NEW TECHNICAL THEORY FOR SERVICING

MDX-U1

OPERATION MANUAL

FM/AM MINIDISC PLAYER

SONY®

Contents

Before reading this operation manual, be sure to read the Operation Manual for MZ-1 MD (Mini-Disc) BASIC THEORY, Part No. 9-957-700-31.
The contents of this manual are as follows.

1. Block diagram

1-1. Keyboard section

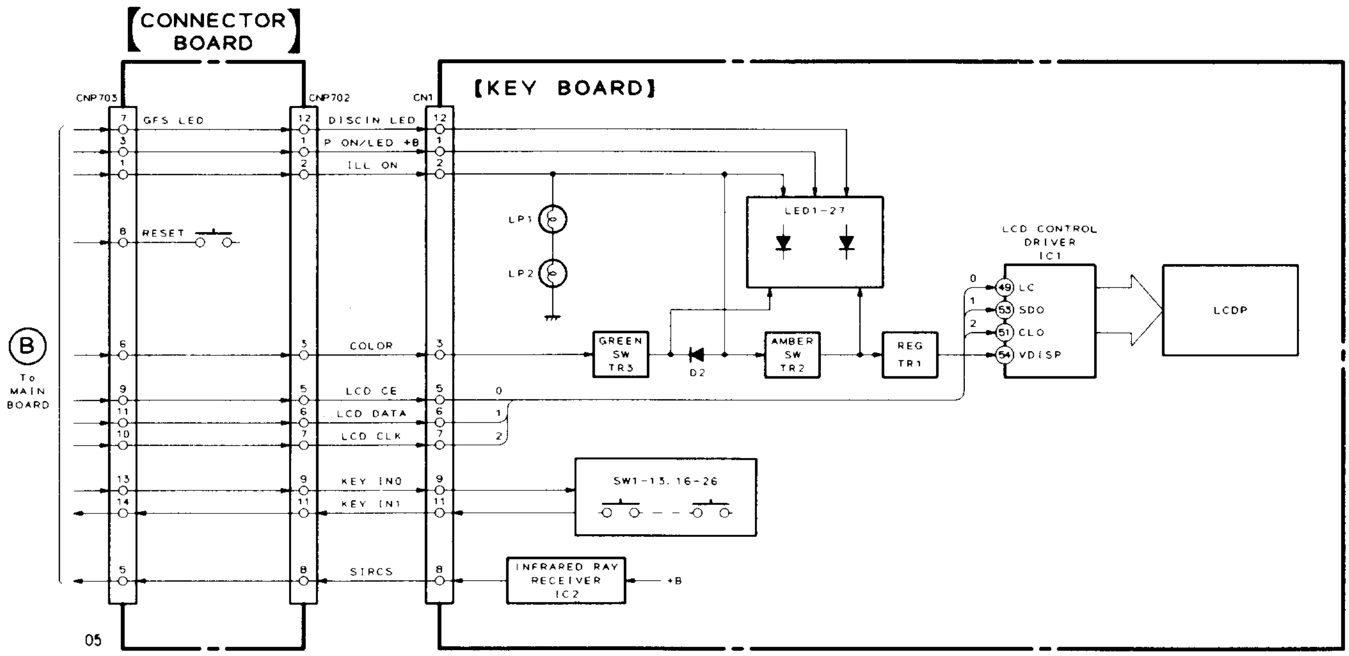


Fig. 1-1 Keyboard section block diagram

1-2. MD section

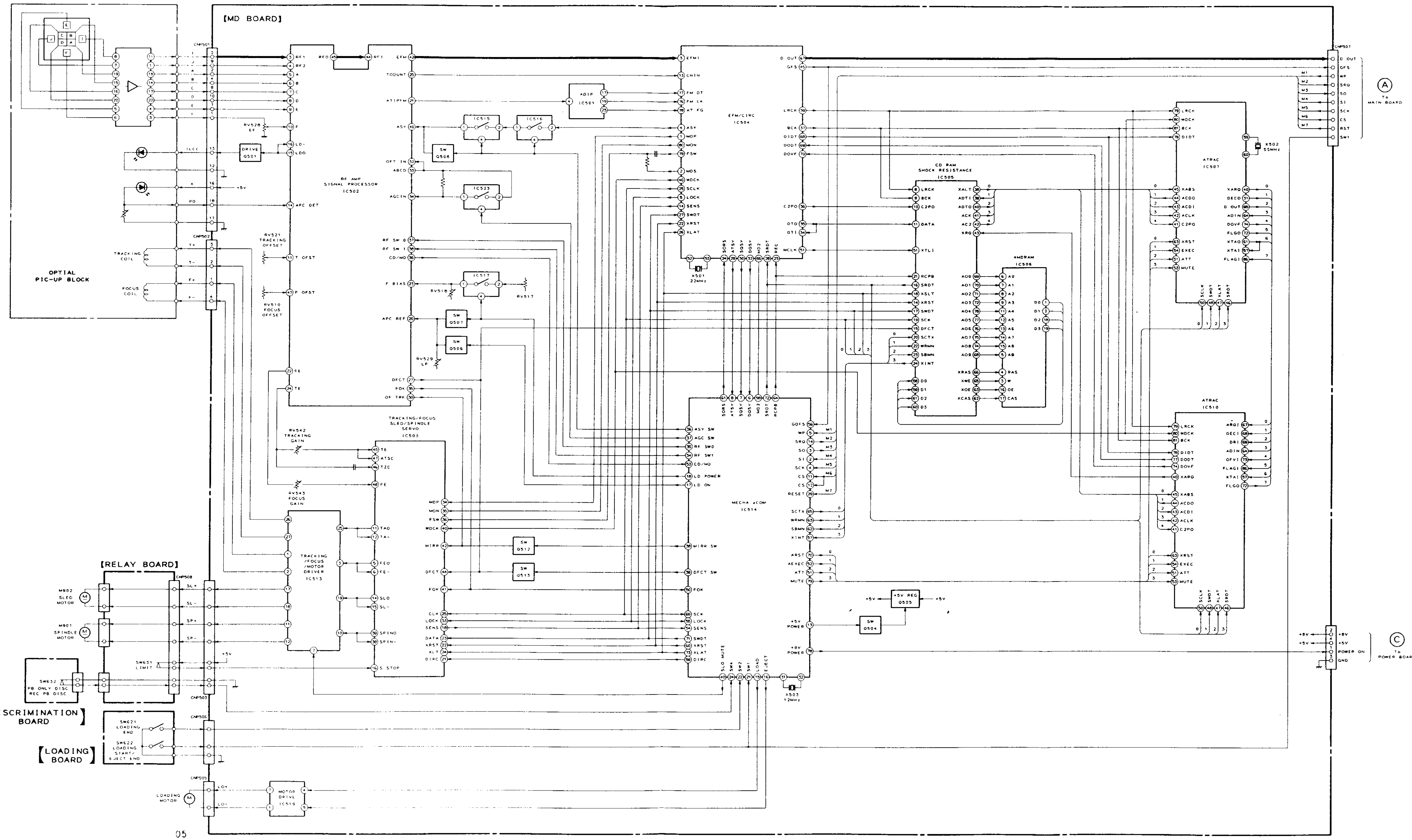


Fig. 1-2 MD section block diagram

1-3. Main section

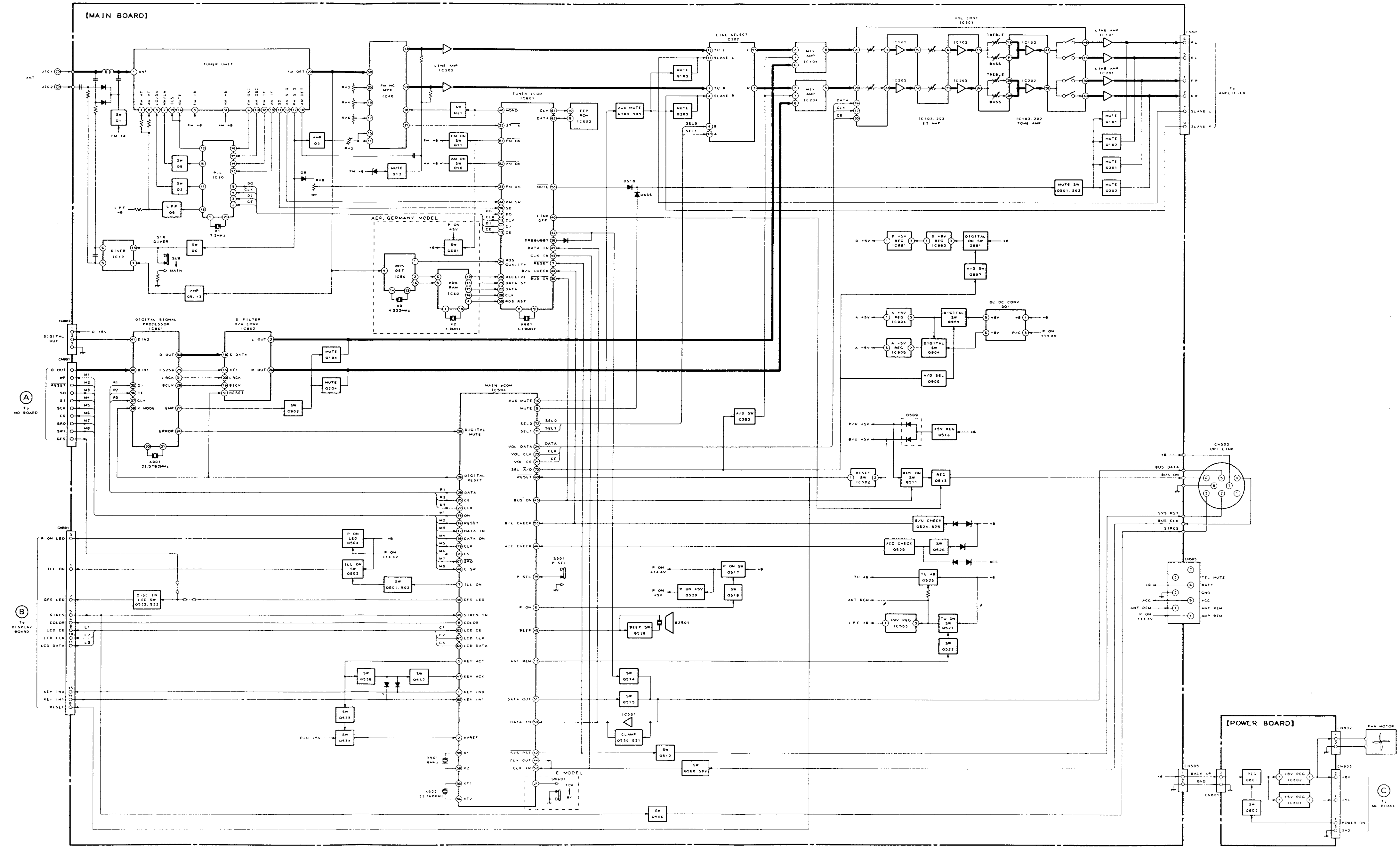


Fig. 1-3 Main section block diagram

2. Circuit operation

2-1. System configuration

The Mini-disc system is a disc system capable of recording, an improved version of conventional CD system. Fig. 2-1 shows a block diagram of Mini-disc player circuits. This unit is designed exclusively for playback operation, so the circuits shown by dotted lines are not included. Fig. 2-2 shows a block diagram of conventional CD player circuits.

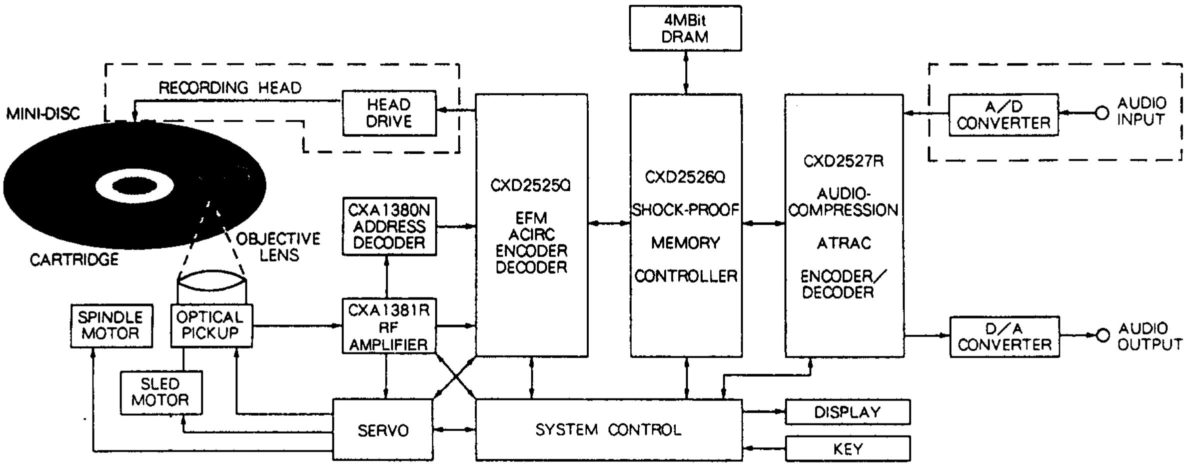


Fig. 2-1 Mini-disc player circuit block diagram

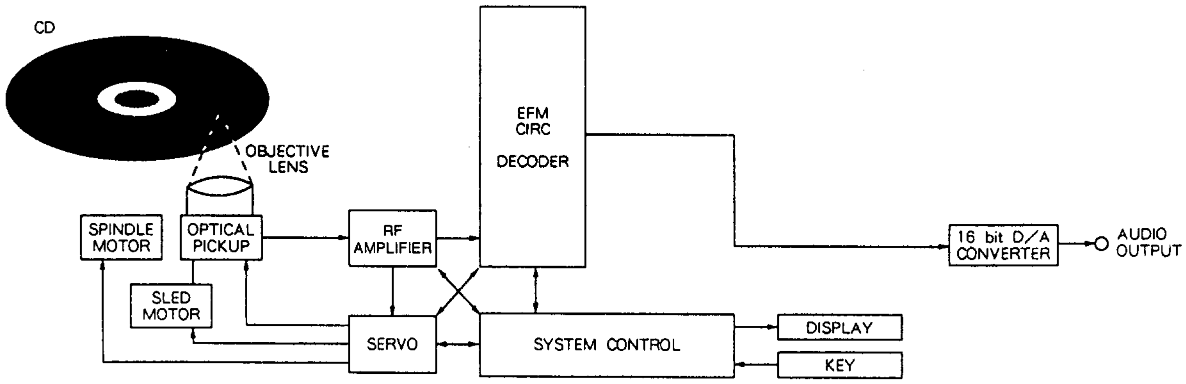


Fig. 2-2 CD player circuit block diagram

The Mini-disc system differs from CD system in the following 4 points.

(1) A/D converter, recording head	(Recording function) ..... Not provided with this unit.
(2) ATRAC encoder/decoder	(Audio compression function)
(3) Shock-proof memory controller, DRAM	(Shock-proof function)
(4) ADIP address decoder	(Random access function)

(1) A/D converter, recording head...... Not provided with this unit.

The Mini-disc system can be used for music recording. It uses a magnetic field modulation over-write system for recording; signals are recorded on disc by the magnetic head while applying laser beams from the optical pickup. So, the Mini-disc system is equipped with a magnetic head and its driver. It is also equipped with A/D converter to change music signals to digital signals.

(2) ATRAC encoder/decoder

In the Mini-disc system, music signals are compressed so that music data of the same playing time (74 minutes) can be recorded on a disc which is far smaller than CD. This audio compression technology is called ATRAC. This ATRAC is encoded by the ATRAC encoder/decoder. Signals recorded on a disc by ATRAC is compressed to about 1/5 of original signals.

(3) Shock-proof memory

In the Mini-disc system, music signals are compressed by above-mentioned ATRAC. Utilizing this feature, music data are stored in RAM to prevent sound skipping due to shocks (shock-proof function). The shock-proof memory controller is used to control the read/write of music data in RAM and intermittent read-out when RAM is full of data.

This unit uses a 4M-bit Dynamic RAM (DRAM) which can be filled with data by about 3 seconds of continuous read-out. Music data stored in RAM allows about 10 seconds of playback.

* Some CD players (D-515, etc.) are equipped with a shock-proof memory control. In CD players, however, the disc speed is raised 2 times faster to raise the read-out speed of music data.

(4) ADIP address decoder

Random access is possible if address is recorded on the entire area of disc. Address is recorded in grooves of recordable (optical magnetism) disc by fine zig-zag patterns of grooves. This ADIP (ADdress In Pre-groove) address is decoded by the ADIP address decoder.

ADIP address decoder is used for the groove area of recordable (optical magnetism) disc alone.

2-2. Signal circuits

1 When MD cartridge is loaded, the reflectance of disc is detected by the disc discriminate switch through the disc reflectance detect hole in the cartridge.
The mechanism micro-computer IC514 selects pin ㉟ RFSW0 (disc reflectance) according to the disc reflectance and outputs the signal to RF amplifier IC502 pin ㊲.
Also, it selects IC514 pin ㉞ RFSW1 (pit/groove) according to pit /groove of disc playback position for mode setting of RF amplifier.

Mode	RF SW 0 (reflectance)	RF SW 1 (PIT/GRV)
Recording area of optical disc	H (CD)	H (PIT)
Innermost pit area of optical magnetic disc	L (MO)	H (PIT)
Groove recording area of optical magnetic disc	L (MO)	L (GRV)

2 Output signals from the photo-detectors (I, J), which have been I/V converted by the optical block, are inputted to RF amplifier IC502 pin ③ RF1 and pin ④ RF2.
The RF amplifier outputs RF signal (I+J) when it is in the pit area or (I-J) when it is in the groove area, to the digital signal processor IC504 pin ③ EFMI from pin ㊷ EFM terminal, according to the pit/groove data (RFSW1 signal) from the micro-computer.

3 EFM signal is inputted to the digital signal processor IC504 pin ③ EFMI. It is demodulated by the internal digital PLL for clock extraction.
The EFM signal is processed for deinterleave (ACIRC decode), data correction and interpolation by the digital signal processing IC, and then it is sent to the (shock-proof) RAM controller IC505, as music signal of MD format (cluster/sector), from pin ㉟ DTO.

4 The RAM controller IC505 decodes the MD format signal inputted to pin ⑪ DATA terminal and stores only the compressed music signal in the 4M-bit memory IC506. The mechanism micro-computer IC514 controls intermittent read of disc according to the data stored (FULL/EMPTY, etc...) in RAM. And music signal is outputted one by one cluster from RAM to ATRAC decoder IC according to the data request signal from Lch ATRAC decoder IC510 pin ㊵, which is inputted to IC505 pin ㊸ XRQ.

5 Music data is inputted, one by one cluster, to each pin ㊸ ACDI of Lch ATRAC decoder IC510 and Rch ATRAC decoder IC507. The music data extended (ATRAC decode) by Rch IC507 is sent from IC507 pin ㉛ DECO to Lch IC510 pin ⑥⑧ and then sent to the digital signal processor IC504 pin ⑥⑨ DODT from IC510 pin ⑦⑦ DODT, together with the music data extended in Lch.

6 This music data is encoded in digital audio interface format for digital OUT by IC504 and is outputted from pin ⑥⑦ DOUT to the digital audio interface receiver IC901.

7 The EIAJ format signal inputted to IC901 is demodulated to normal digital signal and is outputted to D/A converter IC902.

8 The serial digital signal inputted to D/A converter IC902 passes through the built-in LPF where it is divided into L/R channel and D/A converted as an output signal.
When pre-emphasized signals are played, IC901 detects the presence of emphasis and turns ON Q104 and Q204 to deemphasize the signals.

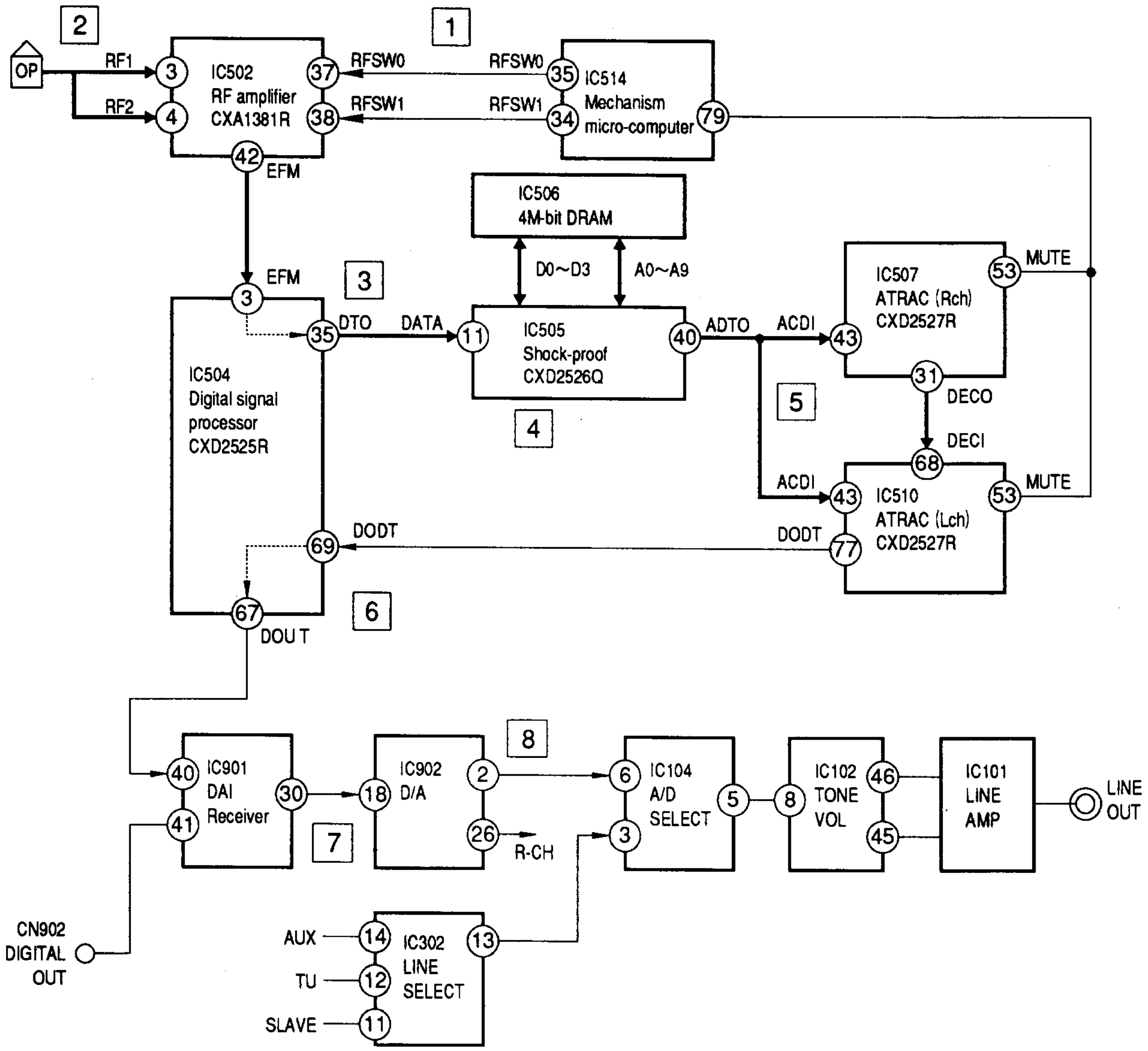


Fig. 2-3 Signal circuit block diagram

2-3. Peripheral circuits of signal system

2-3-1. PLL circuit

This circuit uses the PLL mode of the digital signal processor IC504 (CXD2525R).
PLL circuit is used to lock the channel clock T demodulating EFM signal (3T-11T) which is read during playback, in the phase synchronized with demodulator master clock.
Decoder PLL circuit uses the decoder digital PLL mode of the digital signal processor IC504 (CXD2525R). It divides the VCO master clock (34.5744MHz) in IC504 into 44.1kHz (fs) and locks the phase synchronized with EFM demodulator in IC. The external circuit connected to the digital signal processor IC504 pins ⑯-⑳ is LPF for the built-in master clock (34MHz) VCO.

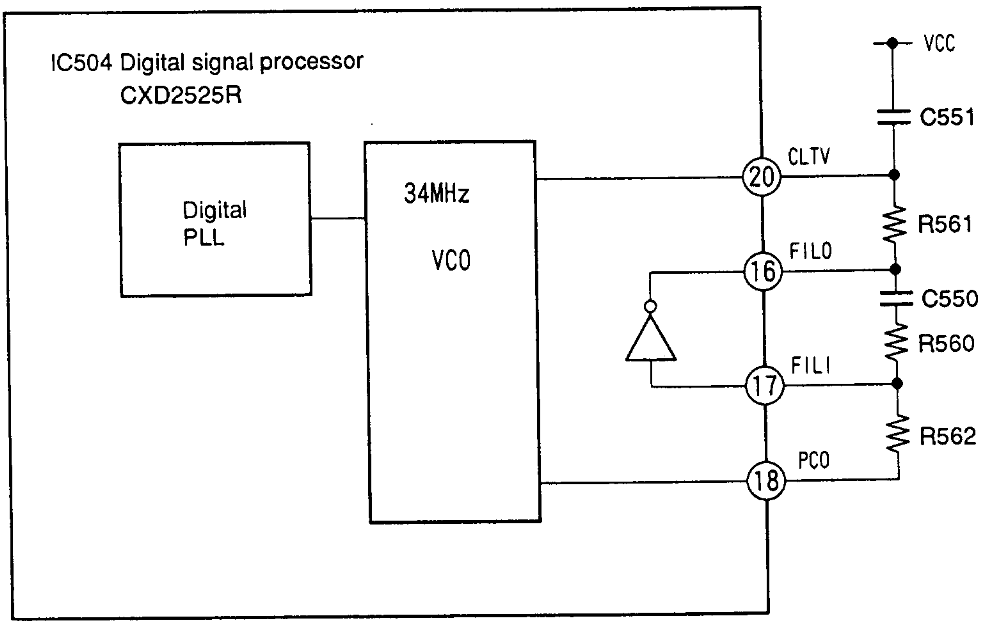


Fig. 2-4 Playback decoder PLL circuit

2-3-2. Asymmetry switch circuit

To prevent entry of noise in the off-track signal, the comparate level needs to be set to +5V at access of an optical magnetic disc so as not to operate the EFM comparator of RF amplifier IC502. The circuit which performs this function is the asymmetry switch circuit.
The asymmetry circuit used with this unit prevents noise by switching the input to the asymmetry circuit at access (track jump, etc.) of optical magnetic disc.

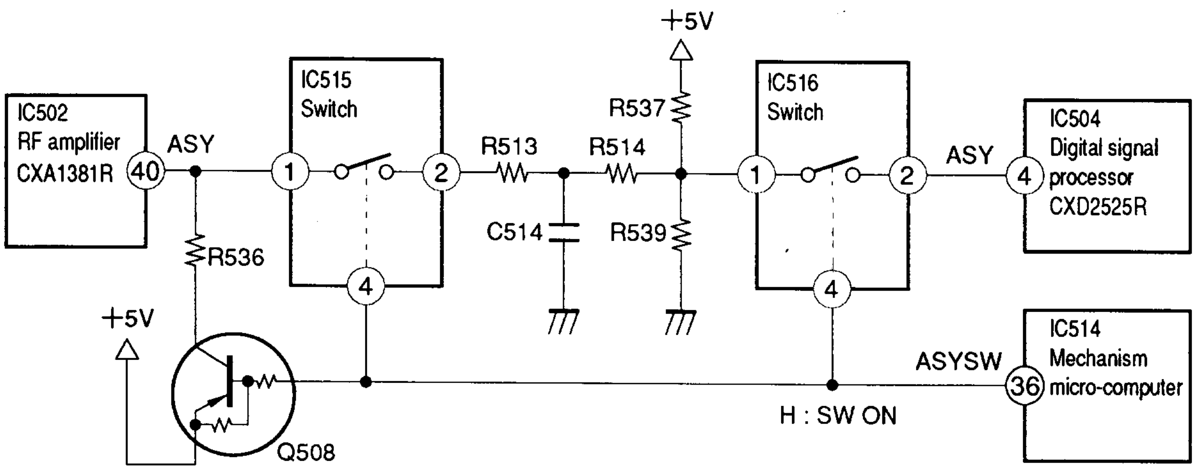


Fig. 2-5 Asymmetry switch circuit

IC515 and IC516 are switch IC to turn ON/OFF the signal between pins ①-② according to input signal at pin ④.
The system control IC514 pin ㊱ ASYSW signal turns to "H" at access of optical magnetic disc for ON/OFF of the asymmetry switch circuit.
During normal playback of disc, the digital signal processor IC504 pin ④ ASY output is inputted to the RF amplifier IC502 pin ㊵ ASY terminal through IC516, LPF and IC515.
Q508 turns ON with ASYSW signal at access of optical magnetic disc and the asymmetry signal input of IC502 is set to +5V.

2-4. Servo circuit

2-4-1. Outline of servo circuit

Fig. 2-6 shows a block diagram of servo circuit. The block shown by dotted lines is required when the optical magnetic (recordable) disc is used.

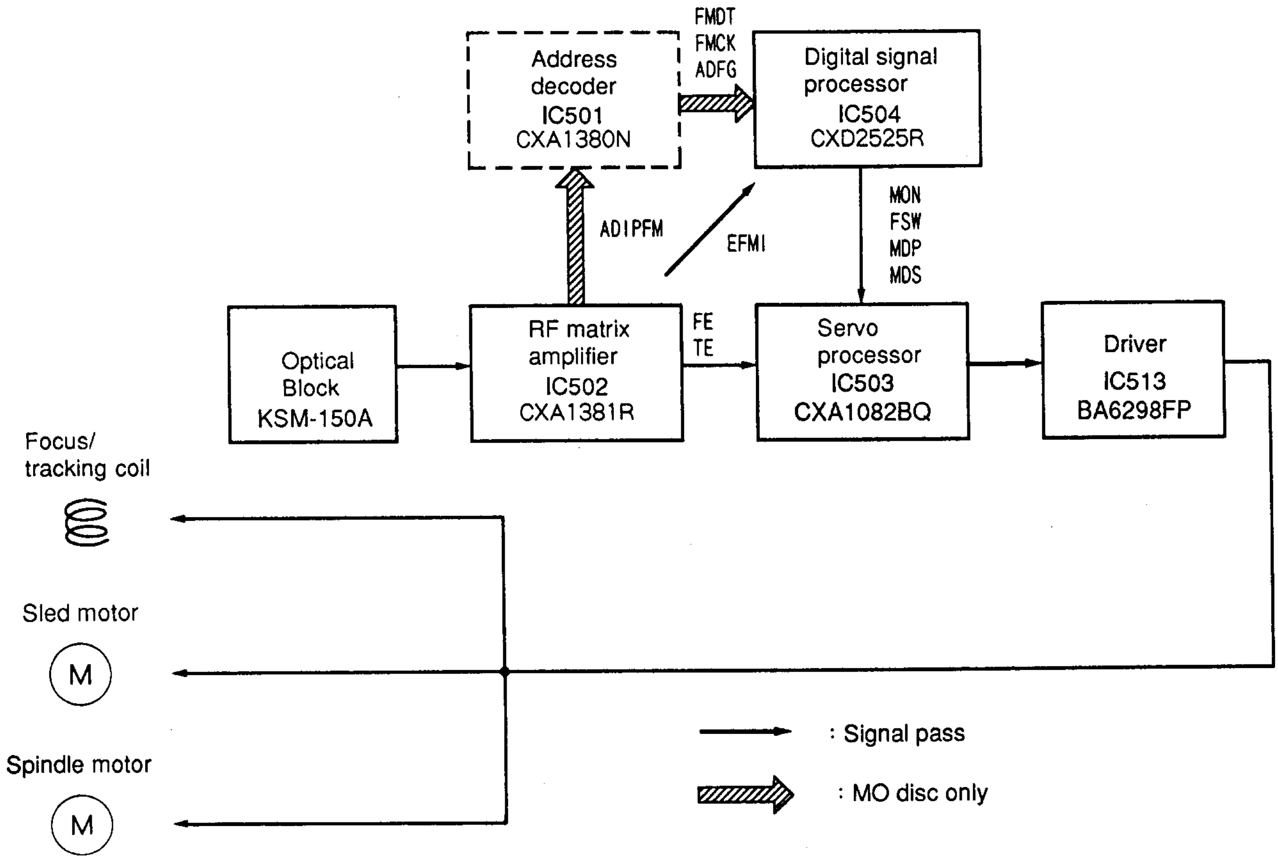


Fig. 2-6 Servo circuit

The servo circuit for use of optical (playback only) disc is basically the same as that of CD players. The focus, tracking and sled servos are used to control the driver from the servo processor IC using error signal given by the RF amplifier. The spindle servo is used to extract clock signal from EFM signal in the disc pit by the digital signal processor IC and control the driver from the servo processor IC.

On the servo circuit for use of optical magnetic (recordable) disc, the control functions of the focus, tracking and sled servos are the same as for use of optical disc, though a different circuit is used only for the spindle servo, because EFM signal cannot sometimes be used (recording to blank optical magnetic disc) for the spindle servo of optical magnetic disc. So spindle servo is effected utilizing the ADIP signal obtained by the wobbling of the grooves. The clock signal and data extracted by this circuit are decoded by the digital signal processor IC to effect spindle servo by controlling the driver from the servo processor IC.

In this unit, only one servo circuit is used for playback of optical (playback only) disc and optical magnetic (recordable) disc. Since the reflectance of optical disc largely differs from that of optical magnetic disc and also the method for reading disc signal is different with each other, signals from disc are amplified by the RF amplifier* to obtain a constant output for the common-use of servo circuit.

*Amplification with RF amplifier

The amplitude of FE (focus error), TE (tracking error) and ADIPFM (ADIP) signals are adjusted by the AGC (Automatic Gain Control) contained in the RF amplifier to obtain a constant amplitude, regardless of the quantity of light. Also, offset and bias are adjusted for optimum values according to the pit of optical disc, the pit of optical magnetic disc, or the grooves of optical magnetic disc.

2-4-2. Focus servo

Fig. 2-8 shows the focus servo circuit.

[1] Optical disc and optical magnetic disc are discriminated by the disc reflectance detect hole and RFSW0 signal is selected by the mechanism micro-computer IC using the switching input for selecting the degree of amplification of the RF amplifier (IC502).
Also, error signal characteristic determined by the pit/groove of disc is selected in the RF amplifier using RFSW1 signal.

[2] The signal (A+C) − (B+D) is generated in the RF matrix amplifier (IC502) using the photo detector output of optical block. It is fed to the AGC (Automatic Gain Control) circuit as FE (Focus Error) signal.

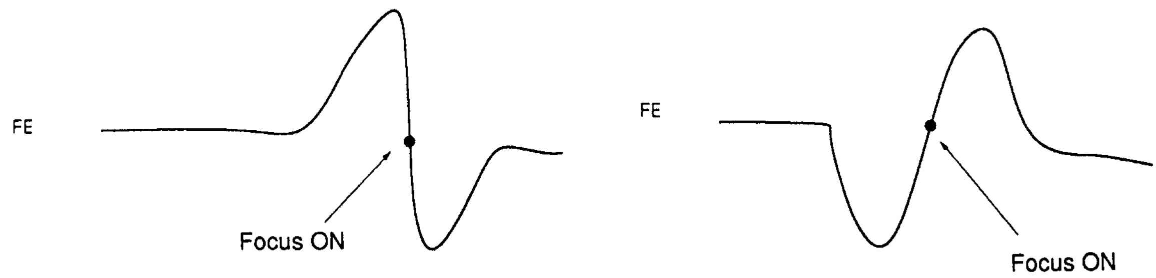
[3] When the signal (A+B) + (C+D) of the photo detector output reaches 0.5V or more in the RF matrix amplifier (IC502), FOK (Focus OK) is outputted from IC502 pin ㉟. The offset value of (A+B)+(C+D) is adjusted by RV510 at IC502 pin ㊼ FOKOFSET terminal.

[4] The volume controls for adjusting the focus bias are RV518 (MO Focus BIAS) and RV 517 (CD Focus BIAS) at IC502 pin ㉓ FBIAS terminal. RV517 is selected by the signal at the mechanism micro-computer IC514 pin ⑱ LD POWER.

[5] Focus error signal from the servo IC503 pin ⑤ FEO is inputted to the driver IC513 pin ③. It is amplified by the driver for driving the focus coil of the optical block.

Note: Operation of focus servo

The reflectance on the signal recording area of optical disc (conventional CD, MD for playback only) is about 80%, while that of optical magnetic disc (recordable MD) is fairly low (about 20%). So, the difference between about 10% of false light reflected from the disc surface (polycarbonate) and the actual light reflected from the disc signal recording area is small and hence these lights cannot be discriminated by IC.
Therefore, the focus search operation is made from the upper side (near the disc) to prevent misoperation due to false reflection light at the time of focusing. Accordingly, the timing of focus servo ON is at the opposite zero cross point (from negative to positive).



CD zero cross point   MD zero cross point

Fig. 2-7 Zero cross point of focus error signal

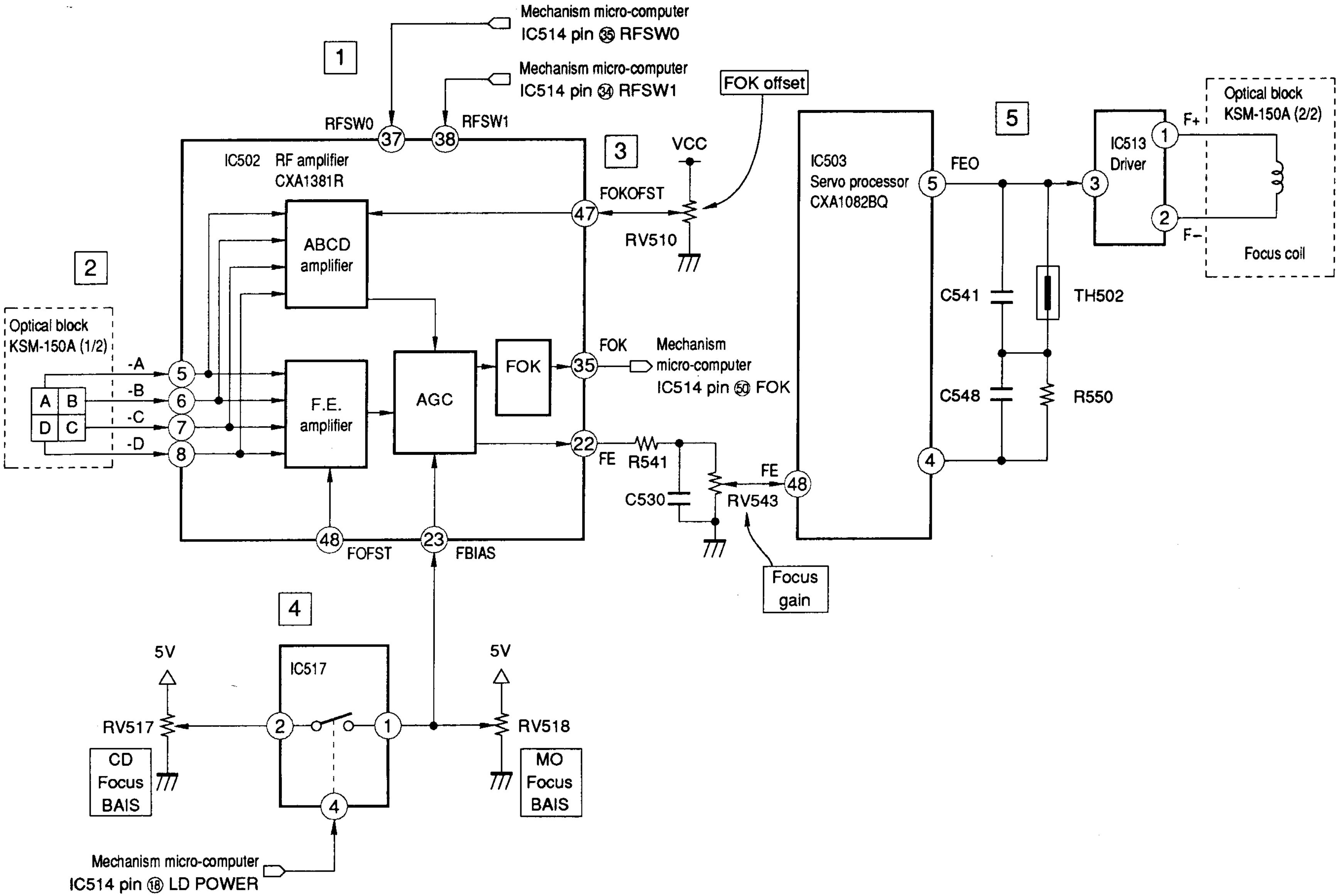


Fig. 2-8 Focus servo circuit block diagram

2-4-3. Tracking/sled servo

Fig. 2-9 shows the tracking/sled servo circuit.

1 Like the focus servo, PIT/GRV select signal is outputted from the mechanism micro-computer IC514 pin (34) RFSW1 for selecting the tracking polarity at PIT/GRV of RF amplifier IC 502.

2 Photo detector outputs E and F from the optical pickup are inputted to IC502 pins (9), (10), and the tracking balance is adjusted by RV582 as photo detector output F.

3 Tracking offset voltage is adjusted by RV521 at RF amplifier IC502 pin (11) TOFST.

4 The signal (MIRR: signal detecting mirror face between tracks) which crosses tracks is generated in IC502, which is given from pin (30) OFTRK as off-track signal for use with servo brake signal. Also, tracking count signal is outputted from IC502 pin (25) TCOUNT and used for counting the number of track jumps (high speed access, etc). When IC502 is in PIT mode, MIRR signal is outputted and, in GRV mode, TE is comparated and outputted.

5 TE (tracking error) signal generated as (E-F) in RF amplifier is outputted from pin (24) TE to adjust the tracking servo gain with RV542. The TE signal is inputted to the servo processor IC503 pin (45) TE and pin (47) ATSC. And, at the same time, its DC component is cut and inputted to pin (46) as TZC (tracking zero cross) signal.

6 LOCK (CLV lock) signal outputted from the digital signal processor IC504 pin (5) is inputted to the servo processor IC503 pin (33). When CLV lock is released, this signal turns OFF the tracking servo in IC503 to prevent the sled motor from runaway.

7 Tracking error signal outputted from the servo processor IC503 pin (11) TAO is inputted to the driver IC513 pin (25). It is amplified to drive the tracking coil of the optical block. The tracking error signal is integrated in the servo processor IC503 and only the component almost close to DC is inputted from IC503 pin (14) SLO to the driver IC513 pin (19), which is then amplified to drive the sled motor.

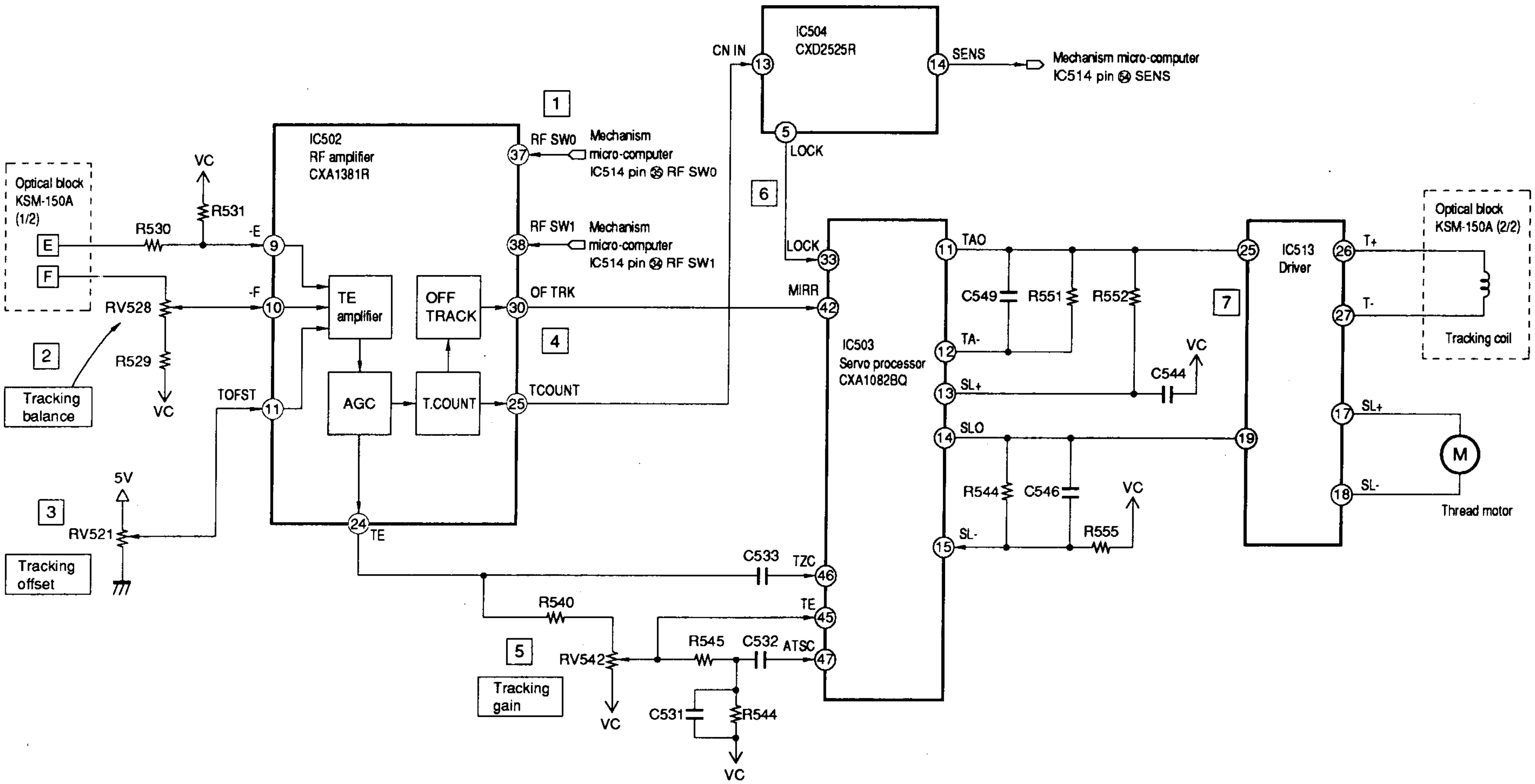


Fig. 2-9 Tracking/thread servo circuit block diagram

2-4-4. Spindle (CLV) servo

(1) Spindle servo system

The spindle servo system for playback (optical) disc is different from that for recordable (optical magnetic) disc. In optical disc, signals are recorded in the pits on the disc, so spindle servo is applied utilizing EFM signal like CD players.
On the other hand, the optical magnetic disc has two recording areas, one is PTOC area, an innermost recording area where signals are recorded in pits, and another is program area where signals are recorded magnetically in grooves, each having different spindle servo system. On the innermost PTOC area where signals are recorded in pits, spindle servo is applied utilizing EFM signal like optical disc but, on the program area where signals are recorded in grooves, servo is applied utilizing ADIP signal cutting addresses in zig-zag pattern (wobbling) formed on the disc, because spindle servo is necessary even when EFM signal is absent during recording on optical magnetic disc.

Method of spindle servo

Disc	Recording area	Servo mode
Optical disc	Pit	EFM
Optical magnetic disc (PTOC area)	Pit	EFM
Optical magnetic disc	Groove	ADIP

(2) EFM-CLV servo (optical disc)

Fig. 2-10 shows the spindle servo circuit (circuits enclosed with dotted lines are not included) using EFM signal. The servo system is the same as that for CD players.

[1] Photo detector outputs (I, J) from the optical pickup are inputted to RF matrix amplifier IC502 pins ③, ④.

[2] On the optical disc and optical magnetic disc, the disc reflectance and modulation degree are different between pit area and groove area, so the gain and polarity are selected by RFSW0 and RFSW1 signals from the mechanism micro-computer IC514. EFM signal turns to I+J signal when optical disc is used, while it turns to I-J signal when optical magnetic disc is used.

[3] The waveform of EFM signal (I+J) for optical disc is equalized by the equalizer of RF matrix amplifier IC502 and then the signal is changed to a 2-value signal by the comparator and, at the same time, the comparator's reference voltage is controlled by the asymmetry compensation circuit. The EFM signal is outputted from IC502 pin ㊷.

[4] EFM signal is inputted to the digital signal processor IC504 pin ③ to generate CLV signal for spindle servo. The spindle servo has 4 modes; rough servo (CLV-S) for pull-in, PLL servo (CLV-P), automatic servo (CLV-A) for automatic selection of CLV-S and CLV-P with GFS signal, and rough servo (CLV-H) for high speed access, each mode being controlled by 4 signals, MON (motor ON/OFF), FSW (filter time constant selection), MDS and MDP.

[5] Spindle servo error voltage outputted from the servo processor IC503 pin ㊴ SPDLO is inputted to the spindle motor driver IC513 pin ⑩ to control the motor.

(3) ADIP-CLV servo (optical magnetic disc)

Fig. 2-10 shows the spindle servo circuit controlled by ADIP signal (circuit enclosed by dotted lines is included).

① Photo detector outputs A, B, C and D from the optical pickup are inputted to the RF matrix amplifier IC502 to generate ADIP signal of (A+D)−(B+C) by ADIP amplifier. The ADIP signal is FM modulated signal of 22.05±1kHz which corresponds to the wobbling of the grooves. The amplitude is regulated by the AGC circuit in the RF amplifier regardless of light volume, and is outputted from pin ㉑ ADIP FM terminal to ADIP decoder IC501 pin ④ ADIP FM.

② The inputted ADIP signal passes through BPF (22.05kHz) in ADIP decoder IC501 to remove noise component of wobbling signal. This signal is outputted from pin ㉓ ADIPFG to the digital signal processor IC504 pin ⑱78 ADFG as a signal for rough servo.

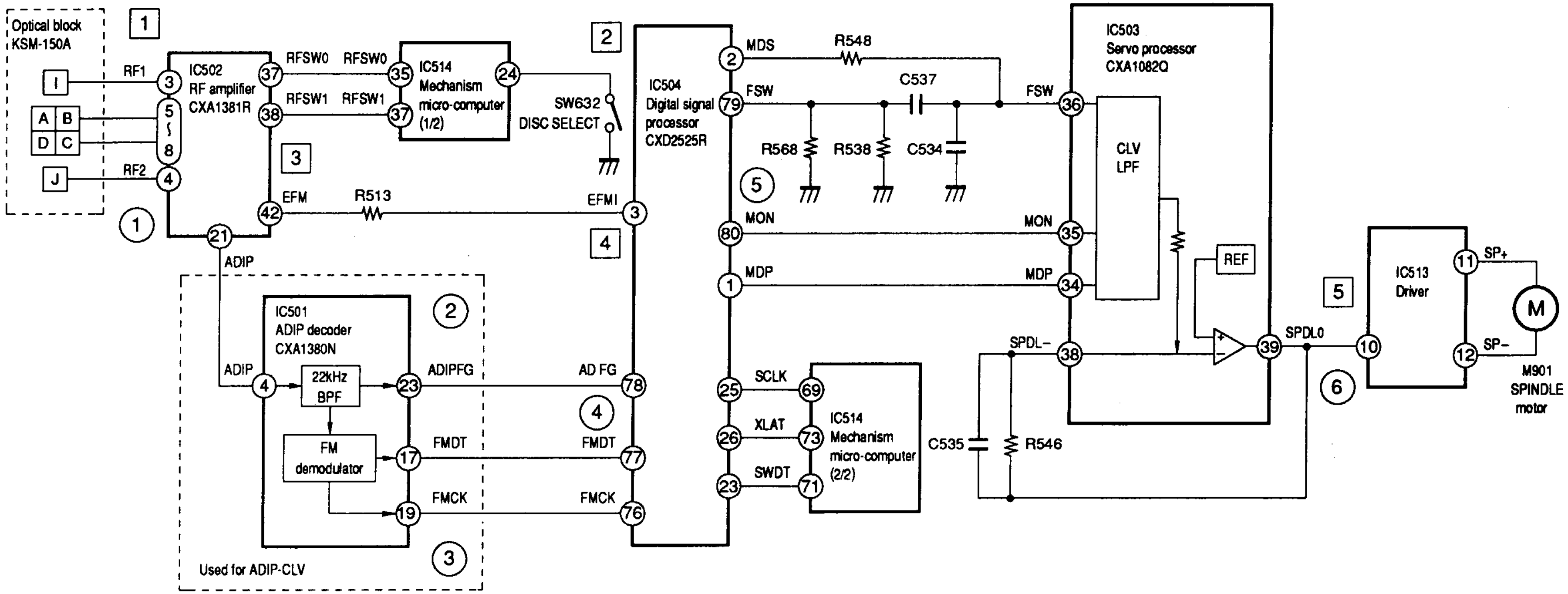
③ ADIP signal of 22.05±1kHz passing through BPF in IC501 is given PLL, and is demodulated into the original 6.3kHz bi-phase data to output from pin ⑰ FMDT terminal to the digital signal processor IC504 pin ⑰77. Also, ADIP bit clock (6.3kHz) is outputted from IC501 pin ⑲ FMCK to IC504 pin ⑯76.

④ The digital signal processor IC504 decodes the inputted ADIP data and another ADIP data from the read clock.

Under ADIP-CLV servo mode, in the rough servo (CLV-S), spindle servo is applied using ADIP carrier signal inputted to pin ⑱78 ADIPFG and, in the PLL servo (CLV-P), it is applied using sync signal of ADIP data.

⑤ The digital signal processor IC504 controls the servo processor IC503 by 4 signals, MON, MDP, MDS and FSW, as in the case of EFM-CLV.

⑥ Spindle servo error voltage outputted from the servo processor IC503 pin ㊴ SPDLO is amplified by the driver IC513 to drive the spindle motor.



1 ~ 5 EFM-CLV servo

(1) ~ (6) ADIP-CLV servo

Fig. 2-10 Spindle servo circuit block diagram

2-4-5. APC circuit

(1) Circuit functions

The APC (Automatic Power Control) circuit is used to regulate the laser output from the laser diode of the optical pickup. This circuit regulates the output regardless of ambient temperatures.

1) Stability of laser power

The output power from the laser diode of the optical pickup varies with temperature, so the laser beams are emitted from the pickup are monitored by the photo detector to apply the servo. This function is the same as that of CD players. But, in CD players, rear APC system using a back monitor photo diode (rear side of laser diode) is employed. On the other hand, this unit uses a front APC system which monitors the laser beams emitted to the disc with a photo diode after dividing with a beam splitter. The reason for use of this system is that the rear APC system generates scoop noise caused by beams returned from disc due to increase in laser beam emission power.

2) Setting of laser emission power

The optical pickup KSM-150A used with this unit has been factory set to obtain the following laser power.

Laser power (mW)

Disc	Mode	Laser power (mW)
Optical disc (CD)	Playback	0.5
Optical magnetic disc (MO)	Playback	0.82

(2) Circuit operation

[1] The mechanism micro-computer IC514 pin ⑰ LD ON terminal is used for APC circuit ON/OFF (laser diode ON/OFF).
LOW...LD ON, HIGH...LD OFF

[2] The mechanism micro-computer IC514 pin ⑱ LD POWER terminal is used to change the laser power according to the type of disc.
LOW...Power output for MO, HIGH...Power output for CD

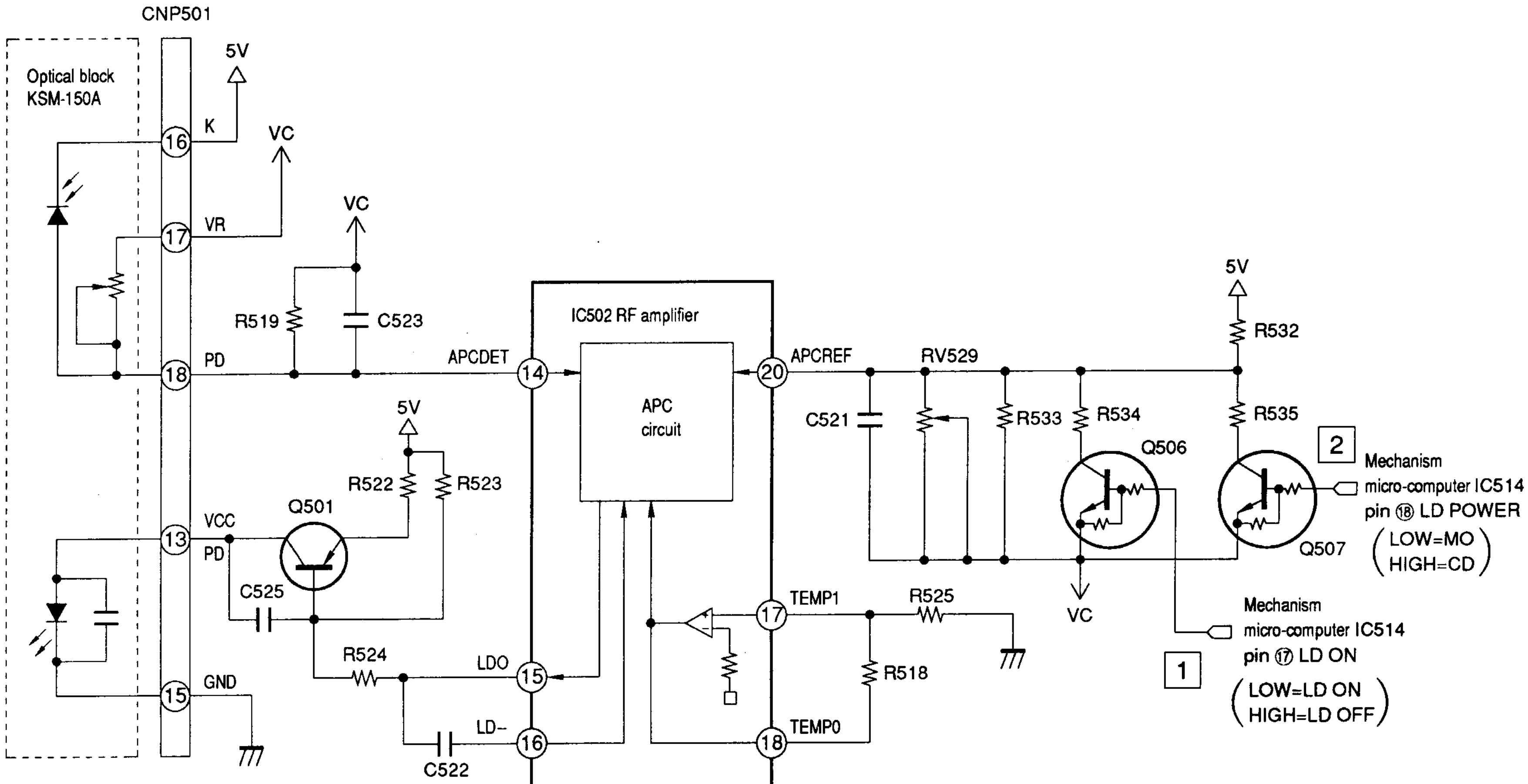


Fig. 2-11 APC circuit block diagram

3.Mechanism operation

3-1. Electric parts layout diagram

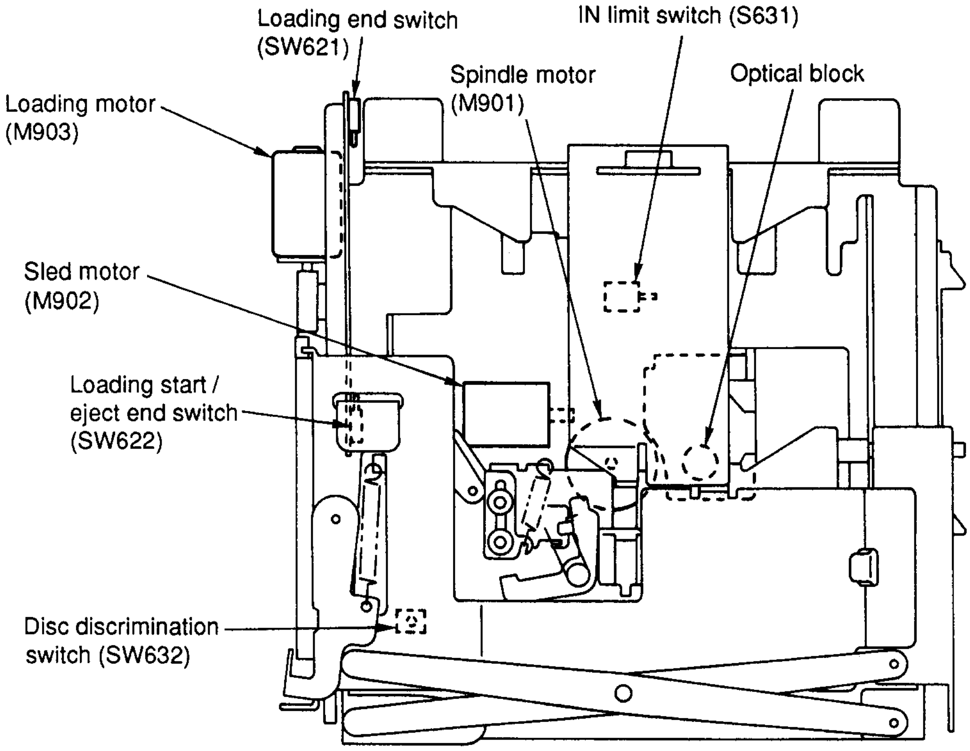
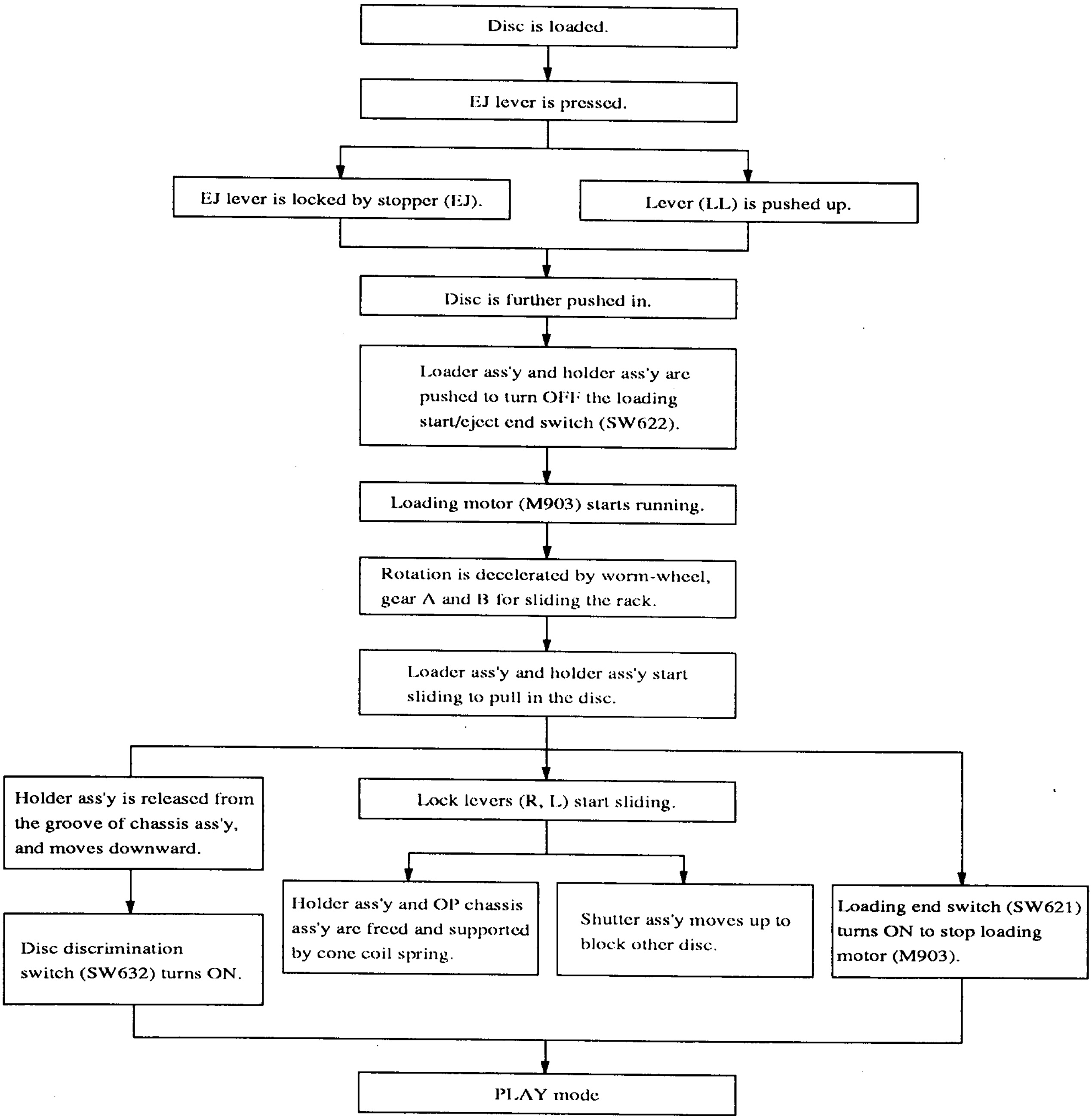


Fig. 3-1

3-2. Disc IN


Disc is loaded.
EJ lever is pressed.
EJ lever is locked by stopper (EJ).
Lever (LL) is pushed up.
Disc is further pushed in.
Loader ass'y and holder ass'y are pushed to turn OFF the loading start/eject end switch (SW622).
Loading motor (M903) starts running.
Rotation is decelerated by worm-wheel, gear A and B for sliding the rack.
Loader ass'y and holder ass'y start sliding to pull in the disc.
Holder ass'y is released from the groove of chassis ass'y, and moves downward.
Lock levers (R, L) start sliding.
Disc discrimination switch (SW632) turns ON.
Holder ass'y and OP chassis ass'y are freed and supported by cone coil spring.
Shutter ass'y moves up to block other disc.
Loading end switch (SW621) turns ON to stop loading motor (M903).
PLAY mode

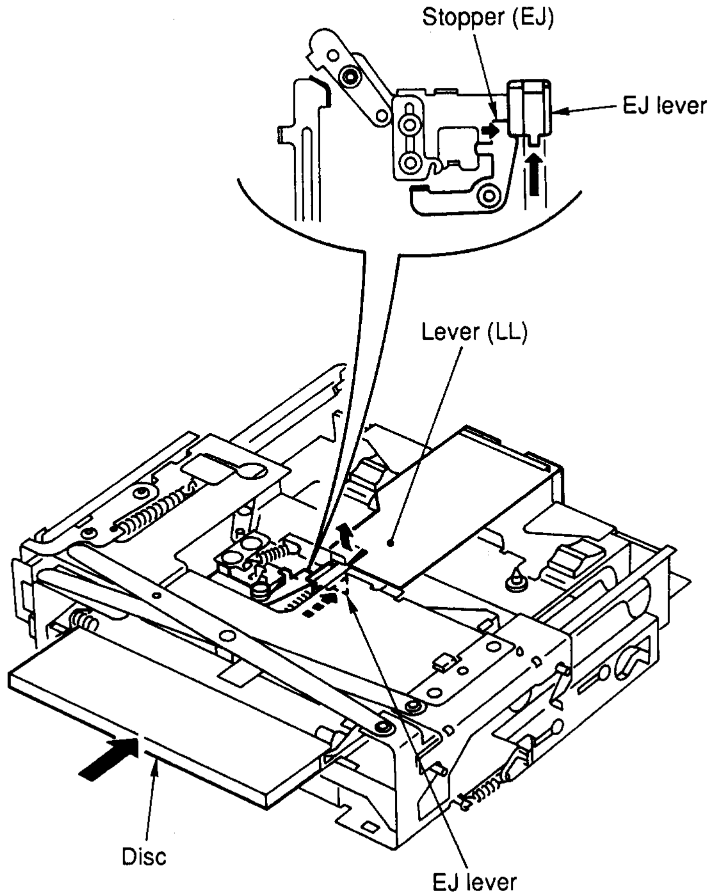

Stopper (EJ)
EJ lever
Lever (LL)
Disc
EJ lever

Fig. 3-2

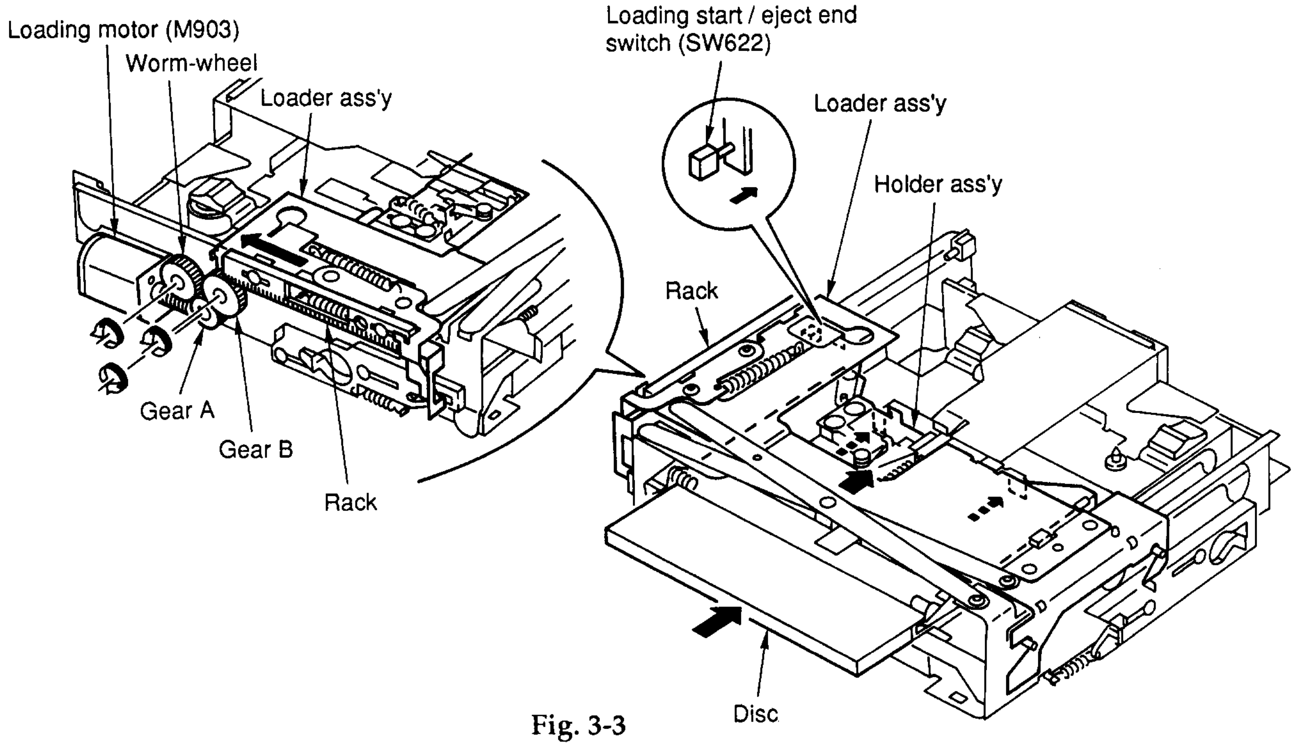

Loading motor (M903)
Worm-wheel
Loader ass'y
Gear A
Gear B
Rack
Loading start / eject end
switch (SW622)
Loader ass'y
Holder ass'y
Rack
Disc

Fig. 3-3

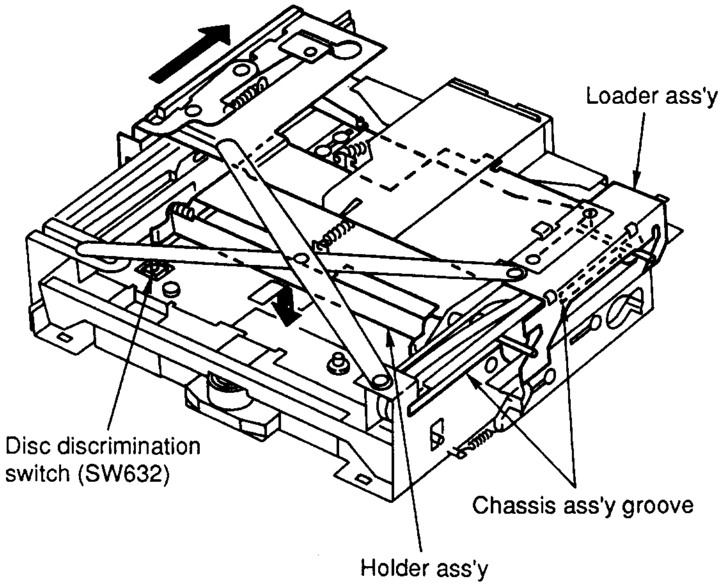

Loader ass'y
Disc discrimination
switch (SW632)
Chassis ass'y groove
Holder ass'y

Fig. 3-4

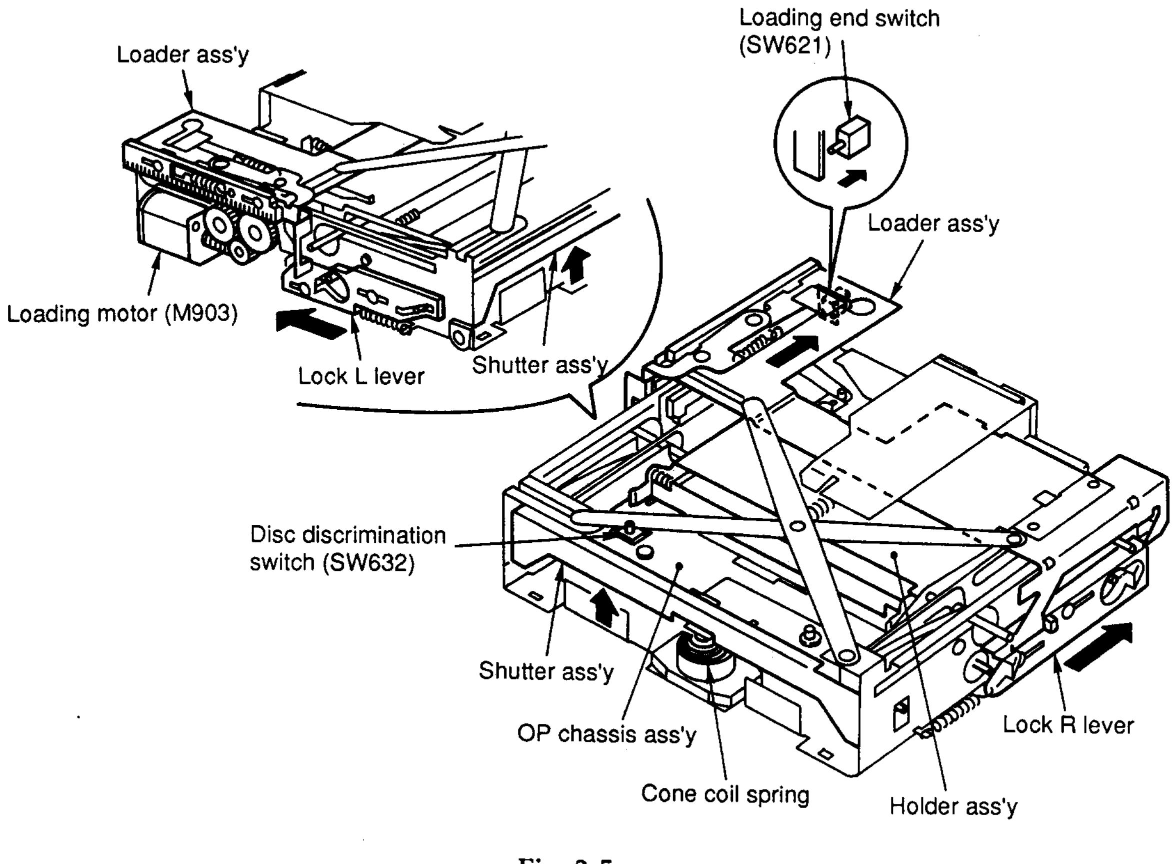

Loading end switch
(SW621)
Loader ass'y
Loading motor (M903)
Lock L lever
Shutter ass'y
Loader ass'y
Disc discrimination
switch (SW632)
Shutter ass'y
OP chassis ass'y
Cone coil spring
Holder ass'y
Lock R lever

Fig. 3-5

3-3. Disc OUT (EJECT)

Eject button is pressed.

↓

Loading motor (M903) starts running.

↓

Rotation is decelerated by worm-wheel, gears A and B to slide the rack.

↓

Loader ass'y starts sliding.

↓

- Lock R lever and lock L lever start sliding.
  - Holder ass'y and OP chassis ass'y are locked.
  - Shutter ass'y moves down.
- Holder ass'y moves up along the groove of chassis ass'y and then starts sliding.
  → Lever (EK) is pressed to operate the link plate and stopper (EJ).
  → EJ lever starts sliding to eject the disc.
  → Lever (LL) moves down.
- Loading start / eject end switch (SW622) turns ON to stop the loading motor (M903).

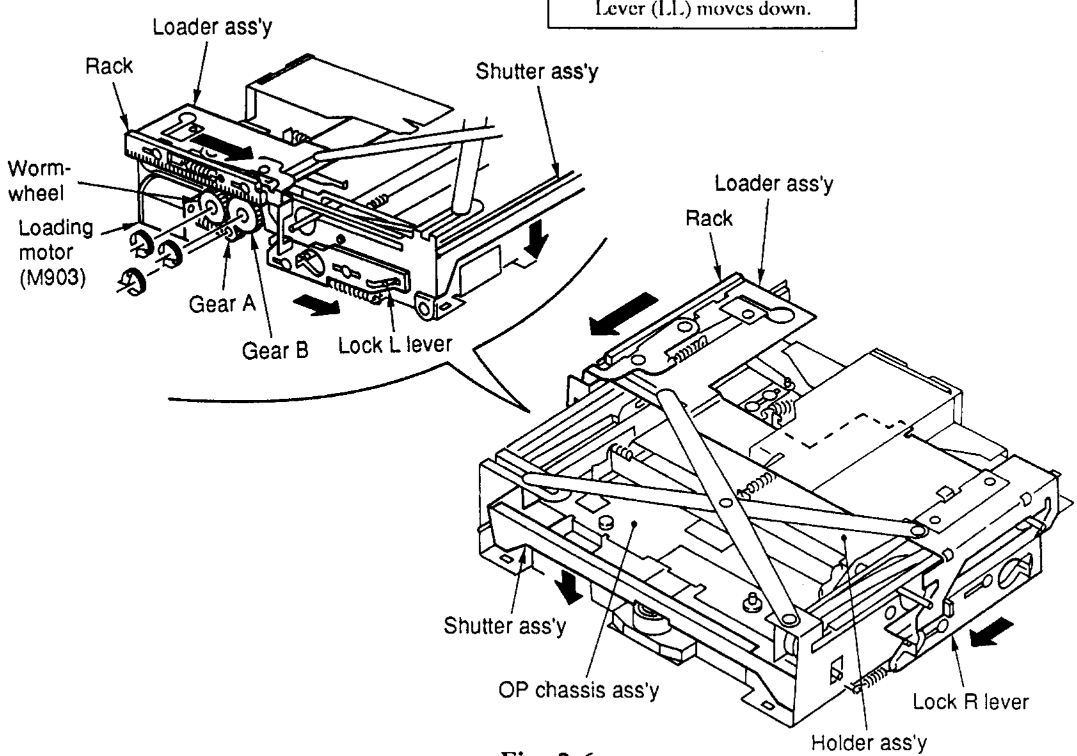


Fig. 3-6

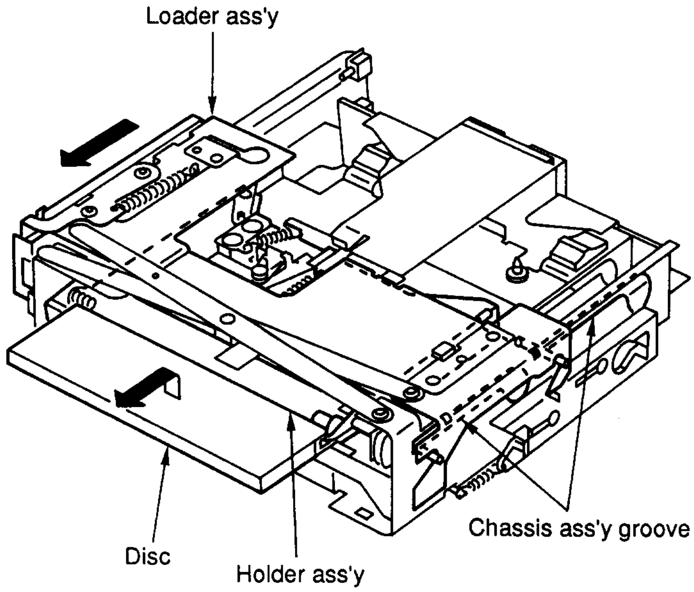

Loader ass'y
Chassis ass'y groove
Disc
Holder ass'y

Fig. 3-7

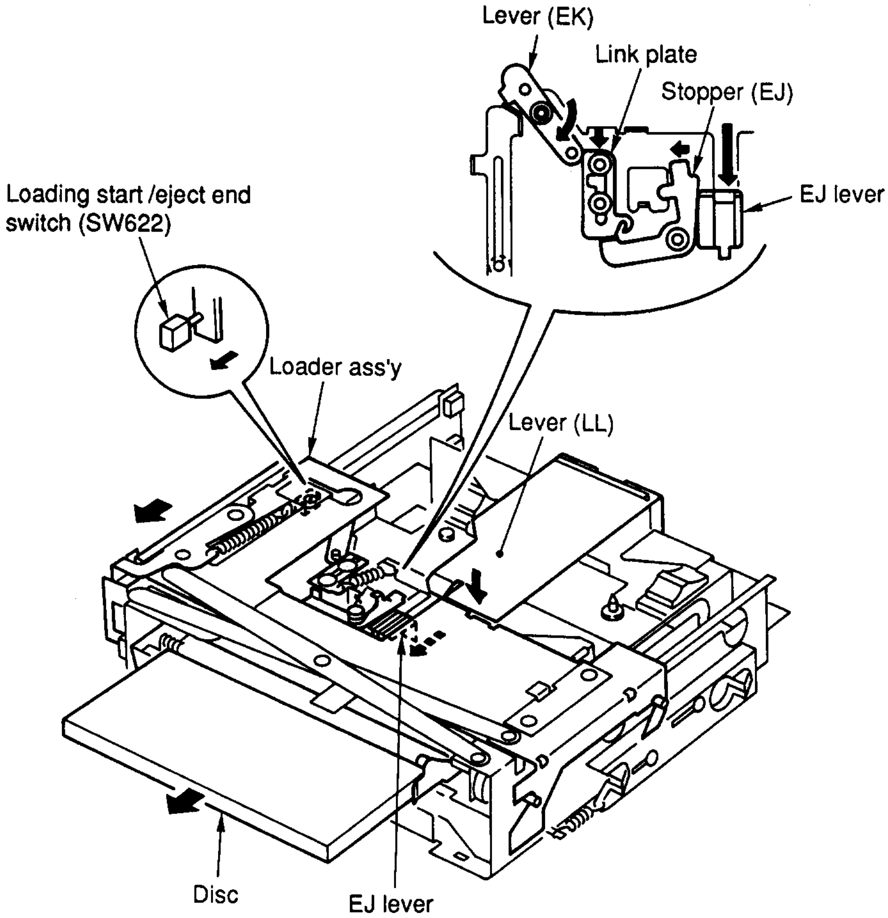

Lever (EK)
Link plate
Stopper (EJ)
EJ lever
Loading start /eject end
switch (SW622)
Loader ass'y
Lever (LL)
Disc
EJ lever

Fig. 3-8