Understanding compact disc troubleshooting concepts-Part 2

By **Marcel R. Kialland**

As considered in Part I of this series it is important to understand how a product works before attempting any troubleshooting. In this part, the single-beam servo system will be examined and common troubleshooting techniques will be applied to both the single-beam and three-beam systems.

In many respects the single-beam and three-beam systems are quite similar. But there are sonic important differences which should be considered. The major difference is in each mechanism's tracking system. The difference is discernible in looking at the CD mechanism itself.

Actually. the single-beam system's CD Mechanism (Figure 1) is simpler. Rather than using a sled assembly to track the disc. the single-beam system uses a radial swing arm, which pivots on a single axis to radially follow the spiral tracks.

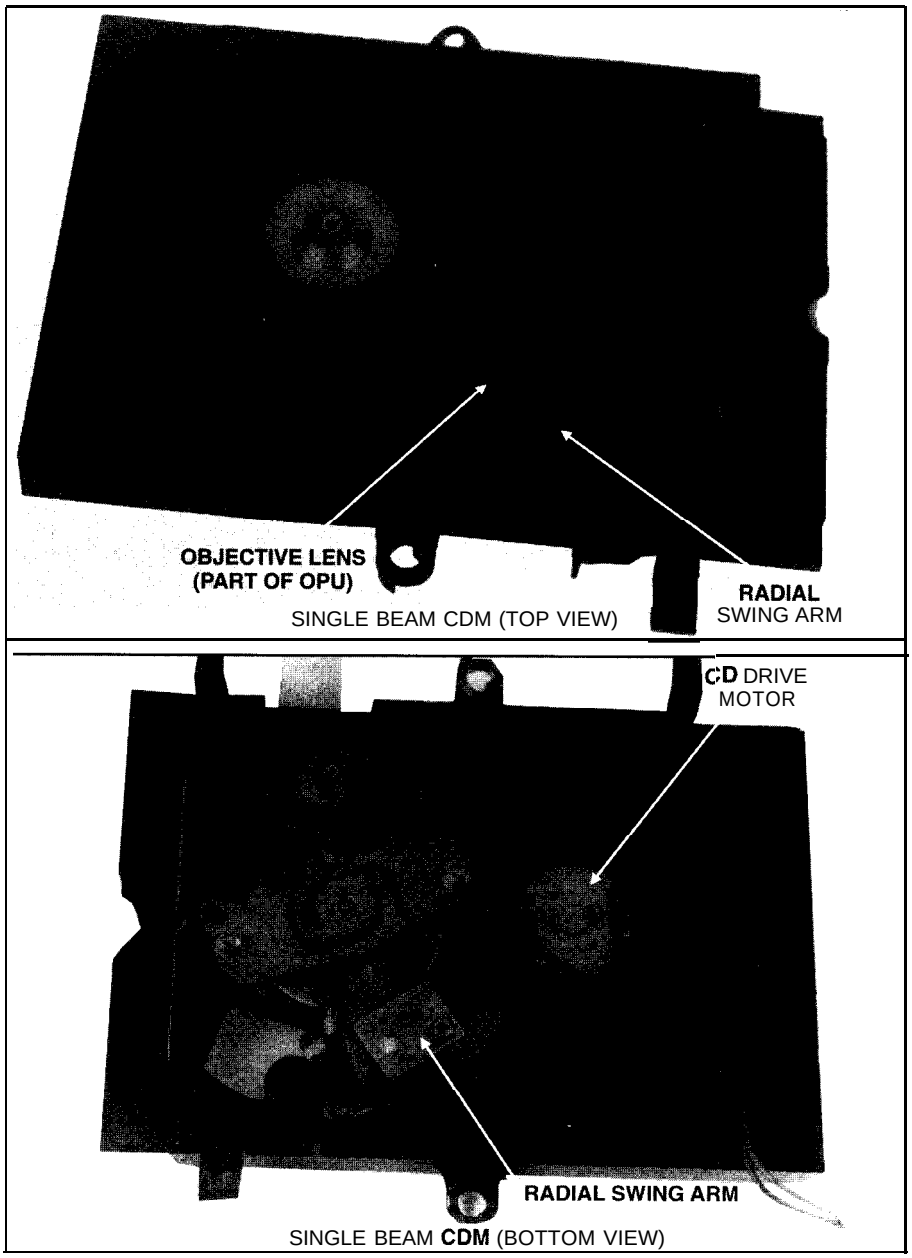


Figure 1. View of single-beam CDM (top and bottom views).

The single-beam servo system

In order to understand the single-beam servo system we need to examine the optical pick-up unit more closely (Figure 2). Just as with the three-beam system, a single laser diode is used to emit a laser beam. The single laser beam is directed to the disc by the half mirror and the collimator lens and is focused via the objective lens.

This single beam must be controlled to read, focus, and track the disc's spiral tracks. The spinning disc modulates the single beam as it is reflected hack into the objective lens. The reflected, modulated beam is directed hack to the photodiodes. In order to detect focus and radial errors the beam is split to strike two areas of the photodiode array as illustrated in the photodiode array physical layout of Figure 3.

The photodiode array contains up to five photodiodes as illustrated. The output from each photodiode is totaled as the HF signal ($I_{HF}=I_{D1}+I_{D2}+I_{D3}+I_{D4}+I_G$). Tracking and focus errors arc detected by calculating the differences in the photodiode low frequency (LF) currents.

Radial (tracking) errors are detected by calculating the difference between the total current of D_1+D_2 with the total current of D_3+D_4, which can be expressed as $I_{RE}=(I_{D1}+I_{D2})-(I_{D3}+I_{D4})$.

Focus errors arc detected by calculating the difference between the total current of D_1+D_4 with the total current of D_2+D_3, or $I_{FE}=(I_{D1}+I_{D4})-(I_{D2}+I_{D3})$.

These signal5 are processed by the servo circuits to provide control of the CD mechanism.

Start-up

In most players. each time a CD is

Riallandis a Senior Training Specialist with Toshiba America

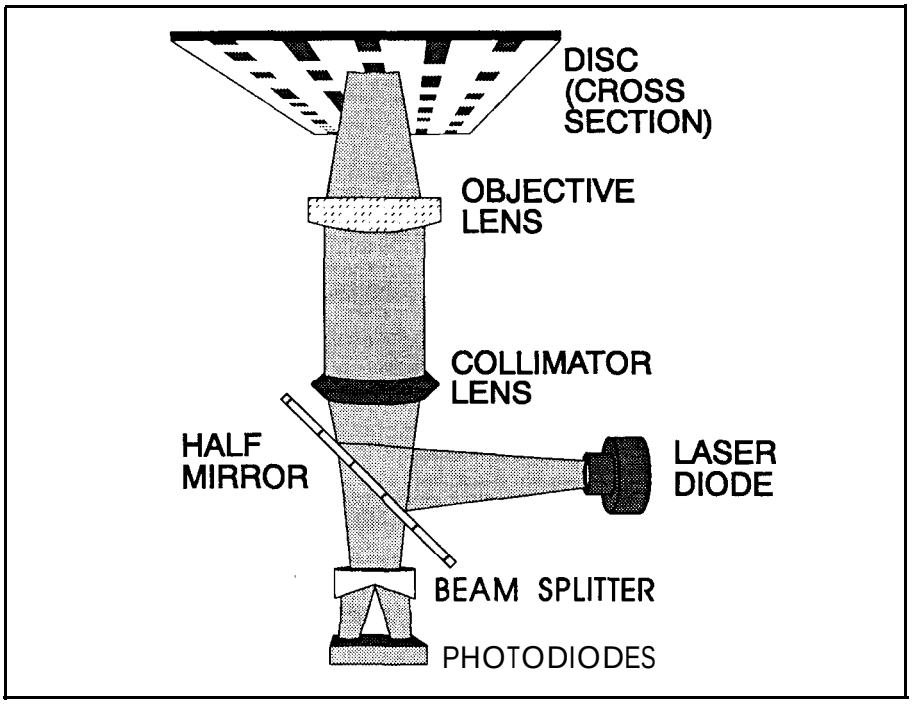


Figure 2. Single-beam OPU

placed in the player, a start-up sequence is initiated to read the table of contents from the CD. In this way, the player detects not only the presence of a CD, but it also determines the type of disc present and decodes information pertaining to that disc. Some of that information is decoded and displayed on the CD player's display.

Some of the data is also used by the microprocessor to control access to the tracks on the disc. The information allows the user to program the tracks to be played. When the play key is pressed, the start-up sequence must again be initiated.

Figure 4 shows a typical single beam laser/focus start-up circuit. Although this is the start-up circuit for a single-beam system, the principles can be applied to the three-beam system. Also there are variations in the start-up circuits between different single-beam models. Check the service manual for the model being serviced when checking the start-up circuit.

Certain player conditions must be met before start-up can be initiated by the decoder microcomputer. When a CD mechanism is removed from the cabinet to allow troubleshooting, these conditions are at times difficult to accommodate. For example, some players have tray switches to signal the microcomputer that the tray is closed. This switch must be closed before you attempt start-up troubleshooting.

In the stop condition, SI/RD (IC6501, pin 6) is low. Start-up is initiated when the photodiode signal processor (IC650 1) receives a start initiate signal (high) from the decoder microcomputer (IC6530) via pin 6. The start capacitor (C25 13) begins to charge as indicated by the start-up signals. At that time pin 17 (low) supplies about 3V to the laser driver circuit to turn the laser diode on.

The focus search is initiated by swinging the FE voltage between +1.2V and –1.2V. This causes the objective lens to move up and down to attempt focus servo lock. The focus search pattern occurs twice in this model. If focus is not found after the second focus attempt, the system assumes there is no disc present.

Start-up problems

In troubleshooting start-up problems, the start-up signals can be checked during the start-up initiation. Using an oscilloscope, with the input set to dc, allows the start-up initiation voltages to be observed.

For example, if the objective lens does

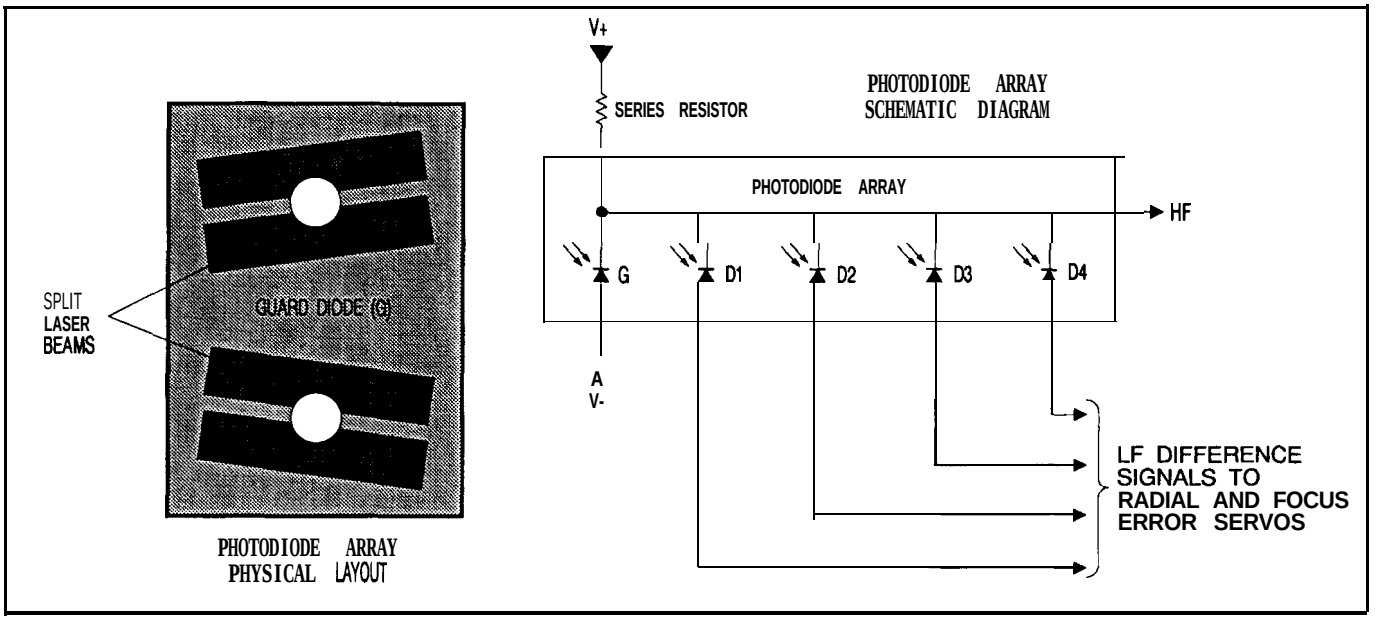
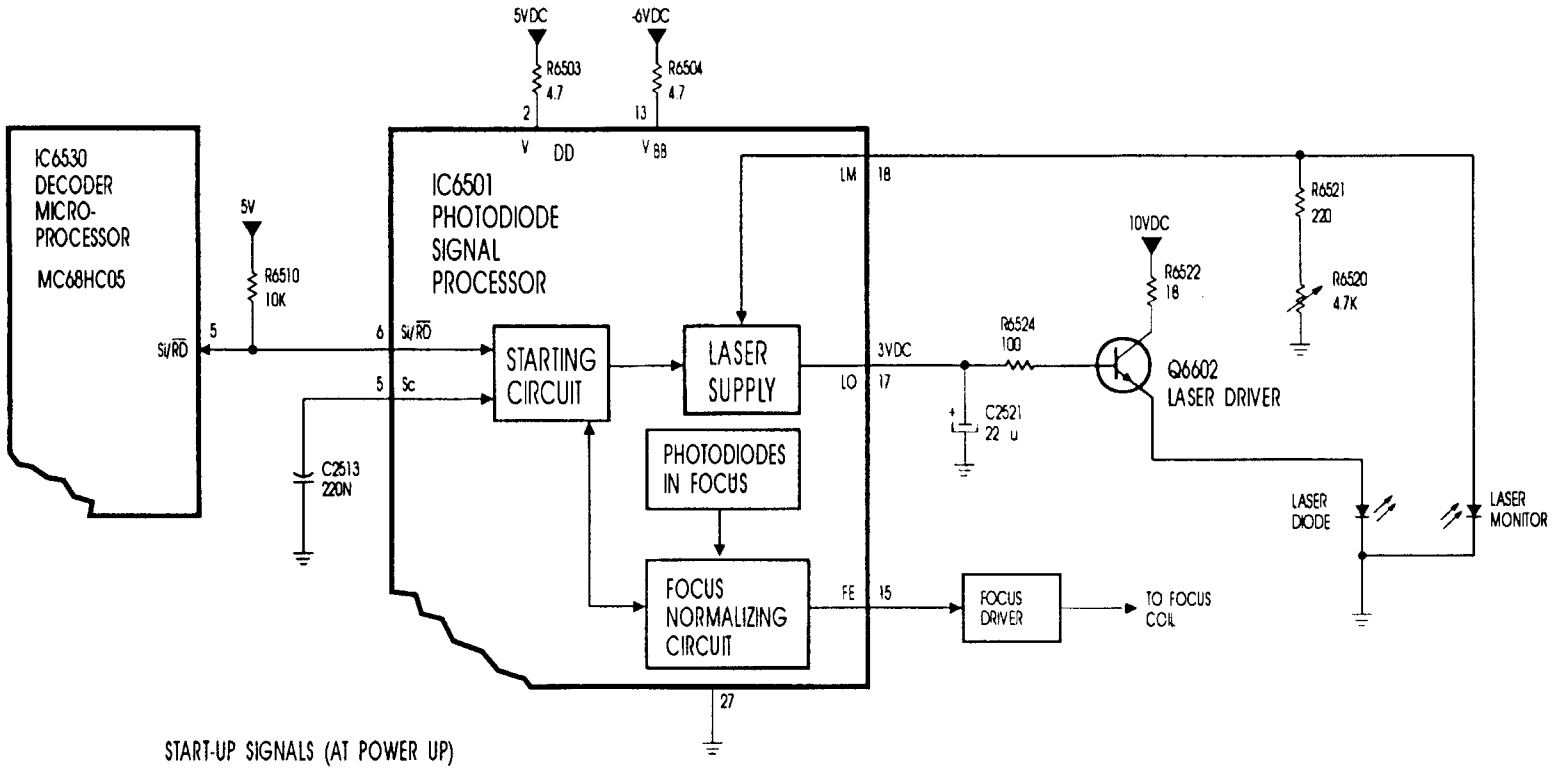
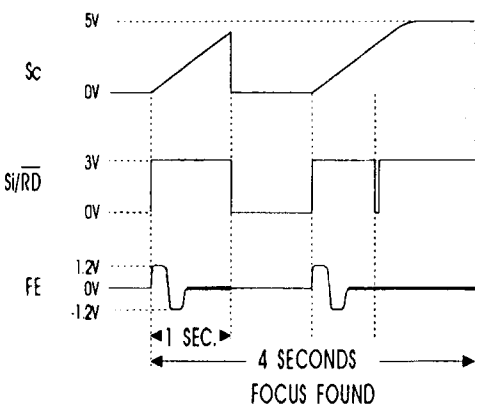


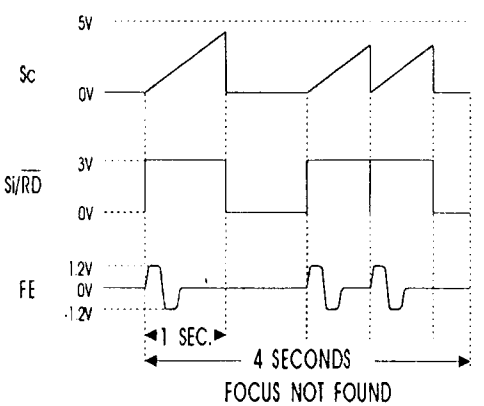
Figure 3. Photodiode array.

Figure 4. Focus/laser start-up circuit.



START-UP SIGNALS (AT POWER UP)





Si/RD	START INITIATE/READY
Sc	STARTING UP CAPACITOR INPUT
LO	LASER AMP CURRENT OUTPUT
LM	LASER MONITOR DIODE INPUT
FE	FOCUS ERROR SIGNAL
SCL	SERIAL CLOCK
SDA	SERIAL DATA

not move up and down during start-up, check the FE signal at pin 15. If the signal is present, check the output from the focus driver. If the signal is present at the output of the focus driver, check the flex cable connection from the circuit board to the CD mechanism. If all the connections are good (don't forget to check the ground return), the optical pick-up unit is most likely defective.

Single-beam servo

The single-beam servo system block diagram is shown in Figure 5. The decoder microprocessor controls the functions of the servo system, including start-

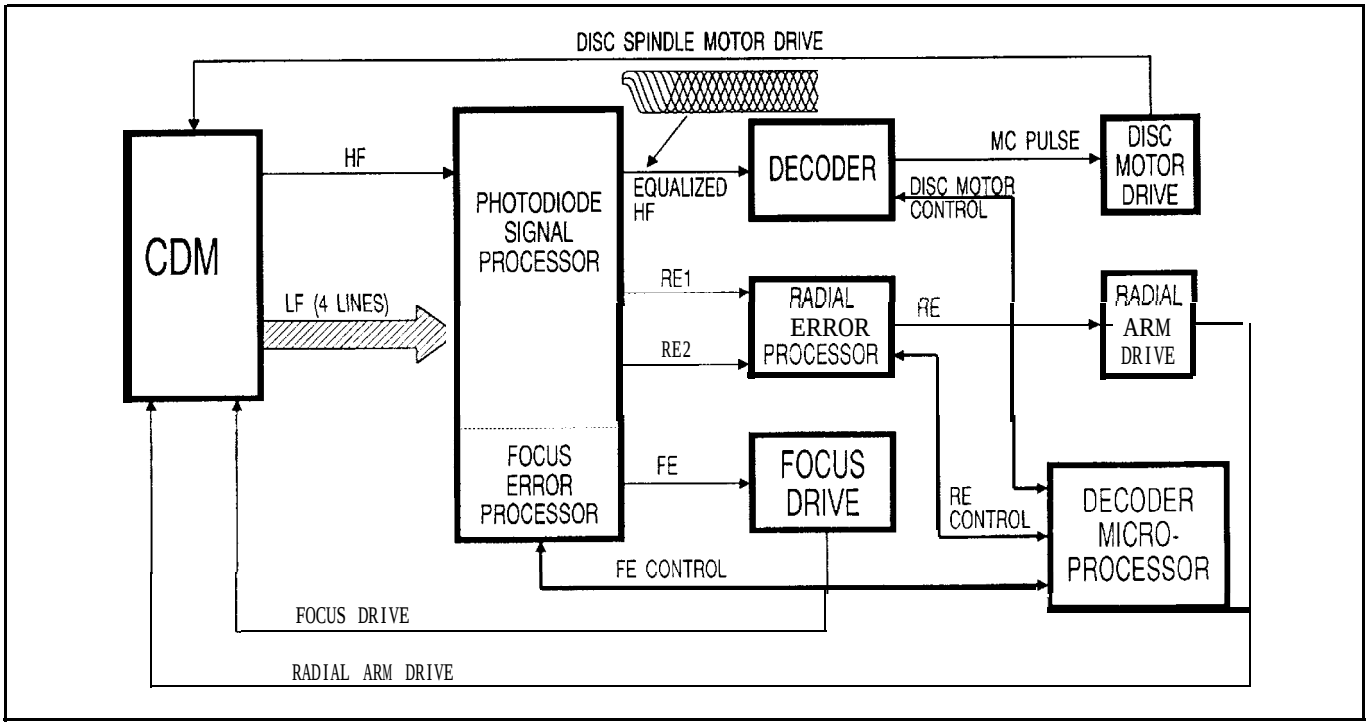


Figure 5. Single-beam servo block diagram.

up. As is the case in the three-beam system, the decoder microprocessor must also control tracking during some operations, such as during track loss and search forward and reverse.

There are three main servo loops in the single beam system: (1) the focus error (FE) servo, (2) the disc motor control (MC) servo, and (3) the radial error (RE) servo. Each of the servo circuits must lock in during the start-up procedure in order for a disc to play.

First the laser diode must come on. Next, the laser beam must be focused onto the CD, which also indicates the presence of a disc. Then the disc motor spins the disc and the radial arm pivots to locate the lead-in track in order to read the CD's table of contents (TOC). The TOC contains information about the disc: the type of disc (CD-DA, CD-ROM, or CDI), total number of tracks, total time, and the CD's catalog number.

After the TOC is read, most CD audio players display the user information, such as the total tracks and total time, on the front display. Therefore, the display is a good place to start looking for clues when troubleshooting.

For example, if disc information is never displayed, there may be a problem in the start-up. If there is a disc error during start-up, monitor the equalized HF signal (eye pattern) output from the photodiode signal processor during the start-up procedure. The clarity of the eye pattern can give a clue as to where the problem may be located.

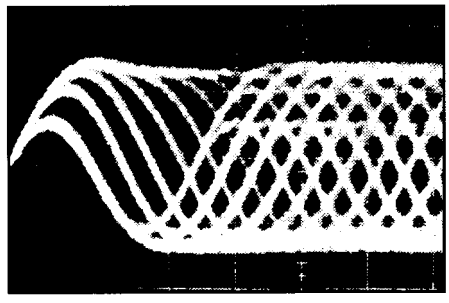


Figure 6. Equalized HF (eye pattern).

Of course, if the HF signal is never present, the problem may be in the start-up initiation. For example, the laser may not even be coming on. The service mode can reveal if this is the case. Moreover, a laser power meter can show if the laser diode is indeed coming on.

Focus error servo

Although the objective lens and the focus drive circuit of each system (single-beam and three-beam) are similar, the focus servo of the single beam is quite different from the focus servo of the three-beam system. The four low-frequency signals from the CDM are processed by the photodiode signal processor to develop the focus error signal.

Internally, the LF signals are applied to adders and comparators to find the focus error (FE is actually a focus error correction signal to keep the laser focused). Generally, there is a focus drive circuit that applies the focus correction drive signal to the focus coils on the optical pick-up unit.

Most CD players require some adjustments (such as focus offset and laser current) in the focus servo loop for optimum performance. If the focus offset adjustment is too far off, the disc may have trouble tracking and may even stop playing due to error occurrences during the decoding process. Observing the eye pattern of the HF signal can help in determining if there is a problem in the optical pick-up system. The eye pattern should be fairly clear as shown in Figure 6.

Disc motor control loop

The method of controlling the disc rotational speed is similar to the three-beam system's method. The disc motor control servo loop controls the rotational speed of the disc motor. As shown by the block diagram, the HF is amplified and equalized by the photodiode signal processor. This equalized HF signal, which is observable as the eye pattern at the output of the photodiode signal processor, is applied to the decoder block.

The decoder is usually an LSI IC which

performs several functions for decoding the incoming data (e.g., data slicer, demodulator, EFM decoder, interleaver corrector and descrambler, and interpolator). In the decoding process, the bit clock of 4.32 1 8Mb/sec must be regenerated.

At the same time the incoming data flow must be regulated so that the data does not come in too fast or too slow. The regulation is provided by means of the pulse width modulated motor control (MC) pulse, which is used to control the rotational speed of the disc spindle motor via the disc motor drive block (integrator circuit).

Starting and stopping the disc motor is controlled by the decoder microprocessor via the SSM line. If the decoder does not receive the control information from the decoder microprocessor, the disc spindle motor may not start; or, the opposite may occur. The spindle may start but not stop when a stop is initiated.

Radial servo loop

Just as in the three-beam servo system, a radial servo loop is necessary to provide proper tracking of the disc in the single-beam system. As shown by the block diagram (Figure 5), the radial error correction signal is primarily developed in the radial error processor.

The radial error (RE) correction signal is developed from RE, and RE_2. RE_1 and RE_2 are derived from the LF signals, which are processed in the photodiode signal processor. RE1 is the sum of the currents from D_1 and D_2, and RE_2 is the sum of the currents from D_3 and D_4.

In addition to these signals, there is also a wobble signal of about 650Hz which is injected into the radial servo loop of the single beam system. This wobble signal is generally produced by an oscillator in the radial error processor. If this signal is not present the disc will not track properly (poor playability).

The wobble signal is introduced into the service loop to compensate for laser spot asymmetry errors (D-Factor) and to compensate for the tracking angle variations as the radial arm moves from the inner tracks to the outer tracks of the disc (K-factor).

Troubleshooting summation

As with any consumer electronics product, it's a matter of isolating the symptom to a particular circuit. Then, with a few more checks, the problem can be traced to a few components. These components can then be checked or substituted to verify which component is indeed defective.

Knowing the operating requirements of the CD player is essential to diagnose a symptom properly. It's a matter of determining the path to follow. For example, if power is applied to the CD player and the display doesn't illuminate and no other activity is observed, the power supply is the most likely place to start.

If, however, the display does illuminate and other activity is observed, the power supply can most likely be ruled out. But even in this case, a problem may still be traced back to the power supply.

Let's apply this troubleshooting technique to both the three-beam and single-beam servo systems. The symptom is: "the disc will not play."

First, look for the start-up condition (you may want to use the service mode to verify the condition of the servo system):

1. Does the laser diode come on? If not, check the laser current source.
2. Is the focus search initiated (the objective lens moves up and down)? If not, check the start-up initiation drive signals with an oscilloscope.
3. Is focus achieved?
4. Does the OPU move to search for the lead-in track?
5. Is the lead-in track found (table of contents track)?

If all these processes are working while in the service mode, the CD player's servos should all be locked. The eye pattern (HF signal) should be available to the decoder circuits. Verify this. There may be a problem in the decoder section.

If, for example, the decoder's subcode processor was not functional, the display may show an error and the disc would go into the stop mode, which may appear to be a no start-up condition. But the problem may be due to a decoder fault.

Diagnosing poor playability symptom

First, let's define poor playability. Poor playability can be poor tracking, poor tracking on only some discs, difficulty in start-up, easy loss of track due to jarring.

What can cause poor playability? Don't overlook the obvious: a dirty objective lens reduces the optical system's efficiency and can even prevent start-up. A little alcohol on the end of a cotton swab can be used to clean the objective lens. However, do not apply too much pressure in cleaning the lens.

If the lens is clean, make sure there is nothing obstructing the mechanical tracking mechanism (both in the three-beam sled system and the single beam radial swing arm). If it is a single beam system, make sure the wobble signal is present.

Do not overlook the possibility that there may be more than one symptom. For example, I came across a CD player (single beam) which displayed two symptoms: the radial arm swung all the way to the outer perimeter and the objective lens was pulled to its lower extremity. I traced the problem to an open resistor from the power supply to a quad op-amp, which was common to both the focus drive circuit and the radial drive circuit.

Part 3 will deal with the decoder part of a CD system. ■