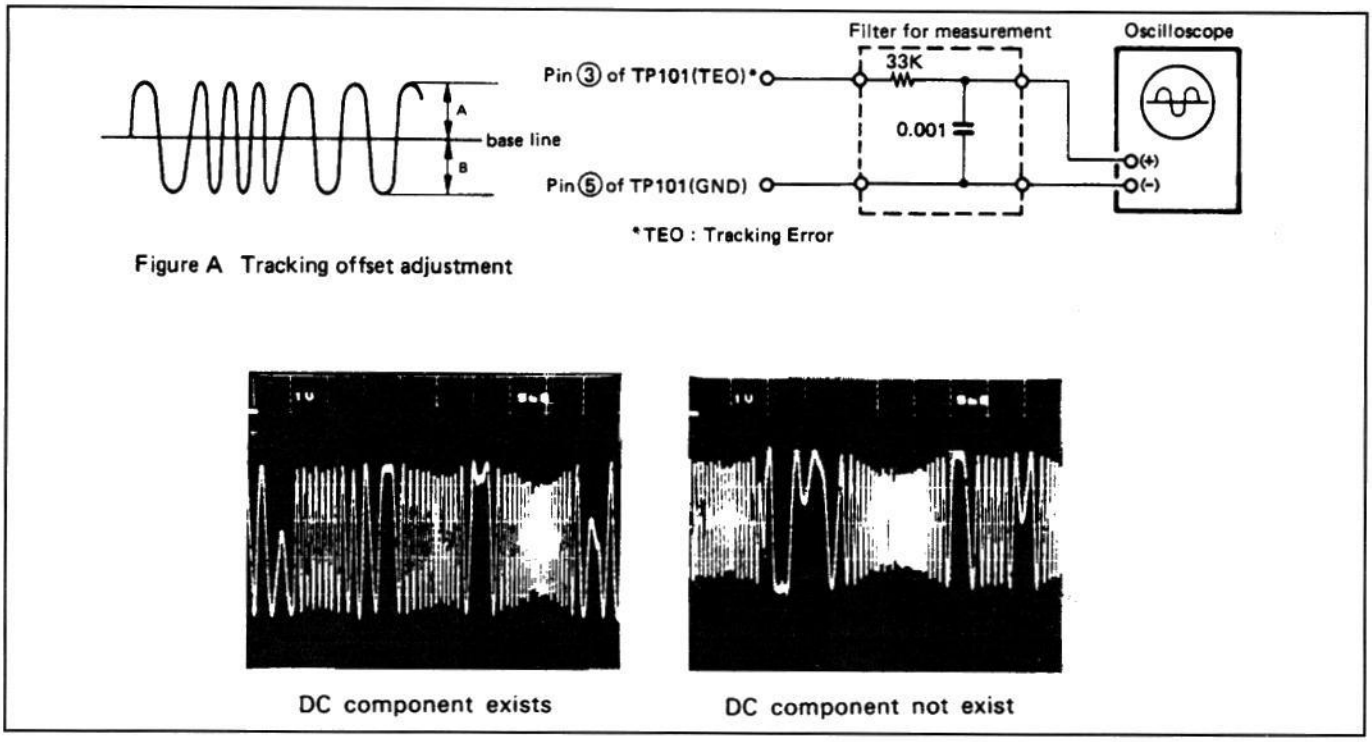


Figure A Tracking offset adjustment

Figure 7. Connect the oscilloscope to the CD player as shown here to adjust tracking offset. Adjust the pot so that the amplitudes of the signal above and below the oscilloscope's baseline are equal.

• Using a 10:1 probe, connect the oscilloscope as shown in Figure 7.

• Adjust VR103 to make A and B equal in height. That is, the signal amplitude should be symmetrical about the vertical zero position. This will minimize the dc component of the signal.

Focus gain adjustment

• Set the oscilloscope Channel 1 to 20mV/div, and connect a 10:1 probe to the input of Channel 1.

• Set the oscilloscope Channel 2 to 50mV/div.

• Connect the oscilloscope, the audio

Function of the operating controls in service mode

Name	Function	Description Indication	Disc No.	Used for
Eject	Ejection of Magazine	Be sure to take out the magazine when the system is in stop mode (Disc No. indication 1).	—	Taking out magazine
Stop	Stopping of System Movement	Push this key when the servo adjustment is completed, or to perform readjustment.	1	Tracking D.C Offset (VR101) RF offset adjustment (VR102) PLL adjustment (VR107) Focus offset adjustment (VR104)
Play	Focus Servo Turns ON Spindle Servo Turns ON	Turning on the focus servo to revolve disc.	2	Tracking offset adjustment (VR103)
Pause	All servos—Focus, Tracking, Slide, Spindle turn ON.	Turning on all servos to shift the unit in play mode.	3	Focus gain adjustment (VR106) Tracking gain adjustment (VR105)

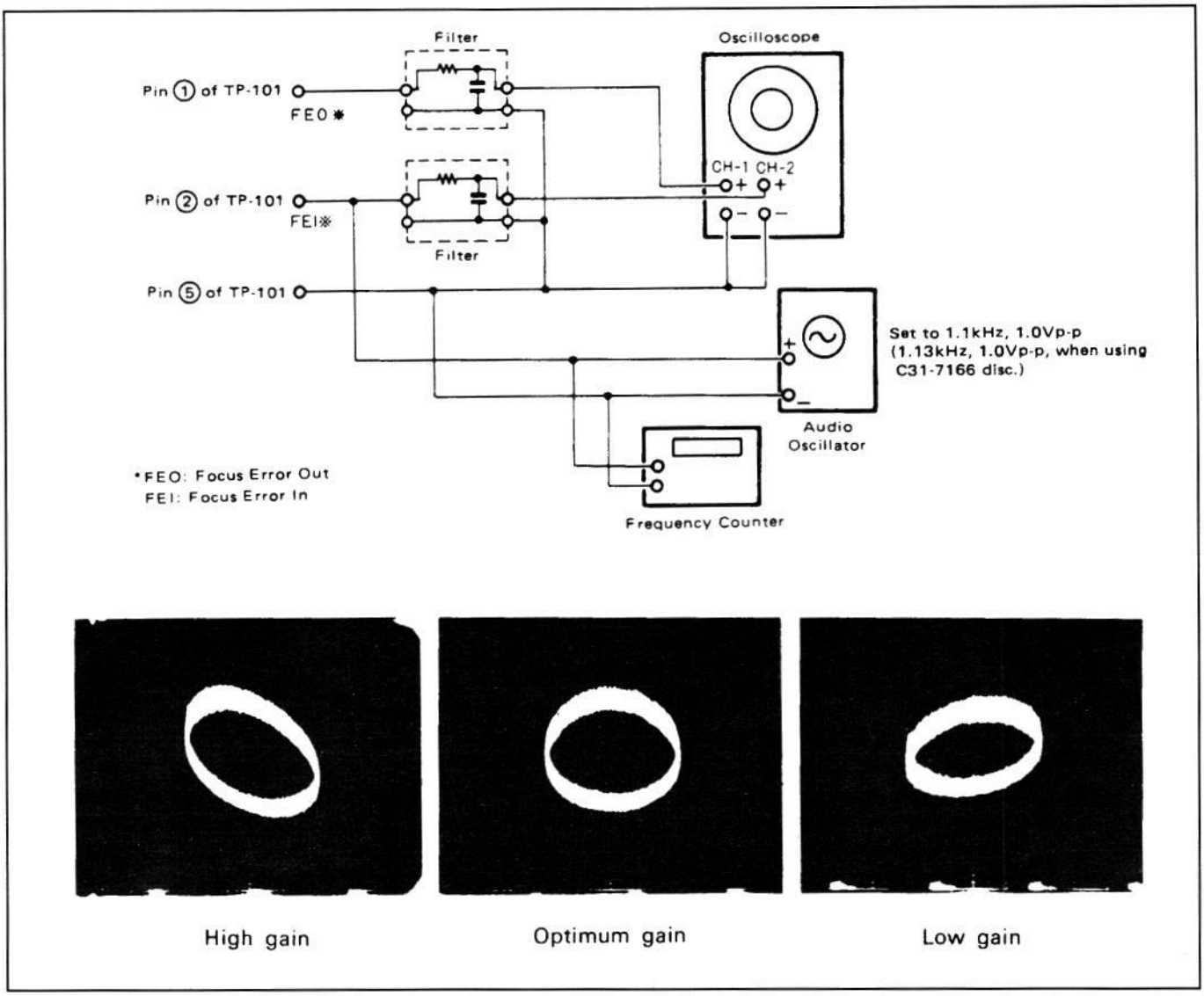


Figure 8. For the focus gain adjustment, connect the oscilloscope, the audio oscillator and the frequency counter to the CD player as shown here. Adjust VR106 so that the Lissajous pattern is symmetrical about the X and Y axes.

oscillator, and the frequency counter to the CD player as shown in Figure 8.

• Press the Pause button on the compact disc player.

• Set the audio oscillator output to 1.1kHz, 1.0Vpp. If you're using C31-7166 disc, set the oscillator output to 1.13kHz, 1.0Vpp.

• Set the oscilloscope to X-Y mode in order to observe the Lissajous pattern.

• Make sure that both channels are set to dc input.

• Adjust VR106 so that the Lissajous pattern is as close to symmetrical about both the X and Y axis as possible (the closer to symmetrical the pattern, the closer the phase difference between pin 1 and pin 2 is to 90 degrees).

Focus offset adjustment

• Set the unit to test mode.

• Confirm that the compact disc player display shows "Disc No. 1."

• Adjust the VR104 (Focus offset adjustment) until the voltage at pin 1 of TP 101 is 0V ± 50mV.

Tracking gain adjustment

The tracking gain adjustment is performed in much the same way as is the focus gain adjustment.

• Set the oscilloscope Channel 1 to 50mV/div, and connect a 10:1 probe to the input of Channel 1.

• Set Channel 2 to 20mV/div.

• Connect the oscilloscope, the audio oscillator, and the frequency counter to the CD player as shown in Figure 9.

• Press the Pause button on the compact disc player.

• Incorrect operation sometimes occurs if the oscillator is connected before the servo is actuated. If this happens, disconnect the oscillator, press the Stop button on the CD player, then push the Pause button to actuate the servo again. Finally, reconnect the oscillator.

• Set the audio oscillator output to 2.6kHz, 2.0Vpp. If you're using C31-7166 disc, set the oscillator output to 3.0kHz, 2.0Vpp.

• Set the oscilloscope to X-Y mode in order to observe the Lissajous pattern.

• Adjust VR105 so that the Lissajous pattern is as close to symmetrical about both the X and Y axes as possible (the closer to symmetrical the pattern, the closer the phase difference between pin 1 and pin 2 is to 90 degrees).

Confirmation of tracking offset

• Adjust tracking dc offset again.

• Adjust tracking offset again.

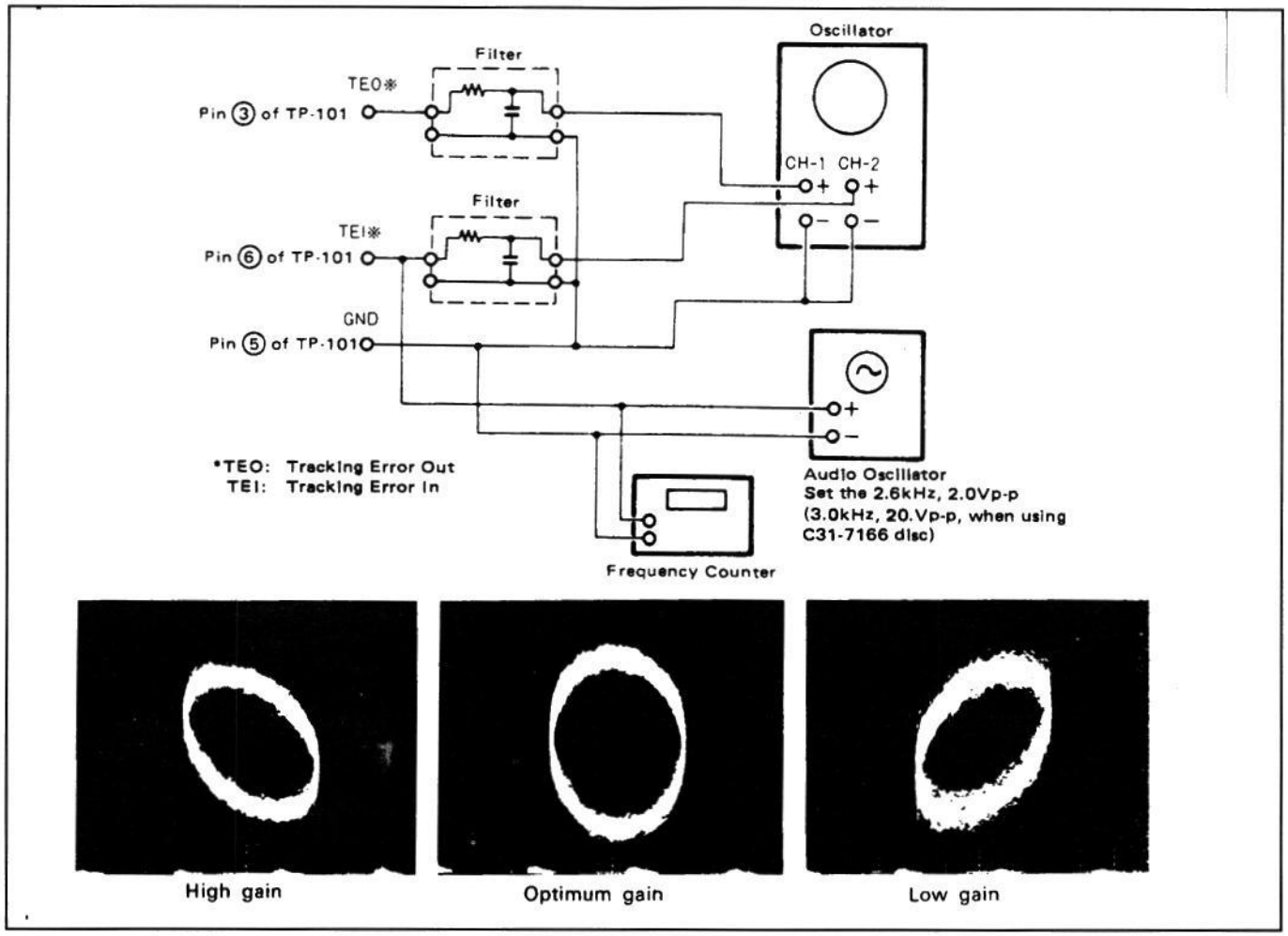


Figure 9. Connect the oscilloscope, the audio oscillator and the frequency counter as shown here to adjust the tracking gain. Adjust VR105 so that the Lissajous pattern is symmetrical about the X and Y axes.

• Press the Stop button.

• Press the Play button to confirm that the disc starts revolution. Sometimes pressing the Play button will not have any effect. If that happens, press the Play button again. Make sure that the display shows "Disc No. 2."

• Confirm that the waveform is symmetrical about the baseline. The height of the waveform above the baseline and the height of the waveform below the baseline must be within 5% of each other.

• If the difference in height exceeds 5%, adjust VR103 to correct this problem.

Adjustments are finished

At this point, all adjustments have been made. Press the Stop button to stop revolution, and press the Eject button to disengage the magazine and remove the adjustment disc.

If you are unable to properly perform

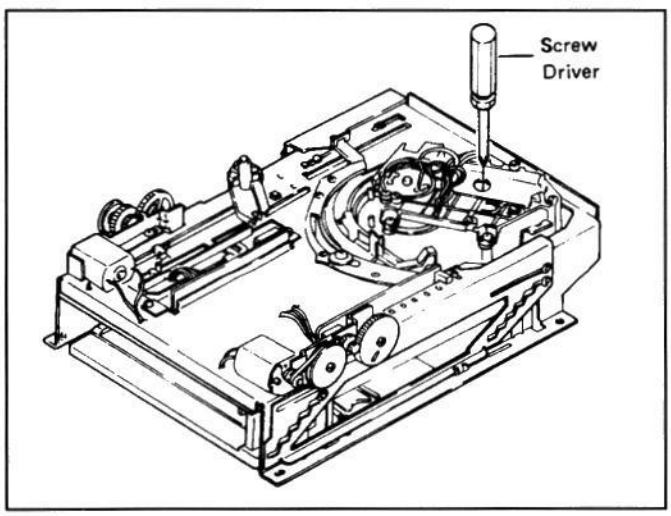
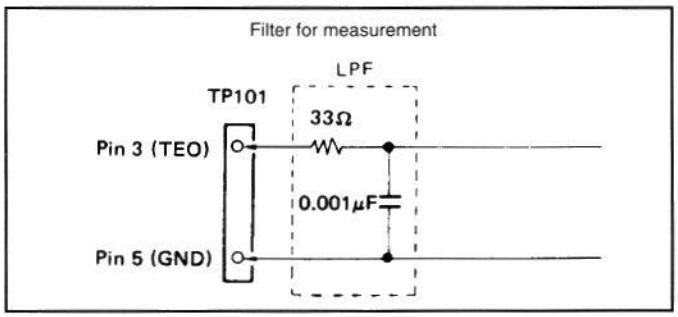


Figure 10. The grating adjustment screw may be reached by inserting a screwdriver through the oval hole in the upper side of the servo mechanism.

Figure 11. For the grating adjustment, observe the waveform at pin 3 (TEO) of TP101 on an oscilloscope. Connect the oscilloscope through a filter such as this one.



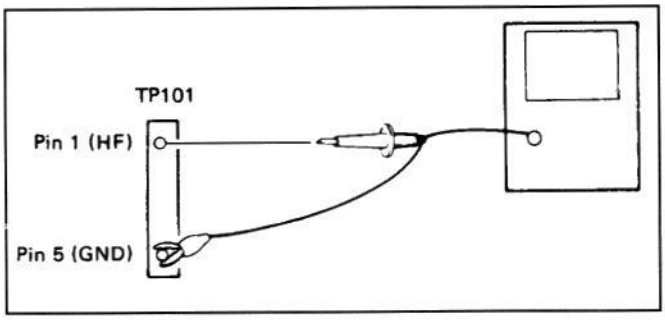


Figure 12: Observe the RF output at pin 1 (HF) of TP101 with the oscilloscope.

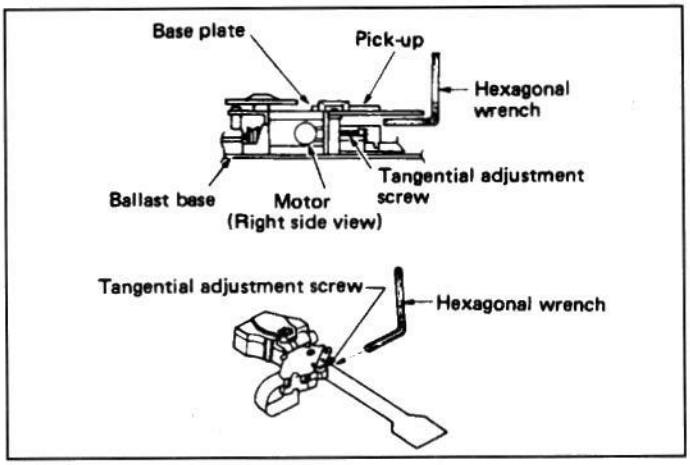


Figure 13. Adjust the tangential adjustment screw until the eye pattern becomes clear.

any of the servo adjustments after correcting a malfunction or replacing the laser pickup, it may be necessary to perform a grating adjustment first.

Grating adjustment

- Set the CD player to service mode.
- Press the Play button to activate the Focus and Spindle servos.
- Shift the pickup toward the center of the disc by pressing the Automatic Search Fwd button so that the grating adjustment screw of the pickup can be seen through the oval hole in the upper side of the servomechanism (Figure 10).
- Insert a screwdriver into the adjustment hole from the upper side of the mechanism, and confirm that the grating screw turns.
- Observe the waveform at pin 3 TEO (tracking error) of TP101 with an oscilloscope. Measure the signal through a 4kHz cutoff low pass filter (Figure 11).
- Turn the screw until you reach the point of minimum amplitude (null point).
- Slowly turn the screwdriver counterclockwise from the null point and adjust until the waveform (tracking error signal) just reaches its maximum amplitude. Don't press too hard on the screwdriver when making this adjustment, or the pickup may move toward the center of the disc, making this adjustment difficult.
- Finally, with the oscilloscope connected directly to the test point (without the 4kHz filter in the circuit), confirm that the tracking error signal (when the pickup is moved toward the disc center) and the peak-to-peak voltage of the tracking error signal at the outer circumference of the disc are not greatly different. If this difference exceeds about 10%, readjust by turning the grating screw to the maximum error amplitude point.

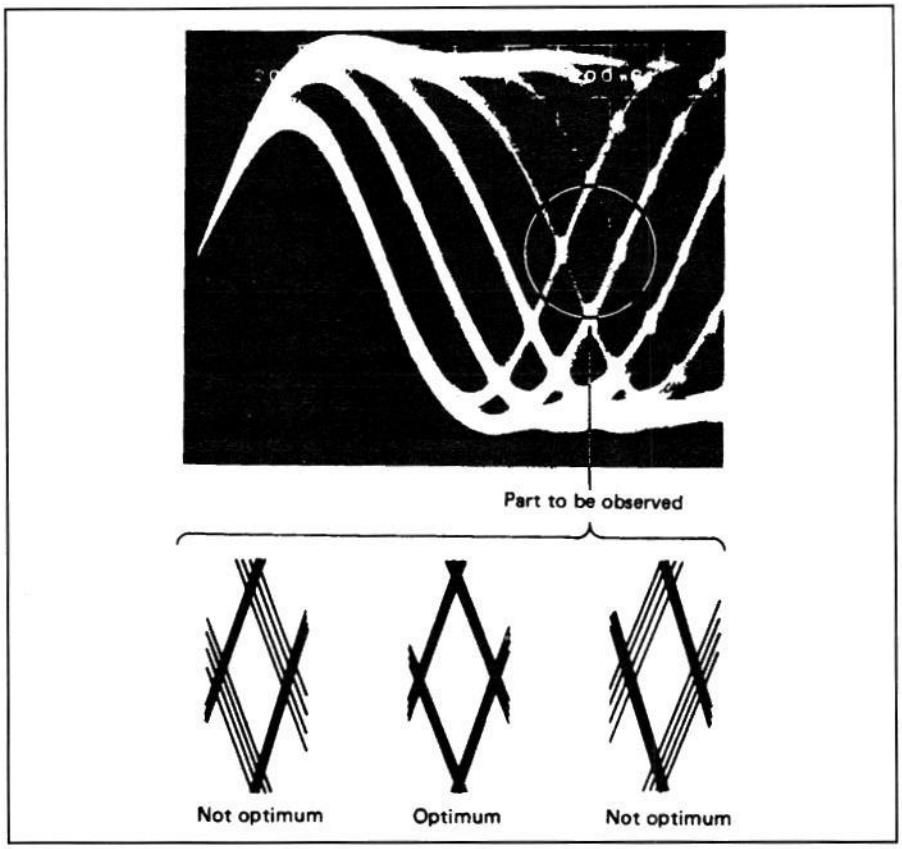


Figure 14. When the grating adjustment is correct, the eye pattern should be clear, as shown here.

Tangential adjustment

- Set Channel 1 of the oscilloscope to 20mV/div, and connect a 10:1 probe to the Channel 1 input.
- Set Channel 2 to 0.2μs/div.
- Insert the test disc into the compact disc player.
- Invoke the service mode.
- Shift the pickup toward the center of the disc by pressing the Automatic Search Fwd button.
- Press the Pause key. This will activate all servos.
- Observe the RF output at pin 1 (HF) of TP101 with the oscilloscope (Figure 12), and adjust the tangential screw (Figure 13) until the eye pattern becomes clear (Figure 14).
- The correct point for this adjustment is the point midway between the point where the eye pattern deteriorates by turning the tangential screw clockwise, and the point where the eye pattern deteriorates by turning the screw clockwise. As a criterion, the overall waveform is clear and the lines that define one of the diamond shapes within the eye pattern should be relatively fine. During this adjustment, hold the hexagonal wrench vertically so that it doesn't exert downward pressure on the pickup as you turn it. ■