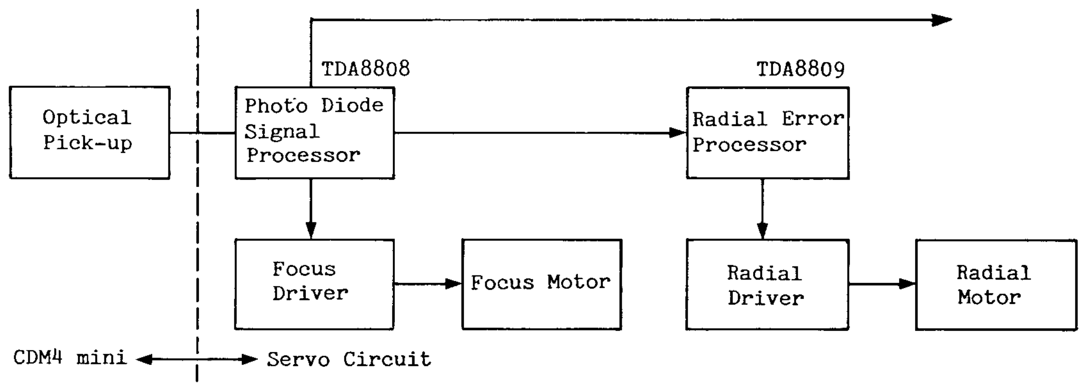
■ TECHNICAL INFORMATION

Explanation on the CDM4 mini system and servo circuit for service engineers

1. System Configuration

1-1. Block Diagram Rough



* Refer to the page 18 and 19.

2. Rough Explanation of the Functions of the CDM4 mini System Part.

2-1. Servo electronics CDM4 mini system.

TDA8808: bipolar photo diode signal processor

- Photodiode signal preamplifiers with separate h.f. and d.c. a.g.c. for optimum generation of the h.f. data signal and the focusing/tracking error signals.
- Tracking error signal amplifier.
- Focus error signal processor with focus normalizing and start-up circuit.
- Data equalizer.

  h.f. level and track-loss detectors.
- Regulated supply for the reading laser diode.
- Low current consumption: 15mA (8V -14V).

TDA8809: bipolar radial error processor

- Tracking error processor with automatic asymmetry control.
- a.g.c. circuitry with automatic start-up wobble generator.
- Tracking control for fast forward/reverse scan, search, repeat and pause functions.
- Low current consumption: 10mA (8V - 14V).

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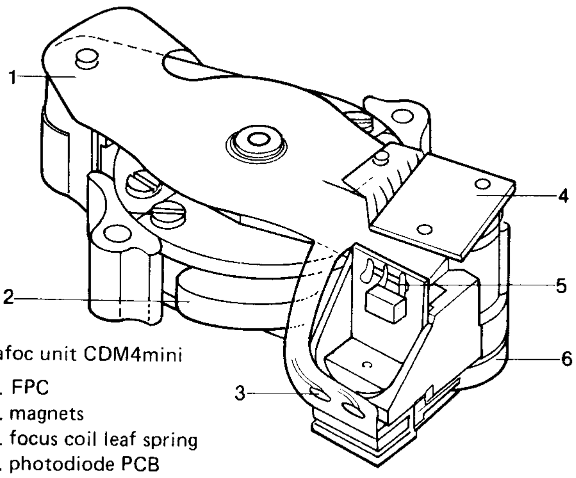
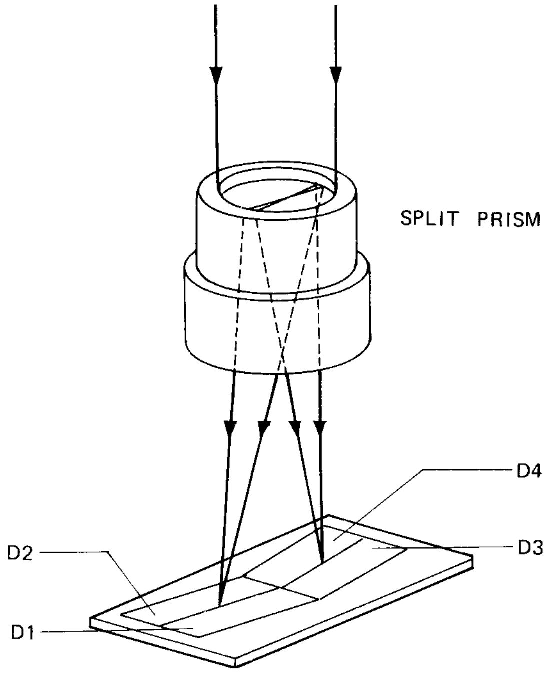
2-2.CDM4 mini Optical Pick-up



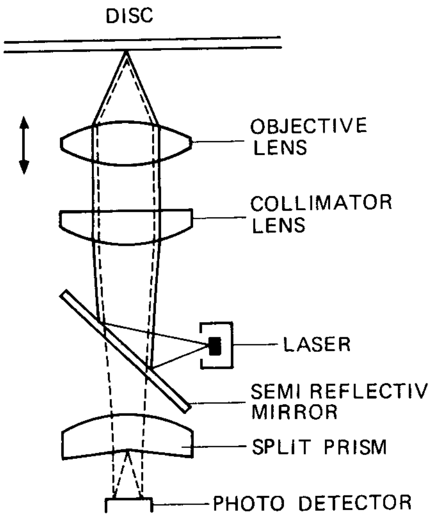
rafoc unit CDM4mini

1. FPC
2. magnets
3. focus coil leaf spring
4. photodiode PCB
5. LASER protection PCB
6. focus unit



DETAIL OF LASER BEAM

A feature of the CDM4 mini pick-up is its simple diffraction limited optics. The laser point source is focused on the information layer of the disc by two lenses: a spherical glass objective with a plastic aspherical skin, and a spherical glass collimator.



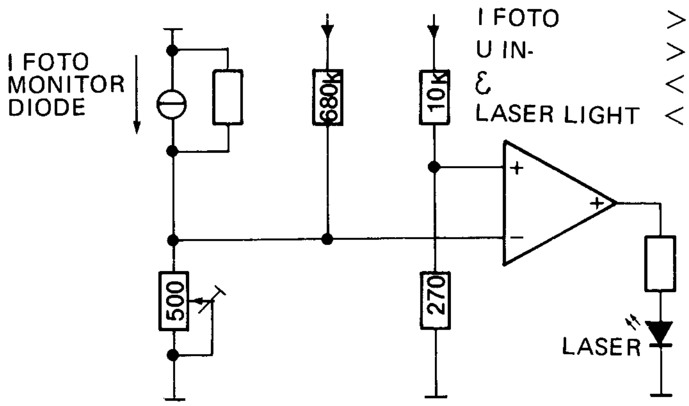
CDM4 Mini

Furthermore, a semi-transparent mirror is used instead of a beam-splitter cube. Astigmatism introduced into the reflected beam by the mirror is corrected by a plastic component (the wedge) which also dissects the beam into the two halves from which the tracking and focus error signals are generated.

3.Detailled Explanation of the Functions in the Servo.

3-1-1 The LASER supply

The LASER supply circuit has a working principle like the basic schematic below.



The LASER supply function integrated in the TDA8808 has as an extra an overload protection and a turn on transient protection. The LASER current is regulated by sensing the monitor photodiode current.

The threshold voltage of the LASER diode is approximately 1.75V and the sense voltage is approx. 200mV. It is not allowed to measure the sense voltage. A distortion at this end of the loop might cause severe damage to the LASER diode.

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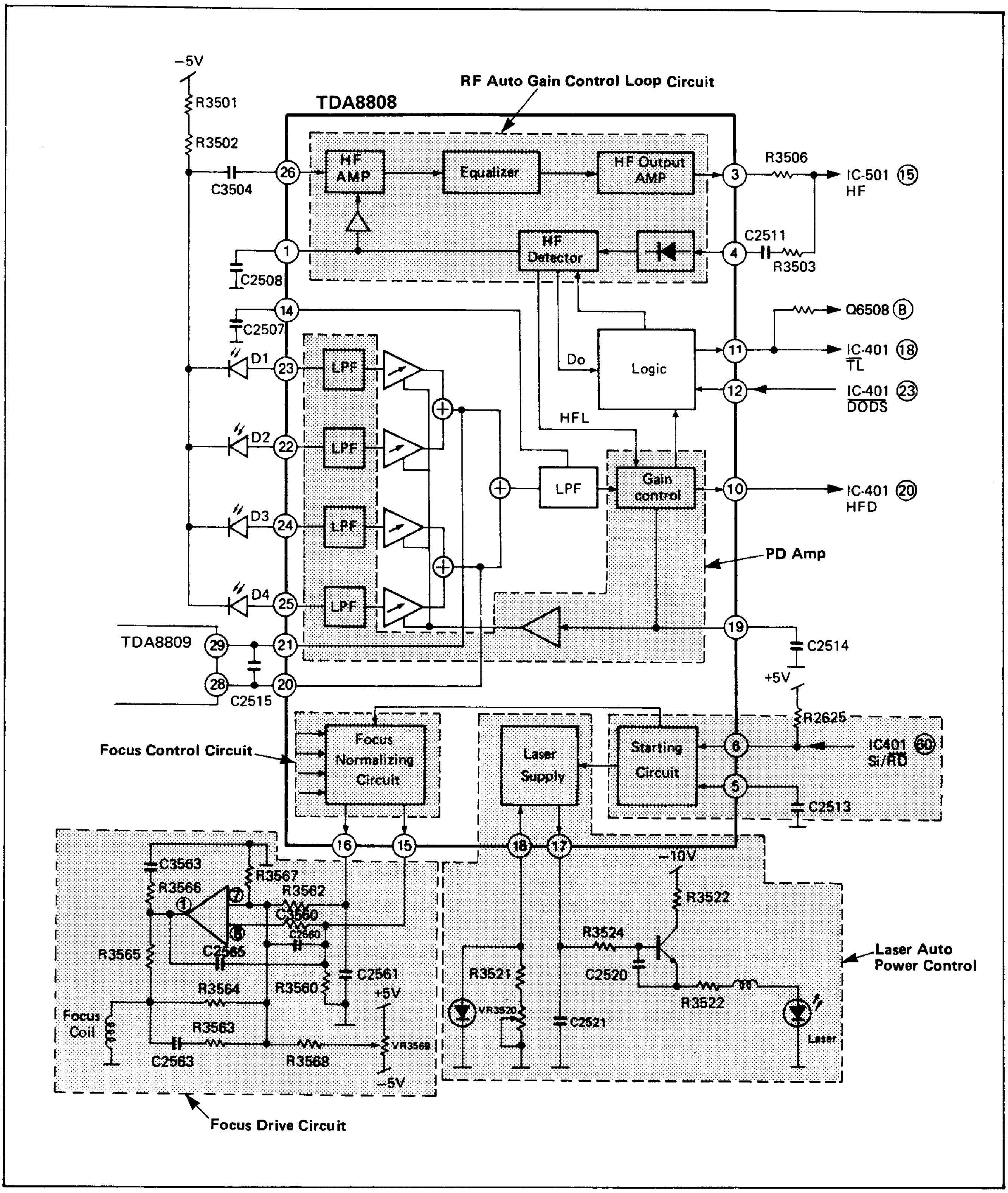
3-1-2 h.f. Signal handling, h.f. a.g.c. and data qeualizer.



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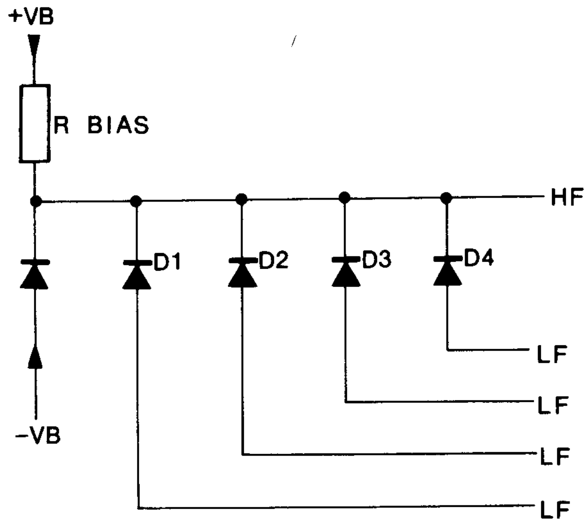
The photodiodes used in the optical pick-up are connected in reverse direction. The photodiodes require a reverse bias of at least 5V. Bias current is set by R3501 and R3502. Supply noise and interference is kept away by R3501 and C2521. Coupling of the h.f. signal is performed by C2504, R3502 and C2521 also prevent h.f. coming into the supply.

The h.f. signal is effectively separated; from the I.f. signals by deriving the h.f. signal from the total substrate current of the four photodiodes and only the I.f. error signals from the individual anode currents.(see figure below).



The h.f. signal is effectively separated; from the I.f. signals by deriving the h.f. signal from the total substrate current of the four photodiodes and only the I.f. error signals from the individual anode currents. (see figure below).

The h.f. amplifier and a.g.c. circuit have to meet the correct transfer function.

The parameters of the transfer function are set by R3505, R3508, R3507, C2509, and C2508.

With internal girators the qeualizer provides a 3rd order bessel filter for making the correct modular transfer function to compensate the optical pick-up system. The total IC bias current is set by the value of R3508 and decoupled by C2510. The girator circuits are set by the value of R3505.

The 3rd pole of the modular transfer function is made by the RC circuit containing R3507, C2511 and the capacitance of the h.f. wire from the CDM to the demodulator circuits.

3-1-3 The amplitued level detector

For the a.g.c. the amplitude of the h.f. signal is measured in a level detector by comparing a full-wave rectified and fitered version of the h.f. signal with an internal reference level. The level detector is not data path but parallel to the data path as in the CDM4 system. For fast response to drop-out the time constant of the high pass filter formed by R3507, C2511 and the detector input resistance has to be 10 sec. In the h.f. amplitude slicer the amplitude of the h.f. signal is sliced in 3 levels.

62% and below is HFD
12% and below is DO

The HFD output is used to switch the PLL on and off ensuring minimum locking loss while having a drop-out or during searching. This provides fast relocking afterwards.

Capacitor C2508 in combination with an internal switch provides a more constant gain control during drop-outs. The switch is operated by the HFD signal. This set-up restricts the h.f. signal and gives the loop a bandwidth of 50Hz.

When the pick-up is searching for a track the DODS (drop-out detection suppression) is activated to keep the h.f. signal level clamped on the normal

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3-1-4 The photodiode current amplifiers and I.f. a.g.c.

The low pass filters for the photodiode inputs D1 - D4 are integrated in the photodiode signal processor.

The outputs for RE1 (RE1 = D1 + D2) and RE2 (RE2 = D3 + D4) are open collector outputs. In case an external pull-up has to be connected, it has to be connected to Vdd.

Normally the pull-up function is done by the inputs of the radial error processor.

The a.g.c. for the photodiode amplifiers keeps the d.c. sum current constant for all discs. The control loop has a LPF which is set by the value of C2507.

3-1-5 The track loss detector

During playback of a disc, the radial error signals keep the pick-up on track. In case of searching for a certain spot of music, the pick-up has to jump over the tracks. To maintain the control of the pick-up during a search operation, the microprocessor must be informed whether the pick-up is on track or off track. This function is performed by the track-loss detector.

Condition to be met for the track-loss:

- The gain controlled h.f. signal has to be between 12% and 62% of the nominal value (100% is set by the h.f. a.g.c.).
- Average light intensity of the I.f. signal is more than 120% of the nominal value (100% is set by the I.f.a.g.c.).

All values are set during track following.

Use of the TL signal:

1. Counting tracks when track jumping.
2. In case a TL is detected during normal playback the control microprocessor looks to the RE dig signal from the radial error processor and compensates the tracking error by means of the DAC signal.

Such a situation can only occur due to large knocks. This set up makes the system extremely tolerant for bumps.

(Formula TL=FS >120% and 63%>HFL>12%).

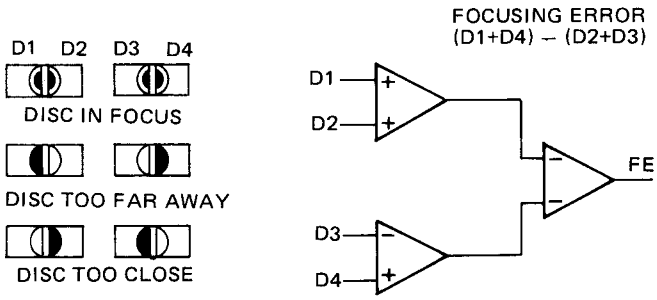
3-1-6 Focus processing

The CDM4 pick-up uses two focuault knife focus pick-ups to keep the reading spot focused on the data layer of the disc.

The TDA8808 has two focus outputs: FE and FE lag.

FE lag is the basic focus error signal. FE is a normalized version of FE to remove the effect of the unequal illumination of photodiode pairs D1, D2 and D3, D4 which occurs in case of tracking errors.

PRINCIPLE



FE lag= (I1 + I4)-(I2 + I3).Ftransfer

$$FE = \frac{I1 - I2}{I1 + I2} + \frac{I4 - I3}{I4 + I3} \cdot \quad I\ control$$

Since in focus I1 + I2 $\approx$ I3 + I4

and I1 $\approx$ I2 $\approx$ I3 $\approx$ I4 with a.g.c. on

FE = FE lag on trace

Either one signal or both signals can be used to control the focus actuator. The FE lag signal gives the loop the correct gain and phase margin. The FE signal has an important role in the start-up procedure.

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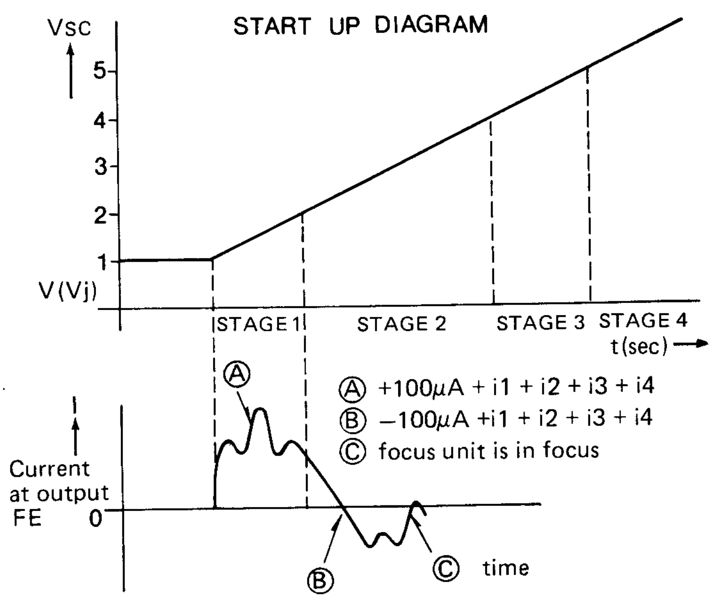
3-1-7 Start-up procedure

The whole start-up procedure is sequenced by the voltage across capacitor C2513. Capacitor C2513 is charged by an internal current source of 1 µA nom.
Together with a starting capacitor of 270 nF, a starting-up time of approximately 0.3 sec. is reached.

The start-up procedure is divided in stages. The procedure is started by putting a logical low level at the Si/$\overline{RD}$ input.



STAGE 1

Laser turns on and the objective is moved to the center of the disc. The turntable motor is switched on. The FE pin delivers a positive going starting current of 100 µA + the sum current (I1 + I2 + I3 + I4).

Note the I.f. a.g.c. does not see light, so max amplification.

STAGE 2

The starting current is reversed, gradually causing the objective to go down. This process is stopped when the starting current equals the amplified sum current (I1 + I2 + I3 + I4).

Note: I1 + I2 + I3 + I4 = 100µA

STAGE 3

A smooth transition is made from the amplified sum current (I1 + I2 + I3 + I4) to the normalized focus error signal

$$\frac{I1 - I2}{I1 + I2} + \frac{I4 - I3}{I4 + I3}$$

The spot is now almost focused on the reflective layer of the disc.

The signals to the FE pin.

STAGE 1 (starting-up current + I1 + I2 + I3 + I4)

STAGE 2 (starting-up current + I1 + I2 + I3 + I4)

Stage 3 $\frac{I1 - I2}{I1 + I2} + \frac{I4 - I3}{I4 + I3}$
This should be almost 0

The signal to the FE lag pin.

Stage 4 (I1 + I4) − (I3 + I2) + the normalized FE (like in stage 3)

The arm is kept at the inside recess by means of a binary word from the microprocessor at B0, B1, B2, and B3 of the radial error processor.

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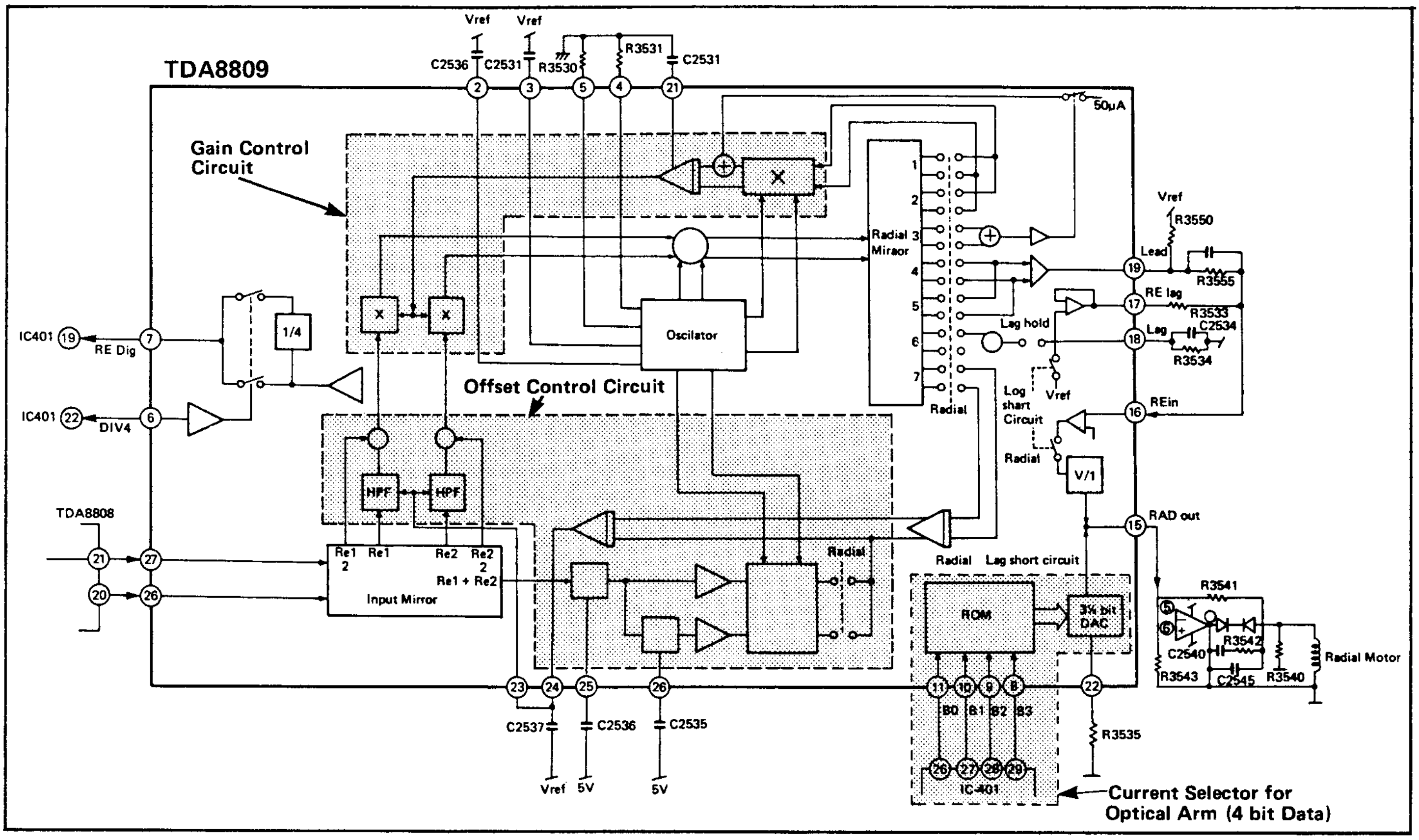
3-2 TDA8809 RADIAL ERROR PROCESSOR

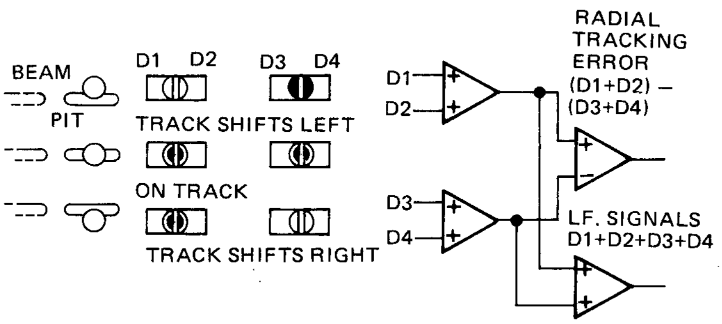


- The resistor R3535 sets the amount of output current of the DAC signal.
- The other components setting the oscillator frequency are R3530, R3531, C2530, C2531.
- The inputs B0 - B3 are used to control the operations which have to be performed by the radial error processor.
- The DAC output is a current source output used to move the radial arm. The normal control is RE, but to jump beyond tracks and to compensate bumps the DAC signal is used.
- The RE lag output gives the loop a more powerful control.
  This output is only activated during normal playback.
- The RE dig is a 1-bit quantized version of the RE signal. The function of RE dig is not in all sets the same. Below is the function in a audio player explained. If a TL occurs the microprocessor looks to RE dig, the value of RE dig indicates whether the microprocessor has to compensate for a right or left bump via DAC . The maximum hold range of RE is normally 1/4 track pitch due to the sinusoidal form of the radial error signal. By means of TL and RE dig the hold range is extended to 3/4 track pitch.
- For high speed track crossing, four dived RE dig signal is given by pulling Div 4 input to low level.

3-2-1 Radial processing

The radial error processor has to process the basic input signals RE1 and RE2 and to generate the full radial error signal RE. The RE signal is the basic signal to keep the reading beam on track.

RE1 and RE2 are caused by more or less light of the laser failing onto diodes D1, D2 or D3, D4 (see figure below)



RE1 = i1+i2 and RE2 = i3+i4

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The processing formula produced by the radial error processor is RE = k d (i1+i2+i3+i4) - k(i1+i2).

The factors k and d are detected from the loop itself by processing a low frequency wobble fault signal, which is injected into the loop. Injection of this causes a displacement of +/- 0.05 µm of the arm.
The k is again factor and has to compensate:

- The tracking angle fault (varies between 90 degrees, smallest radius, and 45 degrees, largest radius).
- The pit geometry of disc (causing the amplitude of radial error signals to vary up to 100% from disc to disc).
- Deterioration of the laserdiode.

3-2-2 Automatic gain control (k-factor)

Detection of the desired value is done by detecting the phase angle of an injected wobble signal in the radial loop.

The closed loop transfer function has a phase shift of 135 degrees at 650 Hz (the wobble frequency).

To maintain the loop gain, the phase of the closed loop signal of RE is compared with a -45 degrees shifted signal derived from the 650 Hz wobble injection oscillator. If the gain is nominal the output of this phase comparator is zero. In other cases a positive or negative phase error signal is detected.

The detected signal is integrated by C2538. The value of this integrated signal sets the gain. This completes the set up for the k factor in TDA8809.

Note: The phase comparator is a linear multiplier which ensures that the a.g.c. loop is unaffected by spurious signals near the odd harmonics of the wobble frequency.

The open-loop gain control is clamped to an internal reference level during starting-up and searching.

3-2-3 Automatic asymmetry control (d-factor)

The radial error signal in a single-beam pick-up is derived from a comparison of the light intensity in each pupil half.

Errors in this signal can be caused by:
- Asymmetry in the far-field pattern of the laser.
- Light path to the disc.
- Imperfections in the beam splitter.

Errors can be corrected by bringing the d-factor in the total transfer function.

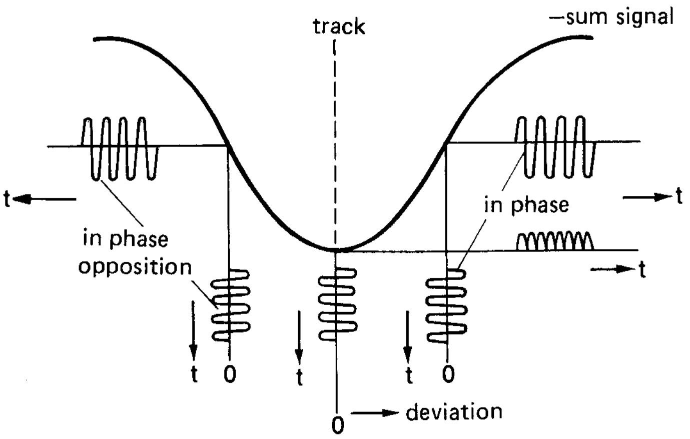
The wobble used to measure the k-factor is also used to measure the asymmetry. The signal causes the beam to wobble with an amplitude of 0.05 um. When the reading spot is to the right of the track the total amount of L.F.light (iTOT = i1+i2+i3+i4 = RE1 + RE2) is in phase with the wobble in the radial error signal.

When the reading spot is to the left the I.f. sum signal (RE1 + RE2) is 180 degrees out of phase with the wobble.

The sum signal is in practice multiplied by a 90 degrees shifted version of the wobble signal. The multiplier is again linear giving the above-mentioned benefits. The loop has a filter which is set by the value of C2537.

The imperfections mentioned above make the beam follow the track at one of its edges. The wobble component in the RE signal for such a situation is visualised below.

Note: C2537 is the capacitor which integrates the d-factor.



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