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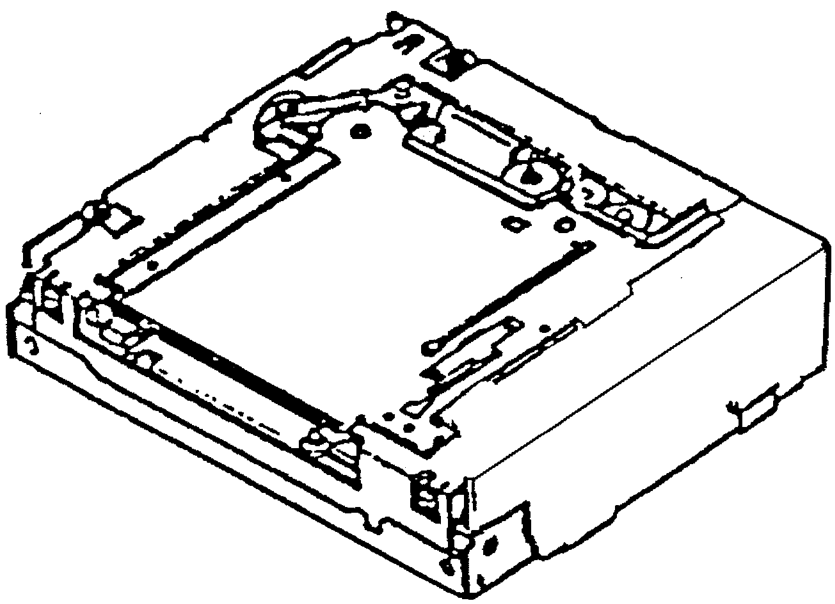
Technical Guide

AUTOMOTIVE CONSUMER ELECTRONICS

Vol. 44

MD Deck Technology



⚠ WARNING

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Panasonic®

Contents

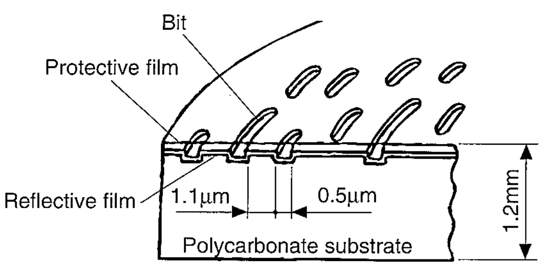
1. Outline Description of the MD (Mini Disc)

1.1 Features of the MD

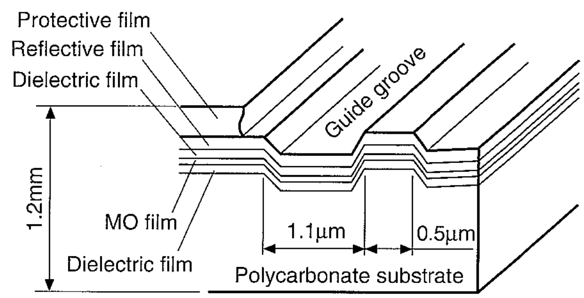
1) Use of an optical disc with a diameter of 64mm, accommodated in a cartridge.
2) Applicable to two types of optical discs.
3) Random access enabled, like ordinary CDs.
4) 74 minutes of high quality sound replay possible by the use of speech compression technology.
5) Use of semiconductor type antiseismic technology.

1.2 Disc construction

The MD comes in three types of discs, the recordable MD using the MO intended for recording, the replay-only MD to be used as musical software, and the hybrid MD that is a combination of the above-mentioned two types, each with a diameter of 64mm. The MD substrate is made of a polycarbonate material with a thickness of 1.2mm (information area).

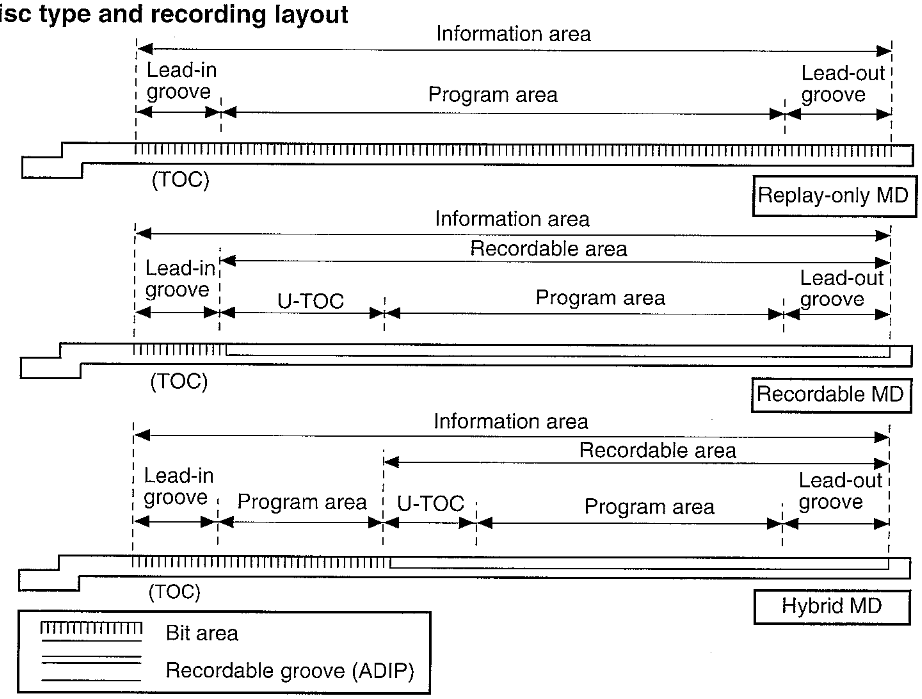


Cross sectional model of replay-only MD

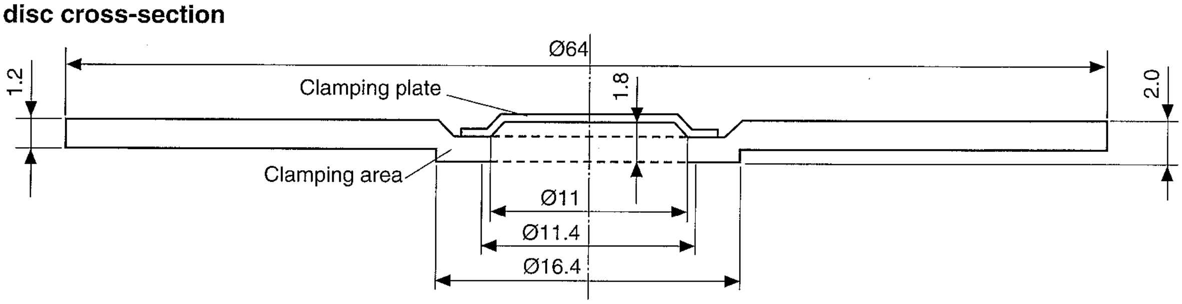


Cross-sectional model of recording/replay MD

MD disc type and recording layout



MD disc cross-section



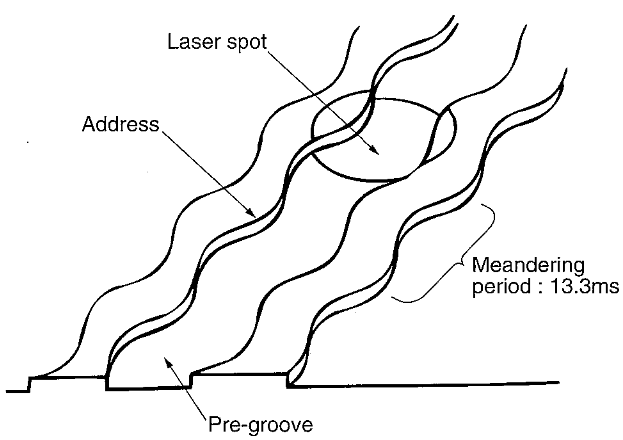
1.3 Pre-groove of the recording MD

The recordable MD is provided with a groove referred to as the pre-groove (ADIP: Address Groove in Pre-groove). This groove is provided with a record of an absolute address (or address in short).

Track pitch (distance between grooves)	: 1.6 μ
Groove width	: 1.1 μ
Track pitch	: 1.2 - 1.4m/s

This pre-groove appears in a shape of a curve.
The reason why such a curvature is needed is that tracking control is enabled by the use of this groove. The tracking error signal carries a signal of 22.05kHz (half the CD sampling frequency). By bending the groove with the above-mentioned sine-wave signal, it is possible to assure the compliance with tracking. By making modulation of this bending with a signal of 1kHz, address information for the absolute address can be recorded.
These data are called one sector that corresponds to 13.3ms. They are distributed throughout the disc surface.
Therefore, even a blank MD without recording can indicate the position of the pickup according to the address defined. During recording, information about the pickup position is written in the UTOC (User's Table of Contents) area of the disc.

Address recording based on the meandering pre-groove



1.4 Replay (reproduction of recording) and principle

1.4.1 MD recording density

The recording density of the MD is the same as that of the CD. The CD pit is 0.5 μ in width and 0.9 to 3.2 μ in length. The track width is about 1.1 μ.

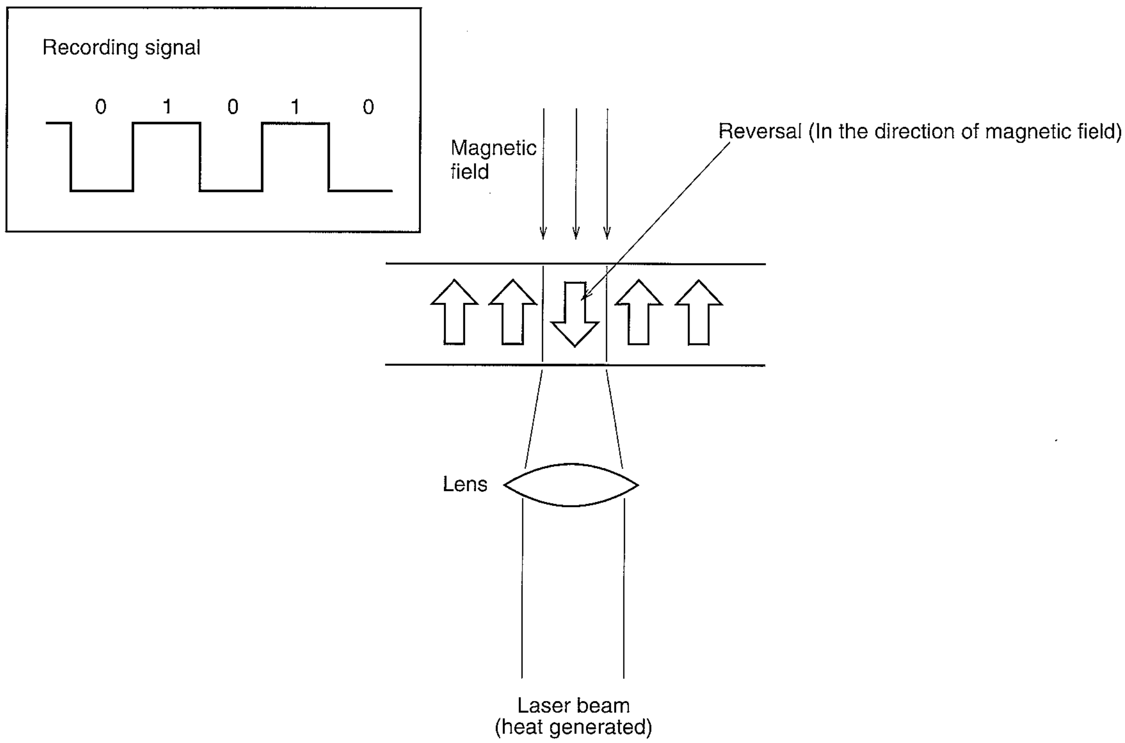
1.4.2 Reproduction of music replay MD

Like the CD, pits are arranged on the disc. They correspond to "1" and "0" of the digital signal. When a laser beam is radiated from the optical pickup to the pits, the reflected beam is returned to the beam receiving element if there is no pit provided there. If there are pits provided, the beam is diffracted and the total energy of beam is not recovered.

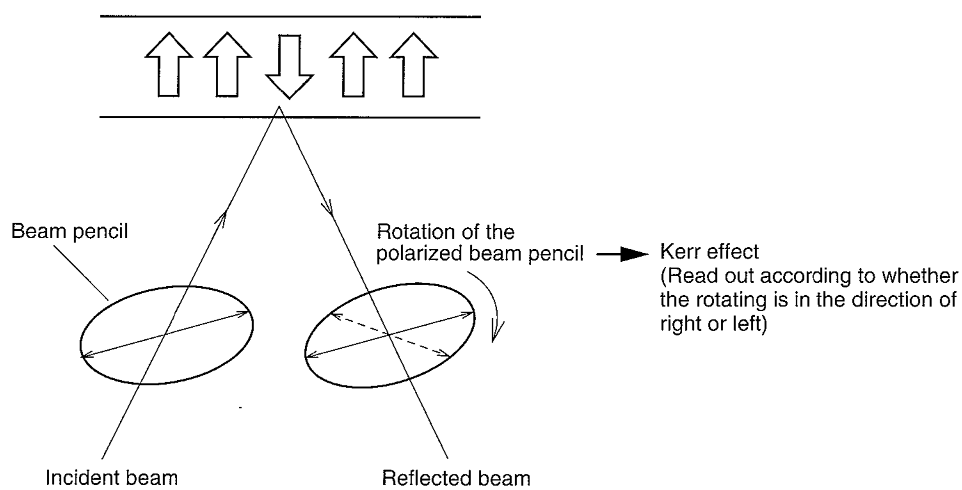
1.4.3 Reproduction of recordable MD

In the photomagnetic recording (MD), the digital signals of "1" and "0" recorded on the disc are recorded by the use of the polarities N and S of magnetization. When a laser beam is applied to these magnetized signals, the polarized beam pencil of reflected beam is turned in the direction of right or left (reverse direction) in response to the polarity N or S. When this reflected beam passes through the polarized beam splitter, the outputs A and B from beam receiving elements (photodiode 1 and 2) are switched by the signal N or S. The A-B values are calculated.

Principle of Recording and Replay

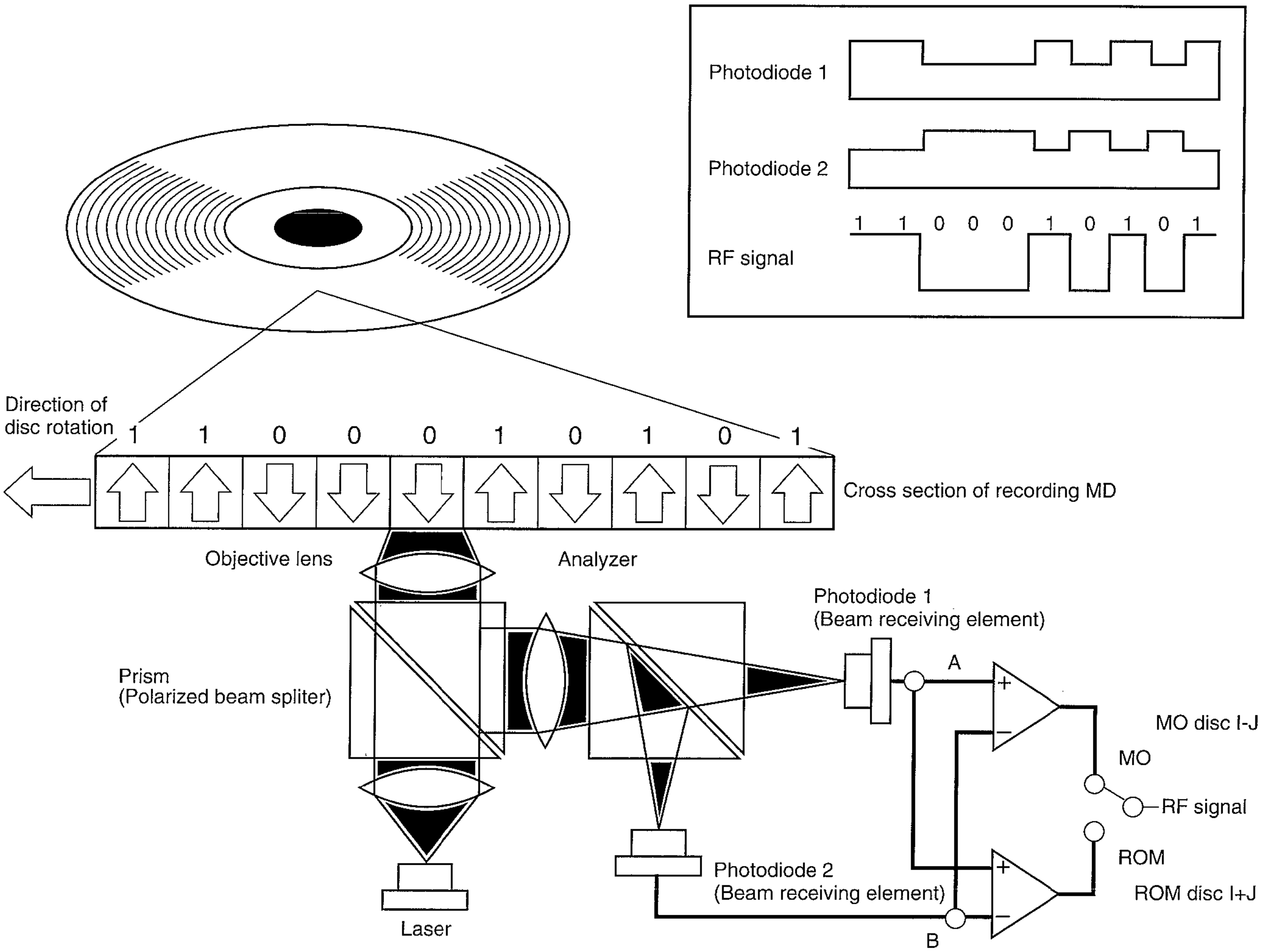


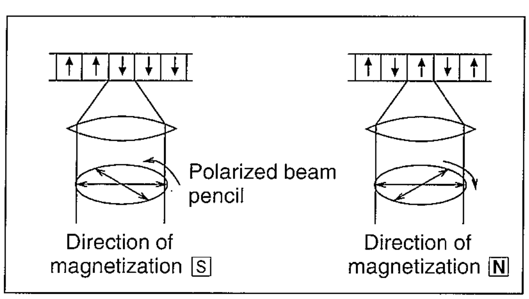
(a) Recording



(b) Reproduction

MO Disc Signal Read-Out



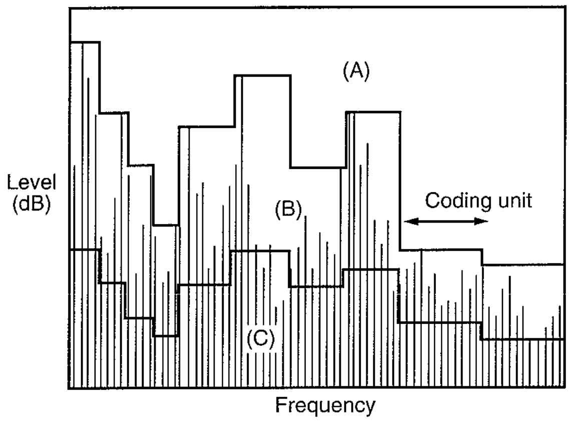


Identified according to whether deflected to the right or left.

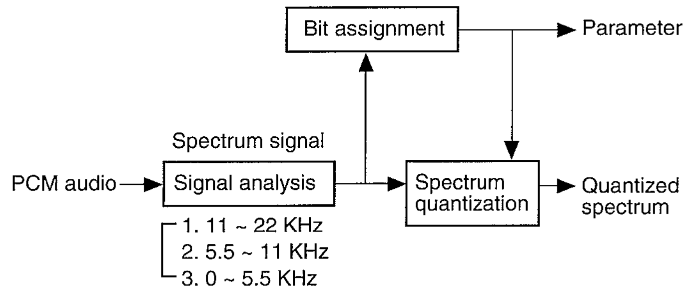
1.5 Outline description of ATRAC

The ATRAC (Adaptive Transform Acoustic Coding) is used to reduce the amount of data to 1/5 of that of the CD.

1) The digital data received from the A/D converter is chopped into fine portions at the predetermined time period.
2) Signal analysis is then carried out to distribute these data portions into three frequency bands by means of band split filters. (Data deletion is effected during band splitting by the use of filters.)
3) Bit assignment and spectrum quantization are carried out.



Spectrum signal normalization and quantization



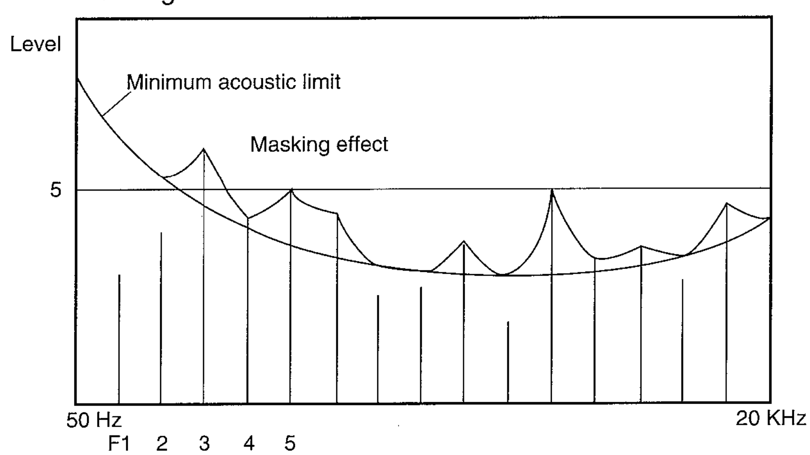
Encoder block diagram

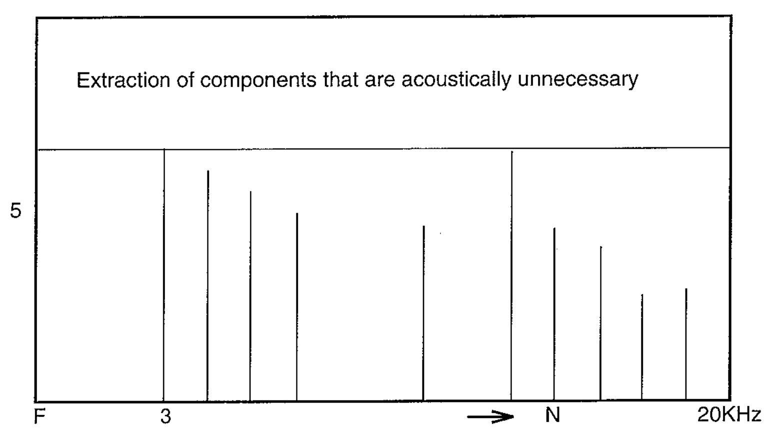
Extraction of effective components

The following signals are deleted because they are unnecessary for acoustic feeling:

1) The F1 sound is maintained at a level higher than the level for human ears.
2) The F2 and F4 sounds cannot be heard because they are hidden behind the F3 sound.

Masking effect





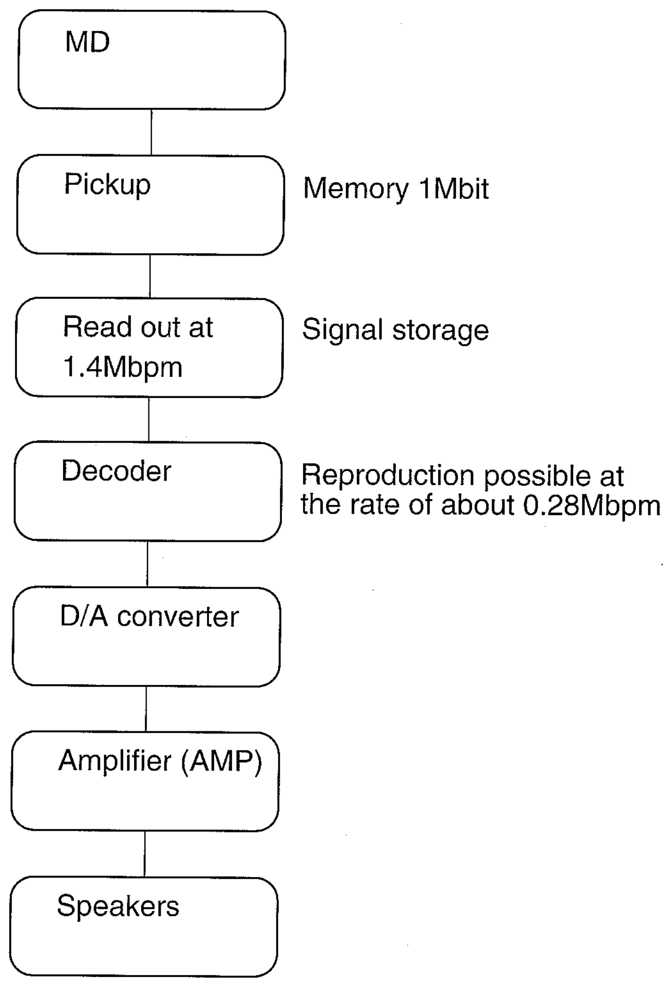
1.6 Unique MD access

In the CD-ROM, 98 frames are regarded as one sector. If they are converted into the replay time, they correspond to 13.3ms. This duration is identical with the spacing of an address that is put in the pre-groove of the MD. Digital audio data from the disc is stored in the memory. While the stored signal is reproduced, there is no chance of sound interruption if the pickup is returned.

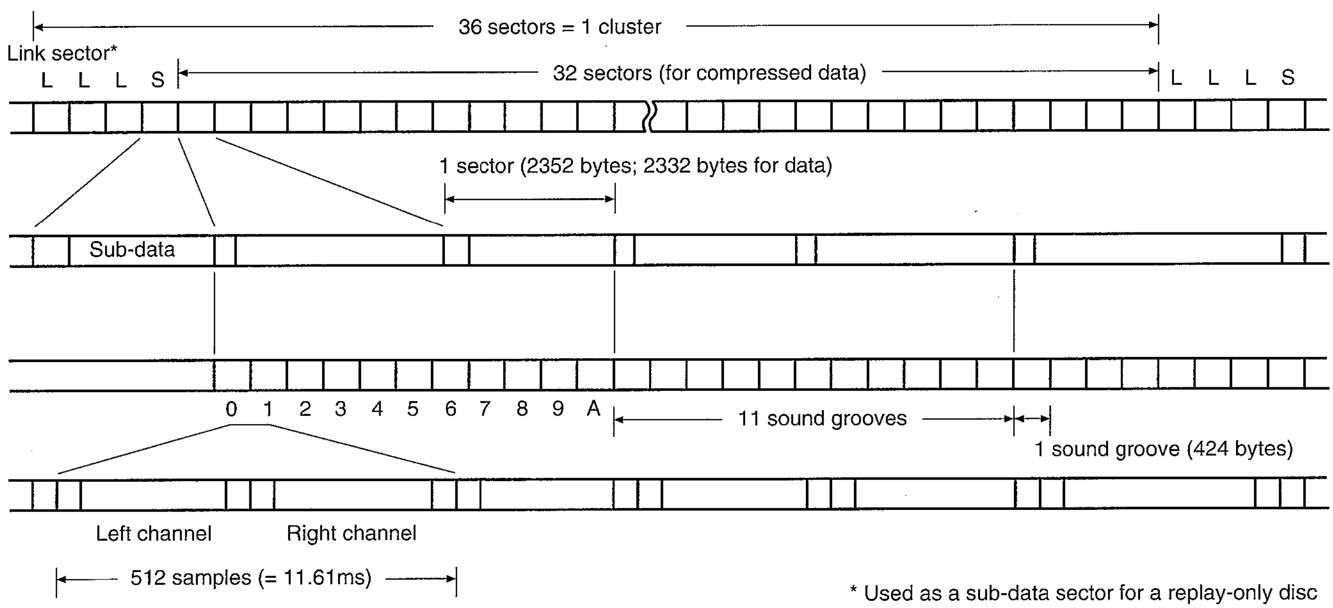
The MD is capable of reading out the digital signal of the disc at the rate of 1.4Mbpm (2Ch x 16 bits x 44.1kHz).

Since this signal is compressed by ATRAC, reproduction is possible by decoding it into a musical signal, provided that there are data of 1/5 available at the rate of approximately 280kbpm.

The recording signal in the sector unit (block) of 1.4Mbpm



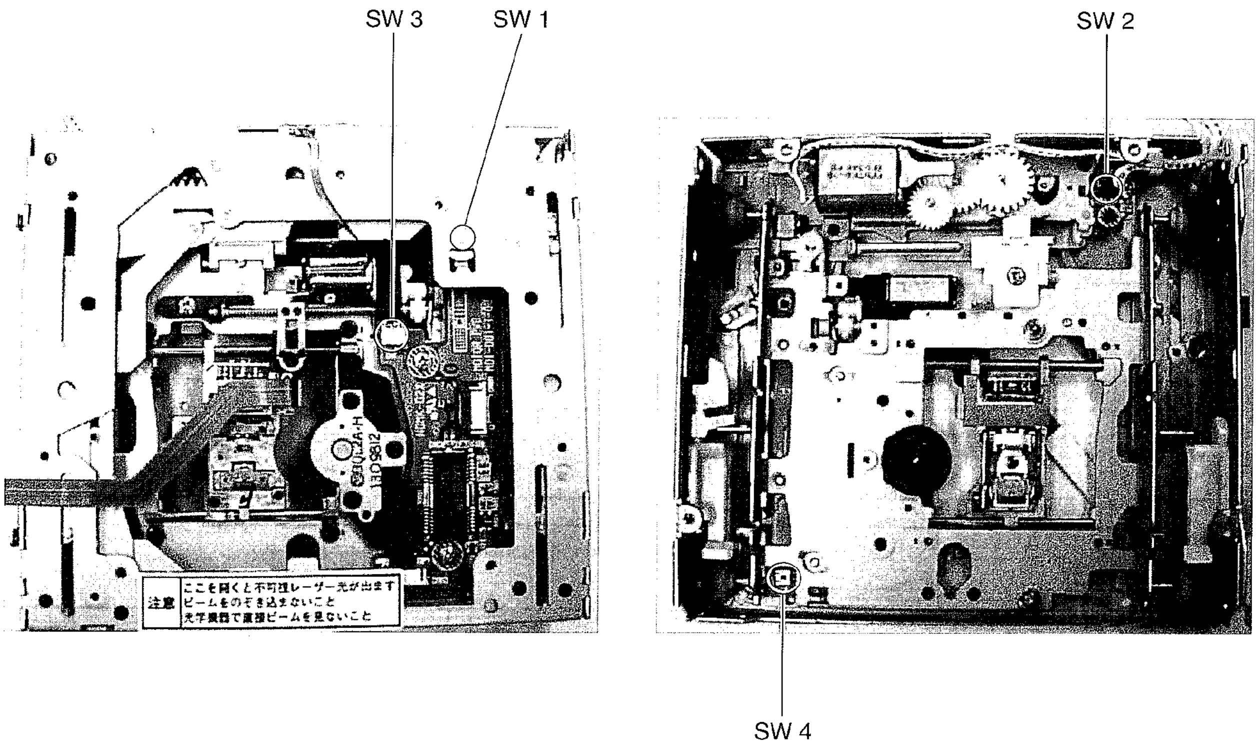
MD Data Construction



* Used as a sub-data sector for a replay-only disc

2. Operational Description of the MD Mechanism

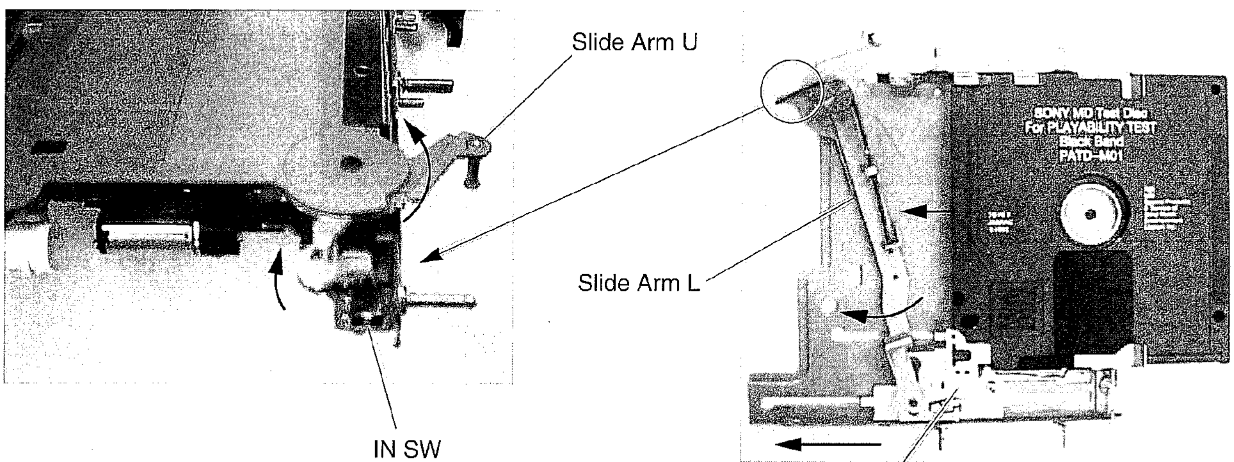
2.1 Sensor switches and their locations

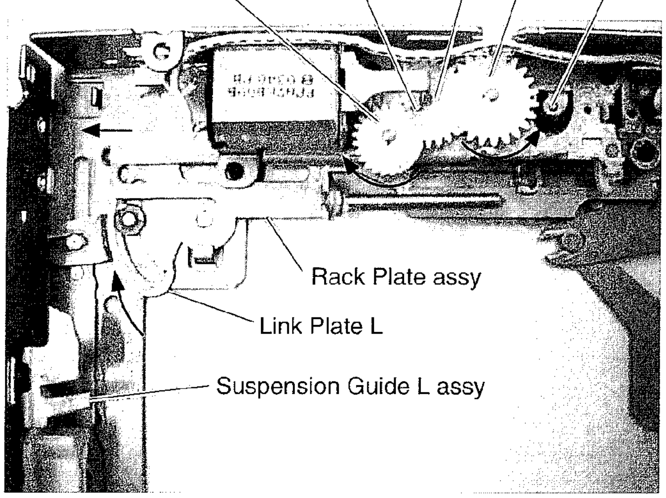


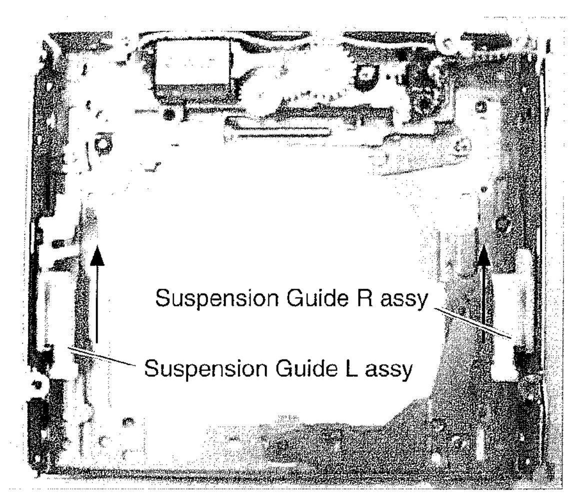
Symbol	Functional name	Functional description	Remarks
SW 1	IN SWITCH	Detection of cartridge inserted	Mechanical
SW 2	CLAMP SWITCH	Detection of cartridge clamped	Mechanical
SW 3	INNER SWITCH	Detection of optical pickup located in internal periphery	Mechanical
SW 4	MEDIA SWITCH	Detection of cartridge type MO: H, ROM: L	Mechanical

2.2 Loading operation

1) An MD cartridge is inserted.
2) The cartridge slider assy is pressed, and the slide arm L and the switch actuator are rotated to push the IN SW.
3) When the IN SW is pushed, the loading motor begins to run.
4) The driving force is transmitted from the motor worm gear to the Gear B, Gear C, Gear D, and Gear E.
5) The rack plate assy, which is engages with Gear E, slides to the left due to the rotation of Gear E.
6) When the rack plate assy slides, the link plate L is turned counterclockwise.
7) When the link plate L is turned, the suspension guide L assy is moved forward.
   At that time, as a result of the counterclockwise rotation of the link plate R, the suspension guide plate R assy is also moved forward.
8) The forward rotation of the suspension guide L assy causes the slide arm U to turn counterclockwise. By the clockwise swinging of the slide arm L, the rear part of the cartridge slider moves to finish loading of the MD cartridge.



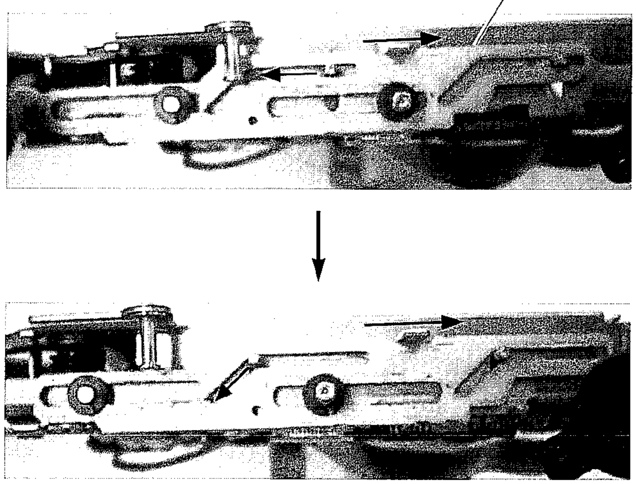




2.3 Clamping operation

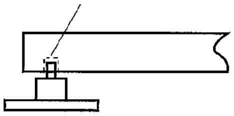
1) When the cartridge is inserted in the specified position, clamping operation ensues
2) As a result of the forward movement of the suspension guide L assy and the suspension guide R assy, the slide cam plates R/L attached to the suspension chassis assy is moved forward.
   * The slide cam plates R/L move with the shrinkage of the spring.
3) When the slide cam plates R/L are moved forward, the cartridge holder comes down to clamp the MD cartridge.
   * The right and left pins of the cartridge holder move along the grooves of the cam, thus lifting or lowering the cartridge holder.
   When the cartridge settles down, the media SW identifies whether it is ROM or MO.
   ROM: L Level (SW OFF)
   MO: H Level (SW ON)
4) The rack plate assy moves to the left and the switch actuator is pushed. The switch actuator is turned clockwise. It is turned ON when the clamp switch is pressed. The loading motor stops to complete clamping operation.

Slide Cam Plate R/L



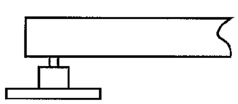
<ROM>

Hole

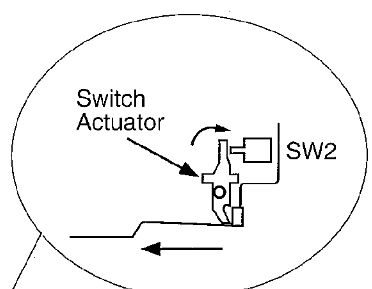


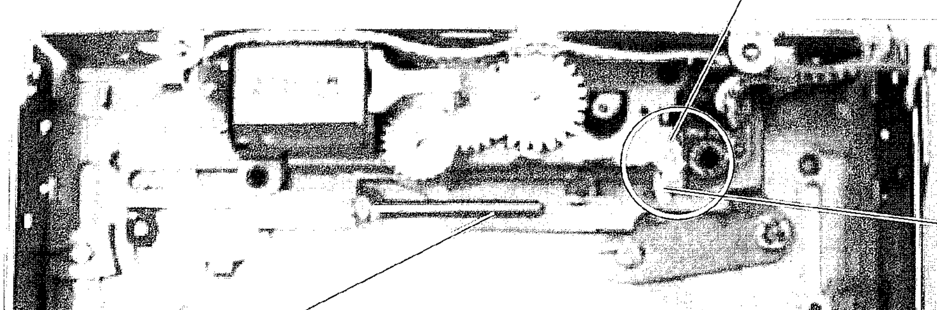
Media SW : OFF

<MO>



Media SW : ON





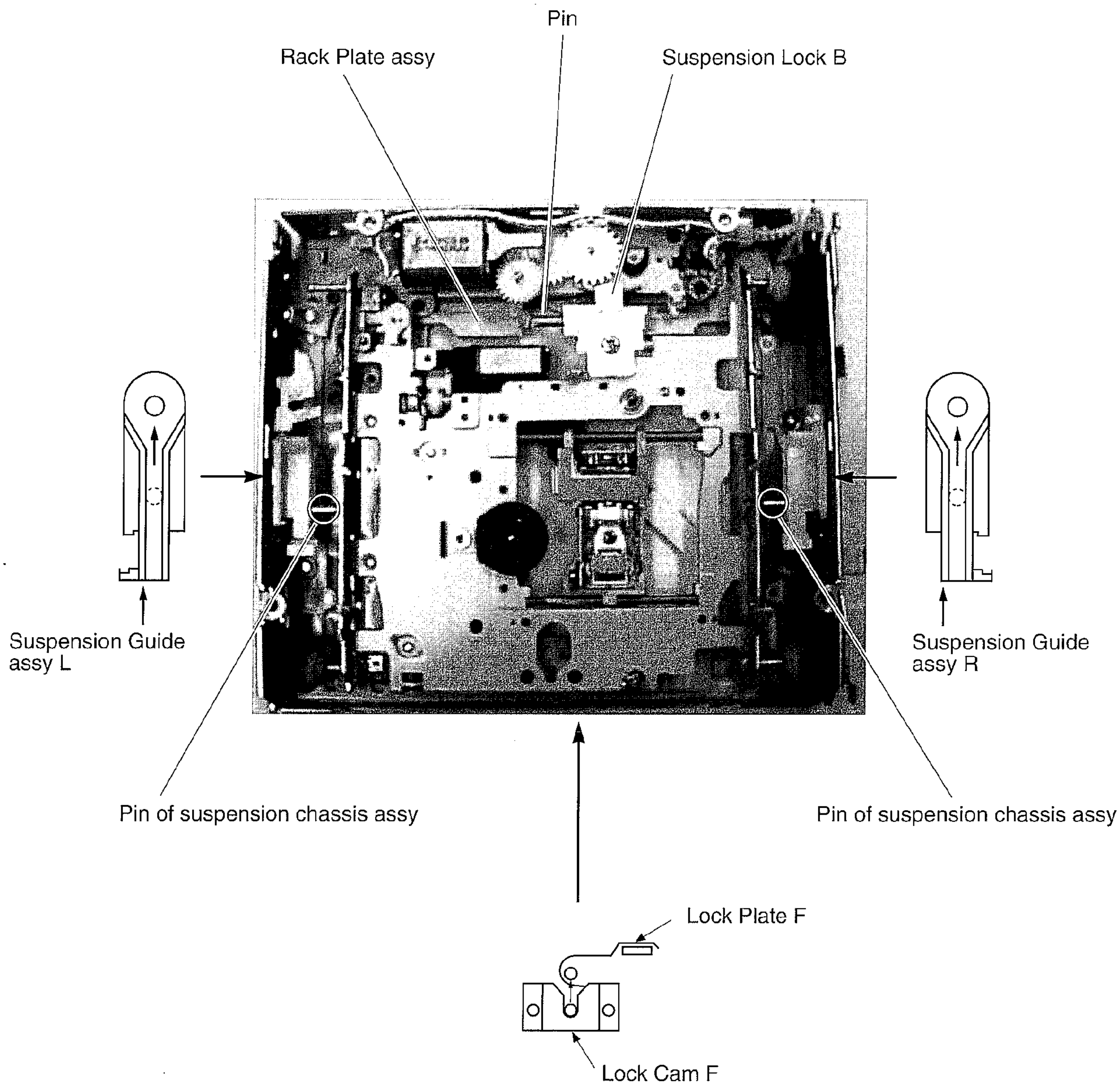
Switch Actuator

Rack Plate assy

2.4 Floating operation

Like the CD, measures are also taken to prevent vibration in the MD mechanism. The mechanical construction is arranged so that the suspension assy is floated by the spring and the rubber damper. This function is utilized in the processes of cartridge insertion and loading.

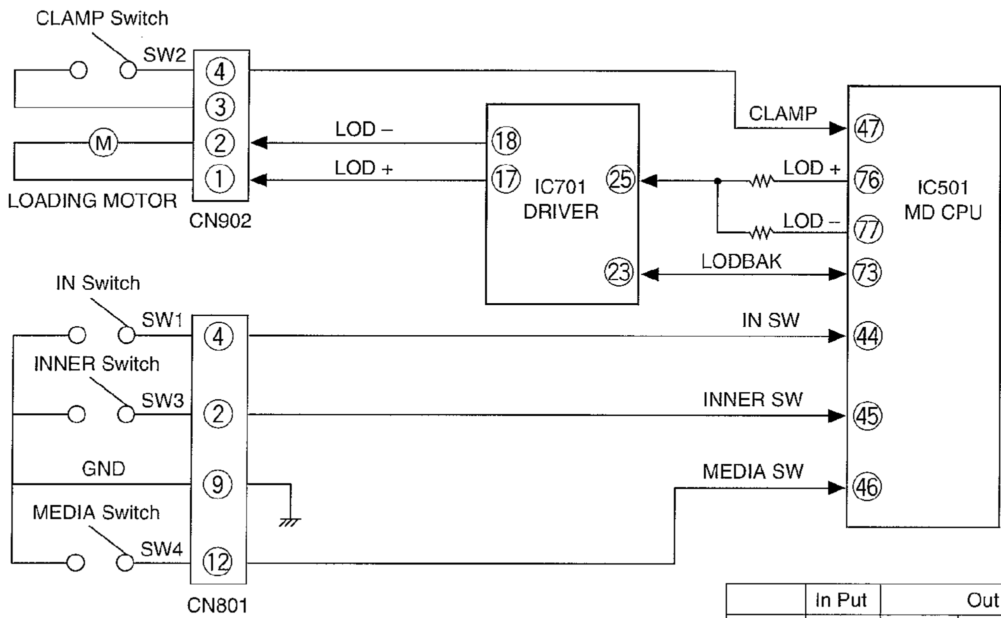
1) The loading motor runs, the rack plate assy slides, and the link plates R/L move forward.
2) The suspension guide assys R/L move forward. This action releases the guide pins, which are provided to the right and left of the suspension chassis assy.
3) At the same time, the guide pins attached to the rack plate assy are released from the suspension lock B.
4) Since the lock plate F moves backward, the lock cam F is released and the suspension chassis assy is in floating condition.



2.5 Eject operation

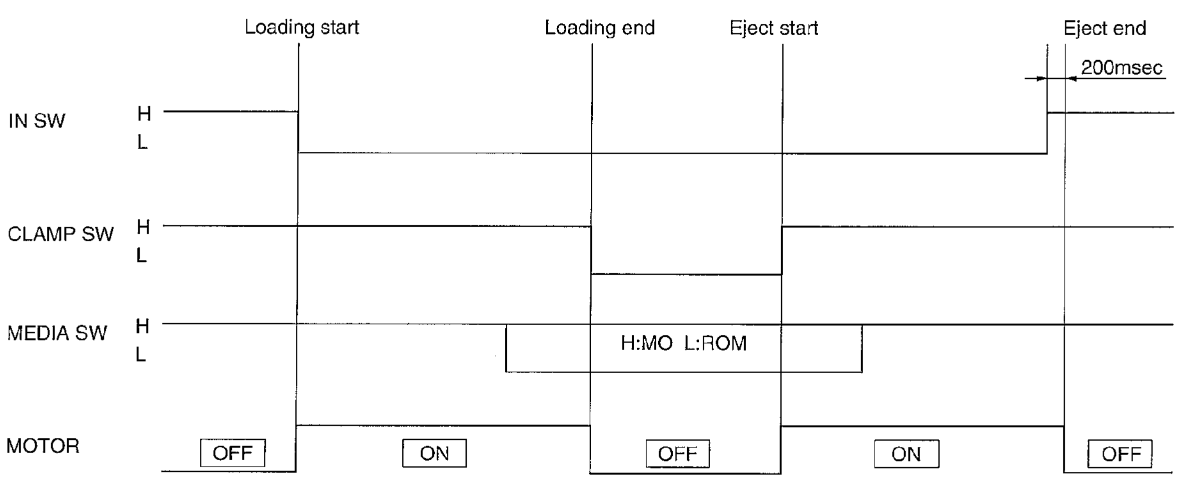
1) When the CPU receives an eject signal (EJECT SW ON), the spindle motor stops.
2) The loading motor runs reversely, and the suspension guide assys R/L move forward.
3) The slide cam plates R/L move backward and the cartridge holder assy rises.
4) The slide arm U turns clockwise. By the counterclockwise swinging motion of the slide arm L, the cartridge moves forward and the cartridge is ejected.
5) The IN SW is turned OFF to stop the loading motor, and eject operation is completed.

2.6 Loading/Ejection Circuit Block Diagram



	In Put	Out Put		
Pin 23	Pin 25	Pin 17	Pin 18	Operation
L	H	H	L	Forward (Loading)
L	L	L	H	Reverse (Eject)
H	–	L	L	Brake
L	2.5V	–	–	Stop

2.7 MD Player Mecha-Timing Chart



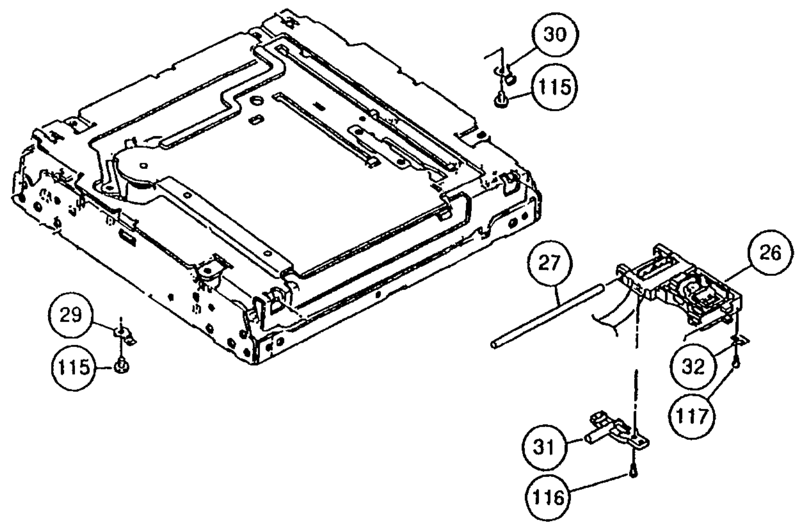
3. Disassembly Procedures

3.1 Disassembly - 1

The following parts can be replaced from the bottom side of the deck unit:

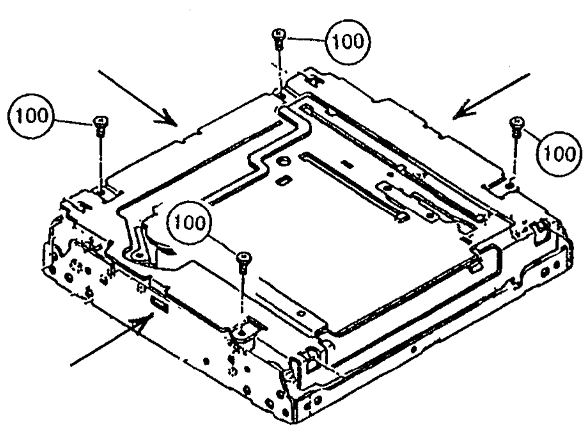
1. Replacement of the optical pickup
   1) When the optical pickup is located on the internal periphery, the feed screw gear section is turned counter-clockwise with a finger so that the optical pickup is moved to the center.
   2) Remove the two screws ⑮ and shaft holder R/L ㉙, ㉚.
   3) Take out the optical pickup by lifting it.
      Remove the guide shaft ㉗.
   4) Remove the one screw ⑯ and take out the feed screw housing assy ㉛.
   5) Remove the one screw ⑰ and take out the guide shaft spring ㉜.

   Note: Be careful not to touch the optical pickup lens.

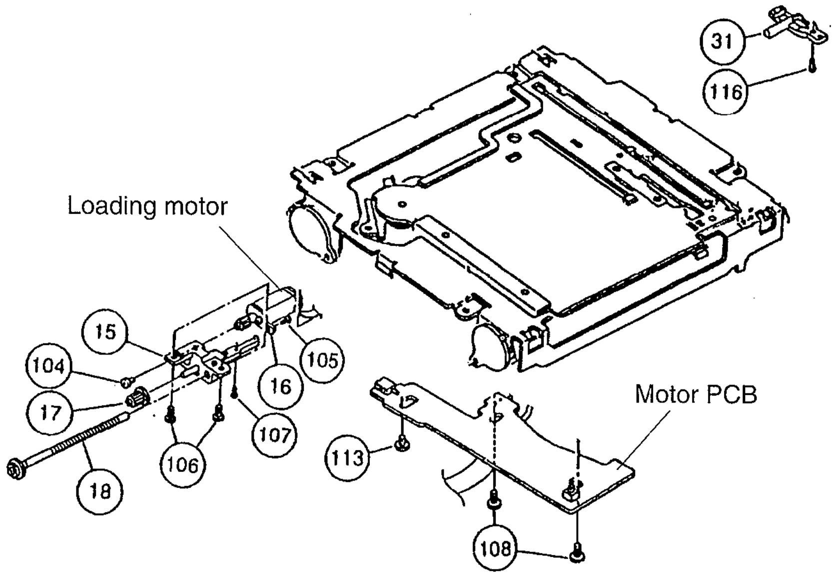


3.2 Disassembly - 2

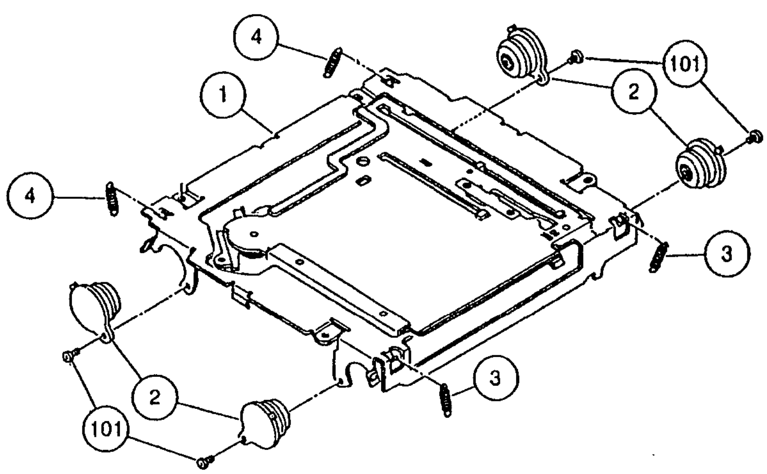
1. Removal of the upper chassis
   1) Apply +4V to the loading motor and unlock the suspension chassis.
      ⁎ Polarity of voltage applied to the loading motor connector:
      - Red stripe wire ------------ –Line
      - White wire ------------ +Line
   2) Remove the four screws ⑩ of the upper chassis.
   3) Using a flatblade screwdriver, remove the upper chassis by prying up the hook parts of the deck unit, in one each position on the right and left, and in one position in the rear.



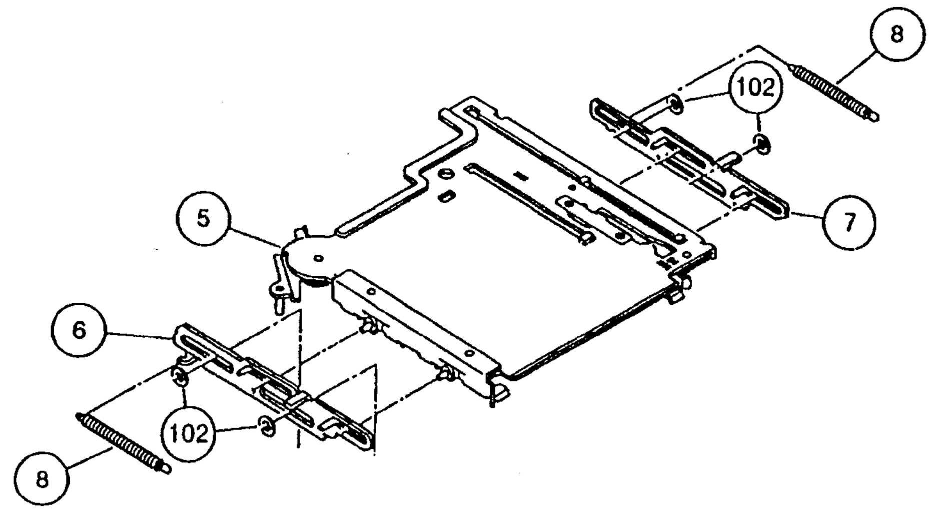
2. Replacement of the traverse motor
   1) Remove the three screws ⑩⑧, ⑪③ and take out the Motor PCB.
   2) Remove the screw ⑪⑥ and take out the feed screw housing assy ㉛.
   3) Remove the three screws ⑩⑥, ⑩⑦ and take out the loading motor ⑯ and the motor bracket A ⑮.
   4) Remove the motor gear B ⑰ and feed screw assy ⑱.
   5) Remove two screws ⑩④,⑩⑤ and take out the loading motor from the motor bracket.
   6) Desolder two positions of the traverse motor terminals.



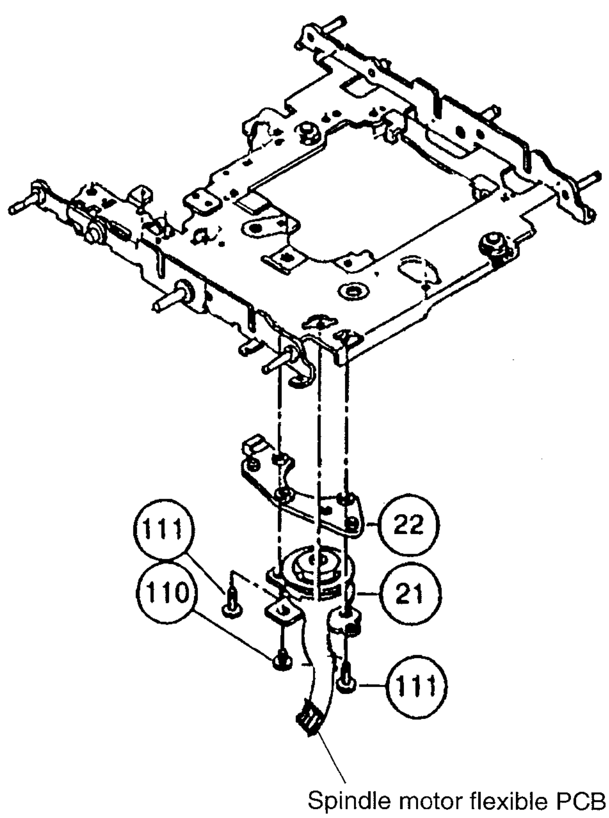
3. Removal of the suspension chassis from the upper chassis
   1) Remove the two float springs A (front) ③ and the two float springs B (rear) ④.
      Notes:
      1 When removing the spring, make sure not to expand it too much.
      2 Be careful the float springs A and B can be confused easily.
         • Longer item ------------ Float spring A
         • Shorter item ------------ Float spring B
   2) Remove the four damper mounting screws ⑩①.
   3) Remove the suspension chassis.
      Caution: When drawing out the pins of the suspension chassis from the damper, be careful not to damage the damper.



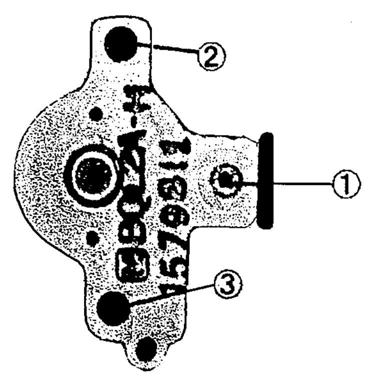
4. Removal of the cartridge holder assy
   1) Remove two slider cam springs ⑧.
   2) Remove four retaining rings (102), and then the slider cam plate L/R ⑥,⑦.
   3) Take out the cartridge holder assy ⑤.
   Caution: Never reuse retaining rings which are open. Be sure to replace with the new ones.



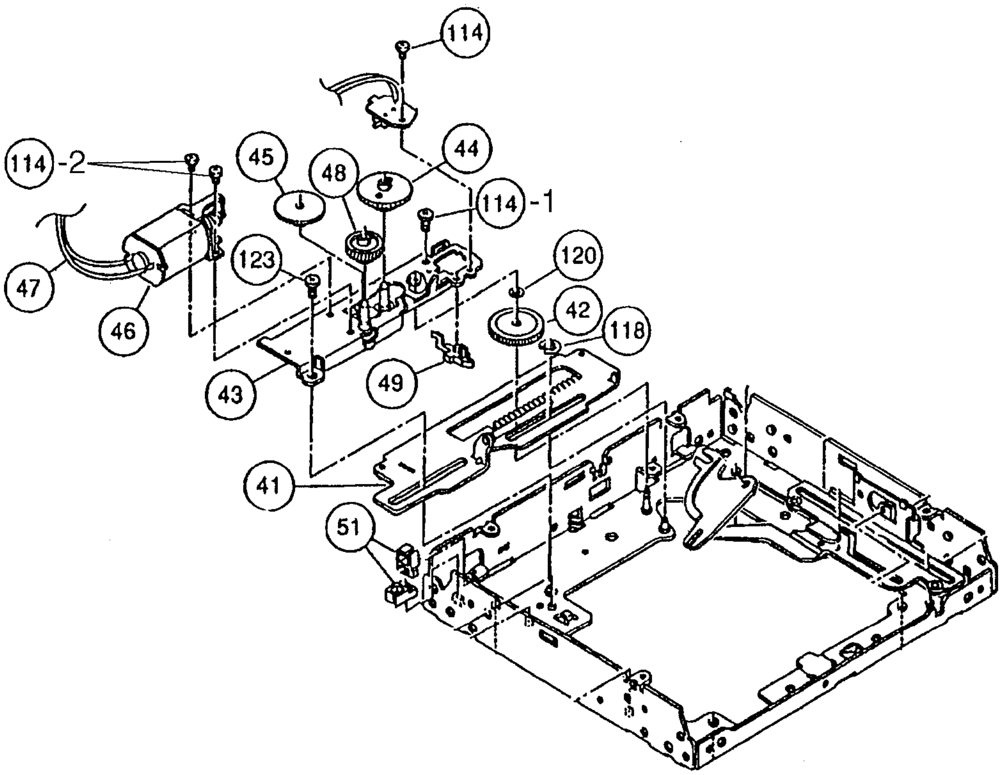
5. Replacement of the spindle motor
   This step follows the cartridge holder assy removal shown in the above.
   1) Disconnect CN802 and remove the spindle motor flexible PCB.
   2) Remove the three screws (110),(111) of the spindle motor.
   3) Remove the spindle motor ㉑.



Caution: The tightening sequence for the spindle motor mounting screws.



6. Replacement of the main chassis assy to the gear mounting bracket assy (loading motor)
   1) Remove the two screws ⑪4-1, ⑫3 and take out the gear mounting bracket assy ㊸.
   2) Remove Gear B ㊽.
   3) Remove the two motor bracket screws ⑪4-2 to take out the loading motor ㊻.
   4) Desolder the motor wires ㊼ and disconnect them.



4. Outline Description of Operation in Each Circuit Block

The circuit board for the deck section comes in a single-board configuration consisting of the MD main board (E-8605A).

1) CPU (IC501 MN101C01DAF)

- This CPU controls communication with microcomputers on the player side, and also overall MD circuitry.
- A disc is loaded and ejected by supervising the signal from the sensor and switch timing.
- The period of FG signal from the spindle motor circuit is measured in the CLV servo in order to determine the line speed of the disc.

2) RF matrix AMP (IC101 AN8771NFH)

- Interrelated with signal processing and servo processing (IC401), adjustments for the gain, offset, focus balancing, and tracking balancing are carried out at the analog signal level (automatic regulation).
- Since an effective equalizer function is available, the resolution power for the RF 3T waveforms has been improved.
- A buffer output is obtained from the VREF generator circuit through resistance division.
- The servo status signals (TRCRS, OFTR, BDO) are generated.

3) Signal processing and servo processing (IC401 MN66614R4C1)

- The various functions are available for focus, tracking, traverse, and spindle servo processing and digital signal processing (EFM modulation/demodulation, error correction, parity coding, MD decode/encode).
- It is possible to use the signal compression/expansion function, shock-proof memory control function (SPMC), and DRAM I/F function.
- Various adjustments are carried out for the RF AMP and analog signal level amplitudes, offset, focus balancing, and tracking balancing.
- Pickup traverse control is effected.
- To improve the vibration-proof performance against track jump, timing control is conducted in the jumping state in order to suppress driver saturation.

4) DRAM (IC451 YEAHHM1740L6)

- About 40-second data is tentatively stored for the digital decoding signal during signal processing and servo processing (IC401).

5) DAC (IC201 YEAMBBDA1717)

- Digital audio signals from the signal and servo processing circuits (IC401) are converted into analog audio signals.

6) MD PICKUP DRIVE (IC701 YEAMBA6891FP)

- The focus and tracking actuators are driven. The loading and traverse motors are driven.

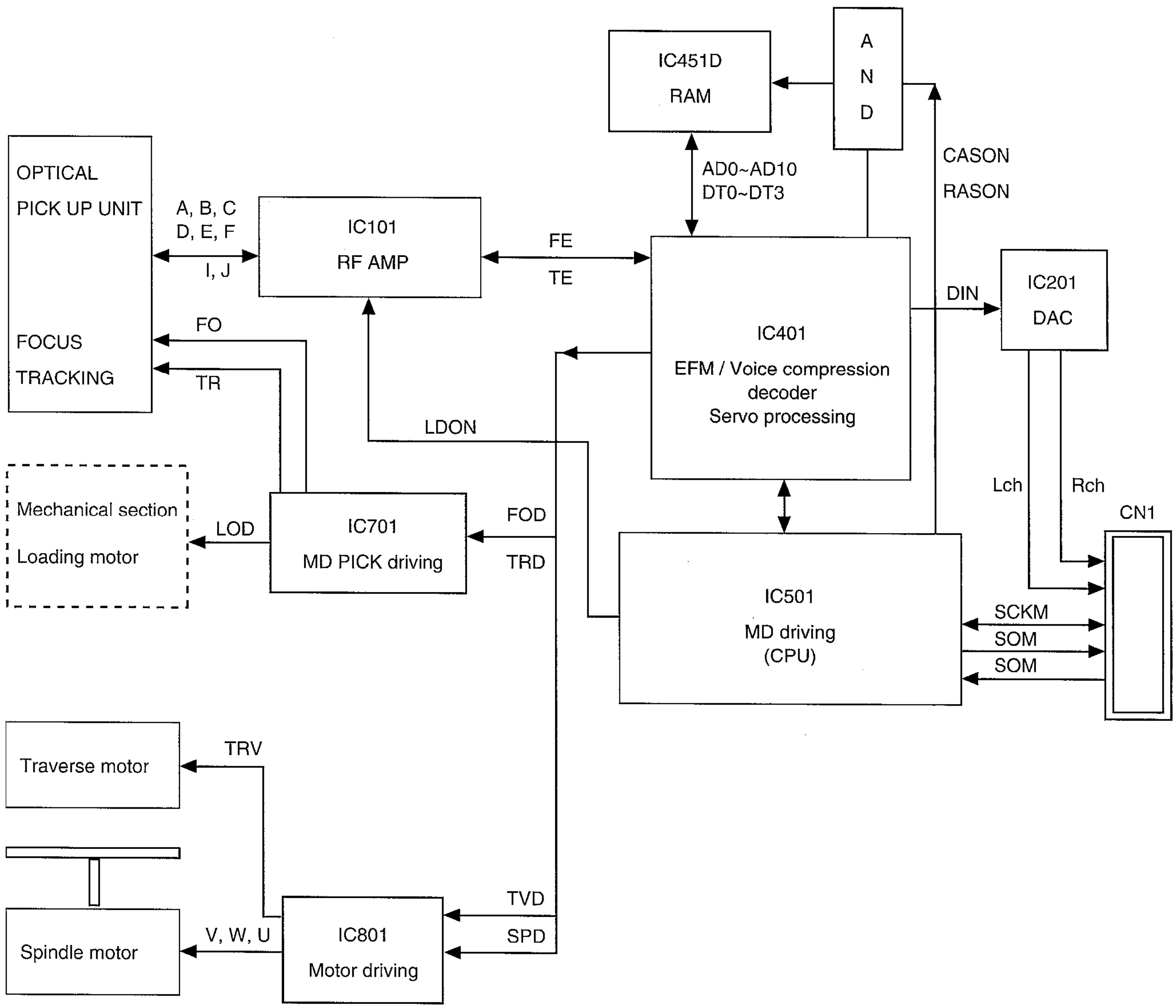
7) Motor drive (IC801 YEAMBA6858FP)

- The spindle motor is driven.

8) 3.3V power supply (IC551 YEAMMC3326903)

- A DC voltage of 3.3V is supplied.

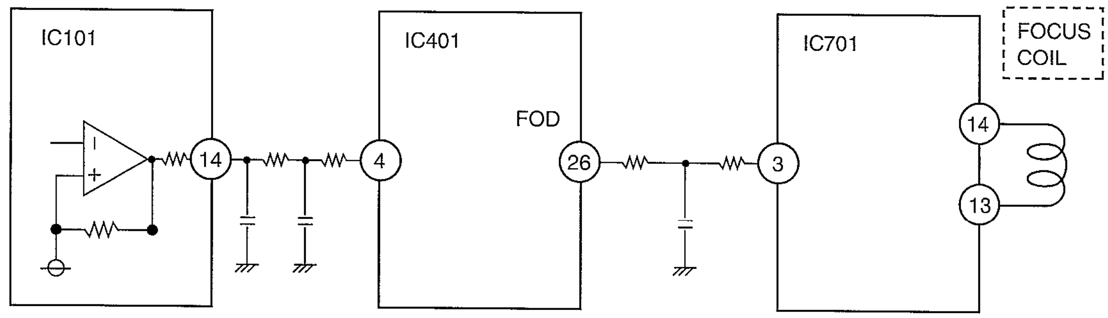
5. MD Player Block Diagram



6. Operation in Each Circuit

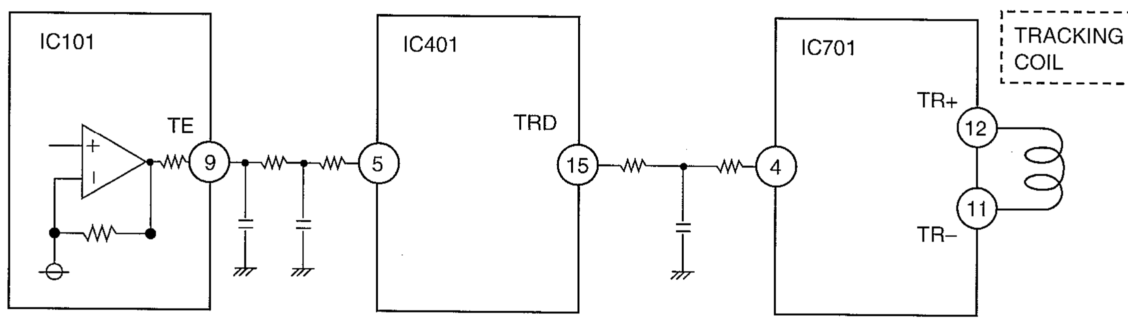
6.1 Focus digital servo

The FE signal obtained from Pin 14 of the RF AMP IC101 (AN8771) is fed to Pin 4 of IC401 (MN66614) where automatic adjustment and D/A conversion are carried out via the loop filter and the variable amplifier of the built-in digital servo processor circuit. The resultant signal is output as an FOD signal from Pin 26. After passing through the focus driver IC701 (YEAMBA6891), this signal output is used to control focus by driving the focus actuator.



6.2 Tracking digital servo

The TE signal obtained from Pin 9 of the RF AMP IC101 (AN8771) is fed to Pin 5 of IC401 (MN66614) where automatic adjustment and D/A conversion are carried out via the loop filter and the variable amplifier of the built-in digital servo processor circuit. The resultant signal is output as a TRD signal from Pin 15. After passing through the tracking driver IC701 (YEAMBA6891), this signal output is used to control tracking by driving the tracking actuator.

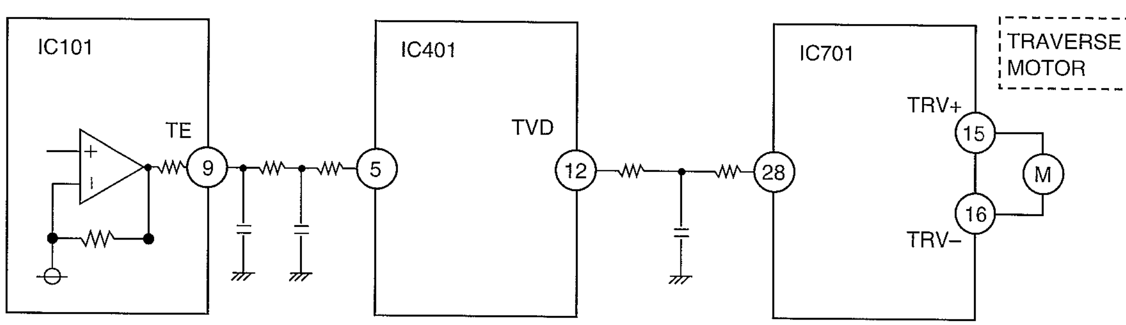


6.3 Traverse driving circuit

Since a DC motor is used for traversing operation in the MD changer, an IC exclusive for motor driving is used and the motor is controlled by IC401.

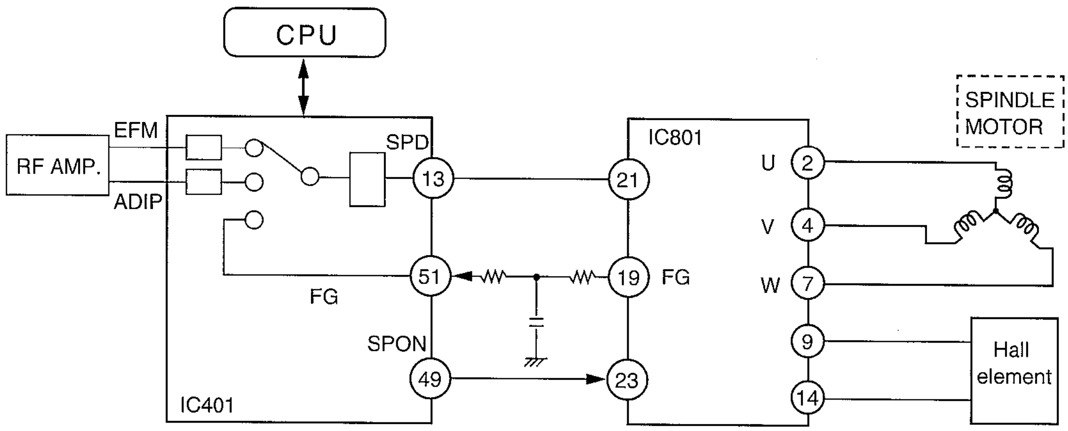
Traverse control is performed for the cogging feed operation to assure follow-up motion of the objective lens during replay and the traverse operation needed for home position search in access mode.

In the PLAY phase, the traverse error signal is obtained from the loop filter of the tracking digital servo incorporated in IC401. This signal is output from Pin 12 as a TVD signal via the traverse loop filter and the D/A converter. The resultant signal output is used to control the driving of the traverse motor via the traverse driving IC701.



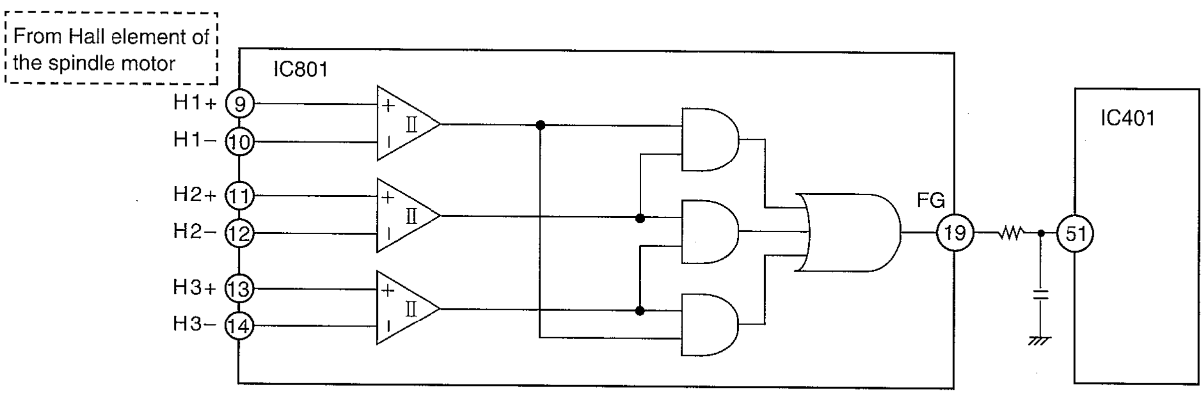
6.4 Spindle servo circuit

In addition to EFM-CLV like the CD, spindle motor control is effected in three kinds of modes; APIP-CLV to be used for rotary control in a group, access, and FG servo to be used for automatic adjustment.
The EFM signal and the ADIP signal are generated in the RF AMP, and the respective rotation sync signals are generated in IC401. Using various CPU commands, control is effected for rotation locks, such as EFM, ADIP, FG, etc. In the case of FG, the goal rpm number is set up to obtain a servo output.



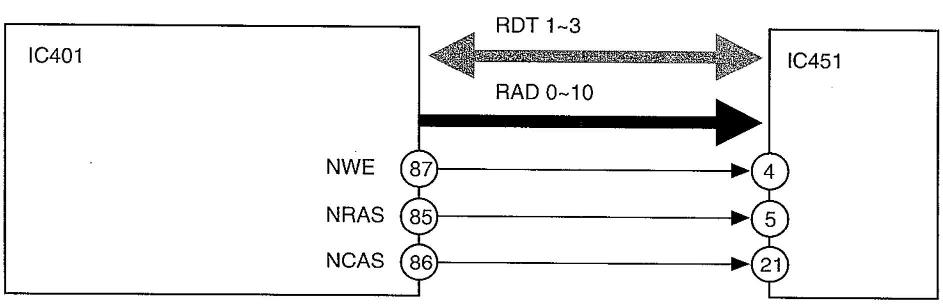
6.5 FG signal generator circuit

The three Hall sensor outputs of the motor entered from the input terminal of the motor driving IC801 are received at the comparator, where processing of addition is carried out. The resultant output is generated from Pin 19 as an FG signal.



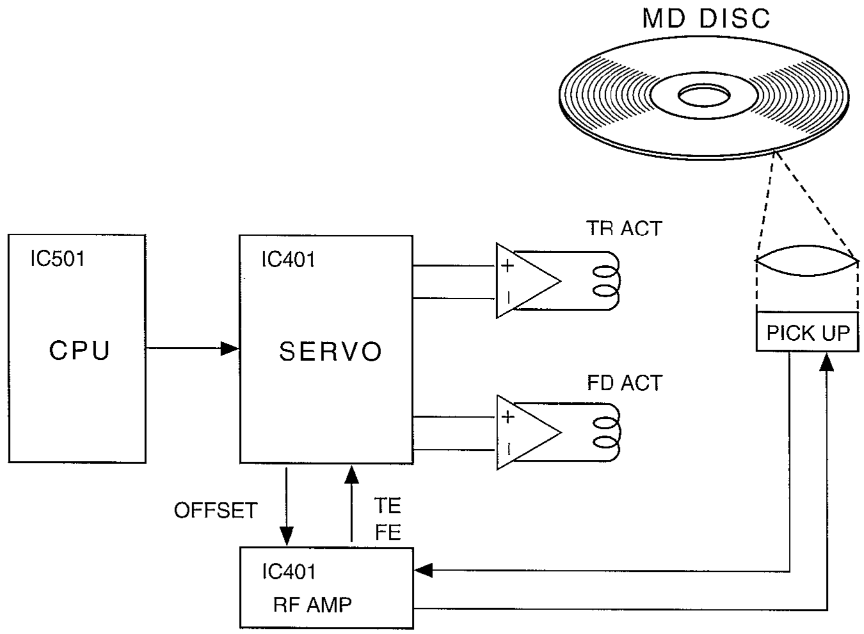
6.6 Memory controller circuit

To avoid unwanted sound skip, the MD uses a system to store the data temporarily in the IC memory. In the MD, data readout and replay are conducted at the rate of 1.4Mbits per second.
From the optical pickup, data are flowing into the memory at the rate of 1.4Mbits per second. However, since the data flow from the memory is only 0.3 Mbits per second, the surplus amount of data can be stored in the memory. Therefore, even though the optical pickup gets out of its normal tracking, sound skip can be avoided, provided that data readout is restarted before the data memory empties.
By RAM control from IC401, optical pickup data are written in and read out of IC451.



6.7 Outline description of automatic adjustments

As seen from the system CPU, the respective adjustments can roughly be classified into two categories.
One is the adjustment intended to regulate the RF AMP outputs to regular values. The other is the adjustment to be performed by the adjusting functions possessed by the servo signal processing IC. Automatic adjustments are effected in the middle of a series of servo buildup operation. In the MD system, two types of discs are used — the replay-only ROM disc and the recordable MO disc. The latter MO disc has the two different data planes of PIT (TOC recording part) and the groove block (recordable part). Therefore, it is necessary to make adjustments according to the type of the part where data are read out.



6.8 Adjusting items and outline description

1) **Analog offset adjustment**
The circuit offset of the FE and TF signals is compensated for within ±60mV.

2) **Digital offset adjustment**
The above-mentioned offset is compensated for within ±20mV by the use of the digital servo.

3) **AS adjustment**
To obtain a proper AS (total amount of light), the signal level is adjusted to 600mV ± 3dB and rough adjustment is also conducted for the FE gain.

4) **Rough adjustment of tracking gain**
The amplitude of the error (TE) signal is adjusted to approximately 1.6Vp-p.

5) **Tracking balance adjustment**
The tracking balance is adjusted within 0.6dB.

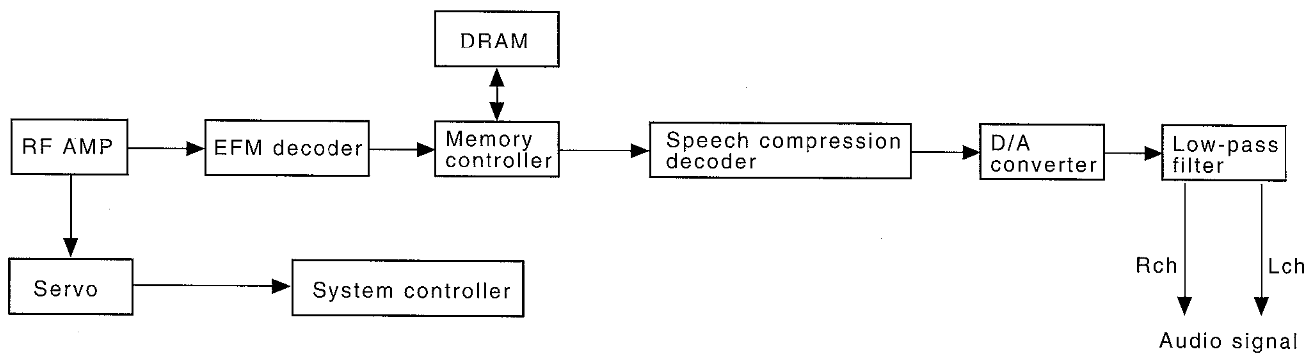
6) **Fine adjustment of AS gain**
The AS signal level is adjusted to 600mV ± 1.2dB and fine adjustment is also conducted for the FE gain.

7) **Focus balance adjustment**
To reduce the jitter and the error rate by setting up the focus at the just focus point, the focus balance amplifier is compensated until the EFM-3T signal amounts to the maximum value.

8) **Loop gain adjustment (Cyclic adjustments)**
To improve the servo stability and cancel the dispersion in actuators, cyclic adjustments are carried out. A turbulence signal is injected in the focus and tracking servo loops in order to compensate for the sensitivity dispersion in actuators.

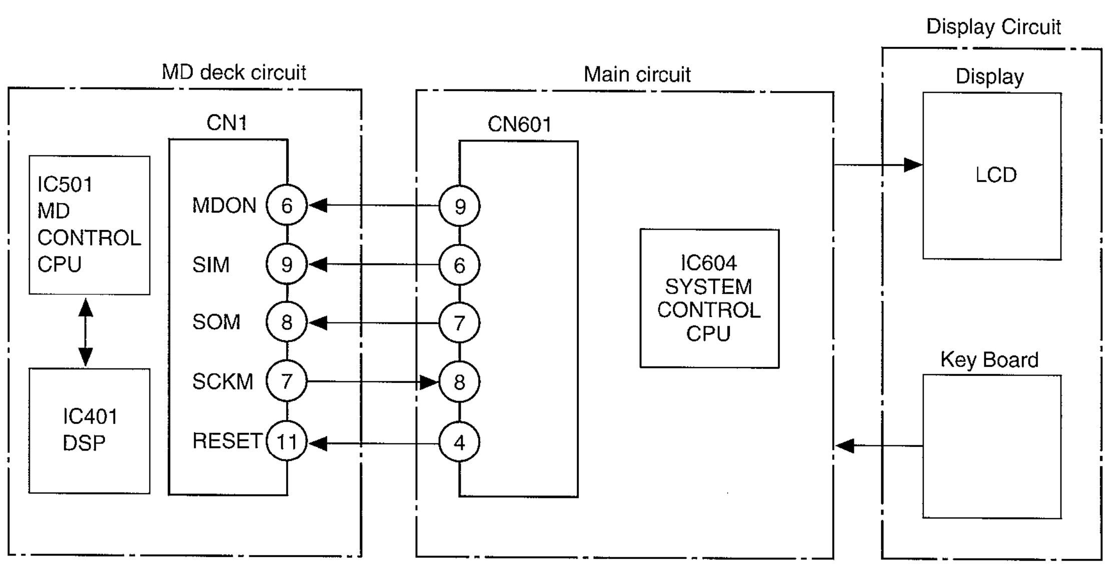
6.9 Signal flow from RF to audio signals

The RF signal output is obtained through the addition (pit) or subtraction (groove) of the two RF signals from the optical pickup. The resultant signal input is entered in the RF amplifier. After amplification and EFM modulation, the signal is entered in the signal processing LSI to process the signal (EFM modulation/demodulation, error correction parity coding, MD decoding). These data (digital signal) are compressed and recorded in the DSP. The recorded data are expanded and read out, and converted into the analog signal by the D/A converter. After passing through the low-pass filter, the signal is output as an audio signal.



6.10 Interface (CPU communication)

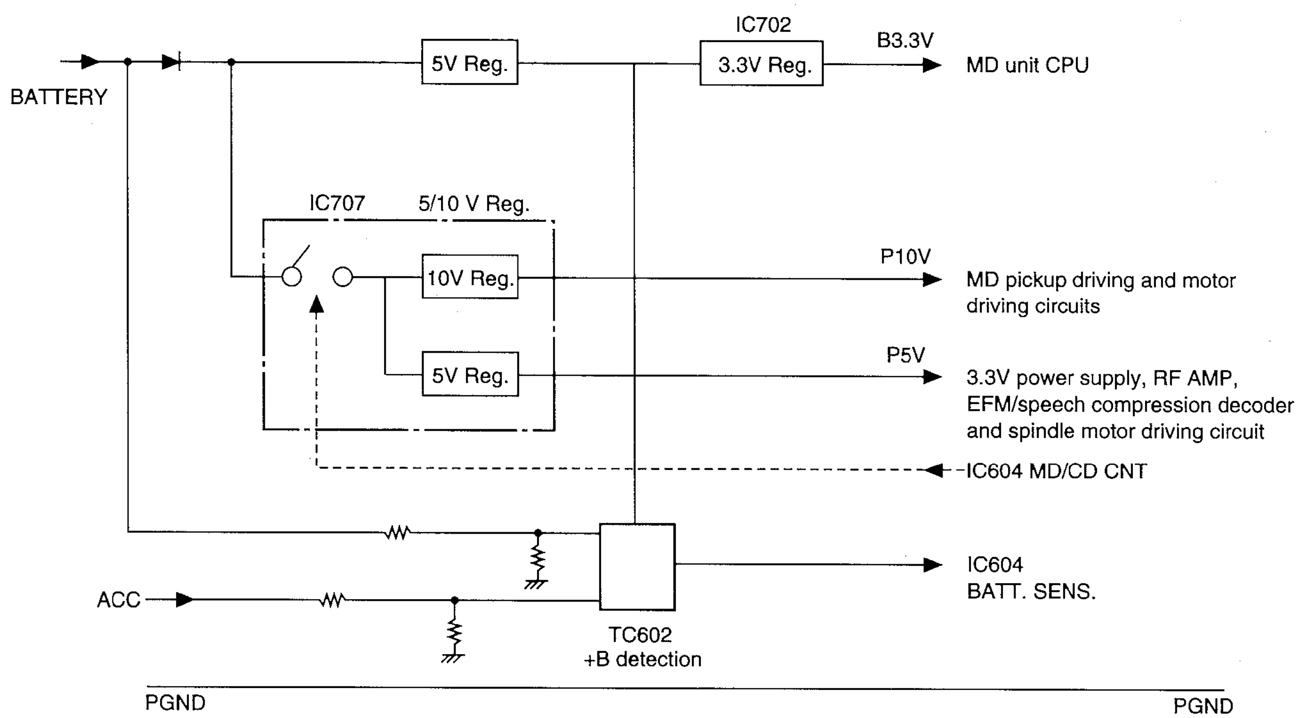
1) Serial communication with the CPU is carried out by the use of SIM, SOM, and SCLK.
2) The communication data are output from the MSB. They are the data of 1-byte for 8-clock (8 bytes).
3) The command signal from the keyboard is entered in the microcomputer IC604. According to the command from IC401, the EFM signal processing and servo circuits are further controlled.
   And information (disc No., track No., performance time, etc.) detected by the microcomputer (IC501) is transferred to another microcomputer (IC604).



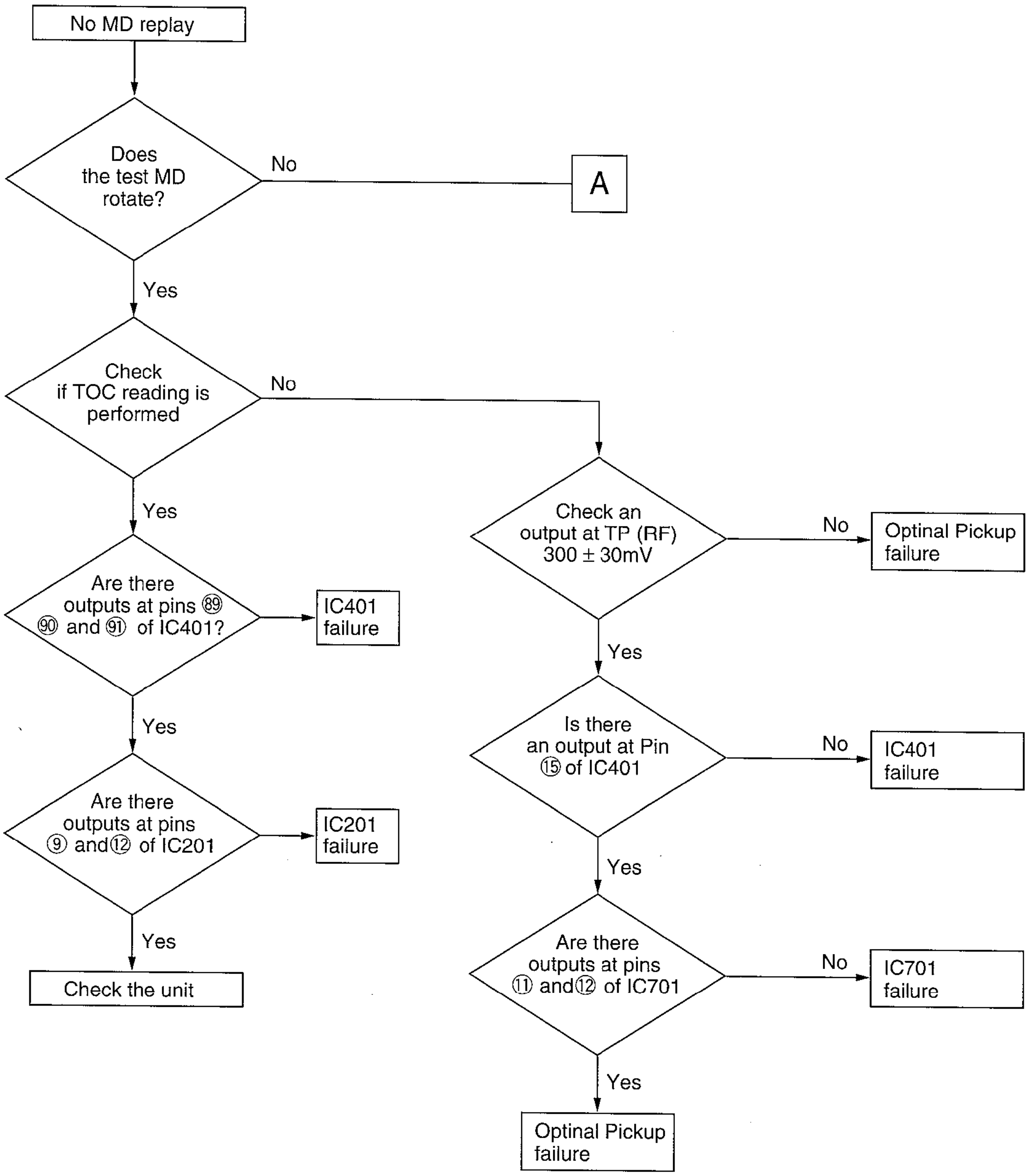
7. Power Supply Circuit

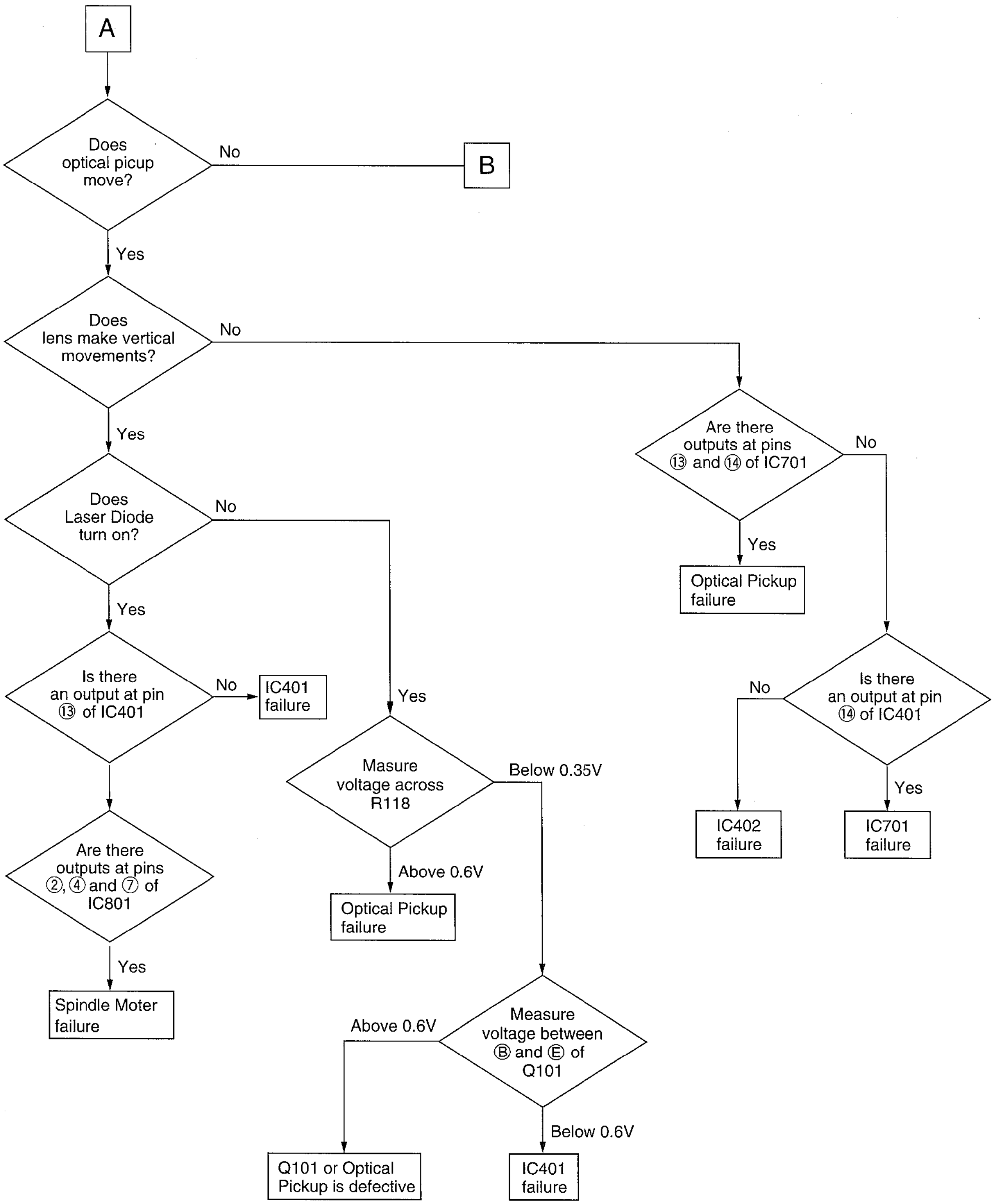
Each power supply circuit on the MD deck side is shown below.

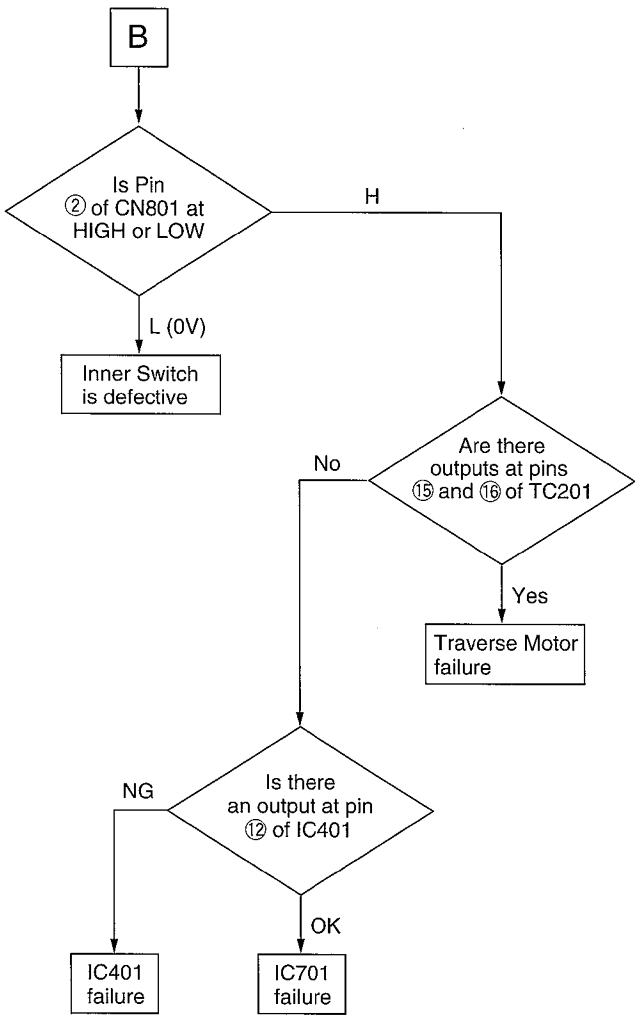
1) B 3.3V : To be fed to the MD unit CPU.
2) P 10V : To be fed to the MD pickup driving and motor driving circuits.
3) P 5V : To be fed to the 3.3V power supply, RF AMP, EFM/speech compression decoder, and spindle motor driving circuit.



8. Troubleshooting Guide (Servo Circuit)




A
Does optical picup move?
No
B
Yes
Does lens make vertical movements?
No
Yes
Are there outputs at pins ⑬ and ⑭ of IC701
No
Yes
Optical Pickup failure
Does Laser Diode turn on?
No
Yes
Is there an output at pin ⑬ of IC401
No
IC401 failure
Yes
Is there an output at pin ⑭ of IC401
No
Yes
IC402 failure
IC701 failure
Masure voltage across R118
Below 0.35V
Above 0.6V
Optical Pickup failure
Are there outputs at pins ②, ④ and ⑦ of IC801
Yes
Spindle Moter failure
Measure voltage between Ⓑ and Ⓔ of Q101
Above 0.6V
Below 0.6V
Q101 or Optical Pickup is defective
IC401 failure


B
Is Pin ② of CN801 at HIGH or LOW
H
L (0V)
Inner Switch is defective
Are there outputs at pins ⑮ and ⑯ of TC201
No
Yes
Traverse Motor failure
Is there an output at pin ⑫ of IC401
NG
OK
IC401 failure
IC701 failure